RESEARCH PAPER

Effect of Sowing Dates, Seeding Rates on Growth, Yield and its Component of Some Rapeseed (*Brassica nupus* L.) Genotypes.*

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**ABSTRACT:**
This study was conducted at Grdarasha Research Field / College of Agricultural Engineering Sciences - Salahaddin University - Erbil during the winter growing season (2014-2015), to investigate the effect of sowing dates, seeding rates on growth parameters, yield and its component of different rapeseed genotypes. A factorial experiment based on Randomized Complete Block Design (RCBD), with three replicates was applied, the first factor included three genotypes (Pactol, Raja and Rendy), the second factor included three sowing dates (15th October, 31st October, and 15th November), while the third factor represented two seeding rates (4 and 6 kg ha\(^{-1}\)). The results indicated that the sowing on 15th October was superior and gave highest rate of leaf area (1986.34 cm\(^2\)), dry matter weight (23.86 g plant\(^{-1}\)), plant height (208.63 cm), number of primary branches (8.05), number of secondary branch (5.75), stem diameter (11.04 mm), number of siliques plant\(^{-1}\) (218.75), number of seeds silique\(^{-1}\) (21.95), weight of thousand seeds (3.31 g), seed yield (3.39 Mg ha\(^{-1}\)). Increasing seeding rate from 4 to 6 kg ha\(^{-1}\) caused reduction in all growth characteristics of Rapeseed genotypes except plant height. While Pactol genotype obtained the highest seed yield (4.49 Mg ha\(^{-1}\)) when sown on 15th October with seeding rate of 4 kg ha\(^{-1}\).

**KEY WORDS:** Rapeseed genotypes, Sowing dates, Seeding rates, Growth and yield parameter.

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**INTRODUCTION**

In many parts of the world, many species of the genus *Brassica* are consumed as vegetable (Yadav et al. 2013). Rapeseed (*Brassica nupus* L.) belongs to (Brassicaceae) family which becomes one of the most important sources of the vegetable oil in the world (Baghdadi et al., 2012). Canola is cultivated for edible oil and for biofuel production, it can be used for phytoextraction of heavy metals (Turan and Esringu, 2007). Also, (Jensen et al., 1996) reported that canola is an important agricultural crop grown primarily for its edible oil and the meal that remains after oil extraction; it is also regarded as a source of protein for the livestock feed industry. The world produced of rapeseed was about (70.95) tones of average yield (1982.2 kg ha\(^{-1}\)) (FAO, 2015). Canola seeds contain about 40-45 percent oil (Tobe et al., 2013). In many parts of the world, many species of the genus *Brassica* are consumed as vegetable (Yadav et al. 2011). There are many factors affecting growth, development and yield of canola crop such as, genotypes which is an important genetic factor. It contributes a lot for growth, yield and yield components of a particular crop. Rapeseed varieties are quite high yielding under appropriate environmental condition, sowing date is an important factor that determines the length of growing season then the yield. Sowing dates obviously affect canola yield and its components. In rapeseed oil, row spacing or plant density vary considerably worldwide, depending on the environment, production system and cultivar. Plant density in rapeseed governs the components of yield, and thus the yield of individual plants (Nasiri et al., 2014). The number of leaves produced before flower initiation has a major
influence on leaf area and hence the photosynthetic potential of the crop. The growth rate of the crop is closely related to the amount of solar radiation captured by the leaves (Edwards and Hertel, 2011). Sarkees et al., (2007) reported that sowing dates and genotypes had significant effect on leaf area. Al-Doori and Al-Dulaimy (2011) pointed out that 15th October is the best sowing time for dry weight plant\(^{-1}\) than 1\(^{st}\) October and 30\(^{th}\) October for two growing seasons (2008 and 2009). On the other hand, they used three different cultivars (Opera, Licord and Oscar) confirmed that the dry weight per plant of Licord cultivar more than the dry weight of Opera and Oscar at both seasons. According to Siadat and Hemayati (2009) the highest number of silique plant\(^{-1}\) and seeds plant\(^{-1}\) (331.00 and 25.33) were obtained from the plants of first sowing dates (7\(^{th}\) November) respectively. Shirani Rad (2012) explained a significant effect of sowing date and variety on seed yield and its components (silique number in plant, seed yield and 1000 seed weight) of rapeseed cultivars.

The aim of this investigation was to study the effect of sowing dates, rates and their interactions on growth, yield and its component of some rapeseed genotypes.

### Materials and Methods:

The study was conducted in Hawler region at Grdarasha Research Field -College of Agricultural Engineering Sciences - Salahaddin University - Erbil with Latitude 36°4’ N and Longitude 44°2’E, the evaluation of 415 MASL having annual rainfall between (250- 600 mm) during the winter growing season (2014-2015), to investigate the effect of different sowing dates and seed rates on growth parameters yield and its component of three rapeseed genotypes. A factorial experiment had been carried out using Randomized Complete Block Design (RCBD) with three replicates. The first factor included three genotypes : (Pactol, Raja and Rendy). The second factor included three sowing dates (15\(^{th}\) October, 31\(^{st}\) October, and 15\(^{th}\) November), while the third factor represented two seeding rates (4 and 6 kg ha\(^{-1}\)). The representative soil samples were taken at depth of (0-30 cm), the land was divided manually into plots, and each replicate consists of 18 experimental units (2m×2 m). Each experimental unit consists of five rows, the distance between them was 40cm and then the seed was sown manually. The experiment had been done under rainfed condition and irrigated at sowing time then according to crop requirement by surface irrigation for each plot, the amount of rainfall was shown in table (1).

