Effect of Sowing Dates on Growth, Yield and Quality of Three Canola Cultivars (*Brassica napus L.*)

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Abstract:

The study included two field experiments for canola (*Brassica napus L.*) conducted during two winter successive seasons 2007 - 2008 , 2008 - 2009 at AL-Rashidia location which is lies about (20 km) west north mosul city. The main objective was to find out the effect of sowing dates in the growth, yield and quality of three canola cultivars.

Each experiment was conducted according to factorial experiment in a randomized completely block design with three replications. Each experiment included three sowing dates (1, 15 and 30 October) with three cultivars of canola crops (Topas, Emma and Monty).

The results could be summarized as:

The second planting date (15 October) gave the highest rate of prescriptions of plant height, number of primary branches, leaf area index, number of silique/ plant, dry weight(g.) /plant, number of seed/ silique , weight of thousand seed (g.), total yield and oil yield (ton.ha^{-1}), While the first planting date (1October) gave the highest percentage of oil in seeds in both seasons .The cultivars effected significantly all the related characteristics, the Emma cultivar come over the other cultivars in plant height/cm, number of branches/plant, number of silique /plant, leaf area index, dry weight gm./plant, number of seed/ silique, 1000 seeds weight (g.) seed yield (ton.ha^{-1}), oil percentage of seeds and oil yield

(ton.ha^{-1})in both seasons .The interaction between sowing dates and cultivars significantly in some of the characteristics of growth, yield and quality, the Emma variety with all sowing dates (1 , 15 and 30 October) gave highest value for each plant height/cm , number of branches/plant , number of seed / silique and the proportion of oil in a planting date 2008, While The interaction between sowing dates and cultivars was significant in leaf area index and number of seed / silique in only 2009 season .

تأثير مواعيد الزراعة في نمو وحاصل ونوعية ثلاثة أصناف من السلجم
Brassica napus L.

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ملخص البحث :

تضمنت الدراسة تجربتين حقليتين لمحصول السلجم (*Brassica napus L.*) للموسم الشتوي من العامين المتعاقبين٢٠٠٧- ٢٠٠٨ و٢٠٠٨-٢٠٠٩ في موقع الرشيدية الذي يبعد حوالي (٢٠كم) شمال غرب مدينة الموصل. استهدفت الدراسة معرفة تأثير مواعيد الزراعة في نمو ثلاثة أصناف من السلجم وحاصلة ونوعيته .

نفذت كل من التجربتين وفق نظام التجارب العاملية بتصميم القطاعات العشوائية الكاملة بثلاث مكررات لكل تجربة . تضمنت كل تجربة ثلاثة مواعيد زراعية (١ ،١٥ و٣٠ تشرين الأول) وثلاثة أصناف من محصول السلجم (توبس ، أيما ومونتي) .

وتم التوصل إلى النتائج الآتية: أعطى موعد الزراعة الثاني (١٥ تشرين الأول) أعلى معدل لصفات ارتفاع النبات، عدد الأفرع/نبات ، دليل المساحة الورقية ، عدد الخردلات/نبات، الوزن الجاف غم/نبات، عدد البذور/خردله ، وزن ١٠٠٠ بذرة/غم ، حاصل البذور الكلي وحاصل الزيت (طن/هكتار)، في حين أعطى موعد الزراعة الأول (١ تشرين الأول) أعلى نسبة للزيت في كلا موسمي الزراعة.

أثرت الأصناف معنوياً في الصفات المدروسة جميعها، إذ تفوق ألصنف أيما في صفات ارتفاع النبات/سم، عدد الأفرع/نبات ، عدد الخردلات/ نبات،دليل المساحة الورقية ،الوزن الجاف غم/نبات، عدد البذور/خردله ، وزن ١٠٠٠ بذرة/غم، حاصل البذور الكلي (طن /هكتار) ونسبة وحاصل الزيت (طن/هكتار) في كلا موسمي الزراعة.

أثر التداخل بين مواعيد الزراعة والأصناف معنوياً في البعض من صفات النمو والحاصل والنوعية، فقد تفوق الصنف أيما عند زراعته بجميع المواعيد (١ ،١٥ و٣٠ تشرين الأول) بإعطائه أعلى قيمة لكل من ارتفاع النبات/سم، عدد الأفرع/نبات ، عدد البذور/خردله، ونسبة الزيت في موسم الزراعة ٢٠٠٨،في حين كان التداخل بين مواعيد الزراعة والأصناف معنوياً فقط في موسم الزراعة ٢٠٠٩ لصفتي دليل المساحة الورقية وعدد البذور/خردله.

