DERİM

The effects of inter-row spacings on yield, yield components and oil ratio of winter canola (*Brassica napus* L.)

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Abstract

The aim of this research was to investigate the effect of different inter-row spacing on yield, yield components and oil ratio of canola. Experiments were established in the trial site of the Department of Field Crops, Faculty of Agriculture, Harran University in randomized complete block design with 3 replications in 2011-2012 and 2012-2013 growing seasons. Licord cultivar, which is known as winter type, was used in the experiment. In the experiment, the plots consisted of 5 rows with 6 m length, inter-row spaces were 10, 20, 30, 40, 50, 60 and 70 cm, and intra-row space was 5 cm. Seed yield (kg ha^{-1}), plant height (cm), number of branches (plant^{-1}), number of pods (plant^{-1}), number of seeds (pod^{-1}), 1000 seed weight (g), oil ratio (%), number of flowering days (day) and number of maturation days (day) were examined. In the results of the study; it was observed that in case of inter-row spaces of 60 and 70 cm, increased the seed yield decreased; the plant height decreased with the increases of the inter-row spacing; number of branches per plant, number of pods per plant, number of seeds per pod; and 1000 seed weight increased with the increases of the inter-row spacing. The effects of inter-row spacing on the oil ratio, number of flowering days and number of maturation days were limited in two years of the trial. Consequently, it can be recommended the most suitable inter-row spacing is 20 cm for canola cultivation.

Keywords: Canola; Inter-row; Yield; Yield components; Oil ratio

Sıra arası mesafelerinin kışlık kanola *(Brassica* napus L.)'da verim, verim unsurları ve yağ oranına etkisi

Öz

Bu araştırma farklı sıra arası mesafelerinin kanolada verim, verim unsurları ve yağ oranına etkisini araştırmak amacıyla yapılmıştır. Deneme, 2011-2012 ve 2012-2013 yetiştirme sezonlarında Harran Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü'nün araştırma alanında tesadüf blokları deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Denemede kışlık olarak bilinen Licord çeşidi kullanılmıştır. Denemede parseller 6 m uzunluğunda 5 sıralı, sıra araları 10, 20, 30, 40, 50, 60 ve 70 cm, sıra üzeri mesafesi ise 5 cm olarak oluşturulmuştur. Denemede dekara tohum verimi (kg da^{-1}), bitki boyu (cm), yan dal sayısı (adet bitki^{-1}), harnup sayısı (adet bitki^{-1}), harnupta tane sayısı (adet harnup^{-1}), 1000 tohum ağırlığı (g), yağ oranı (%), çiçeklenme gün sayısı (gün) ve olgunlaşma gün sayısı (gün) incelenmiştir. Çalışma sonucunda; her iki deneme yılında da sıra aralığının artmasıyla (60 ve 70 cm) dekara verimin düştüğü; sıra aralığının azalmasıyla bitki boyunun arttığı, geniş sıra aralığında ise bitki boyunun kısaldığı; sıra aralığının genişlemesiyle yan dal sayısının, bitkide harnup sayısının, harnupta tane sayısının, 1000 tohum ağırlığının arttığı; yağ oranı, çiçeklenme gün sayısı ve olgunlaşma gün sayısına etkisinin ise sınırlı olduğu ve kanola yetiştiriciliğinde en uygun sıra arası mesafesinin 20 cm olduğu saptanmıştır.

Anahtar Kelimeler: Kolza; Sıra arası; Verim; Verim unsurları, Yağ oranı

1. Introduction

Canola is one of the most important oil plants grown in the world. Canola is used in many agricultural and industrial enterprises. It is a plant that can be used to supply the rough feed requirements of livestock as green herbage and silage (Aytaç, 2007). After the removal of oil from the rapeseed, the remained oil cake contains 33-44% protein (Doğan and Zincirlioğlu, 1982). In addition, rapeseed is a valuable plant for the beekeepers and attracts honey bees by the early spring yellow flowers with pollen and nectar source (Aytaç, 2007). Furthermore, its oil is rich in oil acids as well as oleic acid and omega-3, which is very important for human health and its limits within the level of human health in terms of unsaturated oil acids

(Carvalho et al., 2006; Aytaç, 2007). 84% of the total oil used to produce biodiesel in the world is obtained from canola (Tickel, 2000; Aytaç, 2007) and in this respect, canola has a great importance.