### Table (1): Metrological data during growing season of (2014-2015):

| Month    | Air temperature in\(^{(°C)}\) | Monthly precipitation (mm) | Relative Humidity% |
|----------|-------------------------------|----------------------------|--------------------|
|          | Max | Min | Mean |                      |                   |
| October  | 35.3 | 10.6 | 22.95 | 56.4 | 45.9 |
| November | 25.5 | 4.5  | 15.00 | 77.7 | 58.8 |
| December | 21.8 | 2.5  | 12.15 | 44.4 | 70.5 |
| January  | 19.3 | -0.2 |  9.55 | 31.5 | 67.9 |
| February | 21.5 | 0.4  | 10.95 | 35.3 | 67.5 |
| March    | 25.1 | 4.1  | 12.8  | 40.4 | 58.4 |
| April    | 34.8 | 5.3  | 20.05 | 11.9 | 44.9 |
| May      | 41   | 14.4 | 27.70 | 3.3  | 24.5 |
| Total    | 224.3 | 41.6 | 132.95 | 300.9 | 438.4 |

Five plants were selected randomly from each experimental unit to study the leaf area, dry matter weight (g plant\(^{-1}\)), number of primary branches, number of silique plant\(^{-1}\), number of Siliques plant\(^{-1}\), and number of seeds silique\(^{-1}\) and weight of 1000 seed (g). All
middle-line of each experimental unit were harvested to calculate the seed yield (kg ha\(^{-1}\)). The Duncan’s multiple range test at level of significance 5% was used to compare between means (Duncan, 1955).

### Table (2): Some physical and chemical properties of the soil at depths (0 - 30 cm).

| Depth Cm | PSD % | Soil Texture | pH | Ec (dS/m) | O.M % | (N) % | Available (P) | K+ mg.g\(^{-1}\) |
|----------|-------|--------------|----|-----------|-------|-------|-------------|----------------|
| 0-30     | 43    | Silty clay   | 7.5 | 0.20      | 0.90  | 0.10  | 4.50        | 0.22           |

**Characteristics that Studied at Flowering Stage:**

- **Total leaf area per plant (LA)** cm\(^2\) plant\(^{-1}\) was determined according to (Pattons, 1984).  
- **Dry matter weight (g plant\(^{-1}\)):**
  
  Dry matter was determined at 50% flowering stage, after drying at 70°C for (68-72) hours (Hunt, 1987).

**Measurements at maturity stage:**

Random representative samples of ten plants from three inner rows of each experimental unit had been taken during physiological maturity stage. The collected samples were used to study the following characters:

- **Number of primary branches plant\(^{-1}\).**  
- **Number of secondary branches plant\(^{-1}\).**  
- **Number of siliqua plant\(^{-1}\).**  
- **Number of seeds siliqua\(^{-1}\).**  
- **Seed yield (kg ha\(^{-1}\)).**

**Abbreviations:**

Seeding dates (D), Seeding rates (R) Genotypes (G).

**RESULTS AND DISCUSSION:**

**Leaf area:**

Table (3) shows the significant effect of D*R*G and their interaction on leaf area. The maximum value of leaf area was obtained from sowing date 15\(^{th}\) October which was (1986.34) cm\(^2\) Plant\(^{-1}\) while the minimum value was recorded from sowing on 15\(^{th}\) November the result was in agreement with Al-Doori (2011). Data in the same table showed that the seeding rates had a significant effect on leaf area. The leaf area decreased with increase in seeding rate, the highest rate of leaf area (1538.76) cm\(^2\) plant\(^{-1}\) was recorded for seeding rate 4 kg ha\(^{-1}\) however; the lowest value (1241.64) cm\(^2\) plant\(^{-1}\) was obtained for seeding rate 6 kg ha\(^{-1}\), this because of the seeding rate 4 kg ha\(^{-1}\) gives the highest rate of primary and secondary branches and significant positive correlation were be found between leaf area and primary and secondary branches the same trend was also determined by Momoh and Zhou (2001). Regarding the effect of different genotypes on the characters of leaf area of rapeseed it showed significant differences, Rendy genotype had highest value (1566.55) cm\(^2\) plant\(^{-1}\) in comparison to Pactol and Raja (1441.14 and 1162.92) cm\(^2\) plant\(^{-1}\) respectively. This may be related to the fact that Rendy genotype had more number of primary and secondary branches than Pactol and Raja genotypes (table 5 and 6) Furthermore, the interaction between (G and R), (G and D), (D and R) as well as among the three factors (genotypes, sowing dates and R) had significant effect on leaf area. The highest rates of leaf area (2374.35, 2281.43, 1687.97 and 2539.74) cm\(^2\) plant\(^{-1}\) were obtained from the interaction treatments (Rendy * 15\(^{th}\) October), (15\(^{th}\) October * 4 kg ha\(^{-1}\)) (Pactol * 4 kg ha\(^{-1}\)) and (Rendy * 15\(^{th}\) October * 4 kg ha\(^{-1}\)) respectively (table 3), This results were in agreement with Al-Doori (2011).
Table (3): Effect of genotypes, sowing dates, seeding rates and their interactions on leaf area of canola genotypes (cm² plant⁻¹).*

