Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2538-2470 (Online)
Vol. 2, No. 3, No.4, 2016
http://JCNS.iauahvaz.ac.ir
OPEN ACCESS

Yield and Nitrogen Fertilizer Efficiency Analyzes in Different Planting Dates of Canola (*Brassica napus* L.) under Warm and Dry Climate Condition

Abdolamir Rahnama*[1] Alireza Jafarnejadi[2] Mohammad Khayat[3]

1- Seed and Plant Improvement Department, Khuzestan Agricultural and Natural Resources Research and Education Center, AREEO, Ahvaz, Iran.
2- Soil and Water Research Department, Khuzestan Agricultural and Natural Resources Research and Education Center, AREEO, Ahvaz, Iran.
3- Young Researchers and Elite Club, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.

RESEARCH ARTICLE

ARTICLE INFO.
Received Date: *10 Sep. 2016*
Received in revised form: *13 Nov. 2016*
Accepted Date: *1 Dec. 2016*
Available online: *30 Dec. 2016*

To Cite This Article: Abdolamir Rahnama, Alireza Jafarnejadi, Mohammad Khayat. Yield and Nitrogen Fertilizer Efficiency Analyzes in Different Planting Dates of Canola (*Brassica napus* L.) under Warm and Dry Climate Condition. ***J. Crop. Nut. Sci., 2(3,4):*** *41-53, 2016.*

ABSTRACT

Canola sensitivity to delayed sowing date should be managed in such a way that the observance of crop rotation with less reduced in seed yield. The research was conducted to evaluate the yield variation of Hyola401 hybrid, affected by sowing date and nitrogen fertilizer treatments. In this study, the effect of planting date and different levels of nitrogen fertilizers on effective characteristics of canola yield were carried out by combined analysis split plot experiment based on randomized complete blocks design in two consecutive years with four replication. Main plot included different planting date (10-Nov, 20-Nov, 1-Dec, 10-Dec.) and four level of nitrogen fertilizers (0, 50, 100, 150, 200 kg.ha^{-1}) belonged to sub plots. The results indicated that canola yield affected by planting date, is subject the linear relationship Y= 2693.0-36.05D (Y= yield and D=planting dates) so crop yield 3.1% decreased per each day delay in planting date. Canola yield in different level of nitrogen treatments was subjected non-liner relation Y=1360.5-0.17N2-0.00063N3 accordingly, most efficiency in the treatment of 100 and 150 kg of nitrogen fertilizer were found. Estimate yield affected by planting date and nitrogen fertilizer based on the relation Y= 1654-36.1D + 10.4N indicated per every day the sowing is delayed about 36.1 kg of seed yield reduction occurs, so to compensate mentioned reduction in the range of studied planting date about 10.4 kg of nitrogen fertilizer should be consumed. Determining the correlation coefficient between yield and its components by using interaction effect of sowing date and nitrogen fertilizer revealed that the number of pods per plants and seed weight had more correlation with the seed yield trait, which is indicated significant effect of the implemented treatments on these two components of yield.