Canola oil contains the most unsaturated oil content in the existing vegetable oils. Particularly high content of oleic acid and linoleic acid ratio more than 20% indicates good quality as edible. This oil is good frying oil with a high boiling point (238°C), It is rich in vitamin E and therefore it is a high quality edible oil. Oil industry that is based on sunflower in Turkey generally is not adequate to meet the demand. Crops such as soybean, peanut, poppy and canola can be recommended to close the oil deficit. However, if soybean byproducts are evaluated with an integrated production it will be economical, due to the oil ratio is lower than other oil plants it would not be economical to grow only for oil production, and it is difficult to produce due to poppy cultivation is subject to permission and peanut has no mechanization. However, adaptation to climate and soil conditions, with the convenience to the crop rotation, canola has a great advantage when compared to other oil plants in closing the deficit of oil (Kaya, 1996). The optimum number of plants per unit area is one of the most important agricultural factors determining the yield and yield components. Row spacing is an important agricultural factor and has a great effect on the seed yield and yield components of plants (Diepenbrock, 2000). It has been reported that adequate row spacing to help to use the available resources such as water, light and plant nutrients in winter varieties (Morteza et al., 2008).

In general, the most suitable environment for plant growth and adequate space should be provided to the amount of seeds sown (Algan, 1985). It was reported that seed yield increased with the increases of plant density (Aytaç, 2007); plant density to be an important management factor affecting seed yield (López-Bellido et al., 2005; Ciampitti and Vyn, 2013). Increasing the structure of the sunlight by penetrating to the lower part of the canopy is a way of increasing yield (Reta-Sanches and Fowler, 2002). James and Anderson (1994), asserted that the increased number of pod per square meter rose the yield due to upwards of the plant density. Many studies have on the density of sowing in canola. Morrison et al. (1990), in a research the different sowing rates used with 15 and 30 cm inter-row spaces; it was reported that the narrow inter-row spaces increased the number of pod per plant and seed yield and reduced lodging rate and the differences between inter-row applications was insignificant in terms of protein and oil ratio. Öz (2002), in a research conducted by using four different sowing densities (50x5, 50x10, 50x15, 50x20 cm); the effects of sowing density and cultivar were significant on the plant height, number of branches per plant, number of pod per plant, 1000 seed weight and seed yield, and on the number of seeds per plant was insignificant. While the highest seed yield was obtained from the 50x15 cm plant density, and the lowest seed yield from the 50x5 cm.

Başalma (2006) reported in a research with 3 different applications (15x10, 30x10 and 45x10 cm) applied; the highest seed yield was obtained from the 35x10 cm and the lowest seed yield from the 45x10 cm. Farsak (2009) reported in a research with 3 different inter-row spaces (13, 26 and 39 cm) and 4 canola cultivars used; different inter-row spaces had significant effects on the plant height, number of lateral branches per plant, number of pods per plant, number of seeds per pod and seed yield. The highest value in terms of seed yield was obtained from the 13 cm inter-row space in all four cultivars, and the lowest seed yield was obtained from the 39 cm inter-row space.

Mousavi et al. (2011) in a research conducted the effects of sowing density on some agricultural characteristics of winter canola varieties; the plant height, stem diameter and seed yield were significantly affected from the sowing densities. Seed yield increased from 1983 kg ha^{-1} to 2211 kg ha^{-1} whilst inter-row spaces upwards from 30 to 50 cm. Uzun et al. (2012) in the research of the effects of inter-row and intra-row spaces on the yield and yield components; the highest seed yield was obtained from the inter-row space of 10 cm and intra-row space of 5-10 cm, and the number of branches per plant, number pod per plant and number of seeds per pod to be adversely affected from the narrow inter-row spaces. Al-Doori (2013) in a study with 3 different plant densities (29629, 44444 and 88888 plant ha^{-1}) applied; it was reported that the highest seed yield, 1000 seed weight, number of pods per plant, number of seeds per pod, number of branches per plant and oil ratio were obtained from the 29629 plant ha^{-1} plant density and the plant height from the 88 888 plant ha^{-1}. The aim of this study was to determine the effect of inter-row spacing on yield, yield components and oil ratio in canola plant.

2. Material and Methods

In this study, Licord cultivar (winter) was used as a material which was obtained from the Çimsan Agricultural Products Trade Limited Company.

The some physical and chemical properties of trial site were given in Table 1. The soil texture is clay and the lime content is very high. In addition, the pH is slightly alkaline.

