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Performance of Canola (*Brassica napas* L.) Seed Yield, Yield Components and Seed Quality under the Effects of Four Genotypes and Nitrogen Fertilizer Rates

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Abstract. This study was conducted at the Agricultural Research Station, Hada El-Sham, King Abdulaziz University during 2006 and 2007 seasons. Four canola varieties, Callypso, Pactole, Sero-4 and Sero-6 varieties were tested under four nitrogen fertilizer rates (0.00, 92,138 and 184 kg N/ha) to determine the effect of nitrogen fertilizer on the canola (*Brassica napus* L.) seed yield, yield components and seed quality. The results showed that as nitrogen fertilizer rate increased, plant height, number of fruit / plant, 1000-seed weights, seed weight / plant and protein content increased. However oil content (%), was the highest under 92 kg nitrogen rate, then significantly decreased under the higher nitrogen rates. In terms of variety differences, the plant height data revealed that Sero-4 was the taller, followed by Sero-6, and then Callypso and Pactole varieties and Pactale and Sero-6 varieties produced the highest number of fruits / plant and significantly dominated over the Sero-4 and Callypso variety. In addition, Pactale and Sero-4 had the highest 1000-seed weights without significant differences between them, while Callypso variety was the lowest. Pactole variety was also the highest in seed weight / plant, while Sero-4 and Sero-6 varieties were not significantly different in seed weight / plant. Pactole variety was the highest in protein content followed with a significant difference by Sero-4, then Sero-6, while the lowest variety in protein content was Callypso variety. The rate of 138 kg N / ha produced the highest seed yield / ha (1550.51 kg), protein content (28%) and had 34.10% oil content. Oil content of the studied varieties ranged from 37.80% for Callypso variety to 32.04% for Sero-4 variety, and the statistical comparisons showed significant differences among the four studied varieties. Furthermore, iodine value and refractive index of the oil under the effects of nitrogen fertilizer rates were not significantly different from each other and the same behavior of iodine value and refractive index values were detected.

Introduction

Canola is a member of the *Brassicaceae* family and has become one of the most important sources of vegetable oil in the world. Its oil also has potentially developed in the bio-diesel market. In addition to oil production, the leaves and stems of canola provide high quality forage matter because of their low fiber and high protein content (Wiedenhoeft and Bharton, 1994) and can be milled into animal feeds (Ban˜uelos, *et al*., 2002). Canola (*Brassica napus* L.) is a specific type of rape seed associated with high quality oil and meal. It has less than 2% erucic acid and its meal has less than 30 µg of glucosinolates. It contains 40-45% oil and 36-40% protein. Oil and meal are now very acceptable as alternatives to soyabean oil and meal (Amin and Khalil, 2005; Muhammad, *et al*., 2007**.** Canola grows well in dry environments and can tolerate moderately saline soil conditions (Ban˜uelos, *et al*., 1997 and Stricker, *et al*., 1997).

Nitrogen is a major nutrient element which provides lush green color to the plant due to increase in chlorophyll. Phosphorus is necessary for young and fast growing tissues and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrates (Shah, *et al*., 2004). Fertilizers containing nitrogen and phosphorus gave a larger increase in the yield of rape than wheat (Reauz, *et al*., 1983) and phosphorus doses up to 180 kg/ha increased yield and oil content in winter rape (Shah, *et al*., 2004). Nitrogen plays a key role in plant growth and protein synthesis, protoplasm, cell size, and photosynthetic activity and thus provides a huge frame on which more flowers and pods are produced (Yasari and Patwardhan, 2006).

Nitrogen (N) fertilizer increases yield by influencing a variety of growth parameters such as the number of branches per plant, the number of pods per plant, the total plant weight, the leaf area index (LAI). Also, it increases the number and weight of pods, seeds and flowers per plant, and overall crop assimilation, contributing to increased seed yield (Wright, *et al*., 1988 and Al-Barrak, 2006). Excess nitrogen rate, however, can reduce seed yield and quality appreciably (Al-Barrak, 2006). As to nitrogen sources, highest yields were obtained with ammonium-sulphate as compared to ammonium nitrate (Rechcigl and Colon, 2000 and Farahbakhsh, *et al.,* 2006). High N applications were found to cause lodging (Wright, *et al.,* 1988 & Bailey and Grant, 1990). Taylor, *et al*. (1991), observed that split applications of N were not more effective than application of the total amount of N at seeding. The highest rates of fertilizer application were reported to give significantly higher total dry weight than the lowest rate of fertilizer application (Singh, *et al*., 1991 & Kjellstrom, 1993). Taylor, *et al.* (1991) reported that despite seasonal differences, shoot dry matter significantly increased as application rate of fertilizer increased. Kumar, *et al.* (1997) also reported higher total dry matter production with increased rate of fertilizer application. Bhan (1976) reported that the average seed production was high when 40-80 kg nitrogen, 30-60 kg phosphorus and 40 kg potassium per hectare were applied. Singh and Rathi (1985) reported that increase in nitrogen significantly increased the crop yield, they observed highest yield with 160kg ha^{-1}. Mudholkar and Ahlawat (1981) reported that nitrogen significantly increased the growth and yield components with highest rate of NP combination. Ali and Rahman (1986) reported that increasing rates of N up to 160 kg ha^{-1} progressively increased the growth and yield components. Scarisbrick, *et al*., (1980) reported that all the growth and yield components were increased with increasing nitrogen 100, 130 and 200 kg ha^{-1}.