| Genotypes | Sowing dates | Seeding Rates | Genotypes × Sowing dates |
|------------|--------------|---------------|-------------------------|
|            |              | 4 kg ha⁻¹ | 6 kg ha⁻¹ |                  |
|            | 15th October | 2458.33 a | 1519.03 e | 1988.68 b |
| Pactol     | 31st October | 1660.36 d | 1258.88 fg | 1459.63 cd |
|            | 15th November| 945.21 ij | 804.99 k | 875.1 e |
| Raja       | 15th October | 1846.23 c | 1345.75 fg | 1595.99 c |
|            | 31st October | 1014.57 hi | 1001.75 hi | 1008.16 e |
|            | 15th November| 908.99 i-k | 860.22 jk | 884.61 e |
| Rendy      | 15th October | 2539.74 a | 2208.95 b | 2374.35 a |
|            | 31st October | 1367.20 f | 1232.03 g | 1299.61 d |
|            | 15th November| 1108.20 h | 943.20 ij | 1025.70 e |

Genotypes × Seeding Rates

| Genotypes | 4 kg ha⁻¹ | 6 kg ha⁻¹ | Means of Genotypes |
|------------|-----------|-----------|--------------------|
| Pactol     | 1687.97 a | 1194.30 ab | 1441.14 a |
| Raja       | 1256.59 ab| 1069.24    c | 1162.92 b |
| Rendy      | 1671.71 a | 1461.39    ab | 1566.55 c |

Sowing dates × Seeding Rates

| Sowing dates | 4 kg ha⁻¹ | 6 kg ha⁻¹ | Means of Sowing date |
|--------------|-----------|-----------|---------------------|
| 15th October | 2281.43 a | 1691.24 b | 1986.34 a |
| 31st October | 1347.37 c | 1164.22 cd | 1255.80 b |
| 15th November| 987.47 de | 869.47 e | 928.47 c |

Means of Seeding Rates | 1538.76 a | 1241.64 b |

*Values with the same letter or letters within the columns are not significantly different according to (Duncan, 1955).

-Dry matter Weight (g plant⁻¹):

As shown in the table (4), dry matter was significantly affected by the sowing dates. The highest value of dry matter (23.86 g plant⁻¹) was obtained from sowing on 15th October, while the lowest value (10.42 g plant⁻¹) was obtained from sowing on 15th November. This variation related to the fact that dry matters increased in early sowing date which attributed to moderate temperature level that prolong vegetative growth and increase photosensitive activity thus total dry matter accumulation. This result was in agreement with Al-Doori (2011). The seeding rates have significant effect on dry matter accumulation. The maximum rate (17.39 g plant⁻¹) was recorded with (R: 4 kg ha⁻¹), while the lowest rate (13.77 g plant⁻¹) was recorded at (R: 6 kg ha⁻¹). This variation of dry matter accumulation may be related to the fact that; with low population of plant become more vigorous, thicker in stem diameter with more Branches plants⁻¹. The results are similar to those recorded by Al-Barzinjy et al., (1999); Al-Dolimey (2003) and Al- Barzinjy et al., (2003). On the other hand, genotypes had a significant effect on dry matter accumulation. (Rendy :G) produced the highest amount of dry matter weight (21.10 g plant⁻¹) compared to Pactol and Raja genotypes which were produced (14.80 and 10.83) g plant⁻¹ respectively. These results agree with Al-Doori and Al-Dulaimy (2011). Data of the same table also indicates to significant effect of the interaction between (G * D), (D * R), (G * R) and (G * D * R) on the weight of dry
matter accumulation per plant. The highest amounts (33.99, 27.04, 24.02 and 40.26) g plant\(^{-1}\) were recorded from the interaction treatments (Rendy * 15\(^{th}\) October), (15\(^{th}\) October * 4 kg ha\(^{-1}\)), (Rendy * 4 kg ha\(^{-1}\)) and (Rendy * 15\(^{th}\) October * 4 kg ha\(^{-1}\)) respectively (table 4). These results agree with Al-Doori and Al-Dulaimy (2011). The mentioned interactions may create the best environmental conditions for plant growth then accumulation of dry matter.

