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INFLUENCE OF SOWING DATES AND NITROGEN FERTILIZER ON GROWTH AND YIELD OF CANOLA

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ABSTRACT: This investigation was performed during 2000/2001 and 2001/2002 winter seasons at the Agricultural and Veterinary Training and Research Station, King Faisal University to study the influence of sowing dates (mid of Oct., Nov. and Dec.) and nitrogen levels (50, 100, 150 and 200 kg N/ha) on growth, yield and yield components of canola "cv. Pactol". Results revealed that sowing dates significantly affected all estimated characters, except stem diameter and seed oil content. Early sowing date (mid-Oct.) was associated with the highest leaf area, plant duration, plant height, number of lateral branches and pods / plant, seeds / pod, 1000-seed weight, seed weight/ plant as well as seed and oil yields/ha. Nitrogen levels exerted significant effects on all studied characters. Increasing nitrogen levels resulted in marked increases in all estimated characters, except seed oil content which markedly decreased as nitrogen rate increased. The application of 150-200 kg N/ha was the adequate rate for canola production. The interaction between sowing dates and nitrogen levels significantly affected seed and oil yields/ha. The highest seed yield/ha was produced with the early sowing of mid-Oct. and the addition of 150-200 kg N / ha. Oil yield/ha reached its maximum with sowing during mid- Oct. to mid-Nov. and the addition of 150-200 kg N/ha.

Generally, it can be stated that sowing canola on mid-Oct and the addition of 150–200 kg N/ha was the recommended treatment for raising canola production under Al-Hassa Oasis conditions.

INTRODUCTION

Canola is the second most valuable commodity in the agricultural trading. It has expanded rapidly in the past two decades (Scarisbrisck and Ferguson, 1995) and therefore in many temperate regions there is still little knowledge developed on the comparative behavior of canola.

Sowing time is an important factor that determines the length of growing season and hence yields. Early spring sowing of canola delayed flowering and reduced reflection of radiation during flowering which were important factors leading to the highest yields achieved by late sowing (Jenkins and Leitch, 1986). Fribourg *et al.* (1989) showed that Sept. plantings of winter canola in Tennessee yielded significantly higher than Oct. one. Planting date studies were also conducted in western Kentucky by Herbek and Murdock (1989) reported that early sowing date significantly yielded the highest. Jasinska *et al.* (1989) reported that seed and oil yields / ha decreased with delaying sowing date. Johnson *et al.* (1995) reported that the greatest canola seed yield / ha was recorded when sown in early and mid-May with reductions occurring at the later sowing dates. Leto *et al.* (1995) found that sowing on mid-November produced the highest seed yield / ha compared to sowing on 31 October, 30 November or mid-Dec. Christmas (1996) revealed that plantings made during Sept. are most likely to be successful with both Aug. and Oct. plantings and showed that winter rape can be successfully grown in northern Indiana and if sown between 25 August and 20 September and that sowings made during September are most likely to be successful in southern Indiana. Christmas and Janick (1996) stated that winter canola can be successfully grown in northern Indiana if planted between mid- Aug. 25 and Sept. 20. Plantings which were made after Sept. 20 will result in significant yield reductions or total loss of the crop. Starner *et al.* (1996) reported that optimum sowing dates for rape "cv. Cascade" were at late Sept. or early Oct. Meanwhile, Nehra *et al.* (1997) found that seed yield of *Brassica campestris, L.* decreased as sowing date was delayed. Miralles *et al.* (2001) stated that developmental patterns were

greatly affected by sowing date. Sharief and Keshta (2002) stated that early sowing of canola on 5th Nov. resulted in marked increases in plant height, number of branches / plant as well as seed yield / plant, seed, biological and oil yields, compared with that sown on 15th Oct. and 25th Nov. However, the highest seed oil percentage was obtained from early planting on mid-Oct.