Introduction:

Canola (*Brassica napus L.*) has some good characteristics such as suitable placement in crop rotation, desirable quality, high value of oil (40 - 45%) and protein (39%) that has changed it to an important crop (Ghassemi-Golezani *et al*,2010). Apart from other factors responsible for increasing per hectare yield , sowing date is considered to play a remarkable role in boosting up production (Panwar *et al* , 2000) .The effect of sowing dates on canola plant growth was reported by some investigators , who found that the sowing in mid of October produced the highest number of silique/ plant , leaf area index and plant height (Auld *et al* ,1984), number of primary branches, Total dry weight/plant and silique dry weight/plant (g.) (Christensen *et al* ,1985) . Effect of sowing dates on yield, yield components and quality was studied by many investigators:-(Jenkins and Leitch ,1986: Yousaf *et al* 2006 and Assey *et al* 2006). Who reported that the early Sowing increase oil yield and oil percentage .

Early seeding is recommended, but seeding should be late enough to avoid damage from spring frost just after emergence. Seeding should

occur from October 1 to 25. Seeding later than November 15 usually results in lower yields (Auld *et al* ,1984 ; Berglund and McKay ,1998).

The present study was undertaken to assess the effect of sowing dates on growth , yield and quality of three cultivars of canola *(Brassica napus L.*) .

Materials and Methods

Tow filed experiments were carried out at the experimental farm of AL-Rashidia field-Mosul 20km west north Mosul city at Nineveh province , during two winter successive seasons 2007 , 2008 – 2008 , 2009 to investigate the effect of three sowing dates (1 , 15 and 30 October) on the growth , yield and certain quality trials of three canola cultivars (Topas, Emma and Monty) . Each experiment included twenty seven plots comprising the combinations of three sowing dates and three cultivars with three replications. Seeds of these cultivars were obtained from the crops industrial company, Baghdad. The experimental design was factorial experiment in a Randomized Completely Block Design with three replications. Then Duncans multiple range test (Duncan ,1955) was used to compare among means (SAS ,2001). A representative soil sample (0 to 30 cm depth) was taken before planting (Table1) with the mean properties as pH (7.12 ,7.82) , organic matter (12.10,13.22%), available N (42.63,38.62),CaCO3 (271.00, 162.00), available P (14.18,12.83) and available K (160.00,112.00) using the methods description by Black ,1965, Jackson , 1973 ,Page et al, 1982 and Tandon ,1999 .

Seeds were sown in hills 20 cm apart on rows 60 cm apart. Each plot 18 M^2 included sex rows 60 cm apart and five meters long. Super phosphate 60 $kg.ha^{-1}$ ($45\%P_2O_5$) and40 $kg.ha^{-1}$ potassium ($48\%K_2O$) were applied to the soil during the sowing period , nitrogen fertilizers was

applied in the form of Urea 100 kg.ha^{-1} (46%N) in two equal doses, immediately after thinning(20 days from sowing) and 10 days later. The plant were thinned to one plant/hill 20 days after sowing .The external two rows were left as border. Two of the remaining Rows were devoted for estimating plant growth and some characteristics . Normal cultural practices of growing canola were conducted in the usual manner followed by the farmers of the district .At harvesting (when the color of seed coat presented in the lower zone of the terminal raceme was darkish at 150, 143, 155 and 146, 155, 148 days after sowing for each cultivars Topas, Emma and Monty to both seasons 2007 , 2008 respectively) , two inner rows were taken to determinate the following characters (silique dry weight/plant (g.), number of seeds/ silique, 1000 seeds weight (g.) and Yield ton.ha^{-1}).

Table (1): The physical and chemical characters of soil filed experiments in both seasons.

Seasons	2007-2008	2008-2009
physical characters		
Sand (%)	62.00	40.00
Silt (%)	20.00	37.00
Clay (%)	18.00	23.00
Texture	Sandy Loom	Silty Sandy
Chemical characters		
O.M. %	12.10	13.22
Available N ppm	42.63	38.62
Available P ppm	14.18	12.83
Available K ppm	160.00	112.00
Total $CaCo_3$ %	271.00	162.00
pH	7.12	7.82
E.C. mmhos/ cm	0.76	0.94

Sample of ten guarded plants each was taken from each treatment at 95days after sowing. The following data were record : number of primary branches, plant height (cm) , leaf area index, number of silique

/plant .At harvest, ten guarded plants were taken randomly from the two inner rows of each experimental plot, then the following data were measured ; dry weight(g.) /plant, number of seeds/ silique, 1000 seeds weight (g.) ,yield and oil yield (ton.ha^{-1}). Oil seed content was determined using Soxhlet method (A.O.A.C. ,1980).

