Tikrit Journal for Agricultural Sciences (2021) 21 (3):41-51
https://doi.org/10.25130/tjas.21.3.5

IRAQI Academic Scientific Journals

المجلات الأكاديمية العلمية العراقية

ISSN:1813-1646 (Print); 2664-0597 (Online)

Tikrit Journal for Agricultural Sciences

Journal Homepage: http://www.tjas.org

E-mail: tjas@tu.edu.iq

TJAS Tikrit Journal for Agricultural Sciences

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

Rezhin Ghareb Nwry *
Shang Haseeb Abdulqader
Shwana Ahmad Hussain

Department of Biotechnology and Crop Science – College of Agricultural Engineering Sciences – University of Sulaimani – Sulaimani – Iraq

KEY WORDS:

Wheat Varieties, Row spacing, seeding rate, yield and its components.

ARTICLE HISTORY:

Received: 24/04/2021

Accepted: 12/07/2021

Available online: 30/09/2021

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 inter-culture 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

* *Corresponding author: E-mail*: rezhin.nwry@univsul.edu.iq

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° 33′ 307″ ; N, Longitude 45° 27′ 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 cultiver introduced from Turkia at the 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 compriesed 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

*Natural Resource Department, College of Agricultural Engineering Sciences, University of Sulaiman

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

Soil Properties		
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} At 25 °C		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
	$SO4^{2-}$	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 photosynethesis 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	Plant Ht (cm)	No. of spikes/ m^2	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 ($p\leq0.05$)	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 6.614tons/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.

Table (4) Effect of varieties on the studied characters

Varieties	Plant ht (cm)	No. of spikes/m^2	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)
Adana-99	108.61	535.963	8.267	1.628	15.531	35.859	1.433	39.744	0.841	13.982	6.614
Aras	107.000	626.000	8.481	1.214	13.078	30.173	1.065	35.742	0.437	14.632	6.360
LSD ($p \leq 0.05$)	0.101	1.415	0.106	0.023	0.080	0.272	0.027	0.337	0.007	0.219	0.029

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, 8.411cm and 14.399 tons/ha) recorded by (240 kg/ha) seeding rates. More ever 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 6.640t ha-1 and significant overtaking by 4.4 and 5.8%, respectively. High seeding rates increases 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).

Table (5) Effect of seeding rates on the studied characters

Seeding Rates (Kg/ha)	Plant ht (cm)	No. of spikes /m^2	Spike length (cm)	Spike weight (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)
160	108.358	536.722	8.350	1.537	15.021	34.618	1.347	38.874	0.447	14.259	6.275
200	107.862	565.722	8.361	1.472	14.620	33.696	1.289	38.069	0.466	14.263	6.548
240	107.197	640.500	8.411	1.255	13.273	30.733	1.111	36.287	0.465	14.399	6.640
LSD ($p \leq 0.05$)	0.123	1.733	0.129	0.029	0.098	0.333	0.033	0.413	0.009	0.268	0.036