Fertilization is among the vital factors affecting growth, yield and quality of canola, especially nitrogen. Nitrogen is referred as a balance wheel of plant nutrition. Canola is extremely sensitive to nitrogen fertilizers, especially under the dry conditions. Application of nitrogen resulted in marked increases in seed and oil yields/ha (Brennan *et al.*, 2000). The addition of 100–200 kg N ha^{-1} was associated with marked increases in seed and oil yields, but seed oil content was significantly decreased as nitrogen fertilizer rate increased (Sheppard and Bates, 1980; Ibrahim *et al.*, 1989; Taylor *et al.*, 1991; Nuttal *et al.*, 1992 and Cheema *et al.*, 2001). Hocking *et al.* (1997) stated that the highest dry matter production and seed yields were obtained with the addition of 75 kg N ha^{-1}. They also added that seed oil contents and harvest indices were not affected by nitrogen rates.

The present investigation was set up to study the influence of sowing dates, nitrogen fertilizer levels and their interaction on growth, yield and yield components of canola "cv. Pactol" aiming to arrive with the suitable sowing date and optimum nitrogen rate under the conditions of Al-Hasa Oasis.

MATERIALS AND METHODS

Experimental design and treatments

This work was performed on the experimental field of the Agricultural and Veterinary Training and Research Station, King Faisal University, KSA during 2000/2001 and 2001/2002 seasons on a sandy calcareous soil. CV. Pactol seeds were sown on three different dates, middle of Oct., Nov. and Dec. Each sowing date was conducted in a separate experiment. Each one was designed as a randomized complete block with six replications contained four nitrogen levels, i.e. 50, 100, 150 and 200 kg N/ha. The

experimental unit included 5 ridges 60 cm in width and 4.0 m length, occupying an area of 12.0 m^2.

Agricultural treatments/practices:

After well seedbed preparation and the experimental site dividing, canola seeds (cultivar Pactol) were sown in hills, 15 cm apart within ridges, as the usual dry method of planting. Seeding rate was 4.5 kg/ha. Plants were thinned 28 days after sowing, leaving one (the healthy) plant/hill. Nitrogen was given as urea (46.5 % N) in two equal portions, before sowing and after thinning, just before the second irrigation. All plots were irrigated immediately after sowing. Recommended fungicides and insecticides were applied to prevent diseases and insect damages. Weeds were removed manually throughout the growing season. All other agriculture practices were also done as recommended for ordinary canola production.

Plant measurements:

Leaf area/plant (cm^2) was estimated at 90 days after sowing, using leaf area meter. Plant duration, days from sowing to harvest, was counted per each treatment. At harvest, when canola plants turned a straw color and seeds colored dark brown, five guarded plants were labelled from each experimental unit, uprooted, tied and left to dry, thereafter the following characters were estimated: Plant height (cm), stem diameter (cm), number of lateral branches/plant, number of pods /plant, number of seeds/pod, seed weight/plant (g), 1000-seed weight (g). Plants in the two central ridges in each plot were harvested for seed yield/m^2, which converted to record seed yields (t/ha).

Seed oil percentage was determined according to A.O.A.C. (1984), then the oil percentage was calculated on dry weight basis. Oil yield (kg/ha) was calculated by multiplying seed yield (t/ha) by seed oil percentage.

Statistical analysis:

The recorded data in the two seasons were subjected to the proper analysis of variance, according to Gomez and Gomez (1984). The homogeneity test of error variances indicated that errors were homogeneous and thus, combined analysis was performed. New Least significant difference (NLSD) at 0.05 % level of significant was used to compare the treatment means (Waller and Duncan, 1969). Computations

were done using SAS, V 6.12 (1996).