Keywords: *Correlation, Rapeseed, Seed weights.*

*Corresponding Author: Abdolamir Rahnama ✉ abam_rah@yahoo.com

INTRODUCTION

Underlining the canola oilseed crop cultivation in seeds alternations such as corn or rice in the south or the north of the country causes part of the area under cultivation of canola to be sown on a date outside the domain of the recommended cultivation dates (Rahnama, 2010; Rabiee *et al*, 2004). Delaying the canola cultivation due to the weeds invasion at the early growth stage and the coincidence of the sensitive flowering, seed production and filling stages with heat and dryness at the end of growing season usually causes a downturn in the performance (Degenhart and Kondra, 1981; Scarisbrick *et al*, 1981), thus sowing date is one of the important factors of crop production management highly influencing canola performance and the components related thereto through changing the environmental conditions of various growth stages (Taylor and Smith, 1992; Whitefield, 1992). Adhering to sowing date in terms of adjusting appropriate temperature of the place when planting by concentrating on sprouting, providing auspicious environmental conditions for the purpose of increasing the flowering duration and preventing inoculation and filling stages coincidence with precocious heat during early spring in Khuzestan region causes an increase in the performance of canola cropped during fall (Ghalibaf *et al*., 2000; Saran and Giri, 1987). Delaying the canola sowing causes a reduction in the number of pods on plants, decrease in seed filling period and decline in the seed performance and canola oil yield due to the reduction in sprouting rate as a result of low temperature when planting as well as due to the coincidence of the important stages of flowering and inoculation with high temperature of the environment (Nykiforuk *et al*., 1994; Pasban Eslam, 2011). Investigating the various sowing dates effects on canola fall varieties in Australia, Taylor and Smith (1992) reported that sowing date significantly influences the canola performance and its components. They also reported that delaying the sowing brings about a reduction in the number of seeds in the sheath, the number of pods per plants, biomass and seed performances. Robertson and Holland (2004) reported that delaying the seed planting in fall canola cropping for reasons such as the increase in the environmental temperature causes a reduction in the flowering period which will be consequently followed by a coincidence between the late season heat and seed filling period and this latter makes the seed performance and canola oil yield suffer a reduction. Faraji *et al*. (2009) also reported that delaying the canola sowing date as a result of the reduction in vegetative growth period causes the production of plants with lower biomass and it will also bring about a decrease in the seed performance and its relevant component due to a coincidence between the generative stage and the high heat period. The results obtained in the studies undertaken by Jenkins and Leitch (1986) and by Mendham *et al*. (1990) also demonstrated that the delay in sowing fall canola seeds causes a significant decrease in the number of pods per plant, the number of seeds per pods and the canola seed performance, thus canola seeds sowing date should be picked up appropriately according to the environmental conditions in such a manner that a higher vegetative and generative growth as well as higher seed performance and oil yield can be attained through adjusting the various growth stages with the favorable environmental growth conditions (Thurling, 1975). According to the high percentage of canola oil yield, the application of appropriate levels of nitrogen fertilizers in different sowing dates is another factor contributing to the seed performance and canola oil yield. Nitrogen plays an essential role in the plant's healthy growth and it is a factor leading to a higher production of protein which is absorbed by canola in its mineral form, ammonium or nitrate (Hopkins and Hunter, 2004). The nitrogen amount required by canola is considerably higher than the other agricultural crops such as seeds. Based on this, canola, in comparison to the other seeds, is in need of higher ready-to-use nitrogen. A great many if the study results signify that lower oil yields are obtained under conditions where lower amounts of nitrogen are consumed and with the increase in the nitrogenous fertilizers application, the canola's oil and protein yields boost (Rathake *et al.*, 2005). Based on the results obtained in a series of studies, Jackson (2000) reported that canola performance and its absorption of nutrient elements is highly correlated with the amount of nitrogen fertilizers applied and the highest seed performance has been found when 120 to 180 kg nitrogen is applied per hectare. Of course, it should be noted that the sufficient and appropriate application of nitrogen fertilizer in each of the canola growth stages causes an increase in the growth speed in the plant and this is significantly associated with the seed filling (Al-Barrak, 2006). Some study results have shown that there is no significant difference in oil yield increase under circumstances where the nitrogen fertilizers are excessively applied (Brennan *et al*., 2000) and even significant decrease in the seed performance and canola oil yield as a result of adverse effects and toxicity in various growth stages have been documented where more than appropriate amounts of nitrogen or luxury nitrogen is applied (Ozturk, 2010). The present research paper was conducted aiming at the survey of the canola performance components' variations considering various sowing dates and different levels of nitrogen fertilizer application through running performance and correlation tests in Mediterranean conditions of the southern Khuzestan.

MATERIALS AND METHODS

Field and Treatment Information

In this study, the effect of planting date and different levels of nitrogen fertilizers on effective characteristics of canola yield were carried out by combined analysis split plot experiment based on randomized complete blocks design in two consecutive years with four replication. Main plot included different planting date (10-Nov, 20-Nov, 1-Dec, 10-Dec.) and four level of nitrogen fertilizers (0, 50, 100, 150, 200 $kg.ha^{-1}$) belonged to sub plots. The current study spanned over two cultivation years from 2004-2005 to 2006-2007 in Shawor Research Station associated to Khuzestan's Agricultural and Natural Resources Research Center, located in a latitude of 31ˊ and 50″ and a longitude of 48ˊ and 32″. The research station is situated within a distance from Karkheh and Karun Rivers and it is classified as dry and semiarid regions of the country based on Emberger Index. Based on the average statistics pertaining to a thirty-year meteorology for the period from 1981 to 2011, the total precipitation in the station has been 254.0 mm/y, mean temperature of the station has been 25.3, the minimum and maximum absolute annual temperature have, respectively, been -1 °C and 51.01°C. Temperature means during the experiment implementation period, in a time interval from October to May, were 20.0 °C, 14.0 °C, 12.2 °C, 14.5 °C, 18.5 °C, 25.4 °C and 31.0 °C. It can be seen that the temperature has undergone a descending trend from October to January and it has increased from February till late March and it shows an increasingly higher speed of elevation during April and June and this is a characteristic featuring Mediterranean climate regions (Table 1). The experiment farms soil is generally composed of silt with an electrical conduction equal to 3.4 ds.m^{-1} and a basic reaction of 7.8 in the active root region. The experiment was carried out in the format of a complete randomized block design based on split methods featuring four cultivation dates 20/11, 30/11, 10,12 and 20/121 executed on the main plots and five levels of nitrogen fertilizer application in subplots which was carried out in four replications.

