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CANOLA YIELD FORMATION UNDER DIFFERENT SEEDING METHODS AND SEEDING RATES

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ABSTRACT

The aim of the present investigation was to study the effect of seeding methods and seeding rates on yielding ability and yield structure of *Brassica napus* and *Brassica campestris* (canola). For this purpose, four separate field experiments were conducted at the Agricultural Experiment and Research Center, Faculty of Agriculture, Cairo University during 2002/2003 and 2003/2004 winter seasons. The experiments were carried out in a split plot design with 4 replications. The main plots were randomly distributed by three seeding methods (broadcasting, drilling in rows 25 cm and 50 cm apart). The sub-plots were devoted to three seeding rates of 1, 2 and 3Kg/fad at each seeding method. Of the main effects on both species, combined data over the two seasons revealed that seeding methods had significant effect on seed yield/fad as well as yield/plant(g) and its contributing traits with some exceptions, while seeding rate effects were only significant for yield/plant(g) and its components in addition to seed oil% of *B. campestris* only. Considering the interaction between the two factors of study, seeding method appeared to be the major one affecting the canola productivity under the present conditions. Drill seeding of both species either in 25 or 50 cm row spacing at any seeding rate produced higher yield/fad than the broadcasting. Numerically highest yield/fad of both species was produced from drilling at 25 cm row spacing combined with 3 Kg/fad seeding rate. Seed yield/plant(g) and all of its components were significantly affected by the interaction. Yield/plant(g) and siliquae/plant as well as yield and siliquae per main, primary and secondary branches in addition to seed index exhibited linear decrease as seeding rates increased, and this was true for almost all seeding methods. High values of these traits were recorded at lower (1 Kg/fad) seeding rate at any seeding method. The interaction had no significant effect on seed oil % for both species. Yield analysis of individual plant showed that the differences in total yield contribution from the main and lateral branches were mostly due to the species. *Brassica. napus* plants carrying on average more than 90% of total yield/plant(g) on the main and primary branches, while the contribution of secondary branches varied from 0.01 to 9.4% taking into account seeding methods and rates. In contrast, the contribution of secondary branches of *B. campestris* accounted for 43.5% as a general mean over the two factors of study. The results overall suggest that drill seeding at 25 cm row spacing combined with seeding rate of 3 Kg/fad should be used for production of both *B. napus* and *B. campestris* canola.

INTRODUCTION

Canola is a recent, high quality form of rapeseed. Rapeseed is a member of the *Brassica* genus of plants. Canola is a relatively new crop and is more commonly known as oilseed rape or rapeseed. The name Canola is a registered trademark of the Canola Council of Canada.

Canola is rapidly gaining value as an oilseed crop. Its seed, when crushed, contains as much as 40% vegetable oil. The oil meal that remains after crushing contains approximately 33% protein,1- 8% fat and 10% fiber. Canola, also known as double-zero or double-low oilseed rape, was developed by plant breeders for the production of an edible vegetable oil low in saturated fats. The oil from improved varieties of rapeseed has important potential in the human diet as cooking oil, while the oil meal can be an important source of protein for animals. Canola is distinguished from other forms of rapeseed by its low levels of erucic acid(a long-chain fatty acid) that can cause adverse health effects if it is found in large amounts in edible vegetable oil as well as glucosinolates(toxic sulfur compounds contained in meal), which in large amount may be injurious to livestock (Bandel *et al*, 1991)

Canola, released from *Brassica* species, has recently been introduced to Egypt as a new crop hoping to overcome oil deficiency. Little is known about agronomic practices and suitable genotypes required to maximize seed and oil yield of canola in Egypt. Like any crop, choice of adapted and high yielding genotypes as well as optimum agronomic practices are the most important two factors influencing canola production under local conditions.

Out of *Brassica* species, *B. napus* and *B. campestris* are the most appropriate two species that may be grown successfully in Egypt. More than one variety of *B. napus* like pactol and serw 4 are released as commercial varieties, whereas *B. campestris* is still under experimentation.

Another factor controlling seed yield of canola is agronomic practices including seeding methods and seeding rates or population density. The suitable seeding method is an essential application for raising germination percentage, increasing number of plants per unit area and hence limits canola production in Egypt (Bassal *et al*, 1998). Broadcasting and drilling or rows seeding are the most common methods used for canola cultivation in Egypt.