RESULTS AND DISCUSSION

A: Sowing date effects:

Data listed in Tables 1,2 and 3 show averages of growth characters and yield components of canola in relation to sowing dates. The statistical analysis of data indicated a significant difference at 5% level of probability for sowing date on all estimated characters, except stem diameter and seed oil content. In both seasons of study, early sowing of canola (mid-Oct.) significantly surpassed both mid-Nov. and mid-Dec. planting in leaf area, plant duration, plant height, number of lateral branches /plant and seed yield/plant. However, the late sowing (mid-Dec.) resulted in a significant reduction in aforementioned characters. The weather during pod and seed formation stages in the late sowing date was very warm resulting in reduction in leaf area, plant height and number of branches /plant (growth parameters) with about 10%, comparing with more than 25% reduction in number of pods/plant and seeds/pod. This trend indicates that late sowing date was much influence seed yield via affecting flowering more than growth. Furthermore, equal reduction in 1000-seed weight and leaf area (phytosynthesized tissue) indicates that the reduction in leaf area in late sowing date is the main factor influencing filling of seeds. Therefore, the increase in growth and yield components with the early sowing of mid-Oct. might be due to the long plant duration and the suitable climatic conditions for canola growth, especially at flowering period and seed formation stages and hence yield potential components were increased. Diepenbrock (2000) came to similar observations.

Data listed in Table (3) show that seed oil content was not affected by sowing date, however the early sowing of mid-Oct. resulted in insignificant increase in seed oil content, compared to the late sowing of mid-Dec. Seed and oil yields/ha were significantly affected by sowing date in the two seasons (Table 3). Over both seasons, seed yields decreased from 3.201 t/ha to 2.820 and 2.321 t/ha with delay planting from mid-Oct. to mid-Nov. and mid-Dec., respectively. The first planting date gave the highest seed yield and it was significantly different from the second and third planting

dates. However, the difference in seed yield obtained from the second and third planting dates was significant in the two seasons of study. The increases in seed yield may be attributed to the increases in number of lateral branches and pods / plant, seeds/pod and 1000-seed weight. These results are similar to these obtained by Thomas *et al.* (1990), Leto *et al.* (1995), Starner *et al.* (1996) and Saini and Sidhu (1997). The late sowing date (mid-Dec.) resulted in significantly lower oil yield than mid-Nov. planting date. However, the second planting date (mid-Nov.) resulted in significantly lower yield than mid-Oct. Oil yield (kg/ha) followed the same trend of seed yield (ton/ha). It decreased from 1287.6 to 1127.3 and 923.7 kg/ha with delay planting from mid-Oct. to mid-Nov. and mid-Dec., respectively. The increase in oil yield with the early planting date (mid-Oct.) may be due to the increase in seed yield/ha.

Table (1): Leaf area/plant (cm^2), days from sowing to maturity (duration), plant height (cm) and stem diameter (cm) of canola (CV. Pactol) as affected by sowing dates and nitrogen levels in 2000/2001(I) and 2001/2002(II).

Characters	Leaf area (cm^2)		Plant duration		Plant height (cm)		Stem diameter (cm)	
Seasons	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
A. Sowing dates:								
Mid of Oct.	256.3	308.7	192.4	194.5	180.0	183.9	2.2	2.2
Mid of Nov.	243.9	286.8	178.0	175.9	178.2	174.4	2.1	2.2
Mid of Dec.	230.3	279.2	160.5	166.1	160.3	166.5	2.1	2.1
F.Test	**	**	**	**	**	**	NS	NS
NLSD(5%)	14.8	17.4	1.3	1.2	1.4	1.0	---	---
B. N-Levels:								
50 kg N/ha	155.5	188.7	169.9	172.2	157.1	156.6	1.9	1.9
100 kg N/ha	203.2	226.8	174.7	176.5	171.2	175.9	2.1	2.1
150 kg N/ha	263.0	303.5	178.8	180.8	177.7	180.7	2.2	2.3
200 kg N/ha	352.4	447.4	184.4	185.8	185.2	186.6	2.4	2.5
F.Test	**	**	*	*	**	**	**	**
NLSD(5%)	8.6	6.8	1.2	1.2	1.9	1.2	0.1	0.1

Table (2): Number of branches and pods/plant, seeds/pod and 1000-seed weight (g) and seed weight (g/plant) of canola (CV. Pactol) as affected by sowing dates and nitrogen levels in 2000/2001(I) and 2001/2002(II) seasons.

