Effect of Row Spacing and Nitrogen fertilization on Growth, Yield and Quality of Some Rapeseed Genotypes (*Brassica napus L.*)

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Abstract:

A field experiment was conducted to determine the response of Rapeseed genotypes *(Brassica napus L.)* to Nitrogen fertilization and Row Spacing in two winter successive seasons 2007-2008,2008-2009. Each experiment comprised of Four Rapeseed Genotypes (Conl, Pactol , Olga and Elvira), three Nitrogen fertilizers levels (0 , 80 and 160 kg N ha^{-1}) and two Row Spacing (30,60 cm). It was conducted according to Randomized Completely Block Design with split - split plot with three replications. The results could be summarized as :

The Conl Genotype gave a high level for characters Plant height, number of primary branches, number of Silique/plant, leaf area index , dry weight/plant (g.), number of seeds/silique, weight of thousand seed(g) ,Total Yield and oil Yield ($ton.ha^{-1}$) and oil percentage in both seasons 2007-2008, 2008-2009 respectively. Nitrogen fertilizers levels had significantly affected on Plant height, number of primary branches, number of silique/plant, leaf area index , dry weight/plant, weight of thousand seed and oil yield. 160 Kg N .ha^{-1} treatment gave highest seed weight and oil yield, while increasing concentration of Nitrogen to 160 Kg. ha^{-1} cause a significant decrease in oil percentage of seed in the two seasons 2007-2008 , 2008-2009 respectively. Increasing row spacing to 60cm led to significant increases in plant high, number of primary branches, number of Silique/plant, dry weight/plant, weight of thousand seed and oil yield, while decreasing Row Spacing to 30cm cause a significant increase in leaf area index and oil percentage of seed in both seasons 2007-2008 , 2008-2009 respectively.

تأثير مسافات الزراعة والتسميد النيتروجيني في نمو وحاصل ونوعية بعض التراكيب الوراثية من السلجم (*Brassica napus* *L.*)

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ملخص البحث :

أجريت تجربة حقلية لتحديد استجابة تراكيب وراثية من السلجم (*Brassica napus* *L.*) للتسميد النيتروجيني ومسافات الزراعة خلال الموسمين الشتويين من العامين المتعاقبين 2007- 2008 و2008-2009.تضمنت كل تجربة تأثير أربعة تراكيب وراثية لمحصول السلجم (كونل ،باكتل،اولكا والفيرا) وثلاثة مستويات من التسميد النيتروجيني(صفر، 80 و 160 كغم نيتروجين/هكتار) ومسافتين للزراعة بين الخطوط (30 و60 سم).نفذت التجربة وفق نظام القطع المنشقة – المنشقة بتصميم القطاعات العشوائية الكاملة بثلاث مكررات. وتم التوصل إلى النتائج الآتية :

أعطى التركيب الوراثي كونل أعلى معدل لصفات ارتفاع النبات ، عدد الأفرع/نبات ، عدد الخردلات/نبات،دليل المساحة الورقية ،الوزن الجاف غم/نبات، عدد البذور/خردله ، وزن الألف بذرة/غم ، حاصل البذور الكلي وحاصل الزيت (طن/هكتار) ونسبة الزيت في البذور في كلا الموسمين 2007- 2008 و2008-2009 على التوالي.أثرت مستويات التسميد النيتروجيني معنوياً في صفات ارتفاع النبات/سم ، عدد الأفرع/نبات، عدد الخردلات/نبات،دليل المساحة الورقية ،الوزن الجاف غم/نبات، وزن الألف بذرة/غم وحاصل الزيت (طن/هكتار).أعطت معاملة التسميد النيتروجيني 160 كغم نيتروجين/هكتار أعلى حاصل لكل من البذور والزيت،في حين سببت زيادة تراكيز النيتروجين المضاف بمعدل160 كغم نيتروجين/هكتار انخفاض معنوي لنسبة الزيت في البذور في كلا الموسمين 2007- 2008 و2008-2009 على التوالي.أدت زيادة مسافات الزراعة إلى 60سم إلى زيادة معنوية في صفات ارتفاع النبات/سم، عدد الأفرع/نبات، عدد الخردلات/نبات، الوزن الجاف غم/نبات، وزن الألف بذرة/غم وحاصل الزيت (طن/هكتار). في حين سبب نقص مسافات الزراعة إلى 30سم زيادة معنوية في دليل المساحة الورقية ونسبة الزيت في البذور في كلا الموسمين 2007- 2008 و2008-2009 على التوالي.

