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Effects of Row Spacing and Weed Control Duration on Yield, Yield Components and Oil Content of Canola

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ABSTRACT

In order to study the effects of row spacing and weed control duration on yield, yield components and oil content of canola, a factorial experiment was conducted using randomized complete block design with 3 replications. The factors comprised row spacing at 2 levels (25 and 35 centimeter) and weed control 4, 8 leaf stages and formation of flower buds. Weeds were permitted to grow by the crop after the above mentioned growth stages. Two check treatments as control, including weedy and weed free were also selected. Evaluated traits were number of pods.plant^{-1}, number of grains.pod^{-1}, 1000-grain weight, grain yield, oil content and oil yield. Results showed that different row spacing had significant effect on all traits except oil content. Increase in row spacing was significantly accompanied by increase in pod number.plant^{-1} and 1000-grain weight. Other traits were significantly decreased with increasing row spacing. In addition, increase in weed control duration resulted in significant increase in all traits except oil content. The interaction of row spacing × weed control duration was also significant for all traits except 1000-grain weight and oil content. Based on the results, the highest values of grain and oil yield were related to 25 centimeter row spacing on total weed free check and the lowest amounts of these traits were obtained from 35 centimeter row spacing on weedy check treatment.

Key words: row spacing, weed control duration, grain yield, oil content, canola

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INTRODUCTION

Canola (*Brassica napus* L.) is the third largest oilseed crop production, after soybean and palm producing as much as 14.7% of total vegetable edible oil in the world (Yasari *et al*., 2008).

It is well known that weeds interference with crop plants causes serious impacts either in the competition for light, water, nutrients and space or in the allelopathy. Canola as a slow growing crop is particularly exposed to severe competition by weeds. Faster growth of weeds is disadvantageous for light and hence photosynthesis needed for rapeseed plants. Through this light deprivation, a less energy is available to crop plant for metabolic production and hence growth, yield and its quality of rapeseed plant will be reduced. In addition, weeds with branched, vigorous root systems inhibit the development of canola plant through severe nutrition deprivation (Roshdy *et al*., 2008). Duration of weed interference is one of the effective factors on weed-crop competition. Weed interference with crops is not similar in various growth and development stages; therefore, weed-crop competition capability is different in their life cycle (Tollenaar *et al*., 1994). Reduction of weed interference and increase in control durations causes increase in yield and yield components. Aghaalikhani and Yaghoobi, (2008) reported that yield of canola increased with increasing the weed control duration. (Hamzei *et al*., 2007) found that grain and oil yield of canola were increased significantly by increasing length of weed-free period. Roshdy *et al*., 2008 also expressed that yield and yield components of canola were increased in weed control treatments, but oil content was not affected.

Row spacing or density is one of the most important management factors indicating amount of radiation intercepted per plant (Fernando *et al*., 2002). Adjusting row spacing is an important tool to optimize crop growth and the time required for canopy closure, along with maximum biomass and grain yield (Ball *et al*., 2000; Turgut *et al*., 2005; Svecnjak *et al*., 2006; Haddadchi & Gerivani, 2009). Some investigations concluded that narrow row spacing resulted in higher yield than boarder rows. Plants growing in too wide rows may not efficiently utilize the natural resources such as light, water and nutrients, whereas growing in too narrow rows may result in severe inter and intra-row spacing competition (Ali *et al*., 1999). Therefore, it is of crucially important to manipulate the row spacing to increase plant productivity (Yazdifar & Ramea, 2009). Yazdifar & Ramea, 2009 reported that the highest grain yield of canola was obtained at 12 cm row spacing, followed by 7.4% reduction in grain yield as row spacing increased to 24 cm. Ozer, 2003 also expressed that grain yield was significantly affected by spacing within rows, and canola yields were higher at the narrow (15 cm) row spacing compared to the middle (30 cm) and broader (45 cm) spacings.

The objective of this study was to evaluate the effects of row spacing and weed control duration on yield, yield components and oil percent of canola (*Brassica napus* L.).