Characters	Branches/plant		Pods / plant		Seeds / pod		1000-seed wt. (g)	
Seasons	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
A. Sowing dates:								
Mid of Oct.	17.3	17.9	186.5	206.0	49.2	53.2	2.8	2.9
Mid of Nov.	15.8	16.5	166.6	184.8	35.1	37.5	2.7	2.7
Mid of Dec.	14.2	14.9	140.1	150.0	35.4	38.3	2.5	2.6
F.Test	**	**	**	**	*	*	**	**
NLSD(5%)	1.5	1.3	10.5	13.6	1.4	3.2	0.1	0.1
B. N-Levels:								
50 kg N/ha	13.5	13.6	126.0	144.0	25.5	26.4	2.3	2.5
100 kg N/ha	13.9	15.4	154.7	163.3	35.5	42.3	2.7	2.7
150 kg N/ha	17.1	17.9	176.4	199.1	48.7	51.0	2.8	2.8
200 kg N/ha	18.5	18.8	200.4	214.6	50.0	52.3	2.8	2.9
F.Test	**	**	**	**	**	**	*	*
NLSD(5%)	1.8	0.9	12.0	11.3	3.6	4.6	0.1	0.1

Table (3): Seed weight/plant (g), seed oil (%), seed yield (ton/ha) and oil yield (kg/ha) of canola (CV. Pactol) as affected by sowing dates and nitrogen levels in 1999/2000 (I) and 2000/2001 (II) seasons.

Characters	Seed weight/ plant (g)		Seed oil (%)		Seed yield (ton/ha)		Oil yield (kg/ha)	
Seasons	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
A. Sowing dates:								
Mid of Oct.	37.1	41.4	40.6	40.4	3.028	3.374	1221.709	1353.4
Mid of Nov.	35.3	40	40.4	40.2	2.657	2.983	1065.477	1189.1
Mid of Dec.	28.5	34	40.0	40.1	2.249	2.393	894.3	953.0
F.Test	**	**	NS	NS	**	**	**	**
NLSD(5%)	1.8	2.5	---	---	0.281	0.213	134.2	117.9
B. N-Levels:								
50 kg N/ha	23.2	26.1	41.8	41.7	1.645	1.74133	688.4	726.9
100 kg N/ha	32.8	37.3	40.8	40.9	2.353	2.65533	961.9	1085.6
150 kg N/ha	37.9	44.3	39.6	39.2	3.160	3.395	1251.0	1332.6
200 kg N/ha	40.6	56.2	39.2	39.1	3.419	3.875	1340.6	1515.6
F.Test	**	**	**	**	**	**	**	**
NLSD(5%)	1.1	1.4	0.6	0.7	0.198	0.203	112.8	101.7

B: Nitrogen level effects:

Data presented in Tables 1, 2 and 3 show that N-fertilizer levels had significant effects on all estimated characters, in the two seasons. Raising nitrogen fertilizer levels from 50 to 100, 150 and 200 kg N/ha resulted in marked increases in leaf area, plant duration, plant height, stem diameter, number of pods/plant and seed weight/plant. However, the differences in number of branches/plant, seeds/pod and 1000- seed weight with raising nitrogen level from 150 to 200 kg N/ha were not significant at 5 % level of probability. Wide variations were found on the optimum nitrogen levels, ranging from 75 (Hocking *et al.,* 1997) to 90 (Cheema *et al.*, 2001), 134 (Nuttal *et al.*, 1992) and 200 kg N/ha (Taylor *et al.*, 1991). The increase in growth characters and yield components with the increase of nitrogen levels might be due to the role of nitrogen in stimulating foliage growth. The nitrogen supply to the plant influences the amount of protein, protoplasm and chlorophyll formed. In turn, this influences cell size and leaf area, and thus photosynthetic activity (Gardner *et al.*, 1985 and Salisbury and Ross, 1994).

