Effect of plant population and cultivars on growth, yield and its component of bread wheat (Triticum aestivum L.) under the rain-fed condition in Kurdistan- Iraq

ABSTRACT

This experiment was conducted at the research field of College of Agricultural Engineering Sciences-University of Sulaimani at Bakrajo, Sulaimani, Iraq during the growing season of 2016-2017 to assess the effect of three-row spaces (10, 15 and 20) cm and three plant densities (160, 200 and 240) kg/ha with their interaction on grain yield and yield components of two bread wheat cultivars (Adana-99 and Aras). For each trait, ranges of statistical analysis were performed, including a Factorial Experiment in a Completely Randomized Block Design (CRBD) with three replications. At a 5% significance level, mean comparisons were done using the least significant difference (L.S.D). Plant height, number of spikes/m², spike length, spike weight, number of spikelets/spike, number of grain/spike, the weight of grain/spike, 1000-grain weight, harvest index, biological yield, and grain yield were all calculated as part of grain yield. The results show that row spaces have a significant impact on the studied characters, with 10 cm producing the highest values for all characteristics except the number of spikes/m², spike length, and harvest index, which were provided by 15 cm. With the exception of the number of spikes/m², spike length, and biological yields, the impact of varieties on agronomic traits was significant; the Adana-99 variety provided maximum values for all of the studied characters. With the exception of spike length, where 200kg/ha density had the ultimate value, plant density had a major impact on the studied characters, with 160kg/ha density producing maximum values for almost all of the characters, and 240kg/ha density producing maximum values for the number of spikes/m² and biological yield. Based on our findings, the Adana-99 cultivar should be sown at a seed rate of 160 kg/ha with a 10 cm inter-row spacing in Bakrajo, Sulaimani Region under guaranteed rained conditions.

INTRODUCTION

The grain yield is a function of interaction between genetic and environmental factors like soil type, sowing time and method, seed rate, fertilizers and time of irrigation. Among these factors row spacing and seeding rates plays a vital role in getting higher grain yield.

Wheat (Triticum aestivum L.) is one of the most important cereal crops in terms of area and production in the world. It was grown on more than 216 million hectares of land with a total production of 651 million tonnes of grain in 2010 (FAOSTAT, 2012). Crop yield is influenced by management practice such as row spacing, which decides the best crop stand and promotes interculture and proper herbicide application for weed control. For optimizing light interception, penetration, light distribution in the crop canopies, and average light efficiency of the canopy leave
s, all of which increase crop production (Hussian, et. al, 2003), the optimum spacing on the row is essential. Wheat row spacing criteria for any variety must be determined based on the architecture and growth patterns of that variety. Crop canopy must intercept a lesser proportion of incident radiation intercepted by canopy layers (Eberbach and Pala, 2005). Similarly, narrow spacing can reduce yield due to increased plant competition for light nutrients and moisture (Das and Yaduraju, 2011). Wheat is commonly sown in rows 22.5 cm apart, with little consideration for the cultivars stature or tillering capacity. As a result of their differing stature and tillering capacity, wheat cultivars behave differently under different row spacing (Hussain et. al, 2012; Hussain et. al, 2013). Plant density or seeding rates have a big influence on the agricultural productivity by improving absorption of sufficient sun light (Maddonni et.al., 2001). Distributing of plant affected the amount absorbed sun light across the canopy thus the main effect of planting pattern and plant density on a crop mainly due to difference how sun light would distribute through the canopy and increasing sunlight absorption would cause improving yield (Naseri et al., 2010). Choosing the right variety or varieties to plant is one of the most important decisions to make for successful wheat production. There are many variations between the varieties, and it is critical to determine which traits are most important in a given production region. Growers should plant a variety of varieties per season to minimize risk and increase their chances of success (UOG, 2018). Wheat varieties have a major effect on yield contributing character variations (Stone and Nicolas, 1995; Tahir et.al, 2009). However, the suitability and specificity of a location-specific variety with high yield potential is critical to the success of any crop production.