Table 1. Min, Max, mean air temperature and precipitation of Khuzestan agricultural research

Months	Jan	Feb	March	April	May	Jun	July-	Aug	Sep	Oct	Nov	Des
Min. Temp.C^0	12.2	14.5	18.5	25.4	31.0	35.0	37.2	36.0	33.1	27.0	20.0	14.0
Max. Temp.C^0	17.4	20.4	25.1	32.7	39.4	44.4	46.4	45.2	42.7	35.4	27.0	19.4
Mean Temp.C^0	7.0	8.4	11.9	17.4	22.6	25.4	27.8	27.6	23.4	18.5	13.0	8.6
Precipitation (mm)	50.0	36.3	32.7	10.0	4.1	1.0	0.0	0.0	0.0	11.3	29.9	65.3

Crop Management

Every plot was cultivated with six 5-meter-long rows, each in a 30-cm-distance from one another. The rapeseed variety used in the present study was early maturation high-yield hybrid, Hyola401, of canola type which is currently cropped in an extensive level in Khuzestan Province. The fertilizer was applied based on soil examinations and also according to a 150 kg superphosphate triple application rates and a 200 kg per hectare potassium scale when sowing seeds and nitrogen fertilizer was applied in two quotas based on one third when planting and two third upon stem emergence in respect to the treatments of concern all of which have been supplied from urea sources. The other cultivation operations such as irrigation and the weeds removal and dumping were identical and similar in all the treatments.

Traits Measure

The trait measurement activities included the number of pods per plant determined via counting the number of pods on ten random plants from every plot, number of seeds per pods through counting the number of seeds in 50 pods selected randomly from every plot, seed mean weight determined via randomly weighing four 500-seed samples from every plot and the seed performance in a 3.6 square meter level was measured and recorded, though the plot margins were excluded from the experiments.

Statistical Analysis

Analysis of variance and mean comparisons were done via MSTAT-C software and Duncan test at 5% probability level. Correlation between traits was determined by Minitab software (Ver. 15).

RESULTS AND DISCUSSION

Main Effects of Cultivation Date

The results of the raw numbers variance analyses obtained for a two-year period of experiment implementation indicated that cultivation date has had a significant effect on the entire performance components (Table 2). Comparing the means obtained for the performance components with Duncan test results indicated that delay in recommended sowing dates till mid-October caused a significant decrease in the performance components. The highest number of plants per unit area for recommended sowing date of October twentieth was found equal to 58.9, the number of pods per plant was equal to 88.5, the number of seeds per pods was equal to 18.8 and weight of one thousand seed was 2.90 gram in Class A seeds. The number of plants per unit area, the number of pods per plant, the number of seeds per pod and weight of one thousand seeds were found suffering a decrease equal to 5.0 plant, 24.6 pods, 3.1 seed perpod and 0.43 gram, respectively when delaying the dates the seeds had to be sown (Table 3). The results of the studies performed in this regard indicated that delay in planting seeds causes a reduction in performance components as a result of sowing to sprouting interval being lengthened, the decrease in the flowering period and the coincidence of the sensitive stages of flowering and seed filling with the inauspicious environmental conditions like the rapid increase in the temperature (Auld *et al.*, 1985; Ferre *et al.*, 2002). Based on this, the results obtained from comparing the seed performance indicated that the seed performance significantly deteriorates with the increase in sowing delay time in respect to the recommended cultivation date. The highest seed performance was 2693.0 kg seeds per hectare which was found in the recommended sowing date, 20^{th} of October, for Class a, as well as, in the sowing date of 30^{th} of November within a statistical class. Seed performance in third and fourth cultivation dates were indicative of reduction equal to 717.0 $kg.ha^{-1}$ and 1085.0 $kg.ha^{-1}$, respectively and they were placed in statistical classes of c and d, respectively (Table 4).

Table 2. ANOVA result of measured traits

S.O.V	df	Plant number	Pod number	Seed number	Seed weights	Seed yield	Nitrogen efficiency
Year (Y)	1	0.21	11.4	7.5	0.24	5364486^{**}	622.8
Y.*Replication	4	6.67	131.6	3.1	0.33	401483	40.3
Planting Dates (P.D)	3	175.30^{**}	3150.7^{**}	53.6^{**}	1.33^{**}	6522925^{**}	176.9^{**}
Y.*P. D.	3	11.54^{ns}	29.3^{ns}	3.9^{ns}	0.07^{ns}	55570^{ns}	5.0
Error I	12	8.34	65.7	4.3	0.03	86257	10.72
Nitrogen (N)	4	119.99^{**}	11964.7^{**}	35.3^{**}	1.57^{**}	16709976^{**}	24.3^{*}
Y.*N.	4	1.35^{ns}	576.2^{ns}	39.6^{**}	0.36^{ns}	574545^{**}	10.4
P. D.*N.	12	82.28^{**}	127.2^{ns}	1.5^{ns}	0.04^{ns}	372750^{**}	123.9^{**}
Y.* P. D.*N.	12	3.91	43.3^{ns}	4.5^{ns}	0.04^{ns}	91449^{ns}	15.3^{*}
Error II	64	7.19	80.7	3.0	0.04	60308	7.4
C.V	-	4.7	11.9	10.1	6.9	11.4	5.2

$^{ns, *\ and\ **}$: no significant, Significant at 5% and 1% of probability level, respectively.