Seed oil content was significantly decreased as nitrogen fertilizer rate increased. Over both seasons, seed oil content decreased from 41.8 to 40.9, 39.4 and 39.2% with increasing nitrogen levels from 50 to 100, 150 and 200 kg N/ha, respectively. Similar results were reported by Sheppard and Bates (1980), Ibrahim *et al.* (1989) and Hocking and Stapper 2001). The reduction in seed oil content could be probably attributed to the sugar translocation affecting oil synthesis (John, 1992 and Salisbury and Ross, 1994). Alternating enzymes imbalance could also contribute in this reduction (John, 1992).

Nitrogen levels had marked effects on seed and oil yields/ha, in the two seasons of investigation. The increase in nitrogen levels resulted in significant increases in seed yield. Over both seasons, seed yield increased from 1.693 to 2.504, 3.278 and 3.647 t/ha with increasing nitrogen levels from 50 to 100, 150 and 200 kg N/ha, respectively. The increase in seed yield with the increase of nitrogen rate might be due to increase in most of yield components (Number of pods/plant, seeds/pod, 1000-seed weight and seed weight /plant). Brennan *et al.* (2000) and

Fig. (1): Seed yield (ton/ha) in relation to the interaction between sowing dates and nitrogen levels in the first season.

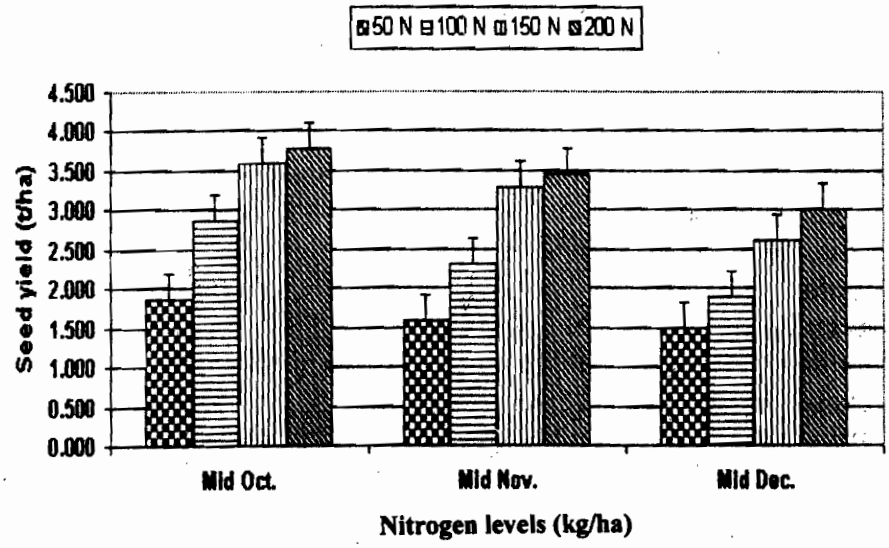


Fig. (2): Seed yield (ton/ha) in relation to the interaction between sowing dates and nitrogen levels in the second season.

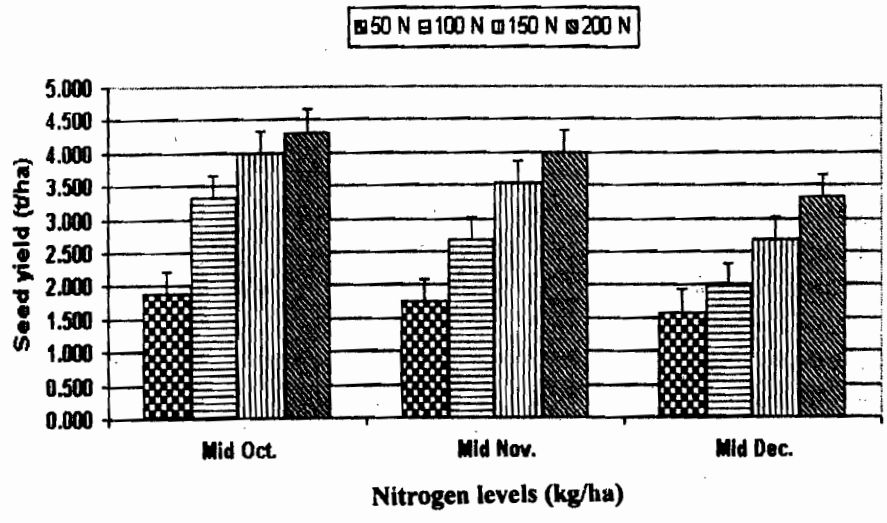


Fig. (3): Oil yield (kg/ha) in relation to the interaction between sowing dates and nitrogen levels in the first season.

