Effects of planting date on seed oil yield quantity and quality of four canola (*Brassica napus* L.) cultivars

Seyed Ali Mohammad Modares Sanavy[1], Gholamreza Daneshgar[1]

[1]*Agronomy Department, Faculty of Agriculture, Tarbiat Modarres University, Tehran, Iran, P.O. Box: 14115-336*
Email: MODARESA@modares.ac.ir

Abstract

Canola is one of the most important oil plants and plays a great role in provision of food oil. It is in the third rank in this respect following soybean and palm oil. Different factors affect directly or indirectly on oil yield of canola. One of the important factors is planting date. Therefore four different planting dates (September 6, 16 and 26 and October 6) were evaluated on quality traits of four winter canola cultivars (Colvert, Orient, SLM046 and Regent*Cobra) in Research Field of Agricultural Research Seed and Plant Improvement Institute. Experimental design was strip plot laid out in complete block design with four replications. Planting dates and cultivars showed a significant difference for grain yield. The second and third planting dates showed the highest and lowest seed yield with 4768 and 3264 kg/ha, respectively. Orient and SLM046 cultivars had the highest and lowest grain yield with 4225 and 3679 kg/ha respectively. The maximum and minimum grain protein percent were for Regent*Cobra and Colvert respectively. Protein and oil yield were more in plants with early planting dates than late planting dates. Late planting can negative effect on grain glucosinolate rate and it may be increased. Canola grain obtained from early planting dates (6 and 16 of September) had lower glucosinolate (6-6.08 μmol/mg) than treatments with late planting dates. Four canola cultivars had different glucosinolate. Colvert (6.05 μmol/g) and Orient (6.12 μmol/g) cultivars had less glucosinolate than Regent*Cobra (6.6 μmol/g) and SLM046 (6.71 μmol/g) cultivars. Average oil percentage was 41.28% with the highest percentage for Regent*Cobra (%41.71) and the lowest for SLM064 (%40.78). Four canola cultivars had erosic acid less than 1%. Thus it can be used in human nutrition. In this research the best planting date was 6 and 16 of September. Higher level of monounsaturated and polyunsaturated fatty acids such as oleic, linoleic and alpha-linolenic were found mainly in canola oils, so animal fat and even other vegetable oils can be replaced by canola oil in the diet. Seed oil of four canola cultivars had the lowest level of eicosenoic fatty acid, so canola oil had high quality. The Orient cultivar was superior to other cultivars due to the highest protein percent and more oil yield.

Key words: Fatty acid, Protein, Planting date, variety, oil, *Brassica napus*

Introduction

Winter canola (*Brassica napus* L.) is a winter annual as such is seeded in late summer or fall. When commercial production was first considered in Iran, site location and planting date were thought to be the two most important cultural decisions. Since winter wheat is commonly grown in Iran, winter wheat areas were considered most likely to be well suited for winter canola. This has proven to be the case. Therefore, good sites for winter canola are easy for producers to identify through their experience with winter wheat production. The advantages that winter canola possesses include lower input costs compared to other broadleaf crops in the region; the same equipment used for solid seeded crops may be used; winter canola facilitates the return to traditional fall planted crops such as wheat. With the introduction of more winter hardy, drought tolerant varieties, the most critical factor in winter canola production becomes planting date. Planting date is critical since if planted too early or late in the fall, canola is sensitive to winter kill. Planting too late results in insufficient top growth. Both scenarios leave the crop vulnerable to winter kill. Therefore the second most important production decision relates to planting date. Fribourg et al. (1996) reported that September plantings of winter canola in Tennessee yielded significantly higher than October plantings. Planting date studies were also conducted in western Kentucky by Herbek and Murdock with plantings on Sept. 1, 15 and Oct.1, 1987 and on Sept. 2, 15, 30 and Oct. 14, 1988 (Christmas, 1996). The Sept. 15 planting date in 1987 produced a significantly higher yield than either the Sept. 1 or Oct. 1 plantings. In 1988, the Sept, 2 and 15 planting dates yielded significantly more that the Sept 30 and Oct. 14 planting dates. Christmas (1996) reported that early seeding of spring canola was resulted insignificantly greater seedling infection from Rhizoctonia solani. The objective of the study was to evaluate the effect of planting dates on yield and quality of canola oil of selected winter canola cultivars when growth under Karaj climatic conditions.