MATERIALS AND MIETHODS

The experiment was conducted in paddy fields of Rasht Rice Researches Institute (51^o $3^'$ E longitude, 37^o $16^'$ N latitude and an altitude of -7 m below sea level) during 2008-2009. The total annual precipitation in the studied region is 1039 millimeters in the growing season; soil texture was silty clay loam with pH of 6.7 with approximately 1.63% organic matter. The experimental design was a factorial randomized complete block with 3 replications. The factors comprised row spacing at 2 levels (25 and 35 cm) and weed control duration in 7 levels (including hand weeding until the end of crop emergence (V_C) along with 2, 4, 8 leaf stages (represented as V_2, V_4, V_8, respectively) and formation of flower buds (FB)). Weeds were permitted to grow by the crop after the above mentioned growth stages. Two check treatments including weedy and weed free were also selected. In mid-September, the land was plowed with moldboard plow. According to soil and water recommendations by the Rice Research Institute, basic fertilizers including 100 kg.ha^{-1} urea, 150 kg.ha^{-1} ammonium phosphate and 150 kg.ha^{-1} potassium sulphate were added to the soil simultaneously during plowing. The field was subsequently flattened by rotary. Experimental units were created in 2.5×3.5 m dimensions and 0.5 m away from the adjacent experimental units. The blocks were also 2 meters apart from each other. Considering the climate conditions of Rasht and likelihood floodings due to meteoric precipitations, some drainage channels were devised between the blocks and experimental units. Plant density for the 25 and 35 row spacing was 80 and 57 plants.m^{-2} and number of planting rows were 7 and 10 rows for desired row spacing's respectively. The plant spacing on rows was also 5 cm. Seeds were planted in the mid-November 2008 in rows with approximately 1-2 cm deep. The selected canola cultivar was Hyola 401. Topdress urea fertilizer was used as much as 100 kg.ha^{-1} during two stages, exiting from the rosette stage (before stem elongation) and squaring stage (before flowering). Metaldehyde was also used particularly in the early stages of rapeseed growth in order to control the existing snails in the farm. Irrigation is not required due to adequacy of atmospheric precipitations during canola growth stages. Treatments were hand-harvested when 30-40% of the seeds changed their color from green to brown (late May in 25 row spacing and early June in 35). Seed moisture was about 25% at harvest. Following the harvest, plants were remained on the field for 2 days to be dried under sunlight. Seed moisture at this time was about 12%. Subsequently, threshing was done and straws were separated from the seeds. To determine the yield components (including number of pods.plant^{-1} and number of grains.pod^{-1}) 10 plants were selected randomly from each treatment and the traits were measured. Grain yield was determined from 5 m^{-2} of each plot after removing marginal effect. Grain weight was determined by grain counter device. In this way/manner, 1000 grains were selected from each yield sample and weighted. Seed oil content was also determined with the soxhlet apparatus. SAS software v.9 (PROC GLM) was used to analyze the data and mean comparison was determined using the Tukey's multiple range tests (at 1 and 5% levels of probability).

RESULTS AND DISCUSSION

Number of Pods.Plant^{-1}

Results (Table 1) showed that the effect of row spacing and duration of weed control on pods number.plant^{-1} were significant ($P<0.01$, Table 1). In addition, row spacing and weed control duration had an interaction effect on number of pods.plant^{-1}. Weed control duration influenced maximum number of pods.plant^{-1} with the most in the 25 row spacing treatment. In other words, increase in row spacing and increase in weed control duration increased number of pods.plant^{-1}. The highest and lowest number of pods.plant^{-1} were related to the total weed free check in 35 cm row spacing (212.20 pods) and total weedy check in 25 cm row spacing (73 pods), respectively (Table 3).

Increase in row spacing significantly increased the number of pods.plant^{-1}, which shows that this trait, in 25 cm row spacing, was 15.08% lower than 35 cm row spacing (Table 2). This might have been the result of decline in light interception by plant canopy in narrower row spacing. Therefore, initiation of constituent buds on secondary branches declined. The decrease in the number of secondary branches is the main cause of decline in pods number.plant^{-1}. Furthermore, the diminishing carbohydrate supply with exceeding competition among the plants at the flowering time is another reason (Eilkaee & Emam, 2003). This result was consistent with those of (Majnon Hosseini *et al.*, 2006 & Ozer, 2003).