Introduction

Winter oilseed rape (*Brassica napus L.* , *Curcieferae*) is an important agricultural crop cultivated for its oil, which can be used as an edible product or for industrial application. Its seed high oil content ranging from 37-45 percent and is rich in protein (34-40) percent (Shirani and Ahmedi 1995 ; Panwar *et al* , 2000) . Its mainly used in the meat packing industry as an aid to flavor, emulsification, water binding, slicing, bologna and other processed meats. Ground Rapeseed can absorb excess fat and fluid (approximately 4.5 times its own weight) and is also used with seasoned hamburger, meatloaf, liver sausage, chili, various canned meat products.

Apart from other factors responsible for increasing per hectare yield , Row Spacing is considered to play a remarkable role in boosting up production. Winter oilseed rape can be used as a catch crop to reduce nitrogen leaching during the autumn–winter period because of its high capacity to take up nitrate from the soil. Other work on oilseed rape grown hydroponically or in field conditions showed that NO_3uptake increased from stem extension to the start of the flowering, whereas little NO_3 uptake was observed during Silique filling (Merrien *et al*, 1988; Jensen *et al*, 1997; Rossato *et al*, 2001).Nitrogen is the most common element limiting Rapeseed yield (Mudholkar and Ahlawat ,1981).

Yield response of Rapeseed to increasing Nitrogen rate and Row Spacing varies with different environmental variables, including weather, soil type, residual fertility (especially nitrate), soil moisture, and cultivars. Previous study (Hassan and El-Hakeem,1996 and Hocking ,1997) revealed that nitrogen reduced oil percentage of the seed. Nitrogen increases seed and oil yields by influencing a number of growth parameters such as seeds per silique and seed weight and by producing more vigorous growth and development (Ashoub ,1989; Wielebski and Wojtowicz ,1998 and Sharief ,2000) found that oil content of Rapeseed was affected by increasing Nitrogen rate. On the other hand, excessive use of Nitrogen fertilizer can decrease seed oil content (Bhan *et al* ,1980; Morrison *et al* ,1990; Khan and Muendel ,1999. For oilseed rapeseed, Mendham *et al* , 1981 also found that seed yield and oil content declined with rates of Nitrogen up to 100 kg ha^{-1}.

The present study was undertaken to assess the effect of row spacing and nitrogen fertilization on growth, yield and quality of some genotypes of rapeseed *(Brassica napus L.)*.

Materials and Methods

Four rapeseed genotypes were selected based on their adaptation to the rapeseed production areas in the AL-Quba. AL-Quba is located in the west north region of Mosul city at Nineveh province (which is far about 22km). A representative soil sample (0-30 cm depth) was taken before planting (Table1) using The methods description by Black ,1965, Jackson ,1973 ,Page *et al*, 1982 and Tandon ,1999 .

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

Seasons	2007	2008
physical characters		
Sand (%)	64.00	44.00
Silt (%)	18.00	40.00
Clay (%)	18.00	12.00
Texture	Sandy Loom	Silty Sandy
Chemical characters		
O.M. %	9.12	10.42
Available N ppm	35.66	38.68
Available P ppm	16.20	14.68
Available K ppm	172.00	160.00
Total $CaCo_3$ %	282.00	214.00
pH	7.84	8.21
E.C. mmhos/ cm	0.82	0.92

Based on soil test conducted in test seasons, super phosphate 80kg .ha^{-1} (48%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 (46%N) as split in two equal doses (40,40 and 80,80 kg nitrogen .ha^{-1}) half with sowing and the remaining half at immediately after thinning(20 days from sowing). Cultural practices, control of insects and weeds and furrow irrigation were given as needed during the growth seasons according to the local recommendations. The trials were conducted using a Randomized Completely Block Design with split - split plot arrangement keeping with genotypes as main plots, the sub plots were assigned to nitrogen levels, while row spacing as sub - sub plots with three replications according to Steel and Torrie (1980).Then Duncans multiple range test (Duncan ,1955) was used to compare among means. Each experiment included seventy-two treatments. Seeds were sown in October 12^{th} and 25^{th} for 2007-2008 and 2008-2009 seasons respectively. Each plot consisted of 6 rows, 5 M in length with 30, 60 cm in width between rows and the distance between hills was 20 cm apart to attain a plant density of 166.666 and83.333 plants .ha^{-1} respectively. The seeds were sown by putting seed to hills by hand. Plants were thinned to one plant per hill 20 days after sowing. Ten randomly tagged plants from each plot were evaluated for characters. At harvesting, two inner rows were taken to determinate of the following characters (silique dry weight, number of seeds, weight of thousand seed and total yield). Sample of ten guarded plants each was taken from each treatment at 90 days after sowing. The following data were recorded: 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/plant (g.), number of seeds/silique, weight of thousand seed (g.) ,yield and oil yield (ton.ha^{-1}). Oil seed content was determined using Soxhlet method (A.O.A.C., 1980).

Results and Discussion

1- Effect of genotypes :

A- Growth characters : All characters were affected by genotypes(Table 2), Conl produced the highest plant(29.57,16.45%), more primary branches(51.46,16.66%), silique per plant(37.59,20.30%) compared to the other three tested genotypes in the two seasons respectively. The differences among the four genotypes 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 (Potter *et al*, 1999). Moreover, the differences in Leaf area index may be attributed to the differences in Leaf area per plant. In this concern, Panwar *et al* (2000) showed that taller genotypes had more number of primary branches and leaf primordial that the others rapeseed genotypes. It can also note that the dry weight per plant of Conl genotype out weighed Pactol, Olga and Elvira in a descending order at both seasons. The superiority of Conl genotype in the dry matter production may be attributed to having the tallest plants and had more number of primary branches per plant, and as well the highest area of photosynthetic number of primary branches and this in turn increased the capacity of dry matter accumulation in the different plant parts .In this report, Shirani and Ahmedi (1995) reported that Monty Genotype had highest seed yield and dry weight per plant than the Pinnacle and Dunkled Genotypes.

B- Yield, yield components and quality : Mean values of seed Yield, yield components and some related traits for the four tested Genotypes are presented in Table (2). The data revealed that Conl Genotype surpassed Pactol, Olga and Elvira Genotypes in weight of thousand seed (g.), 1000 seeds weight in both seasons. Pactol surpassed Olga and Elvira in those traits in both seasons. This means that Conl plants were more efficient to accumulate dry mater in their silique. Regarding to the seed characters studied i.e., weight of thousand seed and oil percentage ,data show that there were significant variations among the four tested rapeseed genotypes in both seasons. Conl genotype surpassed significantly Pactol, Olga and Elvira Genotypes in weight of thousand seed, 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 Conl genotype may be due to their high seed yield per ha. (Table 2) rather than differences in seed oil content. Similar conclusion were reported by Auld, *et al* ,1990 and Potter *et al* ,1999. The superiority of Conl Genotype in the most seed characters may be due to that Conl genotype had better vegetative growth and hence photosynthetic area which led to more carbohydrates was which translocated from the source (number of primary branches and stem)to the sink (seeds) (Mengel and Kirkby, 1982). The results showed that weight of thousand seed and yield, oil yield (ton.ha^{-1}) were always significantly higher for Conl than that for Pactol, Olga and Elvira genotypes. This indicates that Conl genotype was more efficient to translocation enough photo assimilates to developing seeds.

2- Effect of nitrogen fertilization:

A- Growth characters: Data presented in Table (3) showed that increasing nitrogen level from 0 to 160 (kg N ha^{-1}) significantly increased all characters at the both seasons .This could be attributed to the low available of nitrogen in the experimental site in the both seasons (Table1). The stimulatory effect of nitrogen in rapeseed plant may be due to its important role in cells division, elongation and enhancing metabolic process. (Hocking ,1997). The number of primary branches per plant, Leaf area index were increased significantly with the addition of nitrogen fertilizer up to 160 kg N ha^{-1} compared to the check and the 80 level of nitrogen in the both seasons. However, increasing nitrogen level up to 80 Kg N ha^{-1} had low significant effect on those traits. These results means that nitrogen application up to 160 Kg N ha^{-1} was great enough to increase the number of primary branches /plant and leaf blade area. These findings confirmed those obtained by Hassan and El-Hakeem (1996) who found that the application of 150 Kg N ha^{-1} increased rapeseed Leaf area/plant and number of primary branches per plant. It can be observed also that the highest dry weight/plant was found in the plant fertilized with 160 kg N ha^{-1}compared to the check and 80 Kg N ha^{-1} in the both seasons. The stimulatory effect of nitrogen in plant may be due to its role in enhancing metabolic process. These results are in harmony with those obtained by Sharief (2000).

B- Yield, yield components and quality : Nitrogen application treatments significantly increased number of seed per Silique, 1000 seeds weight, total seed yield and oil yield (Table 3). These results are in line with those of various researchers reported that the nitrogen had significant effect on weight of thousand seed , seed yield silique and oil yield (Mudholkar and Ahlawat ,1981; Rood and Major ,1984). Nitrogen rates 80 and 160 kg.ha^{-1}produced the highest number of seed / silique, 1000 seeds weight, total seed yield and oil yield. Maximum seed / silique (12.30,12.23) was produced when nitrogen was applied at the rate of 160 kg N ha^{-1}. The minimum values for investigated traits were generally recorded in check treatment(0 nitrogen) compared to the 160 kg.ha^{-1} level of nitrogen in the both seasons. When nitrogen was increased from 0 to 160, 1000 seeds weight, total yield were increased approximately 28.0,78.0; 1.16 and 0.86% in the both seasons respectively. Nitrogen increases seed and oil yields by influencing a number of growth parameters such as seed / silique and seed weight and by producing more vigorous growth and development (Hocking ,1997 and Sharief ,2000).On the contrary ,The seed oil percentage were decreased with increasing nitrogen application up to 160 (Kg N $ha.^{-1}$) . However , The decrease in seed Oil contents by nitrogen fertilizer may be duo to the increase in 1000 seeds weight at the expense of oil concentration . In this concern, Many researchers reported that the nitrogen application to rapeseed plant caused a reduction in seed oil percentage (Mendham *et al,* 1981; Rood and Major,1984).

3- Effect of row spacing:

A- Growth characters : Data pertaining to row spacing are presented in Table (4). All investigated characteristics were significantly affected by row spacing . Although the distance 30 cm produced the highest leaf area index, the distance 60 cm gave the highest plant height (cm), number of primary branches, number of silique/plant, and dry weight/plant, This increase may be due to the increase in the dry matter accumulated in plants with wide spacing which is may be increase the yield components and also because of sufficient of environmental elements as light,Co_2, nutrients, water ,which increase plant ability to build metabolites.(Kondra ,1975 and Ohlsson ,1976). Similar observations were made by Morrison *et al* (1990) ; Khan and Muendel (1999) ;Bryan *et al* (2001) ; Herbek and Lioyd murdok (2001), who reported that increased row spacing resulted in a significant increase in number of Silique/plant.

B- Yield, yield components and quality: Data reported in table (4), in the two growing seasons, the attributes of rapeseed exhibited significant differences for the different row spacing. With increasing row spacing, weight of thousand seed (g.) generally tended to increase. The yield silique^{-1} reductions in confection rapeseed at high density can be explained by lower number of silique/plant, number of total seeds Silique^{-1}. This reduction in seed yield silique^{-1} with increasing plant populations has been verified in early field studies Bryan *et al* (2001) ;Herbek and Lioyd murdok (2001) working with rapeseed, also founded that high plant density produced small silique. The increase in weight of thousand seed may be due to the increase in the dry matter accumulated in plants with wide spacing which is may be increase the yield represented in Silique and weight of 1000 seeds and also because of sufficient of environmental elements as light ,Co_2 nutrients, water ,which increase plant ability to build metabolites. The yield silique^{-1} reductions in rapeseed at high density can be explained by lower number of total seeds Silique^{-1} and 1000 seeds weight. This reduction in seed yield Silique^{-1} increasing plant populations has been verified in some studies (Jensen *et al* ,1997). Numerous research studies for different climates have shown that plant density or row spacing influences the growth, seed yield and quality of rapeseed (Malagoli *et al* ,2004). The present results were in a good agreement with the finding of Rossato *et al* ,2001, who reported that increased plant density or row spacing resulted in a significant increase in seed oil content and oil yield.