Performance estimation based on the linear relation, R^2=0.99.0%, Y=2693.0-36.05D (where, Y denotes seed performance and D is the cultivation date) indicated that the seed performance suffers a loss by approximately 36.0 kg/ha or 1.3% per every day the sowing is delayed. Considering the absence of a significant difference in nitrogen consumption efficiency in contrast to the first sowing date, a ten-day delay in sowing seems acceptable but it is rendered unadvisable with the increase in the temporal interval of the sowing delay and the significant decrease in the nitrogen consumption efficiency.

Table 3. The canola seed yield components means comparison in different planting dates and N fertilizer levels

Treatments	Plant numner (per m^2)	Pod numner (per plants)	Seed numner (per pods)	1000 Seed weights (gr)	Nitrogen efficiency ($kg.kg^{-1}$)
Planting date					
10-Nov	58.9*a	88.5a	18.8a	2.90a	14.0 a
20-Nov	59.1 a	77.1b	17.9a	2.86a	12.5 a
1-Dec	57.5 a	72.4c	16.7b	2.59b	9.9 b
10-Des	53.9 b	63.9d	15.7b	2.47c	7.9 b
Nitrogen ($kg.ha^{-1}$)					
0	57.4 b	43.8e	15.2b	2.29c	0.0
50	54.5 c	62.6d	17.8a	2.63b	10.8 ab
100	55.8 c	81.1c	18.2a	2.90a	11.8 a
150	59.3 a	90.8b	17.9a	2.80a	12.0 a
200	59.7 a	99.1a	17.3a	2.89a	9.8 b

*Similar letters in each column show non-significant difference at 5% level in Duncan test.

Table4. Canola seed yield trend estimate in different main effects treatments

Treatments	Real seed yield ($kg.ha^{-1}$)	Estimated seed yield ($kg.ha^{-1}$)	Estimated seed increase ($kg.ha^{-1}$)	Estimated seed increase (%)
Planting date				
10-Nov	2693.0a*	2693.0	0.0	0.0
20-Nov	2335.6b	2332.5	360.5	13.4
1-Dec	1976.9c	1972.0	721.0	26.8
10-Des	1608.6d	1611.5	1081.5	40.2
Nitrogen ($kg.ha^{-1}$)				
0	1056.3e	1136.5	0.0	0.0
50	1589.9d	1489.6	352.5	31.0
100	2237.4c	2234.2	744.5	65.5
150	2862.1b	2898.0	663.8	58.4
200	3022.0a	3008.7	110.7	9.7

*Similar letters in each column show non-significant difference at 5% level in Duncan test.

The studies conducted in this regard are suggestive of the canola's high sensitivity to sowing date (Jenkins and Leitch, 1986; Abdoli *et al*., 2004).

Main Effects of Nitrogen Fertilizers

Comparing the means obtained for performance components in various nitrogen fertilizer treatments showed that with the increase in fertilizer application from zero to 200 $kg.ha^{-1}$, the number of pods increased from a average value of 43.8 to 99.1 pods per plant, the number of seeds were also indicative of an increase from a mean value of 15.2 to 17.3 seeds per pod; furthermore, the weight of one thousand seed also increased from 2.29 to 2.89 grams and, finally, the number of plants per unit area was also found increased from an average of 57.4 to 59.7 plants per unit area all of which are reflective of the positive and significant effect that nitrogen fertilizers exert on the canola seeds' performance components. The results of the studies carried out in this regard are also expressive of the idea that the performance components including the number of pods per plant, the number of seeds per pod, total plant weight and the harvest index have also been found improved in various rapeseed varieties with an increase in nitrogen application (White et al, 2015). Applying nitrogen below the required level brings about a slack in growth speed, early senescence of the old leaves and the reduction in the photosynthesis level and, generally, a reduction in performance. Taylor and Smith (1992), as well, reported that the increase in applying nitrogen fertilizers to a 200-kg level per hectare causes a significant increase in the canola performance as well as its relevant components. Estimating the performance based on a cubic equation, $Y=1360.5- 0.17N^2- 0.00063N^3$, $R^2= 0.93.0\%$ (where, Y denotes the seed performance rate and N is nitrogen fertilizer), is reflective of the nonlinear relationship between the fertilizer application rate and performance. Performance rate in control treatment (not applying nitrogen fertilizers) was 1136.5 kilograms seed per hectare and the extents to which the performance was increased after applying the first to fourth levels of fertilizer were 352.5, 744.5, 663.8 and 110.7 kilograms seed per hectare, respectively. In other words, the first level of applying nitrogen fertilizer, 50 kg, caused a 31% increase in seed performance and the second, third and fourth levels of fertilizer application were followed by 65.5%, 58.4% and 9.7% increase in performance, respectively (Table 4). Comparing the nitrogen fertilizers application efficiencies indicated that the index follows an ascending trend up to a 150 $kg.ha^{-1}$ application of fertilizer and then it shifts to a descending trend. Thus, it has to be noted that the accumulative increase in the performance as a result of fertilizer application should not encourage the higher application of fertilizer (Table 3). Based on the results offered by many researchers, nitrogen fertilizers efficiency in canola is generally found lower than in other seeds (Sieling and Kage, 2006; Berry, 2009); moreover, applying higher rates exceeding the recommended proper rates or luxury nitrogen causes toxicity during growth stages of a canola plant and this brings about a significant reduction in seed performance and canola quality (Ozturk, 2010). Hocking and Stapper (2001) also reported that delay in sowing agricultural crops causes an increase in fertilizer consumption, reduction in the efficiency, wastage of capital and severe contamination of the ground waters. Managing optimum fertilizer application, corresponding to the plants growth requirements and soil tests are but two solutions to the qualitative and quantitative elevation of the agricultural products performance because the quantity and the quality as well as the crop health should all be taken into consideration in cropping agricultural products. Applying fertilizer based on the common methods causes a reduction in fertilizer efficiency besides endangering the environment and human health (Malakuti *et al*., 2008).