In both row spacing, number of pods.plant^{-1} in control treatments indicated an uptrend with increase in duration of weed-free and reached its highest value in weed-free check. The lowest number of pods.plant^{-1} was also related to weedy check in both row spacing (Table 3). The average of pods number.plant^{-1} in weed-free check in comparison with weedy check indicated an increase of 143.9% (Table 2). The reason for decline in the number of pods.plant^{-1} is increase in the duration of weed interference which can be attributed to the presence of weeds competing with agricultural crops resulting in the diminish of canola competition ability for receiving light and nutrients as well as allocation of less generated materials to the fertile organs. In order to maintain the equilibrium between generated materials of the source and amount of consumed materials in the reservoir, some of the flowers shed (Safahani Langerodi *et al.*, 2008) and decreasing number of flowers ultimately led to a decline in the number of pods in the weedy check treatment. This result was consistent with the results of the research done by (Khoshnam, 2007 & Keramati *et al.*, 2008).

Number of Grains.Pod^{-1}

Results (Table 1) showed that the effect of row spacing and duration of weed control on number of $grains.pod^{-1}$ were significant (P<0.01). In addition, row spacing and weed control duration had an interaction effect on number of $grains.pod^{-1}$. Weed control duration influenced maximum number of $grains.pod^{-1}$, mostly in the 25 row spacing treatment. In other words, decrease in row spacing and increase in weed control duration increased number of $grains.pod^{-1}$. The highest and lowest number of $grains.pod^{-1}$ were related to the total weed free check in 25 cm row spacing (29.32 seeds) and total weedy check in 35 cm row spacing (17.82 seeds), respectively (Table 3).

Increase in row spacing significantly decreased the number of $grains.pod^{-1}$; therefore this trait in 25 cm row spacing was 12.648% higher than 35 cm row spacing (Table 2). This phenomenon can be justified as follow; as the row spacing decreases (plant density increases), the plant competition for absorbing environmental resources exceeds resulting in decrease in the production of photosynthetic materials and its transfer to grains (Leach *et al*., 1999; Salehi, 2004). Consequently, the existing grains reduce in size but increase in number. These results were consistent with the results obtained by (Rahman *et al*., 2009) & Ozoni Davaji, 2006) who believed that the increase in plant density up to an optimal level would result in the enhancement of number of grains. On the contrary, obtained results from this experiment contradicted the results of (Abadian *et al*., 2008 & Eilkaee & Emam, 2003) which concluded that row spacing does not significantly affect number of grains in the pods. In their opinion, narrow row imposes its impact via reduction of number of pods, and as a result, there is no considerable decline in the number of grains in the pods.

In both row spacings, number of $grains.pod^{-1}$ in control treatments showed an uptrend with increase in duration of weed-free and reached its highest value in weed-free check. The lowest number of $grains.pod^{-1}$ was also related to weedy check in both row spacings (Table 3). The average of grains $number.pod^{-1}$ in weed-free check was 47.71% higher than weedy check (Table 2). Reduction in grain $number.pod^{-1}$ in weedy check treatment can be attributed to the diminishing absorption of generated materials by the agricultural crop and consequently draping and elimination of the grains (Leach *et al*., 1999). This result was consistent with the results reported by (Khoshnam, 2007 & Keramati *et al*., 2008).

1000-Grain Weight

Results of the current experiment (Table 1) indicated that the effect of row spacing and duration of weed control on 1000-grain weight were significant (P<0.01). The Results also showed no significant response of 1000-grain weight with interaction between these factors. The highest and lowest 1000-grains weight were related to the total weed free check in 35 cm row spacing (4.56 g) and the total weedy check in 25 cm row spacing (3.1 g), respectively (Table 3).

Increase in row spacing significantly increased the 1000-grain weight, so that this trait in 35 cm row spacing was 3.67% higher than 25 cm row spacing (Table 2). Reduction of grain weight in narrower row spacing can be attributed to the formation of smaller grains because of more limited access to environmental resources particularly light due to higher competition among plants; declining production of photosynthetic materials and finally, transfer of less photosynthetic materials to the grains especially at the time of grain filling (Salehi, 2004; Abdolrahmani, 2003). This result was consistent with the results obtained by (Shekari & Javanshir, 2000; Abdolrahmani, 2003 & Sedghi *et al*., 2008), while contradicted with the results of (Abadian *et al*., 2008 & Eilkaee & Emam, 2003). The latter researchers believed that different row spacing (plant density) have no significant effects on 1000-grain weight. Their reason was that grains act as strong physiological reservoirs and rarely respond to the treatments like row spacing (plant density).