Furthermore, better cultural traditions are an important component that cannot be overlooked. Great yielding varieties have been grown as a result of breeding programs and cultural management, which plays an important role in wheat production (Sayed et.al, 2017). It's important to have adequate row spacing and a wide range of plants (Eissa et.al, 1995). Furthermore, the variety does not perform well at optimal plant densities and spacing, which differ greatly depending on location, climatic conditions, soil, and variety (Darwinkel et.al, 1977). Some agronomic traits and yield components of wheat can be influenced by seeding speeds. Grain weight and harvest index are also reduced when the seeding rate is increased (Varga et.al, 2000; Zaheer, et.al, 2000).

Despite the fact that grain yields react to seeding intensity, special densities are recommended for particular areas and cultivars depending on location and cropping time (Azizi and Kahrizi, 2008).

Wheat, on the other hand, can suppress weeds by seeding densely (Ijaz and Hassan, 2006). Low wheat yield is caused by a combination of factors like traditional sowing methods, delayed sowing, low seed rate, and excessive row spacing (Iqbal, 2010). The most important management factors influencing wheat's agronomic characteristics are row spacing and seed rate (Chaudhary et.al, 2000; Marwat et.al, 2002; Ansari et.al, 2006).

The wheat productivity was so decreasing because of the less managements practices especially for plant population and new release cultivars. Therefore, the present study was conducted to determine the effect of variety, seeding rates and row spacing and their interaction growth on yield and yield components of wheat under rain feed conditions of Sulaimani.

**MATERIAL AND METHODS**

This investigation was carried out in Sulaimani city, to study the effect of different row spacing (10, 15, and 20 cm) and seeding rates (160, 200, and 240 kg/ha) on yield and yield components of different wheat varieties in the experimental Farm at the Qlyasan Agricultural Research Station, College of Agricultural Sciences, University of Sulaimani southwest of Sulaimani city (Latitude 35° 33ʹ 307” ; N, Longitude 45° 27ʹ 992” ; E, 830 MASL), located 2 km North West of Sulaimani city during the winter seasons of 2016-2017. The meteorological data of Bakrajo location is shown in Table (1). The experimental area plots were ploughed twice, harrowed and well leveled. Some physical and chemical properties of the experimental soil is given in Table (2).

Two wheat varieties were selected for cultivation, which has been provided by The Bakrajo- Agricultural Research Center, namely; (Adana-99 and Aras). Adana-99 cultivar introduced from Turkia at the

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**Table (1):**

| Year | Season   | Rainfall (mm) | Temperature (°C) | Humidity (%) |
|------|----------|---------------|-----------------|--------------|
| 2016 | Winter   | 350           | 12              | 45           |
| 2017 | Winter   | 380           | 15              | 50           |

**Table (2):**

| Soil Property | Value |
|---------------|-------|
| pH            | 7.5   |
| Organic Carbon| 2.5   |
| Nitrogen      | 0.3   |
| Phosphorus    | 0.2   |

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last decade with high yield potential, while Aras cultivar was local cultivar in Kurdistan region with high adapted to Kurdistan enviromental condition.

The experiment was lay as effects of (3×3×2) Factorial in a Completely Randomized Block Design (Al-Rawi and Khalfalah, 1980) with thre replicates which comprised three row spacing (10, 15, and 20 cm) and three seeding rates (160, 200, and 240 kg/ha) on yield and yield components of two wheat cultivars was studied in the field (Adana-99 and Aras). Planting date was on November 1, 2016, and harvesting on June 25, 2017.

**Studied Characteristics**

Plant height, number of spikes/m2, spike length, spike weight, number of spikelets/spike, number of grains/spike, 1000-grain weight, biological yield, harvest index, and grain yield were all measured during the analysis.

**Table (1) Average air temperature and rainfall during the growing seasons of 2016-2017 at Qlyasan Location**

| Months       | Average Air Temperature (°C) | Rainfall (mm) |
|--------------|------------------------------|---------------|
|              | Max.                        | Min.          |               |
| November     | 21.3                        | 7.6           | 44.5          |
| December     | 11.1                        | 3.0           | 158.0         |
| January      | 11.10                       | 1.46          | 59.2          |
| February     | 13.02                       | 0.26          | 96.5          |
| March        | 17.73                       | 7.45          | 111.5         |
| April        | 23.89                       | 10.97         | 54.5          |
| May          | 31.63                       | 13.48         | 27.7          |
| Total        |                             |               | 551.9         |