### Table (4): Effect of genotypes, sowing dates, seeding rates and their interactions on dry matter weight of canola genotypes (g).*

| Genotypes | Sowing dates | Seeding Rates | Genotypes × Sowing dates |
|-----------|--------------|---------------|--------------------------|
|           |              | 4 kg.ha\(^{-1}\) | 6 kg.ha\(^{-1}\) |                         |
| Pactol    | 15\(^{th}\) October | 22.64 c | 21.38 cd | 22.01 b |
|           | 31\(^{st}\) October | 15.01 e-g | 11.83 g-k | 13.42 c |
|           | 15\(^{th}\) November | 9.52 h-k | 8.43 jk | 8.98 d |
| Raja      | 15\(^{th}\) October | 18.21 c-e | 12.93 f-j | 15.57 c |
|           | 31\(^{st}\) October | 9.36 i-k | 7.23 k | 8.30 d |
|           | 15\(^{th}\) November | 9.69 h-k | 7.54 k | 8.62 d |
| Rendy     | 15\(^{th}\) October | 40.26 a | 27.72 b | 33.99 a |
|           | 31\(^{st}\) October | 17.35 d-f | 13.96 e-i | 15.65 c |
|           | 15\(^{th}\) November | 14.46 e-h | 12.88 f-j | 13.67 c |

Values with the same letters within the columns are not significantly different according to (Duncan, 1955)
-Number of Primary Branches per Plant:

Table (5) shows significant effects of sowing dates, seeding rates and genotypes on number of primary branches plant$^{-1}$. The highest values (8.05, 6.80 and 6.86) branches plant$^{-1}$ were produced with first sowing dates 15$^{th}$ October, 4kg ha$^{-1}$ and Rendy genotype respectively. Yousaf et al., (2002) and Mousavi et al., (2011) suggested that with early sowing date lateral branch becomes higher. This can be justified by the fact that, if the sowing takes place in suitable time, the plant grows naturally and has enough opportunity for branching. But if the sowing occurs late, the plant would rather pass the different growth stages and produce flowers than produce the branches. This result is similar to Bhuiyan et al (2008) and Bala et al (2011). Furthermore, increasing in seeding rate caused increase the number of plants thus decreases vegetative growth with decrease in efficiency of photosynthesis process lead to decrease in dry matter accumulation and consequently reduction in the number of branches. These results are in accordance with those obtained by each of Yousaf et al., (2002) and Champiri and Bagheri (2013).

The same table showed significant effects of the interaction between (G * D), (D * R), (G * D * R) and (G * D * R) on number of primary branches plant$^{-1}$. The highest values (8.98, 9.12, 7.49 and 10.20 branches plant$^{-1}$) were recorded from the interaction treatments (Rendy * 15$^{th}$ October), (15$^{th}$ October * 4 kg ha$^{-1}$), (Rendy * 4 kg ha$^{-1}$) and (Rendy * 15$^{th}$ October * 4 kg ha$^{-1}$) respectively (table 5). These results were in agreement with Bala et al., (2011) they showed that the interaction between sowing dates and variety was significant on number of primary branches.

Table (5): Effect of genotypes, sowing dates, seeding rates and their interactions on number of primary branches plant$^{-1}$ for canola genotypes.*

| Genotypes | Sowing dates   | Seeding Rates | Genotypes × Sowing dates |
|-----------|----------------|---------------|--------------------------|
|           |                | 4 kg.ha$^{-1}$ | 6 kg.ha$^{-1}$           |                          |
|           |                |               |                          |                          |
| Pactol    | 15$^{th}$ October | 9.40 b        | 5.77 f-h                 | 7.58 b                   |
|           | 31$^{st}$ October | 6.40 ef       | 4.83 jk                  | 5.62 cd                  |
|           | 15$^{th}$ November | 4.67 jk       | 4.30 kl                  | 4.48 d                   |
| Raja      | 15$^{th}$ October | 7.77 c        | 7.40 cd                  | 7.58 b                   |
|           | 31$^{st}$ October | 5.70 f-i      | 5.00 i-k                 | 5.35 cd                  |
|           | 15$^{th}$ November | 4.80 jk       | 3.93 l                   | 4.37 d                   |
| Rendy     | 15$^{th}$ October | 10.20 a       | 7.77 c                   | 8.98 a                   |
|           | 31$^{st}$ October | 6.97 de       | 5.87 fg                  | 6.42 bc                  |
|           | 15$^{th}$ November | 5.30 g-j      | 5.07 h-j                 | 5.18 d                   |

| Genotypes × Seeding Rates | 4 kg.ha$^{-1}$ | 6 kg.ha$^{-1}$ | Means of Genotypes |
|----------------------------|---------------|---------------|-------------------|
| Pactol                     | 6.82 ab       | 4.97 c        | 5.89 b            |
| Raja                       | 6.09 a-c      | 5.44 bc       | 5.77 b            |
| Rendy                      | 7.49 a        | 6.23 a-c      | 6.86 a            |

| Sowing dates × Seeding Rates | 4 kg.ha$^{-1}$ | 6 kg.ha$^{-1}$ | Means of Sowing date |
|-----------------------------|---------------|---------------|---------------------|
| 15$^{th}$ October            | 9.12 a        | 6.98 b        | 8.05 a              |
| 31$^{st}$ October            | 6.36 b        | 5.23 c        | 5.79 b              |
| 15$^{th}$ November           | 4.92 cd       | 4.43 d        | 4.68 c              |
Number of secondary branches plant\(^1\):