The 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

Row Spacing (cm)	Varieties	Plant Ht (cm)	No. of spikes/m^2	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	Adana-99	107.576	560.111	8.389	2.009	17.432	39.933	1.773	44.539	0.399	16.472	6.575
	Aras	106.082	607.667	8.422	1.539	15.045	34.778	1.341	39.698	0.407	16.027	6.516
15	Adana-99	108.692	527.333	8.333	1.469	14.944	34.186	1.272	36.355	0.512	13.158	6.705
	Aras	107.124	677.111	8.633	1.032	11.872	27.305	0.901	33.206	0.433	14.413	6.228
20	Adana-99	109.566	520.444	8.078	1.407	14.216	33.457	1.254	38.339	0.491	12.315	6.038
	Aras	107.794	575.222	8.389	1.073	12.319	28.435	0.952	34.323	0.442	13.455	5.896
LSD ($p \leq 0.05$)		n.s	1.189	n.s	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 (109.041cm, 1.787g, 16.549, 38.103, 1.565g and 41.202g) 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 15.001tons/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)	No. of spikes/m^2	Spike length (cm)	Spike weight (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	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	107.950	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 height (cm)	No. of spikes/m^2	Spike length (cm)	Spike weight (g)	No. of spikelets/spike	No. of grains/spike	Weight of grains/ spike (g)	1000 grain 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 and46.137g) 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	Seeding Rates (Kg/ ha)	Plant height (cm)	No. of spikes/m^2	Spike length (cm)	Spike weight (g)	No. of spikelets/spike	No. of grains/ spike	Weight of grains/ spike (g)	1000 grain weight (g)	Harvest Index	Biological yield (tons/ha)	Grain yield (tons/ ha)
10	Adana-99	160	108.041	515.33	8.067	2.183	18.315	42.196	1.908	46.137	0.381	16.539	6.302
		200	108.036	562.333	8.300	2.140	18.027	41.685	1.901	45.330	0.413	16.339	6.743
		240	106.653	602.667	8.800	1.705	15.954	35.918	1.511	42.150	0.421	16.537	6.691
	Aras	160	106.558	543.667	8.067	1.667	15.581	35.680	1.452	41.955	0.372	17.100	6.356
		200	105.879	617.667	8.867	1.482	14.818	34.552	1.276	38.469	0.417	15.859	6.613
		240	105.808	661.667	8.333	1.467	14.735	34.102	1.295	38.669	0.460	15.122	6.954
15	Adana-99	160	109.081	453.000	8.467	1.625	16.214	37.109	1.389	37.414	0.494	13.632	6.737
		200	109.070	450.000	8.100	1.588	15.900	36.351	1.382	37.314	0.567	12.054	6.832
		240	107.925	679.000	8.433	1.193	12.717	29.099	1.045	34.335	0.495	13.789	6.813
	Aras	160	107.846	647.667	8.467	1.084	12.564	28.782	0.950	32.826	0.467	13.708	6.393
		200	106.829	693.667	8.533	1.028	11.587	26.544	0.878	33.359	0.451	14.822	6.683
		240	106.696	690.000	8.900	0.984	11.465	26.588	0.875	33.434	0.448	14.708	6.590
20	Adana-99	160	110.000	482.667	8.333	1.553	15.119	35.003	1.398	40.053	0.477	12.790	6.103
		200	109.945	479.667	8.233	1.537	15.069	34.815	1.359	39.836	0.533	12.181	6.497
		240	108.754	599.000	7.667	1.131	12.460	30.552	1.005	35.128	0.546	11.974	6.539
	Aras	160	108.623	578.000	8.700	1.112	12.333	28.939	0.986	34.855	0.489	11.783	5.756
		200	107.414	591.000	8.133	1.057	12.316	28.230	0.935	34.107	0.413	14.321	5.918
		240	107.346	610.667	8.333	1.050	12.307	28.137	0.935	34.008	0.419	14.262	5.980
LSD ($p \leq 0.05$)			n.s	4.246	0.317	n.s	0.240	0.815	n.s	1.011	0.021	0.657	0.087

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.

REFERENCES

Abbas, G., M.A. Ali, G., Abbas, M., Azam and Hussain, (2009). Impact of planting methods on wheat grain yield and yield contributing parameters, J. Anim. Plant Sci., Vol. (19), pp: 30-33.

Ali, M.A., R., Rehman, M., Siddique and M., Rashid, (1996). Effect of seed rate and row spacing on wheat yield, J. Agric. Res., Vol. (34), No.6, pp: 351-357.

Ali, M.L., Ali M., Sattar and M.A., Ali, (2010). Improvement in wheat (Triticum aestivum L.) yield by manipulating seed rate and row spacing in vehari zone, J. Animal & Plant Sci., Vol. (20), No.4, pp: 225-230.

Al-Rawi and Khalfalah, (1980). Design and Analysis of Agricultural Experiments. College of Agriculture and Forestry, Mosul University. Pp: 361-363.

Amare, A., L. Adane and M. Mekonen, (2015). Yield Response of Bread Wheat to Timing of Urea Fertilizer application in Eastern Amhara Region. Sirinka Agricultural Research Center, Woldia, Ethiopia. J. Biology, Agriculture and Healthcare, 5(3): 180-183.

Ansari, M.A., H.R., Meman, S.D., Tunio and S.A., Keerio, (2006). Effect of planting pattern on growth and yield of wheat. Pakistan J. Agri., Agril. Eng.,Vet. Sci.,22 (2).

Arif, M., M. Ali, Q.M., Din, M., Akram and L., Ali, (2003). Effect of different seed rates and row spacing on the growth and yield of wheat", J. Anim. Pl. Sci., Vol. (13), No. 3, pp:161-163.

Azizi, K., and D., Kahrizi, (2008). Effect of Nitrogen levels plant Density and Climate on yield Quantity and Quality in cumin (Cuminum cyminum L.) under the conditions of Iran". Asian Journal of Plant Sciences, 7(8), pp: 710-716.