Materials and methods

Four winter canola caltivars (Colvert, Orient, SLM046 and Regent*Cobra) were planted in four replicated field experiment during 2004-2005 crop season to determine the effects of three planting dates (Sept. 6, 16, 26 and Oct. 6) on yield and quality of canola oil. Field soil texture was loam with pH between 7.8 and 8. Experiment was conducted in strip plot design as that planting dates and varieties were located in horizontal and vertical strips respectively. The varieties were seeded into a conventionally tilled seedbed using a double disc type seeder which planted 7 rows with 18.75 cm row spacing. Each plot was 7 rows wide and 9.6 m long. Field was fertilized while planting with 220kg/ha of ammonium phosphate plus 150 kg/ha urea before flowering. Plots with planting dates Sept. 6, 16 and 26 were irrigated three, two and one time with 10 days interval before winter respectively. All management practices were done in proper time starting from land preparation to crop harvest. All plots were harvested at maturity, approximately during the first week of June, 2005. At maturity, data were collected on yield and quality (test weight, oil content) of the harvested grain. Lipids were extracted from 20g of ground seed at room temperature by homogenization with hexane/isopropanol (3:2, v/v) (St. John and Bell 1989). The fatty acid methylesters (FAME) of the lipid were prepared (Dahmer *et al.,* 1989) and analyzed in a Varian model vista 6000 gas chromatograph equipped with a fused silica capillary column (SP-Wax10, 25m × 0.25 mm i.d.), a flame ionization detector and a spectra physics model 4290 integrator. The carrier gas was heat a column flow rate 0.8 ml/min with a split ratio of 1:80 oven, injector and detector temperatures were maintained at 210, 240 and 260 and 176°C respectively. Peaks were identified by comparison to retention of FAME Standards and qualified by aid of 17:0 as an internal standard. Antinutritive glucosinolate in harvested seeds for each plot was determined by high performances liquid chromatography equipped with a column (100Rt –18), ACS Model 750/ 14 mass detector and Merch-Hitachi L-6200 pump. Pressure air within column was $1.38*10^4$ Pa. Nitrogen concentrations and crude protein in seed and canola seed meal were measured by Kjeldahl digestion, distillation, and titration (Bremner and Mulvaney, 1982). Recorded data were analyzed statistically using "Analysis of variance" technique and mean differences were adjudged with Duncan's Multiple Range Test at %5 level significance.

Result and discussion

Oil percent was significantly different among varieties while the planting dates and the interaction between varieties and planting dates were non-significant (Table 1). Canola varieties were ranked in two groups in aspect of seed oil percent. Colvert and Regent*Cobra had the most seed oil percent and other varieties had lower oil in their seeds. Generally, varieties had little difference in seed oil percent as that Regent*Cobra and SLM046 had the most and least oil percent with average 41.71 and 40.78% respectively. It seems that seed oil percent is high inheritable trait that environmental conditions has little effect on it. Previous research in England was showed similar result (Scott et al., 1973). Some researches showed that late planting date reduced seed oil percent through decreasing 1000-grain yield. Significant planting date effects existed for oil yield, but the interaction between treatments was generally non significant (Table 1). Varieties also had different oil yield. The mean oil yield during 2004-2005 season was 1990.5, 1659.9, 1348.4 and 1517.8 kg/ha in Sept. 6, 16, 26 and Oct. 6 planting dates respectively. Late planting reduced both seed and oil yields. Varieties in earlier planting dates (Sept. 6 and 16) had more oil yield than later planting dates. Orient and Colvert had more oil yield than SLM046, but former variety had the same oil yield with Regent*Cobra variety.