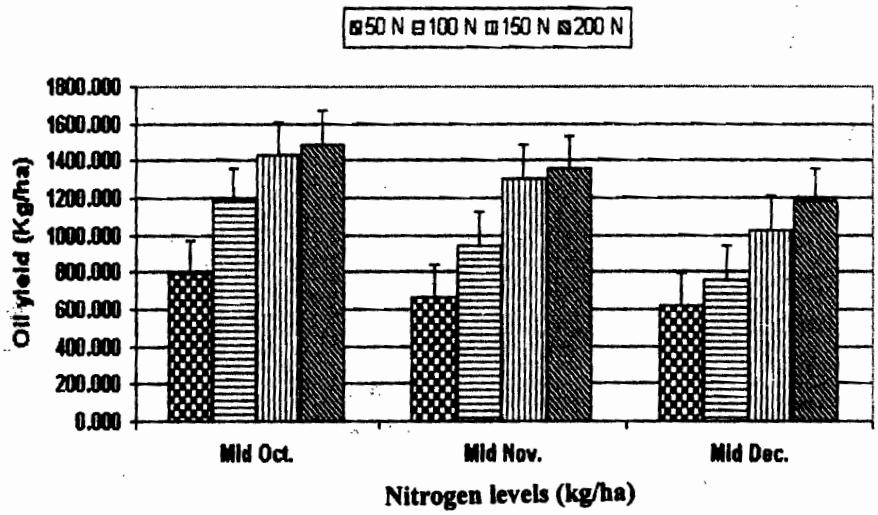
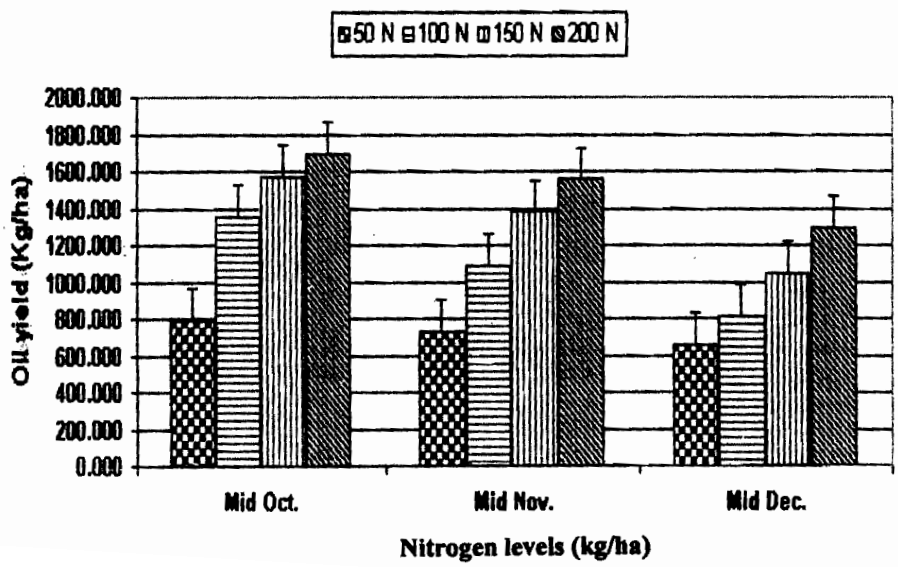


Fig. (4): Oil yield (kg/ha) in relation to the interaction between sowing dates and nitrogen levels in the second season.