4- Effect of interaction between genotypes and nitrogen fertilization on growth characters, yield and yield components and quality:

There were significant differences for plant height, No. of silique/plant, dry weight (g.)/plant among genotypes derived from 160 Kg N.ha^{-1} in 2007 season, plant height, number of primary branches, number of silique/plant, Leaf area index, dry weight, number of seeds/silique, weight of thousand seed (g.), Yield (ton.ha^{-1}) and oil percentage in 2008 season, as illustrated in table (5). The interaction between the genotypes and fertilization for the other investigated traits were not statistically significant in first season, therefore the data were excluded (table10). Data illustrated in table (5) show generally that Conl genotype appeared to be clearly affected by nitrogen fertilization for plant height, number of silique/plant, dry weight (g.)/plant in first season, plant height, number of primary branches number of silique/plant, leaf area index, dry weight, number of seeds/silique, weight of thousand seed (g),yield (ton.ha^{-1}) and oil percentage in second season, while they appeared to be little response to nitrogen for those traits. On the other hand , Conl genotype reflected the greatest response to nitrogen for these traits.

5- Effect of interaction between genotypes and row spacing on growth characters, yield and yield components and quality:

Data illustrated in table (6) show generally that Conl, Pactol , Olga and Elvira genotypes appeared to be clearly significant affected by row spacing for all characters in the two growing seasons except of No. of primary branches and oil percentage in the first season .On the other hand , Conl genotype reflected the greatest response to row spacing for these traits, with this regard ,Khan and Muendel (1999) ;Bryan *et al* (2001) found that increasing row spacing produced maximum 1000 seeds weight(2.91g) and seed yield (2852 kg ha^{-1}) .The insignificant effect between genotypes and row spacing on number of primary branches and oil percentage in the first season showed that each of these two factors acted independently on these traits .

6- Effect of interaction between nitrogen fertilizer and row spacing on growth characters, yield and yield components and quality:

The interaction effect between nitrogen levels and row spacing reached the 0.05 and 0.01 levels of significant for plant height (cm), leaf area index, dry weight/plant and total yield in both seasons, number of seeds/silique in 2007 season , number of silique/plant in 2008 season (table 7). The fertilization with 160 kg nitrogen. ha^{-1} at row spacing 60cm yielded the highest means for, plant height(242,243 cm), dry weight/plant (55.48,55.99g),in both seasons respectively. This result clearly indicated the importance of nitrogen and row spacing for higher seed production in rapeseed. Similar conclusion were reported by Potter *et al* (1999) and Sharief (2000). Data obtained in table (7) indicated that planting of rapeseed at a distance of 60 cm and fertilizing at the level of 160 kg N. ha^{-1} caused a significant increase in total seed yield(0.82,0.88 ton.ha^{-1}). Such increase may be due to increasing the dry weight per plant when planting at wide spacing, and increase in the photosynthetic and transporting efficiency of the plant (Bryan *et al* ,2001).

7- Effect of interaction between genotypes, nitrogen fertilizer and row spacing on growth characters, yield and yield components and quality:

The effect of this interaction was significant for some characters in the two growing seasons (tables8,9). Other characters under investigation were not significantly affected by this interaction (table10), therefore the data were excluded. Conl genotypes with fertilizer 160 kg N.ha^{-1} at row spacing 60 cm gave highest means for total seed yield(0.88,0.93ton.ha^{-1}) in both growing seasons, plant height(273.30cm) in only 2007 season, number of primary branches and number of silique/plant (247.33)in only 2008 season. The positive response of rapeseed to the application of nitrogen for all characters in the two seasons may be duo to the low total organic matter and available of nitrogen in the experimental site in the both seasons (Table1).

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