In both row spacing, 1000-grain weight in control treatments showed an uptrend with increase in duration of weed-free and reached its highest value in weed-free check. The lowest 1000-grain weight also related to weedy check in both row spacing (Table 3). The average of 1000-grain weight in weed-free check in comparison with weedy check indicated an increase up to 43% (Table 2). The reason for declining 1000 grain weight due to increase in the duration of weed interference can be explained as follows: in the case of weed competition the amount of produced photosynthetic materials diminished due to the restricted availability of environmental resources specifically sunlight which reduces 1000-grain weight (Safahani Langerodi *et al*., 2008; Eftekhari *et al*., 2005). Similar results were also reported by (Eftekhari *et al*., 2005 & Keramati *et al*., 2008).

Grain Yield

Results (Table 1) indicated that the effect of row spacing and duration of weed control on grain yield were significant ($P<0.01$). In addition, row spacing and weed control duration had an interaction effect on grain yield. Weed control duration influenced maximum grain yield the most in the 25 row spacing treatment. In other words, decrease in row spacing and increase in weed control duration increased grain yield. The highest and lowest amounts of grain yield were related to the total weed free check in 25 cm row spacing (4432.27 $kg.ha^{-1}$) and the total weedy check in 35 cm row spacing (1940.33 $kg.ha^{-1}$), respectively (Table 3).

Increase in row spacing significantly decreased grain yield in manner that this trait in 25 cm row spacing was 19.29% higher than 35 cm row spacing (Table 2). The reason can be postulated in a way which grain yield is a function of some parameters including; the number of $pods.plant^{-1}$, number of $grains.pod^{-1}$ and 1000-grain weight. Although the decrease in row spacing decreased the yield of individual plant via reduction of pods number as well as the 1000-grain weight due to exceeded competition among plants for utilizing environmental resources. On the other hand, the increase in the total number of plants compensated the weaker yield of single plants. Accordingly, the overall yield was enhanced per surface area (Salehi, 2004). This result was consistent with the results observed by (Ozer, 2003 & Yazdifar *et al*., 2007).

In both row spacing, grain yield in control treatments showed an uptrend with increase in duration of weed-free and reached its highest value in the weed-free check. The lowest grain yield also related to weedy check in both row spacings (Table 3). The average of grain yield in weed-free check as compared to weedy check indicated an increase equivalent to 81.07% (Table 2). The reason of grain yield reduction in weedy treatment can be attributed to the reduction of yield components including pod number.plant^{-1}, grain number.pod^{-1} and 1000-seed weight due to competition of weeds with agricultural crop which ultimately reduced the grain yield (Safahani Langerodi *et al*., 2008). This result was consistent with the research result of (Hamzei *et al*., 2007).

Oil Content

Obtained results (Table 1) showed no significant response of oil content to row spacing, weed control duration and their interaction. The highest and lowest amounts of oil content were related to weed free until emergence in 35 cm row spacing (40.49 %) and total weedy check in 35 cm row spacing (39.20 %), respectively (Table 3). The reason of no significant effect of row spacing on oil content is due to the fact that oil content is a trait with high heritability and less influenced by environmental conditions (Abadian *et al*., 2008). This result was consistent with the results obtained by (Ozer, 2003 & Abadian *et al*., 2007 &

Table 1. Analysis of variance for the effects of row spacing, weed control duration and their interaction on studied traits for canola

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S.O.V	**df**	**Pod no plant^{-1}**	**Grain no pod^{-1}**	**1000-grain weight**	**Grain yield**	**Oil content (%)**	**Oil yield**
Replication	**2**	205.49**	118.93**	0.02^{ns}	167974.47**	0.002^{ns}	27243.32**
Row spacing	**1**	3967.32**	74.80**	0.35**	3260400.10**	1.13^{ns}	535484.71**
Weed control duration	**6**	10926.91**	65.27**	1.17**	2977861.78**	0.85^{ns}	483162.54**
R×W	**6**	82.57**	1.21**	0.004^{ns}	72204.36**	0.28^{ns}	10326.14**
Error	**26**	9.35	0.16	0.006	673.79	0.18	359.06
C.V%	**-**	6.18	8.72	2.92	14.80	3.08	12.47

* and **:Significant at 5% and 1% probability level, respectively ns: non significant

Table 2. Means comparison of studied traits in different treatments of row spacing and weed control duration