It is generally evident from the previous studies that the most promising methods are drilling and, to a lesser extent, broadcasting. The broadcast method can save time and reduce machinery requirements, if used, but stand reliability is sometimes reduced using this method. The major disadvantages of broadcast seeding are shallow placement of seed, uneven planting depth, poor seed distribution and a greater dependency on moisture. Whereas, drilling is the most reliable and preferred method due to its advantages including better seed placement, better seed-to-soil contact and uniformity of stand (Herbek and Murdock, 1992). Moreover, precise drilling will place the seed slightly deeper into the soil and improving chances of more acceptable germination (Bandel *et al*, 1991). Furthermore, drill seeding of rapeseed at narrow spacing generally produces higher seed yields than when sown in more widely spaced rows (Christensen and Drabble, 1984; Misra and Rana, 1992). Also, Androsoff (1998) compared broadcast seeding to row seeding with spring canola and concluded that broadcast seeding resulted in lower yields with both *B. napus* and *B. juncea*.

In India, Kurmi and Kalita (1992) compared the effect of broadcast seeding and row- seeding at 30 cm apart on growth, yield and oil content of “M27” rapeseed (*B. napus*). Results indicated that row seeding gave uniform germination and resulted in higher seed yield/ha than broadcast seeding. Siliquae/plant, length of siliqua and estimated oil yield/ha were also significantly higher in row seeding. Conversely, plant height, seeds/siliqua and 1000-seed weight were not influenced by method of seeding. They concluded, also, that though row seeding did not show very high differences in yield, it has to be preferred in view of the convenience in management of the crop and weeds in the field.

In respect of seeding rate, seed yield of canola is a function of population density or seeding rate as well as yield components, i.e. number of siliquae per plant, number of seeds per siliqua and seed weight. However, yield structure is very elastic and adjustable across a wide range of plant populations (Angadi *et al*, 2003). The number of siliquae per plant is the most responsive of all the yield components in canola (Diepenbrock, 2000).

Using seeding rates instead of actual plant populations, Morrison *et al* (1990) focused on above-optimal plant population range of rapeseed. They found that under the generally good growing moisture season in Southern Manitoba, Canada, lowest seeding rates of 1.5 to 3 Kg/ha (35 to 70 plants/m^2) were enough to produce maximum seed yield. Furthermore, McGregor (1987) in Canada, used actual plant populations to compare yield formation of very low population (<22 plants/m^2) with the highest population during the season (144 to 200 plants/m^2). Canola yields plasticity in that study varied widely indicating the importance of weather conditions in determination of the optimum population. Because of the wide range of yield plasticity, a population of 80 to 180 plant/m^2 has been recommended for canola in the Canadian prairie (Thomas, 1984). Christensen and Drabble (1984) studied the effect of row spacing and seeding rate on the yield of *B. napus* and *B. campestris* for 2 years in Northwest Alberta, Canada, using row spacing of 7.5, 15 and 23 cm apart with seeding rates of 7 and 14 Kg/ha at each spacing. Results showed that the decreasing row spacing from 23 cm to 15 cm and from 15 cm to 7.5 cm increased yields by an average of 11% and 33%, respectively. However, seeding rate had no significant effect on yield.

Worth noting is that in the short growing season of the Canadian prairie, canola has limited time to express potential plasticity compared with other regions of the world where the canola growing season is longer (Mendham and Salisbury, 1995). Therefore, optimum plant population of canola is higher in the Canadian prairie than other regions of the world and it is more critical to optimize plant populations (Angadi *et al*, 2003).

In Egypt, Kandil *et al* (1990) studied the effect of seeding rates and row spacing on growth, yield and its components of oilseed rape. Data indicated that 20 cm row spacing combined with 2-3 Kg seeds/fad produced highest seed yield/fad, while the highest yield/plant(g), siliquae/plant and seed oil content were recorded at 60 cm row spacing.

The main objective of the present investigation was to examine the differential responses in yield and yield structure of two *Brassica* species to three seeding methods and three seeding rates.

MATERIALS AND METHODS

Four separate field experiments were conducted for *Brassica napus* and *Brassica campestris* (2 experiments for each) at the Agricultural Experiment and Research Center, Faculty of Agriculture, Cairo University during 2002/2003 and 2003/2004 winter seasons. *Brassica napus* was represented by the commercial variety (Serw 4), while *B. campestris* was represented by the line 225 obtained from Sakha Research Station. The experimental soil type was clay loam in texture. The preceding crop was maize in the firstseason and fallow in the second season.