The presented results in the table (6) indicated to significant effect of planting dates on number of secondary branches plant\(^1\). The sowing date of 15\(^{th}\) October with (5.75) branch.plant\(^1\) is ranked above other sowing dates (31\(^{st}\) October and 15\(^{th}\) November) significantly. In regard of sowing date the current results were agreed with those of Yousaf et al., (2002) as they suggested that with early sowing date, lateral branched growth higher. The maximum number of primary branches (4.80) was obtained at seeding rate of 4kg.ha\(^{-1}\) and the minimum value was obtained at seeding rate of 6kg.ha\(^{-1}\). This may attribute to that the increasing in seeding rate caused increase the number of plants.m\(^{-2}\) thus decreased vegetative growth with decrease in efficiency of photosynthesis process. This lead to decrease in dry matter accumulation and therefore reduction in number of branches. These results are harmony with those obtained by Yousaf et al., (2002) and Champiri and Bagheri (2013). Further, the significant differences were observed between dual interaction (G * D), (G * R), the highest number of secondary branches (5.26 and 7.75) were recorded for (Pactol * 4 kg ha\(^{-1}\)) and (Rendy *15\(^{th}\) October) respectively. It means the effect of interaction between the studied factors was different in their effect on the number of secondary branches and other studied traits. Moreover, the interaction among three studied factors had significant effect on this trait, the highest value (9.70) was recorded from the triple interaction treatments (Rendy *15\(^{th}\) October * 4 kg.ha\(^{-1}\)) and the lowest value (1.22) was recorded from the triple interaction treatments (Pactol *15\(^{th}\) November *6 kg.ha\(^{-1}\)) table (6). It means creating different conditions for plant growth as a result of interaction between or among the studied factors.

Table (6): Effect of genotypes, sowing dates, seeding rates and their interactions on number of secondary branch plant\(^1\) for canola genotypes.

| Genotypes | Sowing dates | Seeding Rates | Genotypes × Sowing dates |
|-----------|--------------|---------------|--------------------------|
|           | 4 kg.ha\(^{-1}\) | 6 kg.ha\(^{-1}\) |                           |
| Pactol    | 15\(^{th}\) October | 7.60 b         | 4.47 e                   | 6.06 b                   |
|           | 31\(^{st}\) October | 6.57 c         | 2.37 hi                  | 4.47 bc                  |
|           | 15\(^{th}\) November | 1.60 jk        | 1.22 k                   | 1.41 e                   |
| Raja      | 15\(^{th}\) October | 3.93 ef        | 3.00 gh                  | 3.47 cd                  |
|           | 31\(^{st}\) October | 5.20 d         | 1.67 jk                  | 3.43 cd                  |
|           | 15\(^{th}\) November | 2.87 h         | 2.13 ij                  | 2.50 de                  |
| Rendy     | 15\(^{th}\) October | 9.70 a         | 5.80 d                   | 7.75 a                   |
|           | 31\(^{st}\) October | 3.60 fg        | 1.67 jk                  | 2.63 cde                 |
|           | 15\(^{th}\) November | 2.17 ij        | 1.23 k                   | 1.70 de                  |

*Values with the same letters within the columns are not significantly different according to (Duncan ,1955)
Sowing dates × Seeding Rates

| Sowing dates | Seeding Rates | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ | Means of Sowing date |
|--------------|---------------|-----------|-----------|---------------------|
| 15th October | 7.08 a        | 4.42 b    | 5.75 a    |
| 31st October | 5.12 b        | 1.90 c    | 3.51 b    |
| 15th November| 2.21 c        | 1.53 c    | 1.87 c    |

Means of Seeding Rates

| Seeding Rates | 4.80 a | 2.62 b |

Values with the same letters within the columns are not significantly different according to (Duncan, 1955).

Number of Siliqua per Plant:

A wide variation was observed between No. of siliqua plant⁻¹. Data in table (7) indicated to significant effects of sowing dates, seeding rates, genotypes and their interaction on number of siliqua plants⁻¹. The highest values (218.75, 199.93 and 246.65 siliquas) were obtained from sowing date 15th October, Pactol genotypes and from the interaction treatment (15th October * Pactol genotype) respectively, while the lowest values (135.88, 157.82 and 125.60 siliquas) were recorded from sowing date 15th November, Rendy genotypes and from the interaction treatment (15th November * Rendy genotype) respectively.

Table (7): Effect of genotypes, sowing dates, seeding rates and their interactions on number of siliqua plant⁻¹ for canola genotypes.*
Therefore it seems that Pactol genotype benefited from existing conditions due to compatibility with climate of Kurdistan region which may cause increasing in number of silique plant$^{-1}$. These results are in agreement with Siadat and Hemayati (2009); Shahraki et al., (2012) and Ahmadpourolia et al.,(2014). At the same time the increase in the sowing rate from lead to significant decrease in number of silique plants$^{-1}$ from 198.59 to 156.72 siliquas. There was negative relation between silique.plants$^{-1}$ and seeding rates so that silique plants$^{-1}$ decreased with increase seeding rates, this may be due to shadowing with increase in density, which caused decrease in flower then decrease in silique plants$^{-1}$. Shahin and Valiollah (2009) explained that with increasing seeding rates from 4 to 6 kg ha$^{-1}$, the number of siliquas plant$^{-1}$ was decreased. Moreover, the interactions among dual and three factors were significant on number of silique plants$^{-1}$. The maximum value (283.33 siliquas) was attained from the interaction treatments (Pactol * 15$^{th}$ October * 4 kg ha$^{-1}$) while the lowest value (118.83 siliquas) was obtained from the interaction treatment (Rendy * 15$^{th}$ November * 6 kg ha$^{-1}$) table (7). This result is in agreement with Al-Door and Al-Dulaimy (2011).