Significant differences in the number of pods per plant were observed amongst the different fertilizer rates and the number of pods per plant increased linearly with increasing rates of nitrogen up to 180 kg N (Basak, *et al*., 1990; Chauhan, *et al*., 1995; Arthamwar, *et al*., 1996 & Nielson, 1997). The number of seeds per pod and 1000-seed weight was significantly increased with increasing levels of nitrogen fertilizer application (Scarisbrick, *et al*., 1980 & Chauhan, *et al*., 1995). Arthamwar, *et al.* (1996) reported an improvement in the canola seed yield and oil content by applying Zn and Fe fertilizers (foliar sprays) along with N and K. A 1.5% increase in oil content of seeds of rapeseed was observed by Laaniste, *et al.* (2004) due to additional application of sulfur. Application of nitrogen fertilizer was reported by Ramsey and Callinan (1994) and Brennan, *et al*. (2000) in canola and Mohan and Sharma (1992) in Indian mustard. Seed yield of canola increased in response to higher nitrogen fertilizer application, with maximum yields (3.99 t/ha) being attained under the highest N rate**,** (Hocking, *et al*., 1997a and Kumar, *et al*., 1997). El-Nakhlawy and El-Fawal (1991) in Saudi Arabia stated that rapeseed oil content significantly decreased as nitrogen fertilizer rate increased especially after the 131 kg N/ha, while El-Nakhlawy (1996) in Egypt found a significant increment as nitrogen rate increased up to 90 kg N/ha. An adequate application of N fertilizer enables the crop to produce rapid leaf growth which may positively contribute in seed filling**.** This is reflected in efficient partitioning of assimilate into economic yield resulting from the greater number of pods per plant and number of seeds per pod (Al- Barrak, 2006).

Fertilizer application did not significantly affect the seed oil content, but the highest rate was associated with light decrease in seed oil content in canola (Al-Barrak, 2006; Hocking, *et al*., 1997b; Leilah and Al-Khateeb, 2003). Leilah, *et al.*, (2002) considered the most effective dose in maximizing the final canola yield/ha was 150 kg N ha^{-1} with no significant differences appearing when N fertilization increased to 200 kg N ha^{-1} under Al-Hassa conditions. Fernandez, *et al.* (1986) reported that nitrogen rates of 0-150 kg/ha had no appreciable effect on oil content but rates higher than 200kg/ha reduced oil content by 8-9%. Muhammad, *et al.* (2007) concluded that different sources of N fertilizer did not show significant improvement in oil and seed yield of canola (*Brassica napus* L.).

Khehra and Singh (1988) studied 29 genotypes of *Brassica napus* L. and reported significant differences for seed yield, number of siliqua, number of secondary branches and plant height. Also, Paramjit, *et al.* (1991) studied 29 genotypes of *Brassica napus* L. for nine quantitative traits and found significant variability for various seed yield related traits. Several investigators (Khoshanazar, *et al.*, 2000; Kolte, *et al.*, 2000; Stringam, *et al.*, 2000) compared different mustard and rapeseed cultivars and reported that all cultivars differed significantly for seed oil yields. Sana, *et al.* (2003) concluded that the variation in plant height of different varieties may be attributed to their genetic potential and the number of siliqua branches per plant is the result of combined effect of genetic make up of the crop and environmental conditions, which play a remarkable role towards the final seed yield of the crop. Variable number of branches per plant among different varieties, which have been related to be under genetic management control, has also been reported by Labana, *et al.* (1987) and Khehra and Singh (1988). Significant differences in the number of siliquas per plant among different cultivars of brassica and significant differences in seed yield among different varieties of brassica species were reported (Khehra and Singh, 1988 & Reddy and Reddy, 1998). Significant differences for 1000-seed weight among different brassica varieties were also reported (Munir and McNeilly, 1992; Hashem, *et al.* 1998; Reddy and Reddy, 1998; Om, *et al.*, 1998; Khoshnazar, *et al.,* 2000 & Sana, *et al.,* 2003). Sana, *et al.* (2003) concluded that certain cultivars may be susceptible to environmental factors while others may be tolerant. In addition, it was reported that different brassica varieties differed significantly regarding their plant heights (Maestro, 1995 & Reddy and Reddy, 1998). However, Munir and McNeilly (1992) found no significant difference for the number of seeds per siliqua between different brassica varieties.

Differences in oil yields of different brassica species were reported (Gentent, *et al*., 1996; Das, 1998 & Baranyk and Zukalova (2000). Bengtsson (1988) reported 9% difference between two varieties of winter rape, while Gentent, *et al.* (1996) observed 2.3% differences between different *Brassica carinata* lines for seed oil content. Sana, *et al.* (2003) concluded that the maximum oil content obtained from some canola (Con 11) might be due to the variation in genetic make up of the variety.

This investigation aims to study the performance of seed yield, yield component and seed quality of four canola varieties under the effects of four nitrogen fertilizer rates.

Materials and Methods

This investigation was conducted at the Agricultural Experiment station, Hada El-Sham, King Abdulaziz University during 2006 and 2007 seasons. Four canola varieties: Callypso and Pactole varieties introduced from Germany and Sero-4 and Sero-6 varieties introduced from Egypt, were tested under four nitrogen rates; 0.00, 92, 138 and 184 kg N/ha in a split plot design with Latin Square arrangement for the nitrogen fertilizer rates as main plot treatments, and the sub plots were occupied with the four canola varieties. Four replicates were used in the two studied seasons (Steel and Torrie, 2000). Sub plot consisted of 7 rows with 40 cm apart and 4 m long. The experiments were cultivated in soil characterized with 8.03 pH, 1.15 DSM^{-1}, 0.501% organic matter and 0.18% N. Before planting, 100kg P_2O_5/ha and 50 kg K_2O /ha were added and incorporated with the soil.

The two seasons' experiments were planted in January 18th and 23rd, respectively. Spraying irrigation was used in this study. Other recommended cultural practices were applied during the period of the experiments. At harvesting ten random guarded plants were chosen from each sub plot and the data of plant height (cm), no. of fruits/plant and seed weight/plant (g) were recorded. Seed yield/ha (kg) was recorded from the yield of the inner 5 rows then converted into kg seed/ha.

Two random seed samples were withdrawn from the seeds of each sub plot and used to estimate the 1000-seed weight (g). Protein content of the seed (%) was determined using Kjeldahl method (A.O.A.C., 2000). Oil content of the seeds (%) was determined using Soxhlet instrument with n-hexane (60°C) as organic solvent. The iodine value of the oil was determined according to A.O.A.C., (2000). The oil refractive index was determined using ABBE refractometer at 25°C according to A.O.A.C., (2000). Combined statistical analysis of variance was done for the obtained data of the two studied seasons after applying the assumptions of analysis of variance.

Results and Discussion

The effects of the four nitrogen fertilizer rates on plant height are presented in Table 1. Means of plant height under the nitrogen fertilizer rates showed an increasing in plant height as nitrogen fertilizer rate increased, but no significant difference was detected between plant height means under 138 and 184 kg N/ha. Plant height means ranged from 85.50 cm to 131.75 cm under the 0.00 kg N/ha and 184.0 kg N/ha, respectively. The previous results might be due to the positive effect of nitrogen on the growth development of stem and leaf, which was reflected into taller plants.

Comparing the varieties, plant height data of Table 2 revealed that Sero-4 was the taller, followed by Sero-6, then Callypso and Pactole varieties with mean values of 122.75, 116.70, 108.50 and 106.76 cm respectively. These significant differences between canola varieties plant height might be due to the differences in genetic background and the genetic × environment interaction effects. Certain cultivar may be sensitive to environmental factors while other may be tolerant (Sana, *et al.,* 2003). Maestro (1995) and Reddy and Reddy (1998) reported that different brassica varieties differed significantly regarding their plant heights. Sana, *et al.* (2003) concluded that the variation in plant height of different varieties may be attributed to their genetic potential.

Table 1. Means of plant height (cm), no. of fruits/plant, 1000-seed weight (g), seed weight/plant (g) and seed yield/ha (kg) under the effect of four nitrogen fertilizer rates as average of the 2006 and 2007 seasons.

Nitrogen fertilizer rate (kg N/ha)	Means				
	Plant height (cm)	No. of fruits / plant	1000-seed weight (g)	Seed weight/ plant (g)	Seed yield /ha (kg)
0.00	85.50 c*	98.75 c	2.65 c	10.20 c	881.75c
92.00	108.50 b	141.00 b	2.85 b	15.04 b	1268.25b
138.00	129.00a	205.70 a	3.00 ab	20.31 a	1550.51a
184.00	131.75 a	205.80 a	3.03 a	21.06 a	1488.74 a

*Means followed by the some letter(s) are not significantly different according to LSD at $P < 0.05$

Table 2. Means of plant height (cm), no. of fruits/plant, 1000- seed weight (g), seed weight/ plant (g) and seed yield/ha (kg) of the four studied canola varieties as average of the 2006 and 2007 seasons.

