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Yield and Quality Traits of Some Canola Varieties Grown in Newly Reclaimed Sandy Soils in Egypt

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Abstract: Some exotic and two local canola varieties were evaluated during the period of 2005/06 to 2009/2010 winter seasons at the Experimental Station of National Research Center, Nobaryia, Behaira Goveronorate, Egypt. Seed yield (t/ha), as well as, yield attributes of canola varieties were significantly different, except seed oil percentage was insignificant affected. AD201 and also Serw 4 cvs were surpassed in their yields, while Serw 6 and Pactol cvs yielded the lowest seed yield. Seed oil content was increased in seeds of Pactol (43.68%) followed by Serw 4 (42.68 %), while Serw 6 produced the lowest (40. 57%) oil percentage. Oil yield (t/ha) was significantly different among canola varieties. The highest oil yield (0.819) was obtained with Serw 4, while the lowest (0.604) was obtained with Pactol. The highest protein percentage (22.13%) was obtained with Serw 6, while the lowest (17.13%) with Silvo. Oleic acid was increased in AD 201; Linoleic acid was increased in Topas and Silvo, while the lowest linolenic and Erucic acids (9.60 and 0.26 %, respectively) were produced with Topas and Serw 6, respectively. Total glucosinolates in the meal was also different among canola varieties; it ranged from 4.30 to 5. 97µmol/g. The highest glucosinolates content (5.97µmol/g) was recorded with Silvo, while the lowest (4.30 and 4.40 µmol/g) with AD201 and Serw 6, respectively.

Key words: Canola varieties · Fatty acid composition · Glucosinolates · Seed yield · Seed oil and protein %

INTRODUCTION

The cultivated area of canola in Egypt is relatively small due to the strong competition between canola and other strategic winter season crops on the limited arable land in Nile Valley and Delta. Cultivation of canola in Egypt may provide an opportunity to overcome some of the local deficit of vegetable edible oil production, particularly it could be successfully grown during winter season in newly reclaimed land outside the Nile Valley soils to get around the competition with other crops engaged the old cultivated area [1]. The genus *Brassica* is an important member of the Brassicaceae family. It comprises of several economically important species which yield edible roots, stems, leaves, buds, flowers and seed as condiment. Most of the species are used as oilseed crop and some as forage [2]. The oilseed *Brassica* species (*B. napus, B. rapa, B. campestris and B. jancea*) are now the third most important source of edible oil in the world after palm and soybean oil [3]. Since, 1978 some spring types of *Brassica napus* L. have been introduced from Europe and evaluated under Egyptian conditions and the crop has great promise as oilseed crop in the winter season in Egypt [4, 5]. The positive relationship between number of pods, seeds/pod and 1000 - seed weight with seeds/plant and quality of some canola genotypes were reported by Mekki [5, 6]. The oil content of the seed varies from 30-45% depending on the species, the variety and climatic conditions under which it is grown. *B. napus* has been known as a rich source of oil with a low content of saturated fatty acids (5-7%) and a high content of polyunsaturated fatty acids with about 7-10% linolenic and 17-21% linoleic acids. It is therefore considered as very healthy edible oil [7]. The improvement of seed quality is one of the most important objectives in *Brassica* breeding for satisfying future edible oil requirements [8]. The level of erucic acid in rapeseed oil has an important bearing on nutritional and industrial acceptability of the oil. During the past decade, one major goal in oilseed rape quality breeding has been to increase oleic acid at the expense of polyunsaturated fatty acids linoleic and linolenic [9], who indicated that the

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seed oil modern canola cultivars contain ≈ 60 % oleic (C18:1), 20 % linoleic (C18:2), 10 % linolenic (C18:3) and small amounts of palmitic (C16:0, 4%) and stearic (C18:0, 2%). The glucosinolates are nitrogen and sulphur containing natural plant products that have become increasingly important as flavor precursors, cancer prevention agents and crop protectants [10]. Variation in the amount and pattern of glucosinolates in *Brassica* plants has been attributed to genetic and environmental factors, including plant age, temperature, water stress and soil type [11,12].

Therefore, the main objective of this study to evaluate the potential of yield and quality of some canola genotypes under newly reclaimed sandy soil conditions in Egypt.