The experimental treatments for all trials were arranged in split-plots as a randomized complete block design with 4 replications. Three seeding methods, i.e. broadcasting, drilling in rows 25 cm and 50 cm apart formed the main plots. The sub-plots were devoted to three seeding rates of 1, 2 and 3 Kg/fad at each seeding method. The experimental unit was 2.5 x 2.5 m consisted of 10 and 5 rows for 25 cm and 50 cm row spacing treatments, respectively.

Phosphorus as calcium super-phosphate at rate of 15.5 Kg P_2O_5/fad and potassium as potassium sulphate at rate of 24 Kg K_2O/fad were added during seedbed preparation as general application. Nitrogen was applied as ammonium nitrate at rate of 40 Kg N/fad in two equal doses, the first one added before the first irrigation and the second was given just before the second irrigation.

The experiments were hand seeded on 25 and 27 October for the first and second seasons, respectively. The plots sown by broadcasting were hand weeded, while hoeing was done for row spacing treatments just before the 1st and 2nd irrigation. Surface irrigation was applied one-month intervals.
At harvest, ten guarded plants were randomly taken from the center of each sub-plot to measure number of siliquae/plant and seed yield/plant(g). For detailed analysis of yield components, number of siliquae and seed yield produced on the main, primary and secondary branches were counted and calculated as percent of total siliquae and seed yield per plant. Seed index was determined as 1000-seed weight taken as a sample from each sub-plot. Seed yield/fad was estimated from the whole sub-plot. Seed oil percentage was determined according to A.O.A.C (1984) using Soxhelt apparatus and petroleum ether as an organic solvent, and then the oil% was calculated on dry weight basis.

Data were statistically analyzed according to the procedures of ANOVA of the split-plot design outlined by Gomez and Gomez (1984). Test of homogeneity of the data was applied, and then combined analysis of variance was performed over the two seasons. Least significant difference (LSD) test at 5% level of probability was used to compare the treatment means.

RESULTS AND DISCUSSION

Effect of seeding methods

Combined data over the two seasons (Table 1) revealed that seeding methods had significant effect on seed yield/fad of both genotypes *Brassica napus* and *Brassica campestris*. Drill seeding at 25 cm or 50 cm row spacing produced higher seed yield/fad than broadcast seeding in both species. Maximum yield(kg/fad) recorded with 25 cm row spacing, however, increasing the space between rows from 25 to 50 cm insignificantly reduced yields of both species. These results are comparable to those of Kurmi and

Kalita (1992) and Androsoff (1998) who pointed out that row seeding of canola resulted in higher seed yield/ha compared with broadcast seeding. The yield superiority of the drilled material is probably due to the effect of competition on the morphology of the plant and its effect on assimilating supply and distribution (Clarke *et al*, 1978).

Table(1): Effect of seeding methods on seed yield and its contributing characteristics (combined data over the tow seasons).

	Broadcast.	Rows 25cm	Rows 50cm	L.S.D
	Brassica napus			
Siliquae/main branch(SMB)	62.1	62.2	63.3	*ns*
Siliquae/primary branches(SPB)	159.6	180.6	165.8	*12.3*
Siliqua/secondary branches(SSB)	21.2	23	18.9	*ns*
Siliquae/Plant (S/plant)	242.9	265.8	248	*13.5*
Yield/main branch(YMB)	3.82	3.79	3.86	*ns*
Yield/primary branches(YPB)	7.9	9.23	8.69	*0.34*
Yield/secondary branches(YSB)	0.68	0.82	0.67	*ns*
Seed index (SI)	3.08	3.14	3.09	*ns*
Yield/plant(g)	12.4	13.84	13.22	*0.46*
Yield/Fad (kg/fad)	1011.2	1073.2	1049.2	*25.0*
Oil %	37.96	37.04	36.76	*ns*
	Brassica campestris			
Siliquae/main branch(SMB)	38.4	40.9	39.6	*1.2*
Siliquae/primary branches(SPB)	106.3	124.5	123.3	*4.1*
Siliquae/secondary branches(SSB)	172.6	188.4	187.4	*10.6*
Siliquae/Plant (S/plant)	317.3	353.8	350.3	*10.1*
Yield/main branch(YMB)	1.45	1.67	1.64	*0.06*
Yield/primary branches(YPB)	4.30	4.88	4.80	*0.23*
Yield/secondary branches(YSB)	4.73	5.13	5.03	*0.15*
Seed index (SI)	3.06	36.16	3.09	*0.07*
Yield/plant(g)	10.48	11.68	11.47	*0.32*
Yield/Fad (kg/fad)	861.4	926.5	912.4	*32.3*
Oil %	37.54	37.78	37.64	ns