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**Table (2) Some physical and chemical properties of soil analysis at experimental site**

| Soil Properties | Qlyasan Location |
|-----------------|------------------|
| Physical properties |
| Soil Properties | Qlyasan Location |
| Textural Class  | Silty Clay Loam  |
| Particle Size Distribution (g kg\(^{-1}\)) | Sand 59.68 |
|                | Silt 619.17      |
|                | Clay 312.15      |
| Chemical properties |
| Soil Properties | Qlyasan Location |
| PH              | 7.42             |
| EC dS m\(^{-1}\) | 0.38             |
| Organic Matter (g kg\(^{-1}\)) | 19.59         |
| Total Nitrogen (g kg\(^{-1}\)) | 1.07           |
| Available Phosphate (mg kg\(^{-1}\)) | 9.61          |
| CaCO\(_3\) (mg kg\(^{-1}\)) | 215.68        |
| Soluble Ions mmol L\(^{-1}\) |
| Calcium (Ca\(^{2+}\)) | 2.00          |
| Potassium (K\(^{+}\)) | 0.16          |
| Sodium (Na\(^{+}\)) | 0.46          |
| Mg\(^{2+}\) | 0.81           |
| HCO\(_3\)\(^{-}\) | 2.51           |
| SO\(_4\)\(^{2-}\) | 0.79           |

As a general test, the data were statistically analysed using analysis of variance methods, and significant differences were tested the general test showed relevance, all possible comparisons...
between the means were made using the L.S.D. (Least Significant Difference) test at a significant level of 5%. Different traits were observed and reported.

RESULTS AND DISCUSSION

The data revealed in Table 3 and Appendix 1 that row spacing had a significant influence on all the studied characters. Row spacing 10 cm showed the maximum value for plant height, spike weight, number of spikelets/spike, number of grains/spike, weight of grains/spike, 1000-grain weight and biological yield were all highest with (108.680 cm, 1.774 g, 16.238, 37.356, 1.557, 42.118 and 16.250 ton/ha) respectively. At 15 cm row spacing, the maximum value of number of spikes/m2, spike length, harvest index and grain yield were observed, with (602.222, 8.483 cm, 0.487 and 6.675 ton/ha) respectively. Wheat yields increased as the spacing between rows was reduced. The constantly narrow space between the rows resulted in more cereals than wider space (Chen and Neill, 2006). A narrow row provided more biomass than a wider row with spacing of 22.5 cm, meaning that a narrow row uses resources more efficiently than a wider row (Hansram and Jagdish, 2015). Dwyer et al., 1991, observed that narrow row spacing causes higher leaf photosynthesis and suppresses weeds growth compared with wider row spacing. Narrow row spacing also produces high leaf area index (LAI), which results in more interception of photosynthetically active radiation (PAR) and dry matter accumulation (Tollenaar, and Auguilera. 1992).

Table (3) Row spacing effect on the studied characters

| Row Spacing (cm) | Plant H (cm) | No. of spikes/m² | Spike length (cm) | Spike wt (g) | No. of spikelets/spike | No. of grains/spike | Wt of grains/spike (g) | 1000-grain wt (g) | Harvest Index | Biological yield (tons/ha) | Grain yield (tons/ha) |
|-----------------|--------------|------------------|-------------------|--------------|------------------------|-------------------|------------------------|-------------------|--------------|--------------------------|---------------------|
| 10              | 106.829      | 583.889          | 8.406             | 1.774        | 16.238                 | 37.356            | 1.557                  | 42.118            | 0.411        | 16.250                   | 6.655               |
| 15              | 107.908      | 602.222          | 8.483             | 1.250        | 13.408                 | 30.745            | 1.086                  | 34.780            | 0.487        | 13.786                   | 6.675               |
| 20              | 108.680      | 556.833          | 8.233             | 1.240        | 13.267                 | 30.946            | 1.103                  | 36.331            | 0.480        | 12.885                   | 6.132               |
| LSD (p≤0.05)    | 0.123        | 1.733            | 0.129             | 0.029        | 0.098                  | 0.333             | 0.033                  | 0.413             | 0.009        | 0.268                    | 0.036               |