Treatments	Pod no plant^{-1}	Grain no pod^{-1}	1000-grain weight (g)	Grain yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
Row spacing						
25 cm	129.98 b	24.51 a	3.85 b	3504.09 a	39.87 a	1397.86 a
35 cm	149.42 a	21.84 b	4.03 a	2946.85 b	39.76 a	1172.03 b
Weed control duration						
WF0	81.07 g	18.59 g	3.14 e	2341.65 g	39.32 c	921.14 g
WFv$_c$	94.15 f	19.97 f	3.68 d	2556.10 f	40.12 ab	1024.14 f
WFv$_2$	126.38 e	21.77 e	3.85 c	2810.43 e	39.83 abc	1120.05 e
WFv$_4$	138.93 d	23 d	3.95 c	3162.69 d	40.14 ab	1269.90 d
WFv$_8$	164.60 c	25.07 c	4.16 b	3618.58 c	39.60 abc	1433.15 c
WFFB	175.03 b	26.34 b	4.28 b	3848.79 b	39.43 bc	1518.24 b
CWF	197.73 a	27.46 a	4.49 a	4240.07 a	40.29 a	1708.01 a

The means with same letter do not have statistically significant difference at 5% probability level.

WFv$_c$, WFv$_2$, WFv$_4$, WFv$_8$ and WFFB: Weed free until the growth stages of emergence, 2-leaf, 4-leaf, 8-leaf and flowering bud initiation WF0:0 day weed free CWF: Complete weed free

Table 3. Means comparison of row spacing × weed control duration interaction on studied traits

Treatments	Pod no plant^{-1}	Grain no pod^{-1}	1000-grain weight (g)	Grain yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
Row spacing×Weed control duration						
25 cm× WF0	73 i	19.35 g	3.1 h	2742.97 h	39.45 a	1081.66 h
25 cm× WFv$_c$	87.3 h	20.74 fg	3.56 g	2971.53 g	39.75 a	1181.51 g
25 cm× WFv$_2$	120.83 f	23.16 de	3.75 fg	3177.05 f	40.08 a	1273.07 f
25 cm× WFv$_4$	132.07 e	24.21cd	3.86 def	3368.5 e	40.22 a	1355.24 e
25 cm× WFv$_8$	151d	26.63 b	4.04 cde	3793.33 c	39.76 a	1507.84 c
25 cm× WFFB	162.04 c	28.13 a	4.19 bcd	4042.98 b	39.64 a	1603.0 b
25 cm× CWF	183.27 b	29.32 a	4.41 ab	4432.27 a	40.22 a	1782.69 a
35 cm× WF0	89.13 h	17.82 h	3.19 h	1940.33 k	39.20 a	760.62 k
35 cm× WFv$_c$	101 g	19.21gh	3.80 efg	2140.67 j	40.49 a	866.76 j
35 cm× WFv$_2$	131.93 e	20.38 fg	3.94 def	2443.81 i	39.57 a	967.03 i
35 cm× WFv$_4$	145.80 d	21.78 ef	4.04 cde	2956.88 g	40.06 a	1184.56 g
35 cm× WFv$_8$	178.2 b	23.52 d	4.27 bc	3443.83 e	39.44 a	1358.46 e
35 cm× WFFB	187.67 b	24.55 cd	4.37 ab	3654.60 d	39.22 a	1433.46 d
35 cm× CWF	212.2 a	25.59 bc	4.56 a	4047.87 b	40.35 a	1633.32 b

The means with same letter do not have statistically significant difference at 5% probability level.

WFv$_c$, WFv$_2$, WFv$_4$, WFv$_8$ and WFFB: Weed free until the growth stages of emergence, 2-leaf, 4-leaf, 8-leaf and flowering bud initiation

WF0:0 day weed free

CWF: Complete weed free

Yazdifar *et al*., 2007), but was inconsistent with results obtained by (Eilkaee & Emam, 2003 & Fathi *et al*., 2002). They believed that oil content in canola is inversely related to seed size and decreases by reduction in pod numbers and relative increasing of seed size in higher densities.

The reason of no significant differences between control and interference treatments in oil content can be explained by the fact that oil content is a polygenetic trait and is controlled by many genes, so it is unlikely that all genes exposed to environmental stress tend to weed competition (Shahvardi *et al*., 2002). This result was consistent with the results obtained by (Khoshnam, 2007 & Hamzei *et al*., 2007).