Seeding methods showed also significant influence on seed yield per plant and its contributing traits with some exceptions. Seed yield/plant(g) of *B. napus* and some of its components like siliquae per plant; siliquae and yield per primary branches were significantly affected by seeding methods. Similarly, seed yield/plant(g) of *B. campestris* and all of its components were significantly influenced (Table 1). Maximum values of seed yield and siliquae per plant of both species recorded with drilling at 25 cm row spacing were significantly higher than broadcasting, but it remained at par with 50 cm row spacing except one case. Seeding methods showed no significant effect on seed oil percent of both species.

Effect of seeding rates

Combined data presented in Table (2) showed that all measured traits of both *B. napus* and *B. campestris* were significantly affected by seeding rates except for seed yield/fad. Seed yield (kg/fad) was statistically similar at all seeding rates for each species, averaging 1045 Kg in *B. napus* and 905 Kg in *B. campestris*. Several studies with *Brassica* species reported that seeding rate did not influence seed yield per unit area (Christensen and Drabble, 1984; Bilgili *et al*, 2003). Also, Van eynze *et al* (1992) stated that there was no significant response of seed yield of *B. napus* to varying seed rates from 3.0 to 9.0 Kg/ha for six trials combined.

Data of Table (2) cleared also that both species responded similarly to seeding rates in relation to seed yield per plant and its contributing characteristics. There was a linear decrease in seed yield/plant (g) and all of its attributes with increasing seeding rate. The primary response of both *Brassica* species plants to lower seeding rate was increased siliquae per plant through increased siliquae per main, primary and secondary branches, and consequently increased seed yield per each. McGregor (1987) and Morrison *et al* (1990) reached to similar conclusion.

Maximum numbers of siliquae/plant and yield/plant(g) of both species recorded with seeding rate of 1 Kg/fad (Table 2). Increasing seeding rates from 1 to 2 and 3 Kg/fad significantly decreased silique/plant by 24.7% and 46.7% in *B. napus*, and by 25.2% and 55.6% in *B. campestris*, respectively. Seed yield/plant (g) showed, also,similar trend, in which reduction in the same order accounted for 26.6% and 53.2% in *B. napus* and 31.5% and 54.7% in *B. campestris*. Comparable trend were also observed for siliqua numbers and seed yield per main, primary and secondary branches of both tested species that showed linear decreased as seeding rates increased with different magnitudes. These results are in line with those reported on rapeseed by Degenhardt and kondra (1981); McGregor (1987); Morrison *et al* (1990) and Bilgili *et al* (2003). Seed oil% showed a small linear decrease with an increase in seeding rate; however such decrease was significant only for *B. campestris*. Van Deynze *et al* (1992) noted similar tendency.

Table (2): Effect of seeding rates on seed yield and its contributing characteristics(combined data ov er seasons).

	1 Kg/ Fad.	2 Kg/ Fad.	3 Kg/ Fad.	L.S.D
	Brassica napus			
Siliquae/main branch(SMB)	69.0	62.9	55.8	***2.1***
Siliquae/primary branches(SPB)	218.6	166.7	120.7	***7.4***
Siliquae/secondary branches(SSB)	43.5	19.7	0.01	***5.9***
Siliquae/Plant (S/plant)	331.1	249.3	176.5	***10.12***
Yield/main branch(YMB)	4.47	3.88	3.12	**0.21**
Yield/primary branches(YPB)	11.76	8.81	5.25	**0.53**
Yield/secondary branches(YSB)	1.68	0.48	0.01	***0.27***
Seed index (SI)	3.18	3.11	3.02	***0.08***
Yield/plant(g)	17.92	13.16	8.38	***0.45***
Yield/Fad (kg/fad)	1035.6	1047.3	1050.7	***ns***
Oil %	37.03	36.91	36.82	***ns***
	Brassica campestris			
Siliquae/main branch(SMB)	45.0	39.1	34.8	***0.8***
Siliquae/primary branches(SPB)	151.6	122.1	80.4	***4.1***
Siliquae/secondary branches(SSB)	269.3	187.5	91.6	***9.7***
Siliquae/Plant (S/plant)	465.9	348.7	206.8	***10.38***
Yield/main branch(YMB)	1.75	1.58	1.43	***0.05***
Yield/primary branches(YPB)	6.22	4.68	3.10	***0.136***
Yield/secondary branches(YSB)	7.76	4.54	2.61	***0.154***
Seed index (SI)	3.24	3.16	2.9	***0.1***
Yield/plant(g)	15.75	10.79	7.13	***0.23***
Yield/Fad (kg/fad)	889.2	914.4	910.8	***ns***
Oil %	37.94	37.60	37.40	0.23