MATERIALS AND METHODS

Field experiments were carried out at the Agricultural Experimental Station of the National Research Center at Nobaryia, Egypt during the period of winter seasons 2005/06 to 2009/2010 to evaluate the yield and seed quality of some canola (*Brassica napus* L.) varieties grown under newly reclaimed sandy soils. The experimental unit area was 10.5m^2 (3.5 m long and 3.0 cm width). Seeds of six canola varieties (Table 1) were sown at the rate of 7.5 kg/ha in November 20th in the all growing seasons. Phosphorus and potassium fertilizer were added before sowing at the rate of 500 and 250 kg/ha as super phosphate (15.5 % P_2O_5) and potassium sulphate (48-50% K_2O), respectively, while nitrogen fertilizer was added at the rate of 150kg N/ha as ammonium nitrate (33.5%N) in two equal doses at 21 and 35 days after planting (DAP), respectively. The experimental soil site are sandy soil in texture, pH 8.43, E.C 0.22 dS/m, OM 0.92%, Ca CO_3 5.85%, total N 392 ppm and available P 5.8 ppm.. At harvest time, a random sample of ten plants from each plot were taken to determine some yield attributes such as number of siliqua/plant; number of seeds/siliqua, seed yield/plant (g) and 1000-seed weight (g).Plants of two square meter from the middle rows of each plot were harvested, dried under sunshine for one week and seeds were cleaned after separated from the pods, then the seed yield and oil yield (t/ha) were estimated.

Crude oil percentage in the seeds were determined according to AOCS [13] using Soxhlet apparatus and petroleum ether 40-60°C as a solvent. Nitrogen percentage in defatted seeds was also determined by using micro-kjeldhl method; the crude protein percentage was calculated by multiplying N% x 6.25. Fatty acids composition of oil was also determined by using Gas Liquid Chromatography; the methyl esters were prepared according to Stahl [14] using Benzene: Methanol: Sulphuric acid (conc.) as a ratio of 10:86:4. Glucosinolate were analyzed by HPLC at the Federal Agricultural Research Center (FAL), Institute of Plant Nutrition and Soil Science (FAL, Germany) according to Wathelet *et al.* [15]. About 100 mg dry sample of seeds was ground in a mixer (PT3000 Polytron-kinematica) for about 20 sec. The ground samples were extracted in boiling methanol (70%) in a water bath at 70°C for 20 min. Subsequently, the extract was centrifuged (1000 x g, 10 min) and the supernatant were collected. The pellet was reextracted three times following the same procedure. An aliquot of the supernatant was loaded onto ionexchange mini-columns (DEAE Sephadex A-25) and the glucosinolates were desulphated on-column without disturbing the resin surface and allowed to drain. Desulphation was carried out by the addition of 75µl of purified sulphatase (E.C.3.1.6.1, Sigma) solution. The column was capped for 12h. The desulphoglucosinolates were eluted with water and separated by gradient system high performance liquid chromatography (Thermo Separation Products) using a Nova Pak C18 (5 mm) reverse phase column. The filtrate was filtered and analyzed using a liquid chromatograph LaChrom (Merck Hitachi) coupled with a variable wavelength UV detector LaChrom L 7400. The desulphoglucosinolates were monitored by UV-absorption at 229 nm and quantified against the internal standard (sinigrin- Sigma). Identification of individual glucosinolates was done by comparing retention times with pure internal standards and expressed as µmol/g DW. The total glucosinolate content was computed as the sum of all the individual glucosinolate present in the sample.

Table 1: Some canola genotypes and origin.

Canola genotypes	Origin
AD 201/ 81 Gi.	Germany
Silvo	France
Topas	France
Pactol	France
Serw 4*	Local (Egypt)
Serw 6**	Local (Egypt)

*Serw 4: produced via anther culture from Fido variety (Sweden) by Serw Experimental Station, Agricultural Research Center, Egypt.

** Serw 6: It is a haploid plant selected from German variety Primire produced also by Serw Experimental Station, Agricultural Research Center, Egypt.

Statistical Analysis: The analysis of variance procedure of randomized completed block design (RCBD) was used according to Snedecor and Cochran [16] and the combined analysis of all data obtained was done according to Steel and Torrie [17] and the treatments means were compared using LSD test at 5% of probability.