The results of this study showed that two varieties significantly differed for studying characters (Table 4 and Appendix1). Variety Adana-99 showed the maximum value for plant height, spike weight, number of spikelets/spike, number of grains/spike, the weight of grains/spike, 1000-grain weight, harvest index, and grain yield, with (108.612 cm, 1.628 g, 15.531, 35.859, 1.433 g, 39.744 g, 0.481 and 6.614 tons/ha) respectively, while Aras variety recorded maximum value for the number of spikes/m², spike length and biological yield, with (626.000, 8.481 cm and 14.632) respectively. Genetic variation is to blame for variations in plant height between different varieties. These findings are consistent with those of Nizamani et al. (2014) and Suleiman et al. (2014), who found that plant height, differed significantly between varieties. According to Saeed et al. (2014), there were significant differences in grain yield among variants. Different wheat varieties had a major impact on biological yield (Gawali et al., 2015).

Data recorded in Table (5) and Appendix (1) indicated that a significant difference was observed among seeding rates. Seeding rates of 160 kg/ha showed the maximum value for plant height, spike weight, number of spikelets/spike, number of grains/spike, the weight of grains/spike and 1000-grain weight, with (108.358 cm, 1.537g, 15.021, 34.618, 1.347g and 38.874g) respectively.
The highest harvest index with 0.466 recorded by (200 kg/ha), while spiking length, the number of spikes/m², spike length and biological yield, with (8.361 cm, 640.500, 8.411 cm and 14.399 tons/ha) recorded by (240 kg/ha) seeding rates. Moreover, the data revealed that increasing seeding rate from 160 to 200 and 240 kg/ha led to significant increases in seed yield from 6.275 to 6.548 and 6.640 tons/ha and significant overtaking by 4.4 and 5.8%, respectively. High seeding rates increase the competition among crops for common particularly water, nutrients and sunlight which resulting in low quality and low yield (Jemal, and Firdissa, 2015). The use of optimum seed rate encourages nutrient availability, proper sun light penetration for photosynthesis, good soil environment for uptake of soil nutrients and water use efficiency; and all necessary for crop vigor and because of this increase the production and productivity of the crop (Amare, and Mekonen, 2015). There have also been considerable differences in grains yield among variants recorded by Ali et al. (1996), Rafique et al. (1997) and Chaudhary et al. (2000) who demonstrated that lower seeding rates resulted in a significant increase in grain production and vice versa. Boosting the seed rate, the number of grains/spikes reduced, increasing seed rate the 1000-grains weight is reduced (Khan, et al., 2002; Mehrvar and Asadi, 2006). These effects lie in correlation with those of previous works of Khan et al. (2001) and Arif et al. (2003), who reported a higher yield with a seed rate of 150 kg/ha. The highest wheat grain yield was obtained from 200 kg/ha and 240 kg/ha than other seeding rates used, 120 kg/ha produced the lowest wheat grain yield (Shwana et al. 2018).

The data in Table (6) and Appendix (1) demonstrated an interaction effect between the row spacing of the row and the varieties. The interaction significantly affects the number of spikes/m², spike weight, number of spikelet/spike, number of grains/spike, the weight of grains/spike, 1000-grain weight, harvest index, biological yield, and grain yield and non-significantly effects on plant height and spike length. The maximum value of spike weight, number of spikelets/spike, number of grains/spike, the weight of grains/spike, 1000-grain weight, and biological yield, with (2.009 g,
17.432, 39.933, 1.773 g, 44.539 g, and 16.472 tons/ha) respectively, exhibited by the combination between (10 cm with Adana-99), except for harvest index and grain yield, with (0.519 and 6.794 tons/ha) respectively exhibited by the combination between (Adana-99 with 15 cm) and the maximum values of harvest index, with (0.519) by the combination between (Adana-99 with 20 cm), while the maximum values of the number of spikes/m2 (677.111) respectively exhibited by the combination between (15 cm with Aras).

These findings are consistent with those of Abbas et al. (2009), Ali et al. (2010) Abbas et al. and Naseeri et al. (2012) who found that due to high competition and limited availability of nutrients and light, the number of grain/spike decreased under narrow row spacing. Ali et al. (2010) finding that during the same time, extreme competition under narrow row spacing decreased photosynthate supply, resulting in lower grain weight and spiked weight. Saeed et al. (2012) found significant yield between different cultivars.