Interaction effect

Combined data presented in Table (3) show that the interaction between seeding methods and seeding rates had a significant effect for all characters measured on both tested species. Seed yield (kg/fad) of both species was significantly differed mainly due to seeding methods. Drill seeding, in general, yielded more than broadcasting at any rates of seeding.

Table (3): Effect of the interaction between seeding methods and seeding rates on seed yield and its contributing characteristics (combined data over the tow seasons).

Treatments		SMB	SPB	SSB	S/Plant	YMB	YPB	YSB	SI	Y/Plant	Y/fad.	Oil%
		Brassica napus.										
Broad-cast	1 Kg/Fad.	65.4	200	43.4	309.0	4.32	10.55	1.55	3.13	16.42	1002	37.06
	2Kg/ Fad.	63.1	166	20.3	249.5	3.99	7.92	0.48	3.10	12.39	1013	36.95
	3Kg/ Fad.	57.9	112	0.01	170.2	3.14	5.22	0.01	3.00	8.37	1019	36.87
Rows 25cm	1 Kg/Fad.	69.7	239	47.4	356.2	4.49	13.16	1.87	3.23	19.52	1065	37.16
	2Kg/ Fad.	64.4	173	21.7	259.0	3.80	9.64	0.58	3.15	14.02	1074	37.03
	3Kg/ Fad.	52.4	130	0.01	182.3	3.08	4.91	0.01	3.05	8.00	1080	36.94
Rows 50cm	1 Kg/Fad.	71.9	216	39.7	327.9	4.60	11.59	1.62	3.17	17.81	1040	36.86
	2Kg/ Fad.	61.1	161	17.0	239.3	3.84	8.86	0.37	3.10	13.07	1054	36.76
	3Kg/ Fad.	57.3	120	0.01	177.4	3.14	5.62	0.01	3.02	8.77	1053	36.66
LSD. For inte.		0.36	0.92	0.47	0.78	0.36	0.92	0.47	0.14	0.78	29.75	ns
		Brassica campestris.										
Broad-cast	1 Kg/Fad.	43.8	136	256	436	1.59	5.77	7.29	3.23	14.65	852	37.82
	2Kg/ Fad.	37.9	111	183	332	1.45	4.33	4.44	3.12	10.22	863	37.50
	3Kg/ Fad.	33.6	71.5	79.1	184	1.31	2.81	2.47	2.83	6.59	869	37.30
Rows 25cm	1 Kg/Fad.	46.4	163	275	484	1.88	6.54	8.01	3.29	16.43	916	38.21
	2Kg/ Fad.	40.9	127	192	360	1.68	4.97	4.67	3.2	11.32	926	37.68
	3Kg/ Fad.	35.5	84.4	98.2	218	1.46	3.13	2.72	3	7.31	938	37.42
Rows 50cm	1 Kg/Fad.	44.8	156	278	479	1.79	6.35	7.99	3.22	16.13	900	37.80
	2Kg/ Fad.	38.6	129	187	354	1.61	4.73	4.5	3.16	10.84	913	37.63
	3Kg/ Fad.	35.3	85.3	97.4	218	1.53	3.33	2.63	2.88	7.49	925	37.50
LSD For inte.		***1.5***	***7.1***	***17***	***18***	***0.1***	***0.24***	***0.33***	***0.2***	***0.39***	***30***	ns

Regarding *Brassica napus*, highest yield/fad (1080 Kg) was produced with drill seeding at 25 cm row spacing and seeding rate of 3 Kg/fad, while the lowest yield (1002) was obtained from broadcasting at seeding rate of 1 Kg/fad. However, there were no significant differences in seed yield/fad due to seeding rates within each seeding method. This means, in general, that the seeding method had the main effect on yield differences as compared to seeding rates. Bilgili *et al* (2003) reached to similar conclusion.