Oil Yield

Results (Table 1) showed that the effect of row spacing and duration of weed control on oil yield were significant ($P<0.01$). In addition, row spacing and weed control duration had an interaction effect on oil yield. Weed control duration influenced maximum oil yield the most in the 25 row spacing treatment. In other words, decrease in row spacing and increase in weed control duration increased oil yield. The highest and lowest amounts of oil yield were related to the total weed free check in 25 cm row spacing (1782.69 $kg.ha^{-1}$) and total weedy check in 35 cm row spacing (760.62 $kg.ha^{-1}$), respectively (Table 3).

Increase in row spacing significantly decreased oil yield, which this trait in 25 cm row spacing was 19.46% higher than 35 cm row spacing (Table 2). The reason for this can be explained by the fact that oil yield is obtained from multiplying the grain yield in oil percent and is a function of these components (Abadian *et al*., 2008). While oil percentage was not influenced by different row spacing, oil yield was directly affected by grain yield and because of the grain yield of 25 cm row spacing was higher than 35 row spacing, oil yield increased in this row spacing. The result was in agreement with (Faraji, 2005 & Ozoni Davaji, 2006) which believed that increase in plant density up to the optimum level increases the oil yield. This result was also inconsistent with the result obtained by (Abadian *et al*., 2008). Abadian *et al*., 2008 believed that row spacing (plant density) has no effect on oil yield.

In both row spacing, oil yield in control treatments showed an uptrend with increasing duration of weed-free and reached its highest value in weed-free check. The lowest harvest index also related to weedy check in both row spacings (Table 3). The average of oil yield in the weed-free check indicated about 85.42% increase in comparison with the weedy check (Table 2). The reason of oil yield reduction in weedy treatment can be explained by the fact that during weed competition with crop, seed yield decreased due to reduction of yield components including pod number per plant, grain number per pod and 1000-grain weight, while oil percent did not changed. Considering that the oil yield is a function of grain yield and oil percent, with no change in oil percent, oil yield was directly decreased by grain yield. This result was in agreement with (Khoshnam, 2007 & Hamzei *et al*., 2007) findings.

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چکیده

به منظور بررسی اثرات فاصله ردیف کاشت و مدت کنترل علف های هرز بر عملکرد، اجزای عملکرد و درصد روغن کلزا، آزمایشی در سال زراعی ۸۸-۱۳۸۷ به صورت فاکتوریل در قالب طرح بلوک های کامل تصادفی در ۳ تکرار در موسسه تحقیقات برنج کشور واقع در شهرستان رشت به اجرا د رآمد. فاکتورهای آزمایشی شامل فاصله ردیف در ۲ سطح (۲۵ و ۳۵ سانتی متر) و کنترل علف های هرز در ۷ سطح (شامل وجین دستی تا پایان مراحل سبز شدن، ۲ برگی، ۴ برگی، ۸ برگی و ظهور (تشکیل) جوانه های گل) بود. پس از این مراحل، به علف های هرز اجازه رقابت با گیاه زراعی داد ه شد. دو تیمار تداخل و کنترل کامل نیز به عنوان شاهد در نظر گرفته شدند . صفات ارزیابی شده شامل تعداد خورجین در بوته، تعداد دانه در خورجین، وزن هزار دانه، عملکرد دانه، درصد (مقدار) روغن و عملکرد روغن بود. نتایج نشان داد که فاصله ردیف های کاشت مختلف اثر معنی د اری بر تمامی صفات به جز درصد روغن داشت. افزایش فاصله ردیف کاشت با افزایش تعداد خورجین در بوته و وزن هزاردانه همراه بود. سایر صفات با افزایش فاصله ردیف کاشت، به طور معنی داری کاهش یافتند. علاوه بر این، افزایش مدت کنترل علف های هرز، تمامی صفات به جز درصد روغن را به طور معنی داری افزایش داد. برهمکنش فاصله ردیف × مدت کنترل علف های هرز نیز بر تمامی صفات به جز درصد روغن و وزن هزار دانه معنی دار بود . بر اساس نتایج، بیشترین مقدار عملکرد دانه و روغن مربوط به فاصله ردیف ۲۵ سانتی متر در تیمار کنترل کامل بوده و کمترین میزان این صفات نیز به فاصله ردیف ۳۵ سانتی متر در تیمار تداخل کامل اختصاص داشت.

کلمات کلیدی: فاصله ردیف، مدت کنترل علف های هرز، عملکرد دانه، میزان روغن، کلزا