Mutual Effects of Sowing Date and Nitrogen Fertilizers

Comparing the means obtained for the mutual effects of sowing date and fertilizer application indicated that the performance components undergo a significant increase with an elevation in nitrogen fertilizers application rate in each sowing date (Table 5). Nitrogen fertilizer application rates were calculated and placed in a separate group called A and, as expected, the lowest number of pods per plant, equal to 35.3 pods, was evidenced in the last sowing date for which no nitrogen fertilizer was applied and this latter calculation was placed in a separate group called n. The highest number of seeds per pod, equal to 20.0, belonged to the first sowing date for which a 100-kg.ha^{-1} nitrogen fertilizer had been applied and it was given a common letter shared by all the fertilizer application treatments at this sowing date which is indicative of this performance component being less sensitive to the fertilizer application. The lowest number of seed per pod, equal to 13.7, was obtained in the last sowing date with no fertilizer application and it was assigned to a separate group called h. Co-placement of the other levels of fertilization application in this treatment is reflective of a re-emphasis on the greater sensitivity of this performance component to the sowing date in respect to the fertilization application. Inauspicious environmental conditions post-flowering such as early spring heat in southern section of Khuzestan province causes the shortening of the flowering period, the lack of perfect inoculation of the formed flowers and the decline in the number of seeds per pod. Also, fertilizer application consumption efficiency undergoes a decrease as a result of vegetative and reproductive growth periods thus the higher elevation in fertilizer application exerts no significant effect on the performance enhancement as well as the increase in the performance components (Mendham *et al*., 1990; Taylor and Smith, 1992). Comparing the mean values obtained for the weight of a thousand seed showed that the highest seed weights pertained to the first and second sowing dates and a high level of nitrogen fertilizers application. The weight of a thousand seed significantly declined in delayed sowing dates and the nitrogen fertilizer non-application which is suggestive of the idea that this component of the performance is highly sensitive to the sowing date and nitrogen fertilizer application. According to the existence of the negative and significant relationship between the performance components, the variations trend in terms of the number of the sprouted plants and the survival rates differed concerning the various levels of fertilizer application in each sowing date. For instance, the increase in the fertilizer application level within a certain limit caused the increase in accessory flowering stems and the elevation of the inter- and intra-plant competition which adversely affected the number of the plants. Generally, the increase in nitrogen fertilizer application in the first to third sowing dates brings about a significant increase in the number of plants per every unit area. But, the increase in the fertilizer application in the last sowing date was found significantly decreasing the number of the plants per every unit area possibly due to the reasons such as the environmental conditions dissimilarity and a significant reduction in the growth period duration stemming from the increase in the sprouting percentage with the increase in fertilizer application, the decrease in the establishment time and the increase in the inter-plant competition as well as because of the greater impressibility of the other performance components (Rahnama and Ja'afarnejadi, 2009). Comparing the mean values acquired for the mutual effects indicated that there is a significant effect between the various treatments but, generally, the delay in sowing causes a significant decrease in the performance and the increase in nitrogen fertilizer application in each of the sowing dates brings about an increase in seed performance that was found following various trends in respect to the other sowing dates and this is why the mutual effects of the performance are rendered statistically significant.

Table 5. The yield means components and N efficiency comparison for interactions of treatmants