Table (6) Effect of row spacing and varieties on the studied characters

| Spacing | Row Varieties | Plant Ht (cm) | No. of spikes/m2 | Spike length (cm) | Spike weight (g) | No. of spikelet/spike | No. of grains/spike | Harvest Index | Grain yield (tons/ha) | Biological yield (tons/ha) | Grain weight (g) |
|---------|---------------|---------------|------------------|------------------|-----------------|----------------------|------------------|--------------|----------------------|------------------------|-----------------|
| 10      | Adana-99      | 107.576       | 560.111          | 8.389            | 2.009           | 17.432               | 39.933           | 1.773        | 44.539               | 0.399                  | 16.472          |
|         | Aras          | 106.082       | 607.667          | 8.422            | 1.539           | 15.045               | 34.778           | 1.341        | 39.698               | 0.407                  | 16.027          |
| 15      | Adana-99      | 108.692       | 527.333          | 8.333            | 1.469           | 14.944               | 34.186           | 1.272        | 36.355               | 0.512                  | 13.158          |
|         | Aras          | 107.124       | 677.111          | 8.633            | 1.032           | 11.872               | 27.305           | 0.901        | 33.206               | 0.433                  | 14.413          |
| 20      | Adana-99      | 109.566       | 520.444          | 8.078            | 1.407           | 14.216               | 33.457           | 1.254        | 38.339               | 0.491                  | 12.315          |
|         | Aras          | 107.794       | 575.222          | 8.389            | 1.073           | 12.319               | 28.435           | 0.952        | 34.323               | 0.442                  | 13.455          |
| LSD (p≤0.05) | n.s       | 1.189         | 0.040           | 0.138           | 0.471           | 0.046                | 0.584           | 0.010        | 0.379                | 0.110                  |

Table (7) and Appendix (1) showed a significant interaction between the row spacing and seeding rates on studied characters. The combination significantly affects the number of spikes/m2, spike length, number of spikelet/spike, number of grains/spike, 1000-grain weight (g), harvest index, and biological yield and non-significantly effects on plant height, spike weight, the weight of grains/spike and grain yield. The maximum mean for the number of spikelet/spike, number of grains/spike and biological yield, with (16.948, 38.938, 44.046 g and 16.820 tons/ha) respectively exhibited by the interaction effect between (10 cm with 160 kg/ha), except for the number of spikes/m2 and spike length, with (684.500 and 8.667 cm) respectively recorded by the combination effect between (15 cm with 240 kg/ha), while the maximum value of harvest index (0.490) recorded by the combination effect between (20 cm with 160 kg/ha). The results were verified by Ali et al. (2010) study that narrow row spacing delivered more biological output than wide row spacing. Increased density improves yield slightly, while excessive density reduces yield. Density is limited due to the low number of plants per unit area in low density and increased competition to attract the factors influencing growth in high density (Jan et al. 2000).

The interaction effect of varieties and seeding rates on yield and its components was revealed by the data in Table (8) and Appendix (1). The combination significantly affects the studied characters except for spike length and grain yield nonsignificant. The maximum value of plant height, spike weight, number of spikelets/spike and number of grains/spike, the weight of grain/spike and 1000-grain weight, with (109.041 cm, 1.787 g, 16.549, 38.103, 1.565 g and 41.202 g) respectively recorded by the interaction effect between (Adana-99 with 160 kg/ha), the maximum value for harvest index (0.504) recorded by the interaction effect between (Adana-99 with 200 kg/ha), the maximum value for the number of spikes/m2, with (654.111) recorded by the interaction effect between (Aras with 240 kg/ha), while biological yield, with 15.001 tons/ha) recorded by the interaction effect between (Aras with 200 kg/ha). Slightly influenced by environmental factors were detected for spikelet/spikes inherent (Jan et al., 2000). Seeding rates can influence plant height, seed weight, and seed yield, and thus be a critical factor in the final yield (Geleta et al. 2002). Most agronomic traits of bread wheat are influenced by the seeding rate (Nizamani et al., 2014).
Table (7) Effect of row spacing and seeding rates on the studied characters