Seed yield/plant(g) and all of its components were significantly affected by the interaction. Seed yield/plant(g) and siliquae/plant as well as yield and siliquae per main, primary and secondary branches in addition to seed index exhibited linear decrease as seeding rates increased, and this right for almost all seeding methods. High values of these characters were recorded at lower (1 Kg/fad) seeding rate at any seeding method.

In contrast to yield (kg/fad), results cleared also in both species that the changes in yield/plant (g) caused by interaction was mainly due to changes in siliqua numbers per plant, which more greatly affected by seeding rates than seeding method. Higher yield/plant(g) (19.52 g) and siliquae/plant (356.2) were achieved with row seeding at 25 cm apart combined with 1 Kg/fad seeding rate. Whereas, lower yield/plant(g) (8.0 g) was obtained with 25 cm row spacing and seeding rate of 3 Kg/fad, while the lower value of siliquae/plant (170.2) was recorded for broadcasting and 3 Kg/fad seeding rate combinations.

It is of interest to note that the treatments recorded highest yield/plant(g) of 19.52 g (25 cm row spacing + 1 Kg/fad seeding rate), and lowest yield/plant(g) of 8.0 g (25 cm row spacing + 3 Kg/fad seeding rate) produced yields of 1065.3 and 1079.7 Kg/fad, respectively, without significant difference between them. Such result may be refer to the plasticity of canola, which means the ability of crop plants to compensate in yield at a wide range of seeding rates and/or plant densities. The plasticity of canola as a function response to different plant population densities is well documented by several researchers (Mendham *et al*, 1981; Ogilvy, 1984; McGregor, 1987; Morrison *et al*, 1990 and Leach *et al*, 1994). Adequate yields of canola can be achieved over a broad range of plant densities (8-90 plants/m^2) because the low density crop compensate by producing a greater leaf area, more branch racemes and a greater siliqua numbers per plant (Mendham *et al*, 1981 and Leach *et al*, 1999). Likewise, Morrison *et al* (1990) reported that the production of branch racemes and siliquae served to buffer the effect of a reduced plant density and maintain yield of rapeseed. *Brassica campestris* plants exhibited relatively similar trend of *B. napus*, in which the interaction between seeding methods and rates caused significant differences for all measured characteristics (Table 3).

Combined data given in Table (3) cleared that significant differences in seed yield/fad were mainly due to seeding methods. Drilling either in 25 cm or 50 cm row spacing at any seeding rate produced higher yield/fad than the broadcasting. As in *B. napus*, maximum yield/fad of *B. campestris* (937.6 Kg) was recorded for drilling at 25 cm row spacing combined with seeding rate of 3 Kg/fad. However, the maximum value of yield/fad was insignificantly differed at any seeding rates of drilling except for 50 cm row spacing with 1 Kg/fad seeding rate, which exhibited significant lower value (899.5 Kg). On the other hand, lowest yield/fad (852.1 Kg) was produced from broadcasting at seeding rate of 1 Kg/fad.

As occurred in *B. napus*, plant characteristics of *B. campestris* including seed yield/plant(g) and its components were significantly influenced by the interaction. Yield/plant(g), siliquae/plant as well as yield and siliquae per main, primary and secondary branches and seed index demonstrate linear decrease as seeding rate increased at any seeding method. Higher mean values recorded for these characters were obtained at seeding rate of 1 Kg/fad for all tested methods of seeding. Maximum yield/plant (g) (16.43 g) and siliquae/plant (483.7) as well as yield and silique per main, primary and secondary branches were recorded at 25 cm row spacing combined with 1 Kg/fad seeding rate. Otherwise, lowest mean values of yield/plant(g) (6.59 g) and siliquae/plant (184.2) as well as its components on main, primary and secondary branches were noted for broadcasting at seeding rate of 3 Kg/fad.

The interaction had no significant effect on seed oil % for both *B. napus* and *B. campestris*. However, seed oil% of both species exhibited a small linear decrease occurring with an increase in seeding rate at each seeding method. Van Deynze *et al* (1992) reported comparable trend.

Data indicate also that both *B. napus* and *B*. *campestris* demonstrated a large capacity to compensate yield per unit area for low plant density with low seeding rate by producing more branch racemes (data not shown) and siliquae per plant. McGregor (1987); Morrison et al (1990) and Leach et al (1999) noted a similar response of canola to low seeding rates. On the other hand, seeding rate effects were different for single plant yield than for yield per unit area. Therefore, yield and yield components evaluated on a single plant basis do not, necessarily, have a direct relationship to yield on a unit area basis.