Chaudhary, M.A., A. Ali, M.A., Siddique, and R., Sohail, (2000). Growth and yield response of wheat to different seed rates and wild oat (Avena fatua) competition durations. Pakistan J. Agri. Sci., 37 (3-4), pp: 152-154.

Chen, C., and K., Neill, (2006). Response of spring wheat yield and protein row spacing, plant density and nitrogen application in Central Montana. Fertilizer Facts: 37, Montana State University, Agricultural Experiment Station and Extension Service.

Darwinkel, A., B.A., Hag and J., Kuizenga, (1977). Effect of sowing date and seed rate on crop development and grain production of winter wheat. Netherlands Journal of Agriculture Science, 24, pp: 83-94.

Das, T.K., and N.T., Yaduraju, (2011). Effects of missing- row sowing supplemented with row spacing and nitrogen on weed competition and growth and yield of wheat. Crop and Pasture Science, 62, pp:48-57.

Dwyer, L. M., M. Tollenaar and D. W. Stewart. (1991). Changes in plant density dependence of leaf photosynthesis of maize (Zea mays L.) hybrids, 1959 to 1988. Can. J. Plant Sci. 71:1-11.

Eberbach, P., and M., Pala, (2005). Crop row spacing and its influence on the partitioning of evapotranspiration by winter-grown wheat in Northern Syria. Plant and Soil, 268, pp: 195-208.

Eissa, A.M., T.M., Shehab and A.M., Dawood, (1995). Row spacing and seeding rate effects on yield and yield components of spring wheat in Al-Qassim Region, Saudi Arabia. Assiut J. Agric. Sci., 26, pp: 25-36.

FAOSTAT, (2012). Statistical databases and data-sets of the Food and Agriculture Organization of the United Nations.http://faostat.fao.org/default.aspx.

Gawali, A., Puril S., and Swamy S.L., (2015). Evaluation growth and yield of wheat varieties under ceibapentandra based agrisilviculture system, Universal Journal of Agricultural Research, Vol. (3), No. 6, pp: 173-181.

Geleta, B., Atak M., Baenziger P.S., Nelson, L.A., Baltenesperger D.D., Eskridge K.M., Shipman. M.J., and Shelton D.R., (2002). Seeding Rate and Genotype Effect on Agronomic Performance and End-use Quality of Winter Wheat, Crop Sci., Vol. (42), pp: 827-832.

Hansram M., and Ch., Jagdish, (2015). Performance of bread wheat (Triticum aestivum L.) varieties under different row spacing. J. Wheat Res.,4(2), pp: 55-57.

Hussain, M., M.B., Khan, Z., Mehmood, A.B., Zia, K., Jabran, and M., Farooq, (2013). Optimizing row spacing in wheat cultivars differing in tillering and stature for higher productivity. Arch. Agron. Soil Sci., 59, pp: 1457–1470.

Hussain, M., Z., Mehmood, M.B., Khan, S., Farooq, D.J. Lee, and M., Farooq, (2012). Narrow row spacing ensures higher productivity of low tillering wheat cultivars". Int. J. Agric. Biol., 14, pp: 413–418.

Hussian, I., M.A., Khan and K., Ahmad, (2003). Effect of row spacing on the grain yield and yield component of wheat (Triticum aestivum L.). Pakistan Journal of Agronomy, 2(3), pp: 153-59.

Ijaz, A.K., and G., Hassan, (2006). Effect of wild oats (Avena fatua) densities and proportions on yield and yield components of wheat", Pakistan Journal of Weed Science Research, 1(1-2), pp: 69-77.

Iqbal, N., N., Akbar, M. Ali, M., Sattar and L., Ali, (2010). Effect of seed rate and row spacingon yield and yield components of wheat (Triticum aestivum L.). Adaptive Research Farm, Vehari, Pakistan. J. Agric. Res., 48 (2), pp:151-156.

Jan, A., M.Y. Khan, M.I., Marwat and T., Muhammed, (2000). Impact of intra –specific competition on the agronomic traits of wheat. Pakistan J. Biol.SCi, Vol. (3), pp:2016-2019.

Jemal, A., T. Tamado and E. Firdissa, (2015). Response bread wheat (Triticum aestivum L.) Varieties to Seeding Rates at Kulumsa, South Eastern Ethiopia. Asian Journal of Plant Sciences, 14(2): 50-58

Kalpana, A., Prusty P., Mukhopadhyay, S.K., (2014). Performance of wheat genotypes under different row spacing in New Alluvial Zone of West Bengal, Journal of Crop and Weed, Vol. (10), No. 2, pp:480-483.

Khan, A.Z., H., Khan, R., Khan, Adel Ghoneim and A., Ebid, (2002). Effect of sowing dates and seed rates on yield and yield components of wheat, Trendsin Applied Sci. Res., Vol. (2), No. 6, pp:529-534.

Khan, M.A., J., Anwar, A., Sattar and M.A., Akhtar, (2001). Effect of seed rate on wheat yield under different sowing dates and row spacing", J. Agric. Res., Vol. (39), No. 3-4, pp:223-229.

Maddonni, G.A., Otegui, M.E. and Cirilo, A.G. (2001). "Plant population density, row spacing and hybrid effect on maize canopy architecture and light attenuation " , Field Crop Research. Vol.(71), pp.183-193.

Marwat, M. I., H. K., Ahmad, H. H., Khan and A., Khan, (2002). Integrated weed management in wheat. Weed density, dry weed biomass, absolute growth rate and grain yield. Pakistan J. Weed Sci. Res., 8(1-2), pp: 81-93.

Mehrvar, M.R., and H., Asadi, (2006). Agronomical and economical assessment of planting methods and seeding rates in irrigated wheat, J. Agron., Vol. (5), No. 4, pp: 626-633.

Naseri, R., A., Soleymanifard, H., Khoshkhabar, A., Mirzaei and K., Nazaralizadeh, (2012). Effect of plant spacing on grain yield and yield components and associated traits of three durum wheat cultivars in western Iran, Intl. J. Agri. Crop Sci., Vol. (4), pp: 79-85.

Naseri, R., Fasihi, KH., Hatami, A. and Poursiahbidi, MM. (2010). "Effect of planting pattern on yield, yield components, oil and protein contents in winter safflower cv.sinai under rainfed conditions ", Iranian Journal of Crop Science, (In Persian), Vol. (12), No.3, pp.227-238.

Nizamani, G.S., A.K., Imtiaz, A., Khatri, M.A., Siddiqui, M.R., Nizamani and M.I., Khaskheli, (2014). Influence of different row spacing on agronomic traits in different wheat varieties. International Journal of Development Research, 4(11), pp: 2207-2211.

Rafique, M., A., Ahmad, N., Muhammad, M., Siddique and M., Kamran, (1997). Effect of seeding densities and planting techniques on late sown wheat (Triticum aestivum L.) yield, J. Agric. Res., Vol. (35), No. 3, pp:147-153.

Saeed, B., Hasina-Gul, Anwar, S., Khan, A., Azra Ali, S., and Naz, I., (2012). Performance of wheat varieties sown under solid and skip row geometry, ARPN Journal of Agricultural and Biological Science, Vol. (7), No. 7, pp:1990-6145.

Sayed, R. D. Gh., Anchal, H., Habibullah, Q.M., Mohammad and O., Abdul Hadi, (2017). Effect of row spacing on different wheat (Triticum aestivum L.) varieties in semi-arid region of Kandahar. International Journal of Applied Research, 3(7), pp: 93-97.

Hussain, Sh. A., Sh. H. Abdulqadr and K.M.Mustafa, (2018). The response of high performance spring wheat (Triticum aestivum L.) yield and its components to wide range of sowing dates and plant densities. J.Zankoy Sulaimani (Special Issue-4-5th April),pp: 717-724

Stone, P.J., and M.E., Nicolas, (1995). Effect of timing of heat stress during grain filling on two wheat varieties differing in heat tolerance, Grain Growth. Aust. J. Pl. Physiol., 22(6), pp: 927-934.

Suleiman, A.A., J.F., Nganya and M.A., Ashraf, (2014). Effect of cultivar and sowing date on growth and yield of wheat (Triticum aestivum L.) in Khartoum, Sudan. Journal of Forest Products & Industries, 3(4), pp: 198-203.

Tahir, M., A., Ali, M.A., Nadeem, A., Hussain, and F., Khalif, (2009). Effect of different sowing dates on growth and yield of wheat (Triticum aestivum L.) varieties in district Jhang Pakistan. Pak. J. Life Soc. Sci., 7(1), pp: 66-69.

Tollenaar, M. and A. Auguilera. (1992). Ear and kernel formation in maize hybrids representing three decades of yield improvement. Crop Sci. 32:432-438.

UOG, (2018). 2017-2018 Wheat Production Guide. The University of Gorgia, College of Agricultural and Environmental Sciences, Cooperative Extension Service.

Varga, