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Canola (*Brassica napus* L.) Seed Yield and Quality as Affected by Planting Date and Varieties

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Abstract. This study was carried out during the 2004/2005 and 2005/2006 seasons at the Agricultural Research Station, Hadda El-Sham, King Abdulaziz University. Five planting dates during the period from Nov.-15 to Jan.-16 and three canola varieties, Sero-4, Sero-6 and Pactole were studied in a split plot design experiment. Plant height was significantly affected by planting date in linear and cubic responses. Number of fruits/plant showed significant linear, quadratic and cubic responses as affected by planting date. Significant linear and cubic effects were detected for seed yield/ha and oil content, while protein content was significantly affected in linear quadratic and cubic effects. Dec.-1 planting produced the highest mean values of plant height (122.40cm), number of fruits/plant (246.65), seed yield/ha (1320kg) and oil content (41.13%) but the mean values of the previous traits decreased as planting date delayed. Protein content was highest (30.69) in the Jan.-16 planting date and lowest (24.50) in the Nov.-15 planting date. Pactole variety was the best variety in plant height (106.8cm), number of fruits/plant (226.27), seed yield/ha (1200 kg) followed by Sero-4 and Sero-6, respectively. Sero-6 produced the highest oil content (37.14%), followed by Pactole and Sero-4, respectively. Sero-4 produced the highest protein content (28.5) followed by Pactole and Sero-6, respectively.

Introduction

Canola (*Brassica napus* L.) is one of the main oil seed crops in the world. Canola has a high adaptability under the different environmental conditions especially under the drought, salinity and temperature stresses. Planting date is critical, since if canola is planted too early or late, and the acceptable planting

dates are based upon location and elevation (Martin, 2006; Fink 2006) stated that planting date is one of the most important production decisions. Taylor and Smith (1992) concluded that seed and oil yields declined when sowing date is delayed. Johnson, *et al.*, (1995) evaluated three canola cultivars at four sowing dates and found that seed yield was the highest at the first two sowing dates. Reduced yield at later sowing was attributed to fewer pods/plant. Shafique, *et al.*, (1999) in Pakistan on ten canola varieties found that delaying planting date significantly increased Aphid population density and caused poor plant growth, and consequently low yield. Kirkland and Johnson (2000) stated that seed yield and oil content were greater in the early planting dates and smaller in the later planting dates. In Australia, Hocking and Stapper (2001) stated that late sowing usually resulted in a great reduction in canola oil content. Brennan, *et al.*, (2002) revealed that oil content in canola seed decreased with an increase in protein. In USA, Horton (2006) found that highest yield of canola was observed from earlier plantings.

Materials and Methods

The present study was carried out during the two successive seasons of 2004/ 2005 and 2005/2006 at the Agriculture Research Station at Hada El-Sham and Laboratories of the College of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, KSA.

Split-plot design experiment with four replicates was conducted in each season according to Gomez and Gomez (1976). Main plot treatments were five planting dates, Nov.-15, Dec.-1, Dec.-16, Jan.-1 and Jan.-16 in each season, while the sub plot treatments were three canola varieties, Pactole, Sero-4 and Sero-6. Sub plot size was 3 m long and 2.1 m apart with 35 cm between each two rows and 20 cm between each two hills in each row. The recommended other agriculture practices were done in the experiment.

At harvesting for each planting date, ten random guarded plants in each sub plot were tagged. The following traits were measured on them: plant height (cm), number of fruits/plant then the seed yield/ha was determined from the yield of the inert four rows and converted into kg/ha. Oil content in the seeds was determined using soxhlet instrument and seed protein content was determined using Kjeldahl instrument according to A.O.A.C. (2000). Statistical analysis was done for each trait according to Steel and Torrie (2000) using SAS (2000).

Results and Discussion

The results of planting date and variety as combined of analysis of variance for the 2004/2005 and 2005/2006 seasons are presented in Tables 1 and 2. Mean squares of plant height under the effects of five planting dates and three canola

varieties showed significant effects for planting date and varieties at 0.05 level of probability (Table 1) but no significant effects were found for the 2-factor or 3-factors interactions (Table 1).

Partitioning planting date mean squares (Table 1) showed that linear and cubic effects were detected at 0.01 and 0.05 levels of probability respectively, while quadratic and quartic effects for planting date were not significant (Table 1). These results are confirmed with the results of Brennan, *et al*., (2002) and Horton (2006).

Significant effects were found for the response of number of fruits/plant to planting date and varieties at 0.01 level of probability (Table 1). Number of fruits/plant responded to planting date in linear and quadratic forms at 0.05 and 0.01 levels of probability, respectively, but no significant effects were shown for cubic or quadratic effects.

Table 1. Mean squares of combined analysis of variance of plant height, and number of fruits/plant under the effects of five planting dates of three canola varieties over 2004/2005 and 2005/2006 seasons.

S.O.V.	df	Plant height	No. of fruits/plant
Seasons(S)	1	456.90 NS	323.67 NS
Rep/S	6	321.50	1216.65
Planting Date(D)	4	4519.84**	23700.8**
Linear	1	16454.89**	79876.8**
Quadratic	1	17.33 NS	4254.86*
Cubic	1	1322.69*	10603.20**
Quartic	1	184.43 NS	68.57 NS
D × S	4	216.56 NS	1542.28 NS
Error "a"	24	218.95	1028.74
Varieties(V)	2	1102.42**	5407.42**
V × S	2	198.87 NS	1135.20 NS
V × D	8	473.82 NS	1419.45 NS
V × D × S	8	266.11 NS	860.99 NS
Error "b"	60	157.94	751.03

NS : not significant at 0.05 level of probability.
*,** : significant at 0.05 and 0.01 levels of probability, respectively.

Seed yield/ha significantly responded to planting date and varieties as shown in Table 2. Seed yield/ha responses to planting date in the linear and cubic effects during the studied five planting dates (Table 2). No significant 1^{st} and 2^{nd} order interactions were found for seed yield/ha.

As for seed oil content (%) of canola under the studied treatments, analysis of variance data (Table 2) showed significant effects under planting date and varieties at 0.01 level of probability. While no significant effects were shown for any interaction treatments. Portioning the mean squares effects of planting date on oil content showed significant linear and cubic effects only.

Seed protein content (%) was significantly affected by both planting date and varieties at 0.01 level of probability, while no significant interactions were shown for seed protein content (Table 2). Significant linear, quadratic and cubic effects were shown for the response of protein content to planting date.

Table 2. Mean squares of combined analysis of variance of seed yield/ha, oil content (%) and seed protein content (%) under the effects of five planting dates of three canola varieties over 2004/2005 and 2005/2006 seasons.

S.O.V.	df	Seed yield/ha	Oil content (%)	Protein content (%)
Seasons(S)	1	5897354.02 NS	16.38 NS	15.97 NS
Rep/S	6	3476095.65	8.58	8.94
Planting Date(D)	4	2002729.97**	370.12**	80.27**
Linear	1	2700000**	1321.89**	205.62**
Quadratic	1	131054.86 NS	5.42 NS	79.16**
Cubic	1	5175717.89**	151.34**	19.88*
Quartic	1	11147.14 NS	1.83 NS	16.43 NS
D × S	4	54754.09 NS	7.34 NS	6.73 NS
Error "a"	24	32600.00	5.66	3.80
Varieties(V)	2	162349.06**	11.56**	14.21**
V × S	2	2109.58 NS	3.66 NS	3.58 NS
V × D	8	47361.63 NS	4.81 NS	3.99 NS
V × D × S	8	26169.17 NS	3.43NS	2.89 NS
Error "b"	60	23563.00	3.84	2.42

NS : not significant at 0.05 level of probability.
*,** : significant at 0.05 and 0.01 levels of probability, respectively.

According to means of the studied canola traits, under the effects of the studied five planting dates, the mean values presented in Table 3 show that plant height significantly decreased after the Dec.-1 date in a linear response, where

the highest plant height (122.4 cm) was produced from the Dec.-1 date then decreased to 100.20 cm, 85.7 and 79.10 cm for Dec.-16, Jan.-1 and Jan.-16 planting dates respectively.

Considering the mean number of fruits/plant under the different planting dates, data in Table 3 detected significant decreasing in no. of fruits/plant after or before the Dec.-1 planting date. Decreasing percentages were 19.07, 28.50 and 48% in planting dates of Dec.-16, Jan.-1 and Jan.-16 respectively compared to the Dec.-1 date.

Means of seed yield/ha linearity decreased after the Dec.-1 planting date by 9.1%, 31.06% and 45.83% from the seed yield of the Dec.-1 planting date. No significant differences were found between the first three planting dates of Nov.-15, Dec.-1 and Dec.-15 in seed yield/ha.

The previous results are confirmed with the results obtained by Mckay, *et al*., (1992), Taylor and Smith (1992), Johnson *et al.*, (1995), Hocking and Stapper (2000), Horton (2006) and Martin (2006) where they reported that the recommended planting date based upon location and elevation and canola seed yield were greater in the early planting dates and smaller in late planting date. This reduction in seed yield might be due to the adversely effects of the high temperature conditions during the flowering and fruit setting of the late planting dates. Delaying planting date significantly increased aphid population density and caused poor plant growth and consequently low yield (Shafique, *et al.*, 1999).

Regarding to oil and protein contents of the canola seeds, mean values in Table 3 showed that the Dec.-1 planting produced seeds having the highest oil content (41.13%). These results were found to be significantly different from the other planting dates followed by Nov.-15, Dec.-16, Jan.-1 and Jan.-16, respectively. These data revealed the significant linear and cubic responses of oil content to planting dates (Table 2).

Vise versa, protein content produced the highest mean value (30.60%) from the Jan.-16 planting date followed by the Jan.-16 planting date (26.7%) then Dec.-1 (25.72%) (Table 3).

These results are similar to that obtained by Kirkland and Johnson (2000) and Horton (2006). Oil decreasing with increasing in protein is confirmed by the results of Mason and Brennan (1998) and Brennan, *et al*., (2002).

Considering the performance of the three canola varieties, the mean values in Table 4 showed that Pactole variety significantly dominated over the Sero-4 and Sero-6 varieties in number of fruit/plant by 21.4% and 15%, respectively, and in seed yield/ha by 21% and 14.2%, respectively. As for plant height, Pactole did

not significantly differ from Sero-6 but significantly differed from Sero-4. Sero-6 produced the highest and significant oil % (37.14%) followed by Pactole (34.83%) then Sero-4 (33.16%), while Sero-4 had the highest protein content (28.50%) followed by Pactole (26.12%) then Sero-6 (24.42%) as shown in Table 4.

Table 3. Means of plant height (cm), no of fruits/plant, seed yield/ha (kg), oil content (%) and seed protein content (%) of canola under the effects of five planting dates as average of three varieties and 2004/2005 and 2005/2006 seasons.

Planting date	Plant height (cm)	No. of fruits/plant	Seed yield/ha (kg)	Oil content (%)	Protein content (%)
Nov.-15	119.30 a*	236.44 ab	1260 a	39.22 d	24.55 d
Dec.-1	122.40 a	246.65 a	1320 a	41.13 a	25.72 c
Dec.-16	100.20 b	215.21 b	1200 a	35.64 c	24.13 e
Jan.-1	85.70 c	176.35 c	910 b	30.80 d	26.71 b
Jan.-16	79.10 c	142.82 d	715 c	28.19 e	30.60 a

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

Table 4. Means of plant height (cm), no of fruits/plant, seed yield/ha (kg), oil content (%) and seed protein content (%) of three canola varieties as average of five planting dates and 2004/2005 and 2005/2006 seasons.

Variety	Plant height (cm)	No. of fruits/plant	Seed yield/ha (kg)	Oil content (%)	Protein content (%)
Sero-4	97.15 b*	186.32 b	992 b	33.16 c	28.50 a
Sero-6	100.10 ab	196.89 b	1051 b	37.14 a	24.42 c
Pactole	106.80 a	226.27 a	1200 a	34.83 b	26.12 b

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

The significant differences among the studied varieties might be due to the genotype and the genotype x environment interaction effects which is reflected in the significant differences between the three varieties.

Finally, this study revealed that Pactole variety was the best variety to produce in the West Region of Saudi Arabia, and the suitable planting date was from Nov.-15 – Dec.-16 time.

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تأثير موعـد الزراعة والصنف عـلى محصول البذور وجودتها في الكانولا

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المستخلص. أجريت هذه الدراسة خلال موسمي ٢٠٠٤/ ٢٠٠٥م ، ٢٠٠٥/ ٢٠٠٦م بمحطة الأبحاث الزراعية التابعة لجامعة الملك عبدالعزيز بهدى الشام، وذلك لدراسة تأثير خمسة مواعيد زراعية على المحصول، وصفات الجودة في ثلاثة أصناف من الكانولا هي سرو-٤ ، سرو-٦ وباكتول، وذلك في تصميم قطع منشقة بأربعة مكررات. وقد أوضحت نتائج الدراسة أن استجابة محصول البذور لاختلاف مواعيد الزراعة في الفترة من ١٥ نوفمبر وحتى ١٦ يناير كانت تمر بمراحل الاستجابة الخطية وغير الخطية Linear and Cubic بينما استجابة نسبة الزيت والبروتين لمواعيد الزراعة من النوع خطي Linear، وتربيعي Quadratic، وتكعيبي Cubic. وقد أعطى موعد الزراعة في ١ ديسمبر أعلى متوسطات لطول النبات (٤ , ١٢٢سم) ، عدد الثمار/ نبات (٦٥ , ٢٤٦ ثمرة/ نبات)، ومحصول البذور/ هكتار (١٣٢٠كجم)، ونسبة الزيت (١٣ , ٤١٪)، مع ظهور تناقص في تلك القيم مع تأخر موعد الزراعة عن ١ ديسمبر ، في حين كانت أعلى نسبة بروتين في البذور هي التي نتجت من الزراعة في ١٦ يناير ، وأقل قيمة كانت في الزراعة في ١٥ نوفمبر.

وقد أوضحت نتائج مقارنة الأصناف أن الصنف باكتول كان الأعلى في ارتفاع النبات (٦ , ١٠٦) سم ، وعدد الثمار/ نبات (٢٧ , ٢٢٦)، ومحصول البذور/ هكتار (١٢٠٠كجم)، ويليه الصنف سرو-٤ ثم الصنف سرو-٦ على الترتيب. وقد كان الصنف سرو-٦ هو الأعلى في نسبة الزيت (١٤ , ٣٧٪)، يليه الصنف باكتول ثم الصنف سرو-٤ على الترتيب، بينما أعطى الصنف سرو-٤ أعلى نسبة بروتين (٥ , ٢٨٪) يليه باكتول ثم سرو-٦ على الترتيب.