RESULTS AND DISCUSSION

Yield and Yield Components: Data presented in Table 2 indicated that canola genotypes were significantly different in their seed yield production (t/ha) and also for other yield components. Serw 4 and Silvo cvs produced the highest seed yield (1.918 and 1.709 t/ha), respectively followed by Topas and AD 201 (1.769 and 1.709 t/ha), while the lowest (1.269 and 1. 382 t/ha) was obtained with Serw 6 and Pactol, respectively. These results are in accordance with those reported by Mekki [5,6], Sana *et al.* [18] and Zhang *et al.* [19], who pointed out the seed yield of various canola varieties was significantly different among them. Also, El-Kholy *et al.* [20] and El-Habasha and Abdel Salam [21] reported that there are significant differences among canola varieties on the seed yield. Data in Table 2 also indicated that the highest seed yield/plant, number of siliqua/plant as well as oil yield (t/ha) were obtained with Serw 4, while the lowest was obtained by Serw 6 in comparison to the other canola varieties. In this regards, number of seeds/siliqua was not significantly different among the all canola varieties, however, Serw 4, Silvo, AD01 and Topas produced the highest seeds per siliqua, while the lowest was obtained by Pactol and Serw 6, respectively (Table 2). Data also indicated 1000-seed weight was also significantly different among canola varieties; the highest 1000-seed weight was obtained by Pactol (3.69 g) and Topas (3.63 g), while the lowest was obtained by Topas (3.19 g) and Serw 6 (3.08 g). The positive relationship between number of pods and 1000 seeds weight with seeds per plant and consequently with seed yield (t/ha) were reported by Mekki *et al.* [5, 6, 22] and Ana Marjanovic-Jeromela *et al.* [23], who reported that 1000-seed weight is very interesting trait for both rapeseed breeders and seed industry and also an important component of seed yield. On the other hand, the oil yield was significantly different among canola varieties under study. The highest oil yield (0.819 t/ha) was produced by Serw 4, while the lowest (0.515 t/ha) by Serw 6. Such increase in oil yield mainly due to the increase in seed yield/plant, seed yield (t/ha), number of siliqua/plant, 1000 seeds and oil percentage in Serw 4 in comparison to other canola varieties (Tables 2 and 3). Ana Marjanovic-Jeromela *et al.* [23] reported that, while the correlation between the number of pods per plant and seed yield per plant kept strong, estimated correlations between the number of pods per plant and seed oil content as well as number of pods per plant and 1000 seeds weight were not. Who also, reported that significant positive correlation estimated between seed oil content and seed yield per plant (0.609**) leads to the conclusion that simultaneous selection regarding oil content and seed yield per plant is possible to be done. Ozer *et al.* [24] calculated significant correlation between seed oil content and seed yield per plant. It probably would not affect seed oil content since there is low correlation between 1000 seeds weight and seed oil content. Other studies estimated significant positive correlation between1000-seed weight and seed yield [23, 25].

Seed Quality

Seed Oil and Protein Percentages: In general, oil percentage was not significantly affected among all canola genotypes (Table 3). However, Pactol and Serw 4 cvs produced the highest oil percentage (43.68 and 42.68%) respectively, while the lowest (40.57%) was obtained with Serw 6 cv. The other three canola genotypes AD201, Silvo and Topas produced approximately the same oil content in their seeds. The maximum oil content obtained from Pactol variety might be due to the variation in genetic make up of the variety. These results are in accordance with those obtained by Mekki [5], El-Beltagi and Mohamed [12] and Fayyaz-ul-Hassan *et al.* [26]. Significant variation for oil content among cultivars, locations and their interactions in present study confirms the earlier finding of Pritchard *et al.* [27] who determined the effects of environment on the quality of canola. They found that oil contents are correlated with cooler spring temperature and higher spring rainfall. Oil contents were lowest, on average, in canola grown in hotter regions during dry years and were highest in canola from cooler and wetter regions. The present data in Table 3 illustrated that Serw 6 was surpassed in protein % over all other canola genotypes that produced the highest protein content (22.13 %), while the lowest (17.13 %) was obtained by Silvo. Ping *et al.* [28] reported that significant values for protein meal ranging from 30 to 46%. Similarly, Ahmad *et al.* [29] reported the highest amount of protein, 25.1% for HS.98, while the lowest amount 21.1 for genotype Oscar.

Table 2: Yield and yield components of some canola varieties grown in newly reclaimed sandy soils.

Canola varieties	Seed yield/ plant (g)	Number of siliqua /plant	Number of seeds/ siliqua	1000-seed weight (g)	Seed yield (t/ha)	Oil yield (t/ha)
AD 201	7.89	93.85	24.46	3.44	1.709	0.796
Silvo	7.84	97.26	24.80	3.19	1.896	0.789
Topas	7.31	81.14	24.92	3.63	1.769	0.740
Pactol	5.84	78.59	20.71	3.69	1.382	0.604
Serw 4	7.98	101.23	24.06	3.29	1.918	0.819
Serw 6	5.25	78.56	22.16	3.08	1.269	0.515
LSD 0.05	0.77	NS	NS	0.22	0.580	0.14

Table 3: Seed oil, protein and glucosinolates contents of some canola varieties grown in newly reclaimed sandy soils.

Canola varieties	Seed oil %	Seed protein %	Total glucosinolates (µmol/g meal)
AD 201	41.74	19.81	4.30
Silvo	41.60	17.13	5.97
Topas	41.82	17.56	5.02
Pactol	43.68	18.06	4.75
Serw 4	42.68	19.38	5.01
Serw 6	40.57	22.13	4.40
LSD 0.05	NS	--	--

Table 4: Fatty acids composition of some canola genotypes grown under newly reclaimed sandy soils.