Treatments		Pod number (per plants)	Seed number (Per pods)	Seed weights	Plant Number (m^2)	Nitrogen efficiency ($kg.kg^{-1}$)
Planting date	**Nitrogen ($kg.ha^{-1}$)**					
	0	51.7*^{lm}	17.0 $^{d-f}$	2.52 ^{fg}	52.8 g-j	13.2 ^{a}
	50	74.0^{hg}	18.7 $^{a-d}$	2.70 $^{c-f}$	55.8 fg	14.2 ^{a}
10-Nov	**100**	88.0^{c-f}	20.0^{a}	3.05 ^{a}	60.3 bd	15.6 ^{a}
	150	107.3^{b}	19.0 $^{a-c}$	3.03^{a}	61.3 ad	13.1 ^{a}
	200	121.5^{a}	19.2^{ab}	3.20 ^{a}	64.0 a	-
	0	45.0^{mn}	15.3 $^{f-h}$	2.43 ^{g}	63.3 ab	14.4 ^{a}
	50	67.2^{j-k}	19.0 $^{a-c}$	2.75 $^{c-e}$	55.2 f-h	11.5 ^{a}
20-Nov	**100**	83.5^{e-h}	18.8 $^{a-d}$	3.10 ^{a}	54.2 fi	13.7 ^{a}
	150	93.5^{c-e}	19.2 ^{ab}	3.00 ^{ab}	60.8 bd	10.6 ^{a}
	200	96.5^{c}	17.2 $^{c-f}$	3.02 ^{a}	62.0 a-d	-
	0	43.2^{mn}	14.7 ^{gh}	2.22 ^{h}	54.3 fi	8.4 ^{a}
	50	57.8^{kl}	17.2 $^{c-f}$	2.55 ^{fg}	54.5 fi	11.1 ^{a}
1-Dec	**100**	80.7 $^{f-i}$	17.5 $^{b-e}$	2.77 ^{cd}	57.0 ef	10.8 ^{a}
	150	86.2 $^{c-g}$	17.3 $^{b-e}$	2.60 ^{cd}	59.5 ce	9.4 ^{a}
	200	94.2 ^{cd}	16.7 ^{ef}	2.80 ^{bc}	62.3 ac	-
	0	35.3 ^{n}	13.7 ^{h}	1.98 ^{i}	59.2 dc	7.0 ^{a}
	50	51.5 ^{lm}	16.2 $^{e-g}$	2.53 ^{fg}	52.3 hg	10.4 ^{a}
10-Dec	**100**	72.3 $^{i-j}$	16.3 $^{e-g}$	2.68 $^{c-f}$	51.8 ig	8.0 ^{a}
	150	76.3 $^{g-j}$	16.2 $^{e-g}$	2.58 $^{d-g}$	55.5 fg	6.3 ^{a}
	200	84.2 $^{d-h}$	16.3 $^{e-g}$	2.55 $^{e-g}$	50.5 g	-

*Similar letters in each column show non-significant difference at 5% level in Duncan test.

The highest performance, 3898.8 kg seeds.ha^{-1}, was obtained in a separate class, called a, in the first sowing date with the highest level of nitrogen fertilizer application and, as expected, the lowest performance, 840.4 kg seeds.ha^{-1} was found in class h in the last sowing date featuring a non-application of nitrogen fertilizer. Performance estimation based on the relation Y=1654-36.1D+10.4N, R^2=93.3% (Where, Y denotes seed performance and D is the delayed days since the recommended sowing date of 20th of October and N is the nitrogen fertilizer rate) indicates that seed performance is decreased by about 36.1 kilograms per every day the sowing is delayed and about 10.4 kilograms nitrogen fertilizers should be consumed so as to compensate for such a reduction. In other words, corresponding to the abovementioned relation, approximately 3.5 kilograms of seed plus the base 1654.0 kilograms would be produced in the sowing dates' domain per every unit of nitrogen fertilizer application. Thus, the optimum level of fertilizer application should be determined with respect to the bioenvironmental concerns, the unit price of the fertilizer, the extent to which the seed yield is increased and the nitrogen fertilizers consumption efficiency (Table 6). Some results obtained in the studies carried out in this regard have indicated that the increase in nitrogen application under certain conditions does not show significant difference in canola performance so the optimum level of fertilizer application should be determined appropriately according to the sowing conditions (Brennan *et al*., 2000).

Table6. Canola seed yield trend estimate in different interactions treatments

Planting date	Nitrogen ($kg.ha^{-1}$)	Real seed yield ($kg.ha^{-1}$)	Estimated seed yield ($kg.ha^{-1}$)	Estimated seed decrease ($kg.ha^{-1}$)	Estimated decrease (%)
10-Nov	0	1284.9 ^{f}	1654.0	2080.0	55.7
	50	1947.6 ^{e}	2174.0	1559.0	41.8
	100	2702.6 ^{c}	2654.0	1079.0	28.9
	150	3631.2 ^{ab}	3214.0	520.0	13.9
	200	3898.8 ^{a}	3734.0	0.0	0.0
20-Nov	0	1128.0 ^{fg}	1293.0	2441.0	65.4
	50	1859.5 ^{e}	1813.0	1921.0	51.4
	100	2279.7 ^{d}	2333.0	1401.0	37.5
	150	3175.3 ^{bc}	2853.0	881.0	23.6
	200	3235.7 ^{b}	3373.0	361.0	9.7
1-Dec	0	971.7 ^{gh}	932.0	2802.0	75.0
	50	1384.1 ^{f}	1452.0	2282.0	61.1
	100	2090.2 ^{de}	1972.0	1762.0	47.2
	150	2588.7 ^{d}	2492.0	1242.0	33.3
	200	2849.7 ^{c}	3012.0	722.0	19.3
10-Dec	0	840.4 ^{h}	571.0	3163.0	84.7
	50	1168.6 ^{fg}	1091.0	2643.0	70.8
	100	1877.2 ^{e}	1611.0	2123.0	56.9
	150	2053.3 ^{de}	2131.0	1603.0	42.9
	200	2103.7 ^{de}	2651.0	1083.0	29.0

*Similar letters in each column show non-significant difference at 5% level in Duncan test.