In the 2011-2012 growing season, the average temperature was 13.6°C and the maximum temperature was 30.6°C, while in the 2012-2013 growing season the average temperature was 15.31°C and the maximum temperature was 29.0°C (Table 2).

Experiments were established in the trial field of Department of Field Crops, Faculty of Agriculture, Harran University according to the randomized complete block design with 3 replications in 2011-2012 and 2012-2013 growing seasons. In the experiment, each plot was designed 6 m in length with 5 rows and while inter-rows spaces were 10, 20, 30, 40, 50, 60 and 70 cm and intra-rows space was 5 cm. Sowings were done by hand in the form of 2 seeds per one seedbed on November 8, 2011 and November 22, 2012. After the emergence, plants were thinned in stage of 3-4 leaves (Jenkins and Leitch, 1986). Fertilizer was applied manually into neighboring rows which located 5-6 cm apart and depth from canola sown rows. Super phosphate fertilizer was applied in the quantity of pure 80 kg phosphorus per hectare as basal. Half of the nitrogen (pure N 60 kg ha^{-1}) was applied in the form of Ammonium sulphate (21%) and the remained half in the form of Ammonium nitrate (33%) at the branching phase.

Table 1. Some physical and chemical properties of trial site (Anonymous, 2012)

Soil properties	
Soil depth (cm)	0-20
Organic matter (%)	1.13
EC (%)	0.087
pH	7.7
Lime (%)	5.5
P_2O_5 (kg da^{-1})	3.6
K_2O (kg da^{-1})	9.0
Fe (ppm)	2.17
Zn (ppm)	0.38
Texture	
Sand (%)	24.56
Clay (%)	53.34
Silt (%)	1.90

Table 2. Average meteorological data for the experimental years (November-June, Anonymous, 2013)

	2011-2012			2012-2013			1929-2013
Months	Monthly avg. temperature (°C)	Rainfall (kgm^{-2})	Relative humidity (%)	Monthly avg. temperature (°C)	Rainfall (kgm^{-2})	Relative humidity (%)	Average of long terms (°C)
November	9.4	62.1	53.7	14.9	68.4	65.6	12.9
December	7.4	47.1	57.4	8.3	142.8	73.0	7.5
January	5.5	170.9	81.0	6.8	86.8	69.5	5.4
February	5.8	95.8	57.0	9.3	107.2	73.6	6.8
March	9.7	35.8	47.3	12.9	12.1	-	10.7
April	19.3	23.3	42.4	18.4	18.0	44.9	16.0
May	22.4	42.3	40.8	22.9	56.2	43.4	22.1
June	30.6	5.8	21.2	29.0	-	24.0	28.0
Average	13.76	-	43.39	15.31	-	49.25	13.67
Total	-	483.1	-	-	491.25	-	-

Crops at the maturity period were harvested with a hedge shears at the level of soil on June 5-12, 2012 in the first year of the experiment and on June 9-14, 2013 in the second year. 3 rows in the middle of each plot were harvested, 0.5 m at the beginning and end of each plot and 2 edge rows put away to eliminate side effects.

Ten plants were randomly selected from each plot and the plant height, number of lateral branches, number of pods per plant, number of seeds per pod and 1000 seed weight were calculated from these selected plants (Öğütçü, 1979). The number of flowering days were calculated as sowing time to the first flowers appear in each parcel (Chay and Thurling, 1989) and the number of maturation days was decided as 80 % of the pods were large, spherical and blackish colored on the plants (Schular et al., 1992). Oil ratios were determined by hexzan extraction in soxhelet device. The data obtained from the experiment were analyzed by using the JMP 11 (SAS, 2013) statistical software and analysis of variance was performed according to the randomized complete block design and the means were grouped by the Tukey ($p \leq 0.05$) test.

3. Results and Discussion

In the analysis of variance (ANOVA) according to the combined years of the properties examined in the trial, statistically differences were found between years. Therefore, the results of each year were analyzed separately. F values obtained from the analysis of variance of the traits in the experiment were given in Table 3.