Hocking and Stapper (2001) came to similar observations. Although the percentage of oil decreased with the addition of nitrogen, the total oil yield/ha increased because of the increased yield with the increase of nitrogen rate. Over both seasons, oil yields increased from 707.7 to 1023.8, 1291.8 and 1428.1 kg/ha with the increase of nitrogen fertilization from 50 to 100, 150 and 200 kg N/ha, respectively.

C: Interaction effect:

In the two seasons, the interaction between sowing dates and nitrogen fertilizer levels had significant effects on seed and oil yields / ha (Figs 1–4). In the two seasons, the early planting of canola on mid-Oct. and the addition of 150-200 kg N / ha recorded the highest seed yield, but the lowest seed yield was obtained with the late planting of mid-Dec. and the addition of 50 kg N / ha. The highest oil yield / ha was also produced with sowing canola on mid-Oct. and fertilizing with 150-200 kg N/ha. Within the early sowing date (mid-Oct.), the difference between oil yield produced with the addition of 150 and 200 Kg N/ha did not reach the level of significance.

Generally, it can be concluded that early planting canola on mid-Oct. is considered the most suitable sowing date for canola and the addition of 150–200 kg N/ha is the adequate nitrogen rate for canola production. However, if sowing canola have been delayed until mid-Nov., the high level of nitrogen (200 kg N/ha) can relatively compensate the delaying in sowing date under the environmental conditions of Al-Hassa Oasis.

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تأثير ميعاد الزراعة والتسميد النيتروجيني على نمو ومحصول الكانولا

عبد الرحيم عبد الرحيم ليله* و سليمـــــان بن علي الخطيب* وسامي بن سعد الثابت* وخالد بن محمد البراك**

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أجريت هذه الدراسة بمحطة التدريب والأبحاث الزراعية والبيطرية، جامعة الملك فيصل بالأحساء خلال موسمي ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ لدراسة تأثير مواعيد الزراعة (منتصف أكتوبر، نوفمبر وديسمبر) ومستويات التسميد النيتروجين (٥٠، ١٠٠، ١٥٠ و ٢٠٠ كجم ن/هكتار) على النمو والمحصول ومكوناته للكانولا "صنف باكتول".

وقد أشارت نتائج الدراسة أن مواعيد الزراعة قد أثرت معنويا على جميع الصفات تحت الدراسة باستثناء سمك الساق ومحتوى البذور من الزيت. وقد أدى تأخير الزراعة عن منتصف أكتوبر إلى إحداث نقص معنوي في معظم الصفات بالدراسة وبلغ محصول البذور والزيت أقصاه بالزراعة في منتصف أكتوبر.

وأوضحت الدراسة أن التسميد النيتروجيني أثر معنويا على جميع الصفات وقد أدت الزيادة المتدرجة في معدلات النيتروجين حتى أعلى معدل إضافة (٢٠٠ كجم ن/هكتار) إلى زيادة واضحة في كل الصفات المقاسة، ما عدا نسبة الزيت بالبذور والتي نقصت قيمتها معنويا مع زيادة معدلات التسميد النيتروجيني. وأوضحت النتائج أن معدل ١٥٠-٢٠٠ كجم ن/هكتار يعتبر كاف لتسميد الكانولا لإنتاج البذور والزيت. وأشارت النتائج أيضا أن التفاعل بين مواعيد الزراعة ومعدلات النيتروجين قد أثر معنويا على محصول البذور والزيت/ هكتار، وقد أدت الزراعة المبكرة (في منتصف أكتوبر) والتسميد بمعدل ١٥٠- ٢٠٠ كجم ن / هكتار إلى الحصول على أعلى محصول بذرة وزيت /هكتار.

وبصفة عامة، يمكن التوصية بزراعة الكانولا "الصنف باكتول" خلال منتصف أكتوبر- منتصف نوفمبر والتسميد النيتروجيني بمعدل ١٥٠-٢٠٠ كجم ن/هكتار لزيادة إنتاجية وحدة المساحة من محصول البذور والزيت للكانولا تحت ظروف محافظة الأحساء.