Yield and its Components Correlation

The investigations on the performance and its components' correlation by taking advantage of the mean values obtained for the sowing dates' primary effects demonstrated that sowing date exerts the highest effect on the performance through influencing the number of seeds per pod. Surveying the performance and its components' correlation through considering the mean values obtained for the nitrogen fertilizer effects indicated that all the performance components are highly correlated with the performance under such a condition and, after all the determination of correlation coefficient between the performance and its relevant components by the use of the mean mutual effects of the sowing date and nitrogen fertilizer showed that, under such a condition, the number of the pods per plant and the seed weights in respect to the number of plants and the number of seeds per pods are highly correlated with the performance (Table 7). A survey of the regression equation, Y= 1303.9 + 48.5pn-1043.0sw.

Table7. Seed yeild and yeild components correlation

Treatments	Planting Dates (P.D)	Nitrogen(N)	P.D*N
Plants per m^2(pn)	0.59^{*}	0.87^{**}	0.71^{**}
Pods per plants(ppp)	0.98^{*}	0.97^{**}	0.99^{**}
Seeds per pods(spp)	0.61^{**}	0.96^{**}	0.56^{**}
Seeds weights(sw)	0.86^{*}	0.95^{**}	0.89^{**}

* and **: significant at 5% and 1% of probability level.

By taking the advantage of the sowing date and nitrogen fertilizer mean mutual effects indicated that performance estimation is possible through inserting the mean pods per plant (PPP) value and weight of a thousand seeds (SW) and applying a determination coefficient of R^2=99.9% and this is reflective of the highly significant effect of the exerted treatments on these two components of performance.

CONCLUSION

In sum, according to the results obtained in the current experiment, the first sowing date and an application of 200 kilograms nitrogen fertilizer with an average number of 121.5 pods per plant, 3.2 gram weight of every seed and 3898.8 kilograms seed/ha produced the highest performance and it was subsequently placed in the statistical class a. Canola seed performance rates in the first sowing date featuring two application rates of 100kg and 150kg nitrogen fertilizers were 3631.32 and 2702.6 kg.ha^{-1}, respectively, which were found outperforming the later sowing dates characterized by higher levels of nitrogen fertilization and this, generally, is indicative of the importance that is required to be given to the close observation of the sowing date versus the nitrogen fertilizer application. Finally, a sowing date of 20/11 featuring an application of 150 kilograms nitrogen fertilizer, a sowing date of 30.11 with an application of 200 kilograms nitrogen fertilizer, a sowing date of 10/12 with an application of 200 kilograms nitrogen fertilizer and allowing a 27% performance downgrade is recommended and delaying the canola seeds plantation after this date even with the application of higher levels of fertilizer is not recommended all of which are indicative of the importance of the sowing date to nitrogen fertilizer application ratio.

REFERENCES

Abdoli, P., A. Siadat, Gh. Fathi. and A. Farshadfar. 2004. Effect of planting date on yield and yield components and oil yield of canola cultivars in Kermanshah. J. Agric. Sci. 27: 105- 118. (Abstract in English)

Al-Barrak, K. M. 2006. Irrigation interval and nitrogen level effects on growth and yield of canola (*Brassica napus* L.). J. Basic Appl. Sci. 7: 87-103.

Auld, D. L., B. L. Bettis. and M. G. Dial. 1985. Planting date and cultivar effect on winter rape production. Agron. J. 6: 197-200.

Berry, P. 2009. Breeding for improved nitrogen use efficiency in oilseed rape, European Workshop. N fertilization of winter oilseed rape, 23–24 March. Berlin. Germany.

Brennan, R. F., M. G. Mason. and G. H. Walton 2000. Effect of nitrogen fertilizer on the concentrations of oil and protein in canola (*Brassica napus* L.) seed. J. Plant Nutr. 23: 339-348.

Degenhart, D. F. and Z. P. Kondra. 1981. The influence of seeding date and seeding rate on seed yield and yield components of five genotypes of (*Brassica napus* L.). Canadian J. Plant Sci. 61: 175-183.

Faraji, A., N. Latifi, A. Soltani. and A. H. Shiranirad. 2009. Seed yield and water use efficiency of canola (*Brassica napus* L.) as affected by high temperature stress and supplemental irrigation. Agric. Water Manage. J. 96: 132- 140.

Ferre, I., M. G. Robertson, G. H. Walton. and S. Asseng. 2002. Simulating phenology and yield response of canola to sowing date in Western Australia. Aust. J. Agric. Res. 53: 1155-1164.