3.1. Seed yield

Significant differences were found between the inter-row spacing in terms of seed yield. The highest seed yield was obtained from the 10 cm (1916.3 kg ha^{-1}) and 20 cm inter-row spaces (1973.3 kg ha^{-1}) in the first year of the experiment, from the 20 cm inter-row space (1874.6 kg ha^{-1}) in the second year. In the two years of the experiment, the seed yield decreased with the increase of inter-row spaces (60 and 70 cm) (Table 4). By broaden inter-row spaces the seed yield per plant increased, but the yield per unit area decreased. Öztürk (2000); Başalma (2006); Aytaç (2007); Shanin and Valiollah (2009); Farsak and Kaynak (2010) and Mousavi et al. (2011) indicated in their studies that as the inter-row spaces decreased the plant density per unit area increased and thus the seed yield went up, and the highest seed yield was obtained from the inter-row spacing of 18 cm (Scott et al., 2013) confirmed the results of our research. Al-Doori (2013) indicated in his study that the highest seed yield was obtained from the lowest plant density (29629 plant ha^{-1}) was incompatible with our result. The differences between researches might have been caused by different genetic structure of varieties and environmental factors (Sarwar, 2008).

3.2. Plant height

In the first year of the experiment 10 cm (148.16 cm), in the second year 10 cm (142.86 cm) inter-row spaces created the highest plant height. In the two years of the experiment, it was observed that the plant height increased with the narrow inter-row spaces, and the plant heights became shorter in the broad inter-row spaces (Table 4). Farsak (2009) showed that the plant height decreased as the inter-row spaces expanded; Ozoni Davaji et al. (2007) reported that Gibberellin hormone contributed to increase the internodes length, plant height and decrease in the number of branches; Naseri (2012) reported that the plant height increased with increases of plant density, and plant height was affected from the growth of nodes due to the production of Gibberellin hormone under open conditions; Al-Doori (2013) indicated that the increased plant height was due to increases of plant density, which was consistent with our results; Shanin and Valiollah (2009) reported that plant height was not affected from the inter-row spacing, which was not consistent with our results.

3.3. Number of branches

While 50 cm and 70 cm inter-row spaces (4.33 per plant) formed the highest number of branches in the first year of the experiment, 40 cm, 50 cm (4.30 per plant), 60 cm and 70 cm (4.33 per plant) inter-row spaces formed in the second year. When Table 4 was examined, it was seen that the number of branches increased with the expansion of the inter-row spacing.

Table 3. Statistical significance (F) of some traits in the ANOVA

Examined properties	F values	
	2011-2012	2012-2013
Seed yield	316.72**	439.99**
Plant height	5.34**	41.76**
Number of branches per plant	11.61**	9.74**
Number of pods per plant	87.02**	102.92**
Seed numbers per pod	3.51 ns	4.11 ns
1000 seed weight	57.46**	7.78**
Oil ratio	0.66 ns	2.76 ns
Number of flowering days	2.22 ns	12.38**
Number of maturation days	0.96 ns	3.11*

*: p<0.05 **: (p<0.01) ns: non-significant

Table 4. The effect of inter-row spacing on seed yield (kg ha^{-1}), plant height (cm) and number of branches (per plant) of canola

Inter row spacing	Seed yield (kg ha^{-1})		Plant height (cm)		Number of branches (per plant)	
	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
10 cm	1916.3 a*	1736.3 b*	148.16 a*	142.86 a*	3.86 c*	4.03 b*
20 cm	1973.3 a	1874.6 a	141.60 ab	140.20 ab	4.24 ab	4.23 ab
30 cm	1201.3 b	1393.3 c	139.06 ab	136.10 bc	4.06 bc	4.03 b
40 cm	1111.3 b	1231.3 d	139.43 ab	132.50 cd	4.13 ab	4.30 a
50 cm	911.3 c	1014.0 e	135.56 b	136.50 bc	4.33 a	4.30 a
60 cm	682.0 d	709.6 f	136.43 b	125.06 e	4.26 ab	4.33 a
70 cm	736.3 d	714.3 f	132.06 b	129.40 de	4.33 a	4.33 a
CV %	14.60	16.93	1.66	4.80	8.17	7.39

*Means in each column followed by the same letter are not significantly different (p>0.05), ns: non-significant

Patil and Rajant (1978) reported that the effect of inter-row spacing on seed yield changed significantly due to climatic conditions, and the number of branches per plant increased in accordance with the increase of inter-row spacing's.

Fathi (2008) remarked that the plant density caused more stimulation at the apical meristems than lateral meristems, and slowed down the plant growth and branches; Naseri (2012) showed that the increased plant density decreases the light penetrating into the lower parts, and consequently auxin hormone stimulates apical meristems and reduces branching; Farsak and Kaynak (2010) indicated that the number of branches per plant increased with the increases of the inter-row spacing is comply with our study results. Al-Doori (2013), the lowest plant density (29629 plant ha^{-1}) created the highest number of branches is not comply.