Table (2) Monthly and growing season precipitation, temperature, and relative humidity in AL-Rashidia location in 2007-2008, 2008-2009 seasons.

Month	Temperature (C°)			Months Precipitation (mm)	relative humidity (%)
	Max	Min	Mean		
2007-2008					
October	28.2	11.0	19.6	0.0	60.2
November	20.4	8.6	14.5	18.2	62.0
December	18.8	4.2	11.5	36.0	65.6
January	10.0	3.8	6.9	126.2	68.8
February	13.6	5.6	9.6	136.0	66.4
March	20.6	9.2	14.9	28.8	60.8
April	23.0	15.0	19.0	86.2	60.0
May	34.6	18.4	26.5	12.0	40.2
Total				443.4	
2008-2009					
October	26.0	10.6	18.3	2.0	62.0
November	18.8	9.2	14.0	16.8	60.4
December	16.2	6.4	11.3	34.6	62.2
January	11.0	4.0	7.5	134.0	64.2
February	14.8	6.0	10.4	142.2	62.8
March	18.2	8.6	13.4	30.6	66.0
April	21.0	17.2	19.1	74.8	62.2
May	30.8	19.2	25.0	10.6	38.6
Total				445.4	

AL-Rashidia Meteorological organization

Results and Discussion

1- Effect of sowing dates:

Temperature, rainfall and relative humidity for the experiment site during the study years are presented in table (1). The average rainfall for 2009 (445.4mm) was higher than that observed (443.4mm) in 2008. In this study, all investigated characteristics were significantly affected by sowing dates (table 11). Data reported in table (3) indicate the effect of sowing dates on canola attributes i.e. Plant height (cm), number of primary branches, number of silique/ plant, leaf area index, and dry weight (g.)/plant in two seasons. In the two growing seasons, the attributes of canola exhibited significant differences for the different dates of sowing .The promising date of sowing was mid of October for canola attributes criteria except Plant height and number of primary branches in the second seasons where the maximum value was obtained with sowing October 30th number of silique/ plant at October 15th exceeded the number of silique/ plant at the other sowing date, These results are true in the two growing seasons. The superiority of 2008 season in some growth characters and yield components may be due to the high available of nutrients in experimental site of this season (table1). The beneficial effect of nutrients could be attributed to its vital role activity in the function of enzymes for the biological processes in plants which lead to increase in yield components, the same results was obtained by Degenhardt and Kondra (1981); Christensen *et al* (1985) ; Taylor and Smith(1992) ; Nanda *et al* (1995) ,Shirani and Ahmedi (1995) and Yousaf *et al.* (2002) who found that the mid season plantings produced taller plant than do early of late plantings. The decrease in dry

weight/plant(55.68 ,53.51g), which obtained with sowing in the October1st, most likely due to lower rainfall which lead to decrease leaf area index (table 2). The mid season plantings significantly increased number of silique/ plant, leaf area index than do early or late plantings at the both seasons.

Table (3) Effect of sowing dates on some growth characters of canola in both seasons .

Seasons	sowing dates (October)	plant height (cm)	no. of primary branches/plant	no. of silique/ plant	leaf area index	dry weight (g.)/plant
2007-2008	1	156.73b	7.50b	345.16c	1.74b	55.68c
	15	160.65a	7.88a	360.05a	1.78a	56.71a
	30	160.03a	7.37b	354.11b	1.76b	56.05b
2008-2009	1	148.49b	6.92c	337.47c	1.68c	53.51c
	15	151.44a	7.51b	351.22a	1.75a	55.83a
	30	151.61a	8.37a	347.83b	1.73b	55.46b

* **The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

It was evident ,from table (4) , that number of seeds/ silique, 1000 seeds weight (g.) , yield and oil yield (ton.ha^{-1}) as affected by sowing dates, it was found that mid of October as well as first of October sowings had statistically the same highest yield(ton.ha^{-1}) Meantime ,it was observed that mid of October sowing had the highest seed yield(0.811,0.790 kg.ha^{-1}) followed by 30th of October sowing .This was true in both seasons . The increases of seed yield per hector (kg) in mid of October sowing due to increases of dry matter accumulation in the later formed siliqua may be attributed to high temperature (19.6 , 18.3 C°) and long photoperiod that exist during siliqua development (tables 2). The same results were found by Ganga and Rajat (1979) and Jenkins and Leitch (1986) show that sowing in mid of October was associated with the highest seed yield of canola per plant. Oil percent and oil yield

(ton.ha^{-1}) were decreased by delaying sowing date from 1st to 30th October (47.72,42.78%,0.33,0.33) in both seasons respectively. The increased seed oil content and oil yield by sowing canola in the October1st may be due to attributed to the short period of vegetative growth, the weather conditions such as temperature and solar radiation, which were beyond the optimum degree for vegetative and reproductive stages that resulted in photosynthetic products accumulated in the source (leaves) and transported to the sink (seeds) (tables 2). Similar results were obtained by Schuster and Sra (1979) ; Degenhardt and Kondra(1981) and Gabrielle *et al* (1998) who found that The mid season plantings significantly increased dry weight/plant , number of seeds/ silique, 1000 seeds weight and oil yield .

Table (4) Effect of sowing dates on yield, yield components and quality in both seasons .

Seasons	sowing dates (October)	no. of seeds/silique	1000 seeds weight (g.)	yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})
2007-2008	1	20.83c	2.05b	0.782c	44.07a	0.344b
	15	21.89a	2.08a	0.811a	43.03b	0.348a
	30	21.29b	2.04b	0.798b	42.27c	0.337c
2008-2009	1	20.11c	2.03b	0.763c	44.67a	0.341a
	15	21.20a	2.10a	0.790a	43.65b	0.344a
	30	20.72b	2.09a	0.784b	42.78c	0.335b

*** The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

2- Effect of cultivars:

Data in table (5) mentioned that Emma variety had taller (172.48 ,162.46 cm) plant then those of Topas and Monty in both seasons 2008 and 2009 respectively. The result of number of primary branches per plant showed that the Emma variety significantly exhibited higher

number of primary branches (9.33, 9.99) than of Topas and Monty cultivars in the two seasons respectively.

The differences among the three cultivars in the number of silique /plant may be attributed to the general varietals differences in the Plant height and number of primary branches per plant (Kwon *et al* ,1990 , Potter *et al* ,1999; Shenoy and Kalagudi,2005 and Ghassemi-Golezani *etal*,2010). Moreover , the differences in leaf area index may be attributed to the differences in leaf area per plant. In this concern , Sharief (2000) showed that taller cultivars had more leaves and leaf primordial that the others canola cultivars. It can also noted that the dry weight per plant of Emma variety out weighed Topas and Monty in a descending order at both seasons.

The superiority of Emma variety in the dry matter production may be attributed to increase the area of photosynthesis, as result of increase leaf area index, the leaves transport the product of photosynthesis to newly grown leaves and stems, and this in turn increased the dry matter of plant. In this report, Wielebski and Wojtowicz ;(1998) ; Gahoonia *et al.*, 2000 and Sharief (2000) reported that Monty variety had highest seed yield and dry weight per plant than the Pinnacle and Dunkled cultivars.

Table (5) Effect of canola cultivars on some growth characters in both seasons.

Seasons	Cultivars	plant height (cm)	no. of primary branches/plant	no. of silique/ plant	leaf area index	dry weight (g.)/plant
2007-2008	Topas	147.05c	7.95b	353.38b	1.72b	55.89b
	Emma	172.48a	9.33a	362.58a	1.91a	58.26a
	Monty	157.87b	5.83c	343.36c	1.65c	54.29c
2008-2009	Topas	141.76c	7.08b	344.47b	1.70b	55.02b
	Emma	162.46a	9.99a	354.88a	1.84a	56.09a
	Monty	147.32b	5.73b	337.16c	1.63c	53.68c

*** The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

Mean values of seed yield, yield components and some related traits for the three tested cultivars are presented in table (6). The data revealed that Emma variety surpassed Topas and Monty cultivars in the yield components (number of seeds/ silique, 1000 seeds weight (g.), Yield ton.ha^{-1}.),Moreover , Topas surpassed Monty in number of seeds/ silique , 1000 seeds weight (g.) ,while the Monty surpassed Topas in yield (ton.ha^{-1}.) in both seasons. This means that Emma plants were more efficient to accumulate dry mater in their silique.