Ghalibaf, M., H. Alyari. and K. Golozani. 2000. Different sowing date effects on yield and yield component of four autumn canola cultivars. J. Agric. Sci. 10(1): 55-62. (Abstract in English)

Hocking, P. J. and M. Stapper. 2001. Effect of sowing time and nitrogen fertilizer on canola and wheat on Indian mustard. Aust. J. Agric. Res. 52: 633-644.

Hopkins, W. G. and N. P. A. Hunter. 2004. Introduction to Plant Physiology. 3rd Ed. John Wiley and Sons Inc. New York. USA. ISBN: 978-0-471- 38915-6. 576 pp.

Jackson, G. D. 2000. Effects N and S on canola yield and nutrient uptake. Agron. J. 92: 644-649.

Jenkins, P. D. and M. H. Leitch. 1986. Effects of sowing date on the growth and yield of winter oilseed rape (*Brassica napus* L.). J. Agric. Sci. 105: 405–420.

Malakouti, M. J., A. Bybordi, M. Lotfollahi, A. A. Shahabi, K. Siavoshi, R. Vakil, J. Ghaderi, J. Shahabifar, A. Majidi, A. R. Jafarnajadi, F. Dehghani, M. H. Keshavarz, M. Ghasemzadeh, R. Ghanbarpouri, M. Dashadi, M. Babaakbari. and N. Zaynalifard. 2008. Comparison of complete and sulfur coated urea fertilizers with preplant urea in increasing seed yield and nitrogen use efficiency in wheat. J. Agric. Sci. Tech. 10: 173-183.

Mendham, N. J., J. Russel. and N. K. Jarosz. 1990. Response to sowing time of three contrasting Australian cultivars of oilseed rape (*Brassica napus* L.). J. Agri. Sci. 114: 275-283.

Mendham, N. J., P. A. Shipway. and R. K. Scott. 1981. The effect of delayed sowing and weather on growth, development and yield of winter oil seed rape. J. Agric. Sci. 97: 389-415.

Nykiforuk, C. L. and A. M. Johnson Flanagan. 1994. Germination and early seedling development under low temperature in canola. Crop Sci. J. 34: 1047-1057.

Ozturk, O. 2010. Effects of source and rate of nitrogen fertilizer on yield, yield components and quality of winter rapeseed (*Brassica napus* L.). Chilean J. Agric. Res. 70: 132-141.

Pasban-Eslam, B. 2011. Study of possibility of delayed planting of oilseed rape (Brassica *napus* L.) in east Azerbaijan in Iran. Seed and plant Improvement. J. 27(3): 269-284. (Abstract in English)

Rabiee, M., M. M. Karimi. and F. Safa. 2004. Effect of planting date on seed yield and agronomic traits of rapeseed cultivars as the second crop after rice in Kuchesfahan. Iranian J. Agri. Sci. 35(1): 187-177. (Abstract in English)

Rahnama, A. A. 2010. Effect of sowing date on the yield and yield components of two canola cultivars in Khuzestan area. Modern Sci. Sust. Agri. J. 6(20): 13-22. (Abstract in English)

Rahnama, A. A. and A. Jafarnejady. 2009. Determination of optimum nitrogen levels in different planting dates of canola in Khuzestan. Plant Prod. (Sci. J. Agri.). 32(1): 53-63. (Abstract in English)

Rathke, G. W., O. Christen. and W. Diepenbrock. 2005. Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (*Brassica napus* L.) grown in different crop rotations. J. Field Crops Res. 94: 103-113.

Robertson, M. J. and J. F. Holland. 2004. Production risk of canola in the semi-arid subtropics of Australia. Aust. J. Agri. Res. 55: 525-538.

Saran, G. and G. Giri. 1987. Influence of dates of sowing on Brassica species under semi-arid rainfed conditions of Northwest India. J. Agri. Sci. 108: 561-566.

Scarisbrick, D. H., R. W. Daniels. and M. Alcock. 1981. The effect of sowing date on yield and yield components of spring oilseed rape. J. Agri. Sci. 97: 189-195.

Sieling, K. and H. Kage. 2006. N balance as an indicator of N leaching in an oilseed rape-winter wheat-winter barley rotation. Agri. Eco-syst. Environ. J. 115: 261–269.

Taylor, A. J. and C. J. Smith. 1992. Effect of sowing date and seeding rate on yield and yield components of irrigated canola (*Brassica napus* L.) growing on a red brown earth in south- eastern Australia. Aust. J. Agric. Res. 43: 1929-1941.

Thurling, N. 1974. Morpho physiological determinants of yield in rapeseed (*Brassica campestris* L. and *Brassica napus* L.). Yield components. Aust. J. Agric. Res. 25: 711-721.

White, C., S. Roques. and P. Berry. 2015. Effects of foliar applied nitrogen fertilizer on oilseed rape (*Brassica napus* L.). J. Agri. Sci. 153: 42-55.

Whitfield, D. M. 1992. Effect of temperature on colza exchange of pod of oil seed rape. J. Field crops Research. 22: 4 -10.