3.4. Number of pods

It was seen that the number of pods per plant increased with the increase of inter-row spaces (70 cm) in the two years of the experiment (Table 5). 40, 50, 60 and 70 cm inter-row spaces created the highest number of pods in the first year of the experiment, 70 cm (186.18 per plant) inter-row spaces in the second year. When table 5 was examined, the number of pods increased in line with increase of inter-row spaces. Leach et al. (1999) reported that the number of pods per branch decreased due to increases of plant density, these contributing to the reduction of micro-climate area and not using of environmental factors. In case of 80 plants per square meter, canola plant did not get enough sunlight and caused decrease in the number of pods per plant. Plant density increased shading and decreased the number of flowers per branch, and thus the number of pods per plant decreased (Farsak and Kaynak, 2010; Naseri, 2012).

3.5. Number of seeds

While 50 cm (28.43 per pod) and 70 cm (28.50 per pod) row spaces created the highest number of seeds in the first year of the experiment, 30 cm (27.00 per pod), 40 cm (25.93 per pod), 50 cm (26.83 per pod) and 60 cm (26.63 per pod) formed in the same group and created the highest number of seeds in the second year (Table 5).

Table 5. The effect of inter-row spacing on number of pods (per plant), number of seeds (per pod) and 1000 seed weight (g) obtained from different inter-row spacing and CV (%)

Inter row spacing	Number of pods per plant		Number of seeds per pod		1000 Seed weight (g)	
	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
10 cm	142.30 b*	132.03 d*	24.10 ns	23.16 ns	3.14 cd*	3.18 c*
20 cm	144.35 b	140.13 cd	25.03	23.30	3.08 d	3.29 bc
30 cm	150.96 b	148.76 c	25.93	27.00	3.22 c	3.32 bc
40 cm	180.87 a	176.40 ab	27.53	25.93	3.48 ab	3.39 ab
50 cm	186.72 a	174.10 b	28.43	26.83	3.52 a	3.38 ab
60 cm	192.72 a	183.33 ab	27.30	26.63	3.37 b	3.51 a
70 cm	192.97 a	186.18 a	28.50	25.10	3.60 a	3.42 ab
CV %	5.48	6.22	7.02	7.97	2.26	8.36

*Means in each column followed by the same letter are not significantly different (p>0.05), ns: non-significant

Table 6. The effect of inter-row spacing on oil ratio (%), number of flowering days and number of maturation days obtained from different row spacing and CV (%)

Inter row spacing	Oil ratio (%)		Number of flowering days		Number of maturation days	
	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
10 cm	39.43 ns	39.66 ns	169 ns	165 a*	213 ns	208 a*
20 cm	39.66	39.40	166	158 b	213	208 a
30 cm	39.86	39.26	167	159 b	212	207 ab
40 cm	40.06	39.16	165	157 b	212	207 ab
50 cm	39.83	39.83	165	157 b	212	207 ab
60 cm	40.13	39.26	167	159 b	213	206 ab
70 cm	39.63	39.36	166	158 b	211	204 b
CV %	2.04	4.21	0.89	2.21	0.46	0.85

*Means in each column followed by the same letter are not significantly different (p>0.05), ns: non-significant

Naseri (2012) reported that 60 plants per square meter were more favorable for nutrition conditions such as light and air for the plant and decreased competition, and plant density (80 plant m^{-2}) increased specific competition is compliance with our study results. Shanin and Valiollah (2009); Farsak and Kaynak, (2010) showed that the number of seeds were not affected from the inter-row spacing is not compliance.

3.6. 1000 seed weight

In the first year of the experiment the highest 1000 seed weight was obtained from the inter-row spacing of 50 cm (3.52 g) and 70 cm (3.60 g) and from the inter-row spacing of 60 cm (3.51 g) in the second year. When Table 5 was examined, it was seen that 1000 seed weight increased as inter-row spaces moves from the narrow to broad inter-row spacing. Naseri (2012) indicated in a research that in case the plant density increased the 1000 seed weight decreased due to competition of photosynthetic phenomena in the filling regions. Seed formation time shortened, as a result it would not turn into seeds and 1000 seed weight decreased was comply with our study results; Shanin and Valiollah (2009); Farsak and Kaynak (2010) indicated that 1000 seed weight was not affected from the inter-row spacing was not comply.