Antinutritive glucosinolate of four varieties should be less than 30 μmol/g dry weight with due attention to their breeding aim. All tested varieties had lower antinutritive glucosinolate than 7 μmol/g dry weight (Table 1). Thus canola meal of these varieties can used for animal feeding especially with due attention to their high protein. Planting dates had different effects on seed glucosinolate concentration. Varieties in the first, second and fourth planting dates produced the same glucosinolate in their seeds while seed of varieties in third planting date had the highest seed glycosinolate concentration (Table 1). The flowering and grain filling period of varieties in third planting date occurred in hot season and high temperatures increased seed glucosinolate concentrations. Seeds of SLM046 and Regent*Cobra varieties had more glucosinolate than other varieties. Interaction between treatments was non-significant for this trait.

Canola meal protein was difference among varieties, but planting dates and interaction between treatments had not significant effects on it. Varieties were ranked in three groups in aspect of canola seed meal protein percent as that Regent*Cobra and Colvert had the most and least this trait respectively. Canola seed meal protein percent was not different among Regent*Cobra, Orient and SLM046 varieties and among Colvert, SLM046 and Orient varieties. Genetic characteristics of varieties are main factor in differences among them for meal protein percent.

There was a significant difference among planting dates for grain protein yield as that the first and second planting dates caused more grain protein production in comparison to other planting dates. Late planting date decreased grain protein yield according to report of Jasinska (1987) that was similar to our result. Varieties and interaction between treatments had not significant effect on grain protein yield.

Seed of four canola varieties had less than %1 erucic acid and eicosenoic acid content (Table 2). Therefore canola oil is the most favourable of the vegetable oil and supports a beneficial role for canola oil as part of a nutritious diet. Canola oil's saturated fatty acids level is the lowest of any commonly consumed vegetable oil. Seeds of four varieties had less than 7% palmetic acid that is a saturated fatty acid (Table 2). Palmetic acid percent in canola oil is more than olive oil. Seed oil of varieties was relatively high in monounsaturated fatty acid, oleic acid (%59.1-67.74) second only to olive oil. Oleic acid has been shown to reduce serum cholesterol levels and LDL cholesterol levels. Oleic acid does not affect levels of HDL cholesterol. Two classes of polyunsaturated fatty acids (n:3, n:6) are essential for humans, as they can not be synthesized in the body and must be supplied through the diet. Canola oil contains a moderate level (22%) of the polyunsaturated fatty acid linoleic acid and an appreciable amount (11%) of alpha-linolenic acid. Alpha-linoleic acid has been shown to be effective in lowering serum triglyceride levels as well as in reducing platelet aggregation and increasing blood clotting time. These anti-blood clotting effects play an important role in the reduction of coronary heart disease. Seed oil of varieties had linoleic acid between %20.2 and 24.9 (Table 2).

On the whole, the best planting date in Karaj zone was Sept. 6 and 16 and Orient variety was preferred to other varieties due to high protein and yield production.

References

Bremner, J.M. and C.S. Mulvaney. 1982. Nitrogen—total. P. 595-623. *In* A.L. page et al. (ed.) Methods of soil analysis. Part 2. SSSA Book Ser. 5. SSSA,

Madison, WI.
Christmas, E.P. 1996. Evaluation of planting date for winter canola production in Indiana. p. 278-281. In: J. Janick (ed.), Progress in new crops. ASHS Press, Alexandria, VA.
Dahmer, M.L., P.D. Fleming, G.B. Collins, and D.F. Hildebrand. 1989. A rapid screening technique for determining the lipid composition of soybean seeds. J. Am. Oil Chem. Soc. 66:543-549.
Fribourg, H.A., C.R. Graves, G.N. Rhodes, Jr., J.F. Bradley, E.C. Bernard, G.M. Lessman, M.A. Mueller, R.B. Graves, M.L. Thornton, B.A. Latka, and A.M. Plouy. 1989. Rapeseed—a potential new crop for Tennessee. Bull. 669. Tennessee Agric. Exp. Stn., Knoxville, TN.
Scott, R.K., E.A., Ogunremi, J.D., Ivins, and N, J., Mendham. 1973. The effect of sowing date season on growth and yield of oilseed rape (*Brassica napus* L). Journal of Agricultural Science cambridge, 81: 227 – 285.
St. John, L.C. and F.P. Bell. 1989. Extraction and fractionation of lipids from biological tissues, cell, organelles, and fluids. Biotechniques 7:476-481.
Jasinska, Z. 1987. The influence of sowing dates and sowing rates on the developement and yield of winter rape varieties. 7th International rapeseed Congress, Poznan Poland, PP. 886 – 892.