In general, results of the present study suggest that drill seeding at 25 cm row spacing combined with seeding rate of 2-3 Kg/fad should be used for production of both *B. napus* and *B. campestris* canola. However, because yield losses are more likely to result from inadequate than from excessive plant densities, the higher rate (3 Kg/fad) may be preferred particularly under less than ideal seeding conditions when planting is delayed or where weed competition is anticipated. Furthermore, the relatively higher density produced plants having fewer siliquae-bearing branches with more synchronous siliquae as well as seed development and result in more uniform seed maturation that consequently improved harvest process.

Yield structure

Yield structure as influenced by seeding methods and rates is represented by seed yield contribution from the main and lateral branch racemes to the total seed yield of individual plant (Figs. 1& 2).

Results cleared that the difference in total yield contribution from main, primary and secondary branches was, mostly, due to the species. *Brassica napus* plants carrying on average more than 90% of total yield/plant(g) on the main and primary branches, while the contribution of secondary branches ranged from 0.01 to 9.4 % taking into account seeding methods and rates (Figs. 1& 2).. In close agreement with our findings, Scarisbrick *et al* (1982) reported that the secondary branches are of minor importance in the determination of seed yield in *B. napus*. On the contrary, the contribution of secondary branches to total seed yield/plant(g) of *B. campestris* accounted for 43.5% as a general mean over the two factors of study.

Seeding method had relatively no effect on the contribution of main and lateral branches for both tested species; the differences in percentages were minimal though the differences in actual yield/plant (g) are cleared (Fig. 1).

However, changing plant density manipulated by altering the seeding rate and row spacing modified plant structure i.e. modified the contribution of yield carried on the main and lateral branches.Seeding rates demonstrated considerable effect on the contribution of main and lateral branches to seed yield/plant(g) of both *B. napus* and *B*. *campestris* . Contribution to seed yield/plant(g) resulted from the main branch increased as seeding rate increased though the actual yield/plant(g) showed an inverse relationship, and this exact for both species (Fig. 2). Therefore, at low seeding rate a relatively large portion of total yield per plant was produced on the lateral branches and as seeding rate increased the yield from the branches decreased. Comparable tendency was observed for number of siliquae per plant in both species (data not shown) that closely related to the seed yield of individual plant. These results are in complete agreement with those obtained by Morrison *et al* (1990) in *B. napus*. Also, Diepenbrock (2000) confirmed that increased competition of *B. napus* plants due to high densities not only reduces branching, but, also the number of siliquae on all branches.

In general, the major yield compensation as affected by seeding rates in both species was through variations in contribution from main and secondary branches, while contribution from primary branches was relatively stable.

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التركيب البنائي لمحصول الكانولا تحت طرق زراعة ومعدلات تقاوي مختلفة

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يهدف هذا البحث إلي دراسة تأثير طرق الزراعة ومعدلات التقاوي علي القدرة المحصولية وبناء المحصول لنوعين من الكانولا وهما *B. napus* و *B. campestris* . ولهذا الغرض أجريت أربعة تجارب حقلية منفصلة بمحطة التجارب الزراعية بكلية الزراعة جامعة القاهرة خلال الموسميين الشتويين ٢٠٠٢/٢٠٠٣-٢٠٠٣/٢٠٠٤ وكان التصميم المستخدم هو تصميم القطاعات المنشقة حيث وزعت القطع الرئيسية بثلاث طرق زراعة هي البدار والزراعة سطور علي مسافة ٢٥سم و٥٠سم والقطع المنشقة ثلاث معدلات تقاوي هي ١و٢و٣ كجم للفدان لكل طريقة زراعة .