Number of Seed Siliqua$^{-1}$:

The results of the table (8) show that sowing dates, seeding rates, genotypes and their interaction significant effect on number of silique plants$^{-1}$. The maximum rates (21.95, 20.94 and 22.89 seed siliqua$^{-1}$) were obtained in (15$^{th}$ October, 4 kg ha$^{-1}$ and Pactol genotype ) respectively. This may be due to genetic variations as well as the delay in cultivation led to shortening of vegetative period and unfavorable conditions at the end of growing season such as heat stress which would reduce the number of seeds siliqua$^{-1}$. These results are in agreement with the results of Bagheri et al., (2011) Hua et al., (2014). Data of the same table showed significant effects of the interaction between Genotypes and sowing dates on numbers of seeds siliqua$^{-1}$. The highest rate (24.23 seeds.siliqua$^{-1}$) was recorded from the interaction treatment (Pactol *31$^{st}$ October). This finding was in conformity with Siadat and Hemayati (2009) and Gholamian and Bayat (2013) mentioned significant effect of sowing date and variety on number of seeds siliqua$^{-1}$, this may be due to single effect of the mentioned factors . Furthermore, the interaction between (G and R) as well as the interaction among the three studied factors affected significantly on number of seeds siliqua$^{-1}$ the highest rates (23.45 and 25.39 seeds) were recorded from the interaction treatments (Pactol * 4 kg ha$^{-1}$) and (Pactol * 15$^{th}$ October* 4 kg ha$^{-1}$) respectively,while the lowest values (18.59 and 15.96 seeds) were recorded from the interaction treatments (Rendy * 6 kg.ha$^{-1}$) and (Rendy* 15$^{th}$ November * 4 kg ha$^{-1}$) table (8) this may be due to single effect of the mentioned factors.
Table (8): Effect of genotypes, sowing dates, seeding rates and their interactions on number of seed per silique for canola genotypes.*

| Genotypes | Sowing dates  | Seeding Rates | Genotypes × Sowing dates |
|-----------|--------------|---------------|-------------------------|
|           |              | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ |                      |
| Pactol    | 15th October| 25.39 a  | 22.19 b | 23.79 a |
|           | 31st October| 24.21 a  | 24.25 a | 24.23 a |
|           | 15th November| 20.76 bc | 20.55 b-d | 20.66 bc |
| Raja      | 15th October| 21.32 bc | 20.84 bc | 21.08 b |
|           | 31st October| 21.55 bc | 20.43 cd | 20.99 b |
|           | 15th November| 19.10 de | 19.86 cd | 19.48 cd |
| Rendy     | 15th October| 21.19 bc | 20.75 bc | 20.97 b |
|           | 31st October| 19.01 de | 18.04 cd | 18.52 d |
|           | 15th November| 15.96 g  | 17.00 fg | 16.48 e |

| Genotypes × Seeding Rates | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ | Means of Genotypes |
|---------------------------|-----------|-----------|--------------------|
| Pactol                    | 23.45 a   | 22.33 ab  | 22.89 a            |
| Raja                      | 20.66 bc  | 20.38 cd  | 20.52 b            |
| Rendy                     | 18.72 d   | 18.59 d   | 18.66 e            |

| Sowing dates × Seeding Rates | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ | Means of Sowing date |
|-------------------------------|-----------|-----------|----------------------|
| 15th October                  | 22.63 a   | 21.26 ab  | 21.95 a              |
| 31st October                  | 21.59 a   | 20.91 ab  | 21.25 b              |
| 15th November                 | 18.61 c   | 19.14 bc  | 18.87 c              |

| Means of Seeding Rates | 20.94 a | 20.44 b |

*Values with the same letter or letters within the columns are not significantly different according to (Duncan, 1955).

-Weight of 1000 seeds (g):