| Row spacing (cm) | Seeding rates (Kg/ha) | Plant height (cm) | Spike length (cm) | Weight of grains/spike (g) | No. of spikelets/spike | No. of grains/spike | Harvest index | Biological yield (tons/ha) | Grain yield (tons/ha) |
|-----------------|-----------------------|------------------|-------------------|---------------------------|-----------------------|-------------------|--------------|---------------------------|---------------------|
| 10              | 160                   | 107.300          | 529.500           | 8.067                     | 1.925                 | 16.948            | 38.938       | 1.680                     | 44.046              | 0.376               | 16.820               | 6.329               |
|                 | 200                   | 106.958          | 590.000           | 8.583                     | 1.811                 | 16.422            | 38.119       | 1.589                     | 41.899              | 0.415               | 16.099               | 6.678               |
|                 | 240                   | 106.231          | 632.167           | 8.567                     | 1.586                 | 15.345            | 35.010       | 1.403                     | 40.410              | 0.441               | 15.830               | 6.958               |
| 15              | 160                   | 108.464          | 550.333           | 8.467                     | 1.355                 | 14.389            | 32.946       | 1.169                     | 35.120              | 0.481               | 13.670               | 6.565               |
|                 | 200                   | 108.950          | 571.833           | 8.317                     | 1.308                 | 13.744            | 31.447       | 1.130                     | 35.337              | 0.509               | 13.438               | 6.758               |
|                 | 240                   | 107.310          | 684.500           | 8.667                     | 1.088                 | 12.091            | 27.844       | 0.960                     | 33.885              | 0.472               | 14.249               | 6.701               |
| 20              | 160                   | 109.311          | 530.333           | 8.517                     | 1.333                 | 13.726            | 31.971       | 1.192                     | 37.454              | 0.483               | 12.286               | 6.930               |
|                 | 200                   | 108.680          | 535.333           | 8.183                     | 1.297                 | 13.693            | 31.523       | 1.147                     | 36.972              | 0.473               | 13.251               | 6.208               |
|                 | 240                   | 108.050          | 604.833           | 8.000                     | 1.090                 | 12.383            | 29.345       | 0.970                     | 34.568              | 0.483               | 13.118               | 6.260               |
| LSD (p≤0.05)    | n.s                   | 3.002            | 0.224             | n.s                       | 0.169                | 0.576            | n.s          | 0.715                     | 0.015               | 0.464               | 0.062                |

Table (8) The interaction effect of varieties and seeding rates on the studied characters

| Varieties      | Seeding rates (Kg/ha) | Plant weight (g) | Harvest index | Biological yield (tons/ha) | Grain yield (tons/ha) |
|----------------|-----------------------|------------------|--------------|---------------------------|---------------------|
| Adana-99       | 160                   | 109.041          | 483.667      | 8.289                     | 1.787               | 16.549            | 38.103       | 1.565                     | 41.202              | 0.451               | 14.320               | 6.381               |
|                | 200                   | 109.017          | 497.333      | 8.211                     | 1.755               | 16.332            | 37.617       | 1.548                     | 40.827              | 0.504               | 13.525               | 6.691               |
|                | 240                   | 107.777          | 626.889      | 8.300                     | 1.343               | 13.710            | 31.857       | 1.187                     | 37.204              | 0.488               | 14.100               | 6.771               |
| Aras           | 160                   | 107.676          | 589.778      | 8.411                     | 1.287               | 13.492            | 31.134       | 1.129                     | 36.546              | 0.442               | 14.197               | 6.168               |
|                | 200                   | 106.708          | 634.111      | 8.511                     | 1.189               | 12.907            | 29.775       | 1.030                     | 35.312              | 0.427               | 15.001               | 6.405               |
|                | 240                   | 106.617          | 654.111      | 8.522                     | 1.167               | 12.836            | 29.609       | 1.035                     | 35.370              | 0.443               | 14.698               | 6.508               |
| LSD (p≤0.05)   | 0.174                 | 2.451            | n.s          | 0.040                     | 0.138               | 0.471            | 0.046       | 0.584                     | 0.012               | 0.379               | n.s                  |

Table (9) and Appendix (1) shows the effect of triple interaction between row spacing, varieties, and seeding rates on the studied characters. This significant interaction impacts the number of spikes/m², spike length, number of spikelets/spike, number of grains/spike, 1000-grain weight, harvest index, biological yield, and grain yield, except for plant height, spike weight and weight of grains/spike which had none significant affect. The maximum value of the number of spikes/m² (693.667) was recorded using the interaction effect (15 cm with Aras and 200 kg/ha). The maximum value of spike length (8.900cm) was recorded by the interaction effect (15 cm with Aras and 240 kg/ha). The maximum value of the number of spikelets/spike, number of grains/spike and 1000-grain weight, with (18.315, 42.196 and 46.137g) respectively recorded by the interaction effect between (10 cm with Adana-99 and 160 kg/ha), while the maximum value of harvest index (0.567) recorded by the interaction effect between (15 cm with Adana-99 and 200 kg/ha). The maximum value of Biological yield (17.100 tons/ha) is the interaction effect between (10 cm with Aras and 160 kg/ha). The maximum value of Grain yield (6.961 tons/ha) was recorded by the interaction effect between (10 cm with Adana-99 and 240 kg/ha). Grain yield increased as row spacing decreased who reported by Hussain et al. (2012) and Kalpana et al. (2014). Due to the variety, changes in yield of wheat have also been observed in (Stone and Nicolas, 1995; Tahir et al., 2009). Sowing bread wheat at the optimal seeding rate and with the most convenient row spacing increases the number of grains per spike, spike length, grain weight per spike, and 1000-grain weight, resulting in a high grain yield (Iqbal et al. 2010).
Table (9) The interaction effect of row spacing, varieties and seeding rates on the studied characters

| Row Spacing (cm) | Varieties | Rates (Kg/ha) | Plant height (cm) | Spike length (cm) | Spike weight (g) | No. of spikelets/spike | Harvest index | Weight of 1000 grain (g) | Grain yield (ton/ha) | LSD (p<0.05) |
|-----------------|-----------|--------------|------------------|------------------|-----------------|-----------------------|--------------|-------------------------|---------------------|-------------|
| 10              | 160       | 108.041      | 515.33           | 8.067            | 2.183           | 18.315                | 42.196       | 1.908                   | 46.137              | 0.381        |
|                 | 200       | 108.036      | 562.333          | 8.300            | 2.140           | 18.027                | 41.685       | 1.901                   | 45.330              | 0.413        |
|                 | 240       | 106.653      | 602.667          | 8.800            | 1.705           | 15.954                | 35.918       | 1.511                   | 42.150              | 0.421        |
| 15              | 160       | 106.558      | 543.667          | 8.067            | 1.667           | 15.581                | 35.680       | 1.452                   | 41.955              | 0.372        |
|                 | 200       | 105.879      | 617.667          | 8.867            | 1.482           | 14.818                | 34.552       | 1.276                   | 38.469              | 0.417        |
|                 | 240       | 105.808      | 661.667          | 8.333            | 1.467           | 14.735                | 34.102       | 1.295                   | 38.669              | 0.460        |
| 20              | 160       | 109.081      | 453.000          | 8.467            | 1.625           | 16.214                | 37.109       | 1.389                   | 37.414              | 0.494        |
|                 | 200       | 109.070      | 450.000          | 8.100            | 1.588           | 15.900                | 36.351       | 1.382                   | 37.314              | 0.567        |
|                 | 240       | 107.925      | 679.000          | 8.433            | 1.193           | 12.717                | 29.099       | 1.045                   | 34.335              | 0.495        |
|                 | 160       | 107.846      | 647.667          | 8.467            | 1.084           | 12.564                | 28.782       | 0.950                   | 32.826              | 0.467        |
|                 | 200       | 106.829      | 693.667          | 8.533            | 1.028           | 11.587                | 26.544       | 0.878                   | 33.359              | 0.451        |
|                 | 240       | 106.696      | 690.000          | 8.900            | 0.984           | 11.465                | 26.588       | 0.875                   | 33.434              | 0.448        |

CONCLUSION

The results showed that using different row spacing, varieties, and seeding rates significantly affected all parameters. High density can affect seed weight; seed weight decreased. Increasing density decreases the light transition to the lower sections of the plant, while increased competition for light causes the plants to grow quickly, with losses reducing the lifespan of the leaves. Seed rates and row spacing interaction also show significant difference except for plant height, spike weight, the weight of grain/spike, and grain yield. The use of 160 kg/ha resulted in the maximum value for most of the characters. Adana-99 predominated Aras variety for most of the characters.

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مفتاح الكلمات
- أصناف
- الحضوة
- مسافات الجيب، خطوط
- السنوية، سنين
- حصاد
- الحاصل و موسيانها.