دلت النتائج المجمعة للموسمين أن التأثيرات الرئيسية لطرق الزراعة علي نوعي الكانولا تحت الدراسة كانت معنوية بالنسبة لمحصول الفدان ومحصول النبات الفردي ومكوناته مع بعض الاستثناءات أما معدلات التقاوي كان معنويا فقط بالنسبة لمحصول النبات الفردي ومكوناته بالإضافة إلي محتوي البذور من الزيت بالنسبة للنوع *B.campestris* وفيما يتعلق بتأثير التفاعل بين العاملين تحت الدراسة , فقد أوضحت البيانات أن طريقة الزراعة تعتبر العامل الرئيسي في التأثير علي إنتاجية الكانولا تحت الظروف الحالية. حيث أن الزراعة تسطير لكلا النوعين سواء علي مسافة ٢٥ سم أو ٥٠سم مع أي من معدلات التقاوي المستخدمة أعطت محصول بذور للفدان أعلي معنويا من طريقة البدا ر ،هذا وقد كانت أعلي القيم لمحصول الفدان من البذور في كلا النوعين لطريقة الزراعة تسطير علي مسافة ٢٥ سم مع معدل تقاوي ٣ كجم/ فدان .أما محصول النبات الفردي وكل مكوناته فقد تأثرت معنويا بالتفاعل بين عاملي الدراسة .حيث اظهر محصول البذور للنبات وعدد القرون علي النبات , وكذا عدد القرون علي الفرع الرئيسي والأفرع الأولي والثانية بالإضافة إلي وزن الألف بذرة نقصا خطيا بزيادة معدلات التقاوي وهذا ينطبق علي جميع طرق الزراعة المستخدمة وقد سجلت اعلي القيم لهذه الصفات عند استخدام اقل معدل تقاوي (١ كجم/ فدان) لأي طريقة زراعة. هذا وقد اظهر التفاعل تأثير غير معنوي علي محتوي البذور من الزيت لكلا النوعيين حيث انخفضت نسبة الزيت بقيم غير معنوية بزيادة معدل التقاوي لكل طريقة زراعة.أما تحليل المحصول للنبات الفردي فقد أوضح أن الاختلاف في مساهمة محصول الفرع الرئيسي والأفرع الأولي والثانية بالنسبة للمحصول النهائي يرجع أساسا الي النوع فنبتات النوع *B.napus* تحمل أكثر من ٩٠% من المحصول الكلي علي الفرع الرئيسي والأفرع الأولي بينما مساهمة الأفرع الثانية تتراوح من ٠,٠١ % إلي ٩,٤ % مع الأخذ في الاعتبار طرق الزراعة ومعدلات التقاوي وعلي العكس فإن مساهمة الأفرع الثانية في المحصول النهائي للنبات للنوع *B.campestris* قدرت بنحو ٤٣,٥ % كمتوسط عام لكلا العاملين تحت الدراسة ويقترح بناء علي نتائج هذا البحث بصفة عامة إلي انه يجب استخدام الزراعة التسطير بمسافة ٢٥ سم بين السطور علي معدل تقاوي ٣ كجم / فدان في زراعة كلا النوعيين من الكانولا.

Fig.(3) : Effect of seeding rates on seed yield and its contribution (%) of main, primary and secondary branches to the total seed yield /plant (combined data over two seasons).

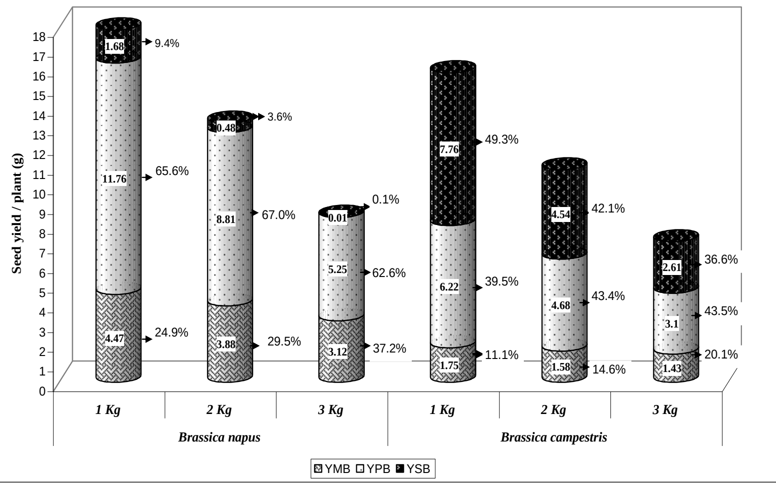

Fig (2): Effect of seeding rates on seed yield and its contcribtion (%) of main, primary and secondry branches to the total seed yield/ plant(combined fata over two

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Fig.(1) : Effect of seeding methods on seed yield and its contribution (%) of main, primary and secondary branches to the total seed yield /plant (combined data over two seasons).