Variety	Means				
	Plant height (cm)	No. of fruits / plant	1000-seed weight (g)	Seed weight/ plant (g)	Seed yield / ha (kg)
Callypso	108.50 c*	112.50 c	2.375 c	14.25 c	916.25 c
Pactole	106.76 c	189.51 a	3.225 a	20.17 a	1471.075a
Sero-4	122.75a	169.25b	3.025 ab	15.93 b	1362.80 b
Sero-6	116.70 b	180.00 a	2.900 b	16.26 b	1438.50 a

*Means followed by the same letter(s) are not significantly different according to LSD at $P < 0.05$.

As for the number of fruits/plant, the mean values in Table 1 revealed that the lowest value (98.75) was produced from the plants treated with 0.00 Kg N/ha followed by 141 fruits/plant under the effect of 92 kg N/ha. No significant difference was shown between the nitrogen rates of 138 and 184 kg N/ha in the number of fruits/plant, but both rates produced the highest no. of fruits/plant (205.7 and 205.8, respectively). Pactale and Sero-6 plants produced the significant highest number of fruits/plant 189.51 and 180.00, respectively, and significantly dominated over the Sero-4 variety (169.25 fruits/ plant) and callypso variety (112.50) as shown in Table (2). The number of siliqua branches per plant is the result of combined effect of genetic make up of the crop and environmental conditions, which plays a remarkable role towards the final seed yield of the crop (Sana, *et al.,* 2003).

Concerning 1000-seed weight under the studied nitrogen rates, data of Table 1 revealed that as nitrogen rate increased 1000-seed weight increased. Under 184 and 138 kg N/ha, 1000-seed weight means were the same, while the lowest value was produced under the 0.00 kg N/ha. Values of 1000-seed weight were 2.65, 2.85, 3.00 and 3.03g under 0.00, 92, 138 and 184 kg N/ha, respectively. As for the studied varieties, Pactale and Sero-4 had the highest 1000-seed weights without significant difference between them, while Callypso was the lowest 1000-seed weight variety (2.375g). These differences between the four varieties might be due to the genetic background of each variety. Several investigators (Munir and McNeilly, 1992; Hashem, *et al.,* 1998; Om, *et al*., 1998 & Sana, *et al*., 2003) found significant differences for 1000-seed weight among different brassica varieties.

Seed weight/plant of canola under the four studied nitrogen fertilizer as shown in Table 1 showed significant increase in seed weight/plant as nitrogen fertilizer increased up to 138 kg N/ha. The highest nitrogen rate produced the highest seed weight/plant (21.06g) while under 0.00 kg N/ha, seed weight/plant was 10.20g. Pactole variety was the highest variety in seed weight/plant (20.17g), while Sero-4 and Sero-6 varieties were not significantly different in seed weight/plant as shown in Table 2. The range of seed weight/plant of the four varieties were from 20.17g to 14.25g.

Comparing the seed yield/ha under the nitrogen rates, data presented in Table 1 showed that the highest seed yield/ha 1550.01 kg was obtained under the 138 kg/ha without insignificant difference from the seed yield under the 184 kg N/ha. The lowest seed yield/ha (881.75 kg) was produced under 0.00 kg N/ha. Seed yield/ha were similar in Pactale (1471.75 kg) and Sero-6 (1438.50 kg) varieties while Callypso variety was the lowest variety in seed yield/ha (916.25 kg) as found in Table 2. Reddy and Reddy (1998) and Khoshnazar, *et al*., (2000) found significant differences in seed yield among different varieties of brassica species.

The significant and insignificant differences between the studied canola varieties in yield and yield components might be due to the genetic × environment interaction effects. Khoshanazar, *et al.* (2000), Kolte, *et al.* (2000) and Stringam, *et al.* (2000) compared different mustard and rapeseed cultivars and reported that all cultivars differed significantly for seed oil yields.

Pactale variety ranked first between the studied varieties in seed yield/ha as a result of the highest value of its seed yield components, seed weight/plant and 1000-seed weight. Sana, *et al.* (2003) concluded that the variation in plant height of different varieties may be attributed to their genetic potential. Maestro (1995) and Reddy and Reddy (1998) reported that different brassica varieties differed significantly regarding their plant heights.

Concerning the quality properties of canola seed, *i.e.*, protein content, oil content, iodine value and refractive index of oil, data of protein content under the effects of nitrogen fertilizer rates in Table 3 showed significant increase as nitrogen rate increased until the 138 kg N/ha and insignificantly different after this rate. The nitrogen rate of 138 kg N/ha produced seeds which had the highest protein content (28.52%) followed by 184 kg N/ha (28.19%), then 92 kg N/ha (26.24%) and the lowest protein content was produced under no nitrogen fertilizer (25.73%). The increasing of nitrogen fertilizer rate might increase the absorbed nitrogen by plant root. Accordingly, nitrogen increases in protein metabolism and is reflected in increasing the protein content in canola seeds. Nitrogen fertilizer increases yield by influencing a variety of growth parameters such as the number of branches per plant, the number of pods per plant, the total plant weight, the leaf area index (LAI), and the number and weight of pods, seeds per plant and flowers per plant and increases overall crop assimilation, contributing to increased seed yield (Wright, *et al.,* 1988; Al- Barrak, 2006). Pactale variety was the highest in protein content (30.24%) followed with a significant difference by Sero-4 (28.29), and then Sero-6 (27.02%), while the lowest variety in protein content (23.13%) was Callypso variety (Table 4).

As for oil content (%), the data of Table 3 revealed that under 92 kg nitrogen rate, oil content was the highest, then significantly decreased under the higher nitrogen rates. Oil contents were 30.54%, 36.93%, 34.10% and 34.65% under the nitrogen rates of 0.00, 92, 138 and 184 kg N/ha, respectively. These reverse relationships between protein and oil contents under the nitrogen fertilizer rates were detected by different investigators in different oilseed crops. Sana, *et al.* (2004) found that the maximum oil content obtained from some canola might be due to the variation in genetic makeup of the variety. Gentent, *et al*. (1996), Das (1998) and Baranyk and Zukalova, (2000) observed differences in oil yields of different brassica species. Bengtsson (1988) reported 9% difference between two varieties of winter rape, while Gentent, *et al.* (1996) observed 2.3% difference between different *Brassica carinata* lines for seed oil content. Oil content of the studied varieties as shown in Table 4 ranged from 37.80% for Callypso variety to 32.04% for Sero-4 variety, and the statistical comparisons showed significant differences among the four studied varieties.

Table 3. Means of protein content (%), oil content (%), iodine value and refractive index of the oil of the four studied canola varieties as average of the 2006 and 2007 seasons.

Nitrogen fertilizer rate (kg N/ha)	Means			
	Protein content (%)	Oil content (%)	Iodine value	Refractive index (25°C)
0.00	25.73c*	30.54 c	110.36 a	1.47032 a
92.00	26.24 b	36.93 a	115.79 a	1.47135 a
138.00	28.52 a	3410 b	120.20 a	1.47162 a
184.00	28.19.a	34.65 b	123.07 a	1.74230 a

*Means followed by the same letter(s) are not significantly different according to LSD at P < 0.05.

Table 4. Means of protein content (%), oil content (%), iodine value and refractive index of the oil of the four studied canola varieties as average of the 2006 and 2007 seasons.

Variety	Means			
	Protein content (%)	Oil content (%)	Iodine value	Refractive index (25°C)
Callypso	23.13 d*	37.80 a	121.39 a	1.47140 a
Pactole	30.24 a	34.25 b	118.86 a	1.47139 a
Sero-4	28.29 b	32.04 d	113.74 a	1.47116 a
Sero	27.02 c	33.15 c	115.93 a	1.47127 a

* Means followed by the same letter(s) are not significantly different according to LSD at 0.05.

Iodine value and refractive index of the oil under the effects of nitrogen fertilizer rates (Table 3) did not differ significantly from rate to another. The same behavior of iodine value and refractive index values were shown under different rates (Table 4). Iodine values ranged from

121.39 for Callypso variety to 113.74 for Sero-4 variety, and the refractive indices ranged from 1.47140 for Callypso variety to 1.17116 for Sero-4 variety. The iodine value and refractive index were oil properties and related to the oil quality genetics more than the environmental effects during plant growth in the field.

References

Al- Barrak, K.M. (2006) Irrigation interval and nitrogen level effects on growth and yield of canola (*Brassica napus* L.), *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, **7**(1): 87-103.

Ali, M.H. and **Rahman, A.M.D.** (1986) Response of nitrogen in TS-72 (Kalyania) cultivar of *Brassica compestris*, *Field Crop Abs*., **40**: 560.

Amin, R. and **Khalil, S.K.** (2005) Effect of pre- and post emergence herbicides and row spacing on canola, *Sarhad J. Agric*., **21**:1 65-170.

A.O.A.C. (2000) Association of Official Agricultural Chemists, *Official and Tentative Methods of Analysis,* 2nd Ed. Washington, DC, USA.

Arthamwar, D.N., Shelke, V.B. and **Ekshinge, B.S.** (1996) Effect of nitrogen and phosphorus on yield attributes, seed and oil yield of Indian mustard (*Brassica juncea*), *Indian J. Agron*., **211**: 382- 285.

Bailey, L.D. and **Grant, C.A.** (1990) Fertilizer placement studies on calcareous and non-calcareous cherrozemic soils, growth, P-uptake, oil content and yield of Canadian rape, *Commun. Soil Sci. Plant Anal*., **21**: 2089-2104.

Ban˜uelos, G.S., Bryla, D.R. and **Cook, C.G.** (2002) Vegetative production of kenaf and canola under irrigation in central California, *Industrial Crops and Products*, **15**: 237-245.

Ban˜uelos, G.S., Ajwa, H.A., Mackey, B., Wu, L., Cook, C.G., Akohoue, S. and **Zambrzuski, S.** (1997) Evaluation of different plant species used for phytoremediation of high soil selenium, *J. Environ. Qual*., **26**: 639-646.

Baranyk, P. and **Zukalova, H.** (2000) Seed yield, oil content and oil yield of hybrid oilseed rape in the conditions of Czech Republic, *Rostlina Vyroba*, **46**: 521-526.

Basak, N.C., Karim, N.M.A. and **Zaman, M.W.** (1990) Performance of some rapeseed lines under two fertilizer levels, *Bangladesh J. Agric. Res.*, **15**: 70-74.

Bhan, S. (1976) Effect of soil moisture and nitrogen on mustard under genetic alluvium of Uttrar Pardesh, *Ind. J. Agro*., **24**: 180-186.

Bengtsson, A. (1988) Current winter rape cultivars, *Aktulla hostrapssorter, Svensk Frotidning*, **57**: 115-117.

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

Chauhan, D.R., Paroda, S. and **Singh, D.P.** (1995) Effect of biofertilizers, gypsum and nitrogen on growth and yield of raya (*Brassica juncea*), *Indian J Agron*., 40: 639-642.

Das, T.K. (1998) Studies on the performance of some new mustard genotypes under irrigated condition, *J. Oilseeds Res*., **15**: 310-314.

El-Nakhlawy, F.S. (1996) Effect of planting date and N-fertilization on performance of rapeseed, *Menofiya J. Agric. Res*., **21**:101-107.

El-Nakhlawy, F.S. and **El-Fawal, M.** (1991) Evaluation of rapeseed potential as affected by row spacing and nitrogen fertilization, *Acta Agronomica Hung*., **40**: 103-110.

Farahbakhsh, H., Pakgohar, N. and **Karimi, A.** (2006) Effect of nitrogen and sulphur fertilizers on yield, yield components and oil content of oilseed rape (*Brassica napus* L.), *Asian Journal of Plant Sciences*, **5**: 112-115.

Fernandez, P.M., Peyrelongy, C.A. and **Contreras, F.E.** (1986) The influence of fertilizer application on oil content of rape, *Field Crop Abst*., **39**: 798.

Gentent, A., Rakow, G. Roney, J.P. and **Downey, R.K.** (1996) Agronomic performance and seed quality of Ethiopian mustard in Saskatchewan, *Can. J. Plant Sci*., **76**: 387-392.

Hashem, A., Majumdar, M.N.A., Hamid, A. and **Hossain, M.M.** (1998) Drought stress effects on seed yield, yield attributes, growth, cell membrane stability and gas exchange of synthesized *Brassica napus* L., *J. Agron. Crop Sci*., **180**: 129-136.

Hocking, P.J., Randall, P.J. and **Demarco, D.** (1997a) The response of dry canola to nitrogen fertilizer: partitioning and mobilization of dry matter and nitrogen and nitrogen effects on yield components, *Field Crops Research*, **54**(2-3): 201-220.

Hocking, P.J., Randall, P.J., Demarco, D. and **Bamforth, I.** (1997b) Assessment of the nitrogen status of field grown canola (*Brassica napes L.*) by plant analysis, *Aust. J. Exp. Agric.*, **37:** 83-92.

Khehra, M.K. and **Singh, P.** (1988) Sensitivity and performance of some *Brassica napus* genotypes in stress and non-stress environments, *Crop Improvement Ind*., **15**: 209-211.

Khoshanazar, P.R., Ahmadi, M.R. and **Ghanndha, M.R.** (2000) A study of adaptation and yield capacity of rapeseed (*Brassica napus L.*) cultivars and tines, *Iranian J. Agri. Sci*., **31**: 341-352.

Kjellstrom, C. (1993) Comparative growth analysis of *Brassica napus* and *Brassica juncea* under Swedish conditions, *Can. J. Plant Sci*., **73**: 795-801.

Kolte, S.J., Awasthi, R.P. and **Vishwanath, R.** (2000) Divya mustard: a useful source to create Alternaria black spot tolerant dwarf varieties of oilseed Brassica, *Plant Varieties and Seeds* **13**: 107-111.

Kumar, S., Sing, J. and **Dhingra, K.K.** (1997) Leaf area index relationship with solar-radiation interception and yield of Indian mustard (*Brassica juncea*) as influenced by plant population and nitrogen, *Indian J. Agron*., **42**: 348-351.

Laaniste, P., Joudu, J. and **Eremeev, V.** (2004) Oil content of spring oilseed rape seeds according to fertilization, *Agron. Res*., **2**: 83-86.

Labana, K.S., Ahuja, K.L. and **Banga, S.S.** (1987) Evaluation of some Ethiopian mustard (*Brassica carinato*) genotypes under Indian conditions, In: *7th International Rapeseed Congress*, Poznan, Poland, p. 115.

Leilah, A.A. and **Al-Khateeb, S.A.** (2003) Influence of sowing dates and nitrogen fertilizer on growth and yield of canola, *Zagazig Journal of Agricultural Research, Zagazig University*, **30**(3): 591-605.

Leilah, A.A., Al-Khateeb, S.A., Al-Naiem, A. and **Al-Thabet, S.** (2002) Response of some canola (*Brassica napus* L.) cultivars to drought, *Agricultural and Water Resources Development Symposium in the Reign of the Two Holy Mosques King Fahad Bin Abdulaziz-God Mercy Be Upon Him*, (14-16 D. Qadah, 1422H) (28-30 Jan., 2002G).

Maestro, G. (1995) Rape, Metapontum area, *Informatore Agrario*, **51**: 26-27.

Mohan, K. and **Sharma, H.C.** (1992) Effects of nitrogen and sulphur on growth, yield attributes, seed and oil yield of Indian mustard (*Brassica juncea*), *Ind. J. Agron*., **37**: 748-754.

Mudholkar, N.J. and **Ahlawat I.P.S.** (1981) Research of rape to plant density and fertilizers, *Indian J. Agron*., **26**: 847-848.

Muhammad, N., Cheema, M.A., Wahid, M.A., Ahmad, N. and **Zaman, M.** (2007) Effect of source and method of nitrogen fertilizer application on seed yield and quality of canola (*Brassica napus* L.), *Pak. J. Agri. Sci*., **44**(1):74-78.

Munir, M. and **McNeilly, T.** (1992) Comparison of variation in yield and yield components in forage and winter oilseed rape, *Pak. J. Agri. Res*., **13**: 289-292.

Nielson, D.C. (1997) Water use and yield of canola under dry land conditions in the central Great Plains, *J. Prod. Agric*., **10**: 307-313.

Om, P., Das, T.K., Singh, H.B. and **Singh, N.** (1999) Performance of three Brassica species as affected by time of sowing and nitrogen, I. Yield attributes and yield, *Annals Agri. Res.*, **20**: 448-454.

Paramjit, S., Khehra, M.K. and **Gupta, V.P.** (1991) Variability and correlation studies for oil and seed yield in ghobi sarsoon, *Crop Impr.*, **18**(2): 99-102.

Ramsey, B. and **Callinan, A.** (1994) Effects of nitrogen fertilizer on canola production in North Central Victoria, *Aus. J. Exp. Agric.*, **34**: 789-796.

Reauz, G.J., Webber, M.D. Soper, R.G. and **Haldin, R.A.** (1983) Phosphorous and nitrogen utilization by rape, flax and wheat, *Agron. J.*, **57**: 335.

Rechcigl, J.E. and **Colon, W.** (2000) Influence of nitrogen sources and sulfur fertilizer on rahigross production and quality, *Proceedings of the 35th Annual Meeting of Caribbean Food Crops Society,* 25-31 July 1999. 83-90 (CAB abst. 2000- 2002).

Reddy, C.S. and **Reddy, P.R.** (1998) Performance of mustard varieties on alfisols of Rayataseema Region of Andhra Pradesh, *J. Oilseeds Res.*, **15**: 379-380.

Sana, M. A., Ali, M., Malik, A., Saleem, M.F. and **Rafiq, M.** (2003) Comparative yield potential and oil contents of different canola cultivars (*Brassica napus* L.), *Pakistan Journal of Agronomy*, **2**(1):1-7.

Scarisbrick, D.H., Daniels, R.W., Chapman, J. and **Parr, M.** (1980) Effect of nitrogen on the development of spring oilseed rape, *Exp. Husb.*, **37**: 63-73.

Shah, A.N., Rehman, M.M. and **Oad, F.C.** (2004) Effects of NP combinations on the seed yield and oil contents of Mustard (*Brassica juncea*), *Asian Journal of Plant Sciences*, **3**(2): 256-257.

Singh, R.A. and **Rathi, K.S.** (1985) Studies on nitrogen requirements of mustard, *Ind. J. Agro.*, **30**: 257-259.

Singh, P.K., Mishra, A.K. and **Imtiyaz, M.** (1991) Moisture stress and the water use efficiency of mustard, *Agriculture Water Management*, **20**: 245-253.

Steel, R.G. and **Torrie, J.H.** (2000) *Principles and Procedures of Statistics in Scientific Research*, 4th Ed. McGraw-Hill, N.Y. USA.

Stricker, J.A., Prine, J.A. and **Riddle, T.C.,** (1997) Yield of kenaf grown on two soils at two locations in Florida, *Soil Crop Sci. Soc. Florida Proc.*, **56**: 35-37.

Stringam, G.R., Degenhardt, D.F. Thalgarajah, M.R., Bansal, V.K. and **Hawklns, G.P.** (2002) Kelsey summer rape, *Can. J. Plant Sci.*, **82**: 559-560.

Taylor, A.J., Smith , C.J. and **Wilson, I.B.** (1991) Effect of irrigation and nitrogen fertilizer on yield, oil content, nitrogen accumulation and water use of canola (*Brassica napus*, L.), *Fertilizer Res.*, **29**(3): 249-260.

Wiedenhoeft, M. and **Bharton, B.A.** (1994) Management and environment effects on Brassica forage quality, *Agron. J.*, **86**: 227-237.

Wright, G.C., Smith, C.J. and **Woodroffe, M.R.** (1988) The effect of irrigation and nitrogen fertilizer on rapeseed (*Brassica napus*) production in South- Eastern Australia, I. Growth and seed yield, *Irrig. Sci.*, **9**: 1-13.

Yasari, E. and **Patwardhan, A.M.** (2006) Physiological analysis of the growth and devolvement of canola (*Brassica napus* L.), *Asian Journal of Plant Sciences*, **5**(5): 745-752.

سلوك محصول البذور، ومكونات المحصول، وجودة البذور لتراكيب وراثية من الكانولا تحت تأثير معدلات مختلفة من السماد النيتروجيني

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المستخلص. أجريت هذه الدراسة في محطة الأبحاث الزراعية بهدى الشام، جامعة الملك عبد العزيز خلال موسمي ٢٠٠٦ و٢٠٠٧م. تمت دراسة أربعة أصناف من الكانولا (*Brassica napus* L.) (Callypso, Pactole, Sero-4 and Sero-6) تحت تأثير أربعة معدلات من التسميد النتروجيني (٠,٠٠، و٩٢، و١٣٨، و١٨٤ كجم/هـ) لمعرفة تأثير النتروجين على محصول البذور، ومكونات المحصول، وجودة البذور. أظهرت النتائج أنه عند زيادة معدلات التسميد النتروجيني زاد كل من طول النبات، وعدد الثمار للنبات، ووزن ١٠٠٠ بذرة، ووزن البذور للنبات، ومحتوى البروتين في البذور، إلا أن محتوى الدهون (٪) تحت تأثير معدل التسميد ٩٢ كجم/هـ كان الأعلى ثم انخفض معنويا تحت تأثير معدلات التسميد الأعلى. أما في ما يخص الاختلافات بين الأصناف، فقد أظهرت النتائج أن ارتفاع النبات في صنف Sero-4 كان الأعلى وتبعه في ذلك صنف Sero-6، ثم Callypso، وأخيرًا صنف Pactole. وأنتجت الأصناف Pactole وSero-6 أعلى عدد للثمار للنبات عن صنفي Sero-4 وCallypso. إضافة إلى ذلك أعطى صنف Pactole، وصنف Sero-4 أعلى وزن ١٠٠٠ بذرة، مع وجود فروقات معنوية فيما

بينهما، وكان صنف Callypso الأقل في وزن ١٠٠٠ بذرة. أعطى صنف Pactole أعلى قيمة لوزن البذور للنبات، في حين كانت الاختلافات غير معنوية بين صنف Sero-4، وصنف Sero-6 في وزن البذور للنبات. كان صنف Pactole الأعلى في محتوى البروتين، يليه مع وجود اختلافات معنوية، صنف Sero-4، ثم صنف Sero-6، وكان الصنف Callypso الأقل في محتوى البروتين. أعطى معدل التسميد ١٣٨كجم نيتروجين للهكتار أعلى محصول بذور/هـ (١٥٥٥,٥١ كجم)، ومحتوى بروتين (٢٨,٥٢٪)، وكان محتوى الزيت (٣٤,١٠٪). تراوح محتوى الزيت في الأصناف المدروسة ما بين ٣٧,٨٥٪، لصنف Callypso إلى ٣٢,٠٤٪ لصنف Sero-4. أظهرت المقارنة الإحصائية أن هناك فروقات معنوية بين الأصناف الأربعة المدروسة. كانت قيم اليود والانعكاس المعياري للزيت تحت تأثير معدلات التسميد النتروجيني ذات فروقات غير معنوية، حيث ظهر نفس السلوك لهما بين الأصناف المختلفة محل الدراسة.