	Fatty acids composition %				
Canola genotypes	Palmitic (16:1)	Oleic (18:1)	Linoleic (18:2)	Linolenic (18:2)	Erucic (22:1)
AD 201/ 81 Gi.	3.77	62.77	22.39	10.59	0.48
Silvo	6.44	56.20	25.03	10.80	1.53
Topas	5.90	58.23	25.22	9.60	1.05
Pactol	3.59	60.48	24.13	11.10	0.70
Serw 4	3.98	61.74	22.82	10.57	0.89
Serw 6	3.80	61.57	23.80	10.48	0.26

Glucosinolates Content: Canola has the lowest saturated fat content among vegetable oils and thus presents an increasing demand for diet-conscious consumers [30]. Glucosinolate is considered toxic for animals health, in addition to its bitter taste [31]. Safe limits for these compounds have been described as less than 30 µmol/g of glucosinolate in oil free meals [30]. Data in Table 3 indicated that the total glucosinolates content in the meal was ranged from 4.30 µmol/g with AD 201 to 5.97 µmol/g with Silvo; however, Topas and Serw 4 contained the same values in their meals (5.02 and 5.01 µmol/g, respectively). Also, Serw 6 and AD201 produced the same glucosinolates content in their meals. Our results are in agreement with those obtained by Islam *et al.* [32], who reported that the highest amount of glucosinolates was found in HS-98 (89.0 µmol/g of seed), while the lowest amount of glucosinolates present in Oscar genotype (29.9 µmol/g of seed). Bhardwaj and Hamama [33] reported that glucosinolate content were higher in *B. napus* than the *B. rapa* meal (49.2 vs. 43.8 µmol/g). Similar findings were reported by El-Beltagi and Mohamed [12], they reported that the total glucosinolate contents were lower (4.40 µmol/g) in local canola Serw 6 than the other exotic variety Silvo (5.97 µmol/g).

Fatty Acid Composition: Data presented in Table 4 illustrated that all canola genotypes were different in their fatty acids contents. In general, the saturated fatty acid Palmitic acid ranged from the lowest (3.59%) in Pactol to the highest (6.44%) in Silvo. Although the low level of Palmitic acid and other saturated fatty acids (less than 5%) in canola oil is considered to be nutritionally desirable [34]. In this concern that, McCartney *et al.* [35] reported that the majority of the variation in Palmitic (C16:0) due to the genotype main effect. Data in Table 4 also indicated that Oleic acid was the most prevalent unsaturated fatty acid and the values were different in all genotypes used. It ranged from the lowest (56.20%) in Silvo to the highest (62.77%) in AD201. Our results are in agreement with those obtained by Islam *et al.* [32], who reported that the highest amount of oleic acid (61.60%) for genotype Oscar and the lowest amount of Oleic acid for Altex (22.7%). Linoleic acid is the second major unsaturated acid, its content ranged from 22.39 % in AD201 to 25.22 % in Topas. Linolenic acid is the third major unsaturated acid; data in Table 3 indicated that Topas had the lowest (9.60%), while the highest value was obtained with Pactol (11.10%), the other canola genotypes tended to the same values. The second oil quality breeding objective is to reduce the percentage of Linolenic acid from the percent 8 - 10 % to less than 3 %, while maintaining or increasing the level of Linolenic acid [36]. Data in Table 3 show that the Erucic acid percentage in all canola genotypes ranged from the lowest (0.26% and 0.48 %) in Serw 6 and AD201 to the highest (1.05 and 1.53%) in Topas and Silvo, respectively. The other canola genotypes Pactol and Serw 4 produced less than 1% of Erucic acid. Such reduction in Erucic acid content in canola genotypes Serw 6 and AD201 mainly attributed to the increase of Oleic and Linoleic acids. Lower Linolenic

acid is desired to improve the storage characteristics of the oil; while higher Linolenic acid content may be nutritionally desirable. Similar observations were reported by Farag *et al*. [37] and Getinet *et al*. [38]. Davik and Heneen [39] reported the same findings, who found that the concentration of two fatty acids Oleic (18:1) and Erucic (22:1) were negatively correlated and a high Oleic acid concentration (>50 %) was always associated with low Erucic acid concentration (<4%). Rahman [40] reported that the Erucic acid content in resynthesized *B. napus* (AACC) lines derived from these crosses was only about half that of the high erucic acid CC genome parents, \ndicating equal contributions of the two genomes to oil (fatty acid) synthesis and accumulation. The fatty acid profile of all canola genotypes reveals that lipids are a good source of the nutritionally essential linoleic and oleic acids. Linoleic acid was the predominant fatty acid, which, along with the oleic acid, comprised about 90% of the fatty acid composition. Similar findings were reported by El-Beltagi and Mohamed [12], Mekki *et al*. [22] and Moghadam *et al*. [41].

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