Data in table (9) showed significant effects of sowing dates on 1000 seed weight of rapeseed genotypes. The highest rate was obtained from sowing date 15th October which was (3.31 g) while the lowest rate (2.85 g) was recorded from 15th November, this can be attribute to; the delay cultivation caused to coinciding seed filling period with high temperature of season that lead to decrease in photosynthetic productions, shortening of seed filling period, accelerating of ripening period and subsequently lead to reduction in 1000 seed weight. Similar trend was also determined by Baghdadi et al., (2012); Abdul Sattar et al., (2013); and Miri and Bagheri (2013) as they explained that 1000-seed weight reduced with the delayed sowing time. This may be attributed to late sowing date gave a very short time for vegetative and reproductive period. In case of 1000-seed weight, the statistical analysis of data revealed that seeding rates significantly affected on 1000-seeds weight. The highest value (3.13 g) was obtained at seeding rates 4 kg ha⁻¹, while the lowest value (3.05 g) yielded at seeding rates 6 kg ha⁻¹. The similar trend was also determined by and Naseri et al., (2014) they explain that thickening density from 60 to 80 plant m⁻² caused to decreasing in 1000 seeds weight this may be due to reducing leaf area duration after flowering and high respiration in thicker densities caused to reducing 1000 seed weight. On the other hand, the genotypes had significant effect on seed yield. The
highest value (3.44 g) was recorded for Pactol genotype, while Rendy genotype yield lowest value (2.57 g) was obtained from Rendy genotypes. The superiority of Pactol genotype in weight of 1000 seeds may be due to that Pactol genotype had better vegetative growth and hence photosynthetic area which led to more carbohydrates which translocated from the source (leaves and stem) to the sink (seeds). The similar trend was also determined by Baghdadi et al., (2012); Abdul Sattar et al., (2013); Shahraki et al., (2012) and Miri and Bagheri (2013) they explained that 1000 seed weight reduced with the delayed sowing time. This may be attributed to late sowing date gave a very short time for the vegetative and reproductive period. The same table indicated to significant effect of the interaction between (D * R), (G * R) and (D * R * G) on 1000-seed weight, the maximum values (3.37, 3.55 and 3.93) g were attained from interaction treatments (15th October * 4 kg ha⁻¹), (Pactol * 4 kg ha⁻¹) and (Pactol * 15th October * 4 kg ha⁻¹) respectively, this may be due to single effect of the mentioned factors table (9). These results were agreed with those recorded by Azimi et al., (2012); Rameeh (2012) and Naseri et al., (2014).

Table (9): Effect of genotypes, sowing dates, seeding rates and their interactions on weight of 1000 seed (g) of canola genotypes.

| Genotypes | Sowing dates | Seeding Rates 4 kg.ha⁻¹ | Seeding Rates 6 kg.ha⁻¹ | Genotypes × Sowing dates |
|-----------|-------------|--------------------------|--------------------------|-------------------------|
| Pactol    | 15th October | 3.93 a                   | 3.42 b                   | 3.68 a                  |
|           | 31st October | 3.38 b                   | 3.35 b                   | 3.37 b                  |
|           | 15th November| 3.32 b                   | 3.24 b                   | 3.28 b                  |
| Raja      | 15th October | 3.43 b                   | 3.76 a                   | 3.59 a                  |
|           | 31st October | 3.25 b                   | 3.32 b                   | 3.29 b                  |
|           | 15th November| 2.89 c                   | 2.89 c                   | 2.89 c                  |
| Rendy     | 15th October | 2.76 cd                  | 2.56 de                  | 2.66 d                  |
|           | 31st October | 2.80 c                   | 2.56 de                  | 2.68 d                  |
|           | 15th November| 2.40 e                   | 2.35 e                   | 2.38 e                  |

| Genotypes × Seeding Rates | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ | Means of Genotypes |
|---------------------------|-----------|-----------|--------------------|
| Pactol                    | 3.55 a    | 3.34 ab   | 3.44 a             |
| Raja                      | 3.19 b    | 3.32 ab   | 3.26 b             |
| Rendy                     | 2.65 c    | 2.49 c    | 2.57 c             |

| Sowing dates × Seeding Rates | 4 kg.ha⁻¹ | 6 kg.ha⁻¹ | Means of Sowing date |
|------------------------------|-----------|-----------|----------------------|
| 15th October                 | 3.37 a    | 3.25 ab   | 3.31 a               |
| Sowing Dates      | Means of Seeding Rates |
|-------------------|------------------------|
| 31st October      | 3.15 ab 3.08 ab 3.11 b |
| 15th November     | 2.87 b 2.83 b 2.85 c  |

Means of Seeding Rates

*Values with the same letter or letters within the columns are not significantly different according to (Duncan, 1955)

- Seed Yield (kg ha⁻¹):

The results in table (10) showed significant effect of sowing dates on seed yield. The highest rate (3388.79 kg ha⁻¹) was recorded by sowing dates (at 15th October), while the lowest rate (2466.47 kg ha⁻¹) was obtained from (15th November), this may be attributed to delay cultivation caused to coinciding seed filling period with high temperature of season (table 1) that lead to decrease in photosynthetic productions, shortening of seed filling period, accelerating of ripening period and subsequently lead to reduction final seed yield. This result was in agreement with Siadat and Hemayati (2009) they explained that early sowing of csnola produced higher seed yield. On the other hand, the increasing seeding rates from 4 to 6 kg ha⁻¹ reduced the seed yield from (3187.11 to 2877.22 kg ha⁻¹), this result was in harmony with those of Sarkees (2015). This may be due to the increase in most yield contributed traits i.e., number of silique plant⁻¹, seed silique⁻¹ and 1000 seed weight (tables 7, 8 and 9). Genotypes affected significantly on seed yield, the maximum rate (3769.11 kg ha⁻¹) was recorded for Pactol, while the lowest value (1584.55 kg ha⁻¹) was obtained from Rendy genotype this difference contributed to their genetic properties. This result is in line with Al-Doori and Al-Dulaimy (2011). The same table also shows significant effect of the interaction between (G and D) on seed yield the highest rate (4316.25 kg ha⁻¹) was recorded from Raja genotype when sown on 15th October, while the lowest rate (1239.06 kg ha⁻¹) was recorded from the interaction treatment (Rendy * 15th November).