3.7. Oil ratio

The first year of the trial was statistically insignificant, 50 cm inter-row space created the highest oil ratio (39.83%) in the second year. When the two years of the study were examined, the oil ratio has shown changes between 39.16-40.13%. This can be said that the canola plant was not affected from the inter-row spacing in terms of oil ratio (Table 6). Morrison et al. (1990); Leach et al. (1999); Farsak (2009); Farsak and Kaynak (2010) indicated in their studies the oil ratio was not affected by inter-row spacing was consistent with our study results. Shrief et al. (1990) found that the high density created high values in oil yield; Chauhan et al. (1992) and Oad et al. (2001) found that broad inter-row spaces created the highest oil ratio was incompatibility with our result results.

3.8. Number of flowering days

In each trial year, 10 cm row space (169 days and 165 days) arrived at the latest flowering in terms of the number of flowering days. The number of flowering days was 165-169 days in

Table 7. Correlation coefficients between examined properties

	1	2	3	4	5	6	7	8
2	-0.733**	1.000						
3	-0.561**	-0.616**	1.000					
4	0.909**	-0.668**	0.619**	1.000				
5	0.609**	-0.409**	0.289 ns	0.641**	1.000			
6	0.798**	-0.634**	0.598*	0.828**	0.561**	1.000		
7	-0.134 ns	0.145**	0.071 ns	0.131ns	0.115 ns	0.050 ns	1.000	
8	0.162 ns	0.500**	-0.408**	-0.120 ns	0.079 ns	-0.277 ns	0.377*	1.000
9	0.213 ns	0.538**	-0.298 ns	-0.053 ns	0.167 ns	-0.183 ns	0.422**	0.794**

1: Seed yield, 2: Plant height, 3: Number of branches per plant, 4: Number of pods per plant, 5: Number seeds per pod, 6: 1000 Seed weight, 7: Oil ratio, 8: Number of flowering days, 9: Number of maturation days

*: P≤0.05, **: P≤0.01, ns: non-significant

the first year of the experiment and 157-165 days in the second year. In the inter-row spacing application, the difference in the first year was 4 days and in the second year was 8 days. The difference between years may have been due to the different response of the plants to the plant density and temperature, which is one of the climatic factors. When table 2 is examined, the average temperature was seen high in the second year of the experiment. When the results were examined, the values were similar in the two years of the experiment (Table 6). The results of our study are consistent with the results of Epirtürk (2009) (161.3-177.8 days); higher than the results of Tan (2007) (98-116 days); Ahmadi et al. (2014), (87.94-101.27 days); and lower than the result of Coşgun (2013) (206.0-215.7 days).

3.9. Number of maturation days

The first year of the trial was statistically insignificant in terms of the number of maturation days and the plants come to harvest between 211-213 days. 70 cm inter-row space was matured at the earliest (204 days) in the second year (Table 6). There was 2 days difference in the first year of the experiment, 4 days in the second year. When the results were evaluated, it could be said that there was no significant effect of inter-row spaces. Bilal et al. (2015) indicated in his study that the number of maturation days (186.64-212.90) was coincide with our study results; Tan, 2007 (149-163 days); Öz (2013) (164.3-171 days) results were lower than our results; Coşgun (2013) (279.3-282.7 days) was found to be higher.

3.10. Correlation coefficients

In this study the winter canola cultivars were grown at different inter-row spaces; significant and positive relationships were found between seed yield and number of pods (0.909**), number of seeds per pod (0.609**) and 1000 seed weight (0.798**). And also; significant and positive relationships were found between plant height and oil ratio (0.145**), number of flowering days (0.500**) and number of maturation days (0.538**); and between number of branches and number of pods (0.619**), 1000 seed weight (0.598*); and between number of pods and 1000 seed weight (0.561**); and between oil ratio and number of flowering days (0.377*), number of maturation days (0.422**); and between number of flowering days and number of maturation days (0.794**) (Table 7).

4. Conclusion

As a result of the study, it cannot be recommended the broad inter-row spacing in the canola cultivation and the most suitable inter-row spacing is 20 cm. However, due to the various environmental and climatic conditions of targeting regions, the cultivars grown in these areas could have various agricultural properties. Therefore, these types of studies are recommended to be carried on in various canola growing locations.

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