Regarding to the seed characters studied i.e. 1000 seeds weight and oil percentage ,data show that there were significant variations among the three tested canola cultivars in both seasons. Emma variety surpassed significantly Topas and Monty cultivars in number of seeds/ silique (22.31,21.81), 1000 seeds weight ,yield and oil yield ton.ha^{-1}. in both seasons respectively. However , the differences in oil percent of seeds may be attributed to genetic factors and their interaction with the prevailing environmental conditions .This increase in oil yield (ton.ha^{-1}) from Emma variety may be due to their high seed yield /ha (table 5) rather than differences in seed oil content. Similar results were reported by Singh and Singh (1985); Hassan and El-Hakeem. (1996) ,Al-Barzinjy *et al* (1999) Gill *et al.*, 2004, and Marschner *et al.*,(2007). The superiority of Emma variety in the most seed characters may be due to that Emma variety had better vegetative growth and hence photosynthetic area which led to more carbohydrates was which translocated from the source (leaves and stem)to the sink (seeds) (Mengel and Kirkby, 1982).

The results showed that number of seeds/silique , 1000 seeds weight and yield, oil yield (ton.ha^{-1}) were always significantly higher for Emma than that for Topas and Monty cultivars.

Table (6) Effect of canola cultivars on yield, yield components and quality in both seasons.

Seasons	Cultivars	no. of seeds/silique	1000 seeds weight (g.)	yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})
2007-2008	Topas	21.43b	2.07b	0.778c	42.47b	0.330b
	Emma	22.31a	2.36a	0.825a	44.79a	0.396a
	Monty	20.27c	1.74c	0.789b	42.11c	0.332b
2008-2009	Topas	20.91b	1.95b	0.766c	43.04b	0.329b
	Emma	21.81a	2.45a	0.798a	45.51a	0.363a
	Monty	19.30c	1.82c	0.774b	42.56c	0.329b

* **The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

3- Effect of interaction between sowing dates and cultivars:

The interaction between the studying factors(sowing dates and cultivars) showed significant effects on Plant height, number of primary branches in 2008 Season, leaf area index in 2009 season as illustrated in tables (7,8). The interaction between the sowing dates and cultivars for the other investigated traits were not statistically significant in both seasons, therefore the data were excluded .Data illustrated in tables (7,8) show generally that Topas ,Emma and Monty cultivars appeared to be clearly affected by sowing dates for plant height (cm), number of primary branches in first season, leaf area index in second season, while they appeared to be little response sowing dates for those traits. On the other hand , Emma variety reflected the greatest response to sowing dates for these traits, with this regard , Singh and Singh (1985) Hassan and El-Hakeem. (1996); Christmas (1996) ; Al-Barzinjy *et al* (1999) Aziz *et al.* (2005) and Assey *et al* (2006) found that sowing dates in 15th October produced maximum 1000 seeds weight(2.91g) and seed yield (2852 Kg Ha^{-1}) .The insignificant effect between sowing dates and cultivars on other characteristic showed that each of these two factors acted independently on these traits .

Table (7) Effect of interaction between sowing dates and cultivars on some growth characters in 2007 -2008 season.

Seasons	Cultivars	plant height (cm)	no. of primary branches/plant	no. of silique/ plant	leaf area index	dry weight (g.)/plant
1	Topas	143.88e	7.64b	344.41	1.69	55.41
	Emma	171.66a	9.18a	354.33	1.90	57.63
	Monty	154.66c	5.67d	336.75	1.64	54.00
15	Topas	148.53d	8.15b	360.33	1.75	56.45
	Emma	173.70a	9.52a	369.50	1.94	58.95
	Monty	159.71b	5.97d	350.33	1.67	54.73
30	Topas	148.75d	6.99c	355.41	1.72	55.81
	Emma	172.10a	9.27a	363.91	1.90	58.20
	Monty	159.25b	5.84d	343.00	1.65	54.15

* **The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

Table (8) Effect of interaction between sowing dates and cultivars on some growth characters in 2008 -2009 season.

sowing dates (October)	cultivars	plant height (cm)	no. of primary branches /plant	no. of silique /plant	leaf area index	dry weight (g.)/plant
1	Topas	139.06	6.86	335.16	1.65d	54.65
	Emma	160.76	8.23	346.91	1.82b	52.51
	Monty	145.65	5.67	330.33	1.59e	53.36
15	Topas	142.80	7.57	350.83	1.73c	55.30
	Emma	163.33	9.10	360.58	1.86a	58.00
	Monty	148.20	5.87	342.25	1.65d	54.20
30	Topas	143.41	6.81	347.41	1.71c	55.13
	Emma	163.28	12.65	357.16	1.83b	57.76
	Monty	148.13	5.64	338.91	1.64d	53.48

* The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.

The interaction between sowing dates and cultivars was significant for oil percentage in 2008 season, number of silique/ plant in both seasons tables (9,10).Maximum oil percentage(45.85) was produced as a result of The interaction of 1st October with canola cultivar i.e. Emma in 2008 season, However ,the early sowing on1st October of Monty cultivar

produced the lowest number of seeds/ silique (19.93,18.78) in both seasons respectively. Similar conclusion were reported by Guardia and Perez (1979); Macleod (1981); Mustapic and Eberhardt (1983); Moore and Guy(1997) ; Habekotte´ (1997); Kwon *et al* (1990); Hassan and El-Hakeema (1996) and Sharief (2000) .

Table (9) Effect of interaction between sowing dates and cultivars on the yield, yield components and quality in 2007 -2008 season.

sowing dates (October)	cultivars	no. of seeds/silique	1000 seeds weight (g.)	yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})
1	Topas	20.75e	2.07	0.763	43.20d	0.329
	Emma	21.81cd	2.34	0.808	45.85a	0.370
	Monty	19.93f	1.75	0.775	43.16d	0.334
15	Topas	22.00bc	2.08	0.787	42.25e	0.332
	Emma	22.90a	2.42	0.841	44.88b	0.377
	Monty	20.78e	1.73	0.804	41.98e	0.337
30	Topas	21.56d	2.06	0.779	41.96e	0.326
	Emma	22.21b	2.31	0.827	43.65c	0.360
	Monty	20.10f	1.74	0.787	41.20f	0.324

*** The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

Table (10) Effect of interaction between sowing dates and cultivars on the yield, yield components and quality 2008 -2009 season.

sowing dates (October)	cultivars	no. of seeds/silique	1000 seeds weight (g.)	yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})
1	Topas	20.18e	1.92	0.748	43.91	0.328
	Emma	21.36c	2.40	0.783	46.53	0.364
	Monty	18.78h	1.77	0.759	43.58	0.330
15	Topas	21.46c	1.97	0.777	42.91	0.333
	Emma	22.28a	2.49	0.809	45.65	0.369
	Monty	19.85f	1.85	0.784	42.40	0.332
30	Topas	21.10d	1.95	0.772	42.30	0.326
	Emma	21.80b	2.48	0.800	44.35	0.354
	Monty	19.28g	1.84	0.780	41.70	0.325

*** The means values within column followed by the different letter are significant at 0.01 and 0.05 probability levels, respectively.**

Table- 11-: Analysis of variance F values for some growth characters, yield and yield components and quality in 2007 -2008 and 2008 -2009 seasons.

S.O.V	D.f	M.S. for 2007 -2008 season									
		plant height (cm)	no. of primary branches	no. of /plant silique	leaf area index	dry weight plant/(g.)	no. of seeds/ silique	1000 seeds weight	seed yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})
Replications	2	130.454	2.648	45.910	0.189	13.192	1.845	0.180	13456.704	37.441	7075.290
A	2	355.471**	0.466 *	242.3649**	11.469**	24.2269*	10 .13 **	0.1512 *	330602.870**	104.31 **	4031.465*
B	2	179.888 **	0.568 **	6333.902**	0.31688*	156.929**	4.472*	0.800 **	260911.263**	21.434 *	49630.870**
A × B	4	152.935 **	0.380 **	21.860 n.s	0.0643 n.s	3.407 n.s	3.930 *	0.034 n.s	1305.020 n.s	31.473 **	829.123 n.s
Error	16	28.968	0.0790	29.558	0.086	6.552	1.153	0.031	3371.327	5.744	754.640
Total	26										
S.O.V	D.f	M.S. for 2008 -2009 season									
Replications	2	77.580	0.293	1.130	0.006	7.802	0.881	0.026	283.466	3.548	41.707
A	2	77.318 **	1.097 **	7355.536**	3.762**	29.629*	19.215 *	2.206 **	11555.047*	122.403 **	1275.409**
B	2	52.496*	0.483*	2983.794**	14.410**	24.767*	17.326 *	0.428*	19323.34 **	21.088 *	363.151*
A × B	4	17.139 n.s	0.295 n.s	24.298 n.s	0.519*	2.771 n.s	20.777**	0.014 n.s	20.7324 n.s	1.989 n.s	9.114 n.s
Error	16	12.068	0.131	29.596	0.114	6.045	3.561	0.087	1927.204	5.693	80.937
Total	26										

*, ** Significant at the 0.05 and 0.01 probability levels, respectively. and n.s. not Significant

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