These results in accordance with Shirani Rad (2012 b) he mentioned that there was a significant effect between sowing date and variety on seed yield and its components; this may be due to single effect of the mentioned factors. Furthermore, the interaction effect of sowing dates with seeding rates and genotypes with seeding rates had significant effect on seed yield of rapeseed genotypes, the highest values (3588.47 and 3912.78 kg ha⁻¹) were obtained from the interaction treatment (15th October * 4 kg ha⁻¹) and (Raja * 4 kg ha⁻¹), while the lowest values (2310.07 and 1424.03 kg ha⁻¹) were obtained from the interaction treatment (15th November * 6 kg ha⁻¹) and (Rendy * 6 kg ha⁻¹) respectively, this may be due to single effect of the mentioned factors. Finally, the interaction among the three studied factors affected significantly on seed yield, the highest value (4494.58 kg ha⁻¹) was recorded from Pactol genotype when sown on 15th October with seeding rate of 4 kg ha⁻¹ and the lowest value (967.50 kg ha⁻¹) was recorded from Rendy genotype on 15th November with rates of 6 kg ha⁻¹. The ratio between the highest and lowest seed value was 4.65, it means the triple interaction is more effective in increasing yield than the single effects of the studied factors and the interactions between two factors. This may be due to that the interaction between the studied factors may create different growth conditions for plant growth and yield. This finding was in agreement with Al-Doori (2011).
Table (10): Effect of genotypes, sowing dates, seeding rates and their interactions on seed yield (kg ha\(^{-1}\)).

| Genotypes | Sowing dates | Seeding Rates | Genotypes \(\times\) Sowing dates |
|-----------|--------------|---------------|----------------------------------|
|           |              | 4 kg.ha\(^{-1}\) | 6 kg.ha\(^{-1}\) |                                    |
| Pactol    | 15\(^{th}\) October | 4494.58 a | 3586.86 b-d | 4040.73 a |
|           | 31\(^{st}\) October  | 4193.13 ab | 4221.25 ab  | 4207.19 a |
|           | 15\(^{th}\) November | 3022.75 d | 3096.04 d   | 3059.40 b |
| Raja      | 15\(^{th}\) October | 4362.29 ab | 4270.21 ab  | 4316.25 a |
|           | 31\(^{st}\) October  | 4040.83 a-c | 3581.86 b-d | 3811.35 a |
|           | 15\(^{th}\) November | 3335.21 cd | 2866.67 d   | 3100.94 b |
| Rendy     | 15\(^{th}\) October | 1908.54 e | 1710.21 ef  | 1809.38 c |
|           | 31\(^{st}\) October  | 1816.04 e | 1594.38 ef  | 1705.21 cd |
|           | 15\(^{th}\) November | 1510.63 ef | 967.50 f    | 1239.06 d |

| Genotypes \(\times\) Seeding Rates | 4 kg.ha\(^{-1}\) | 6 kg.ha\(^{-1}\) | Means of Genotypes |
|------------------------------------|----------------|----------------|-------------------|
| Pactol                            | 3903.49 a      | 3634.72 a      | 3769.11 a         |
| Raja                              | 3912.78 a      | 3572.92 a      | 3742.85 a         |
| Rendy                             | 1745.07 b      | 1424.03 b      | 1584.55 b         |

| Sowing dates \(\times\) Seeding Rates | 4 kg.ha\(^{-1}\) | 6 kg.ha\(^{-1}\) | Means of Sowing date |
|--------------------------------------|----------------|----------------|---------------------|
| 15\(^{th}\) October                   | 3588.47 a      | 3189.10 ab     | 3388.79 a          |
| 31\(^{st}\) October                  | 3350.00 ab     | 3132.50 ab     | 3241.25 a          |
| 15\(^{th}\) November                 | 2622.86 ab     | 2310.07 b      | 2466.47 b          |

| Means of Seeding Rates | 3187.11 a | 2877.22 b |

*Values with the same letters within the columns are not significantly different according to (Duncan, 1955).

Conclusions

In light of current study, the most outstanding conclusions can be summarized as follows:

- In general early sowing caused increase in all of growth characteristics, yield and yield components. In the same time, the highest value of yield, yield component, where recorded from seed rate of 4 kg ha\(^{-1}\)
- Pactol which is the local genotype recorded the highest value for yield and yield components except primary and secondary branches, dry matter Pactol genotype yield was 2.38 times more than Rendy.
• The interaction treatments have significant effect on yield; the highest value was recorded from Rendy sown at 15th October while the lowest value was recorded from Rendy sown at 15th November. The interaction between genotypes and seeding rate caused increase in yield by 247 kg ha\(^{-1}\).

• The triple interaction caused 4.65 times increase in rapeseed yield which equivalent to 3,527 kg ha\(^{-1}\). This increase was recorded from Pactol * 15th October * 4 kg ha\(^{-1}\) in compare with interaction treatment of Rendy * 15th November * 6 kg ha\(^{-1}\).

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