Table 1. Analysis of variance on meal protein percent and seed protein yield, oil percent and seed glucosinolate concentration of four winter canola varieties at Karaj region

S.O.V.	d.f.	Mean Squares				
		Meal protein	Seed protein yield	Oil	Oil yield	Glucosinolate
Relication	3	2.02	55464.5	.67	98278.1	094
Planting date (D)	3	8.50	428084.5*	1.85	1187737.4*	6.41
Error (R*D)	9	7.03	85357.9	.76	185229.2	1.61
Variety (V)	3	22.19*	63877.3	3.46**	150398.22*	1.81
Error (R*V)	9	5.97	32774	.35	31362.2	.14
D*V	9	4.74	22917.9	.23	44805.7	.44
Error	27	4.65	61911.9	.33	163415.6	.91
C.V. (%)		7.93	23.3	1.4	24.8	14.96
Planting date		Mean comparison				
		%	kg/ha	%	kg/ha	μmol/g
Sept. 6		-	1251.8 a	-	1190.5 a	6.1 b
Sept. 16		-	1134.3 a	-	1659.9 ab	6.0 b
Sept. 26		-	870.4 b	-	1348.4 b	7.3 a
Oct. 6		-	1003.0 b	-	1517.8 b	6.1 b
Varieties		Mean comparison				
SLM046		27.3 ab	-	40.79 b	1501.79 b	6.71 a
Regent*Cobra		28.7 a	-	41.72 a	1622.39 ab	6.0 a
Colvert		25.9 b	-	41.64 a	1657.89 a	6.05 b
Oriet		26.9 ab	-	40.99 b	1734.54 a	6.12 b

ns, * and **: no significant and significant at 1 and 5% probability level respectively.
Different letters indicate significant difference between the values in the column (Duncan's multiple comparison test, P<0.05).

Table 2. Fatty acid content in seed oil of four tested varieties

Fatty acid / Treatments	Palmetic acid	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid	Erucic acid
D_1V_1	5.04	63.52	20.01	8.90	0.58	0.06
D_1V_2	4.03	59.84	24.31	8.87	0.70	0.18
D_1V_3	6.25	62.20	22.04	9.59	0.84	0.18
D_1V_4	4.48	64.96	20.76	8.79	0.61	0.47
D_2V_1	5.02	59.10	22.50	8.80	0.73	0.54
D_2V_2	4.80	61.21	22.87	9.09	0.05	0.13
D_2V_3	5.06	63.84	20.01	9.19	0.70	0.18
D_2V_4	3.98	64.60	20.48	9.11	0.86	0.37
D_3V_1	4.60	64.43	20.02	9.25	0.70	0.80
D_3V_2	4.98	67.74	20.36	9.10	0.25	0.24
D_3V_3	5.53	58.99	23.76	9.35	0.11	0.45
D_3V_4	5.09	67.01	20.25	9.02	0.03	0.25
D_4V_1	4.23	62.70	24.90	9.46	0.60	0.15
D_4V_2	4.83	61.84	20.70	9.01	0.65	0.24
D_4V_3	6.87	62.90	23.09	9.44	0.66	0.31
D_4V_4	4.97	58.10	22.69	9.03	0.70	0.45

D_1= Sept. 6, D_2=Sept. 16, D_3=Sept. 26, D_4=Oct. 6, V_1=SLM046, V_2=Regent*Cobra, V_3=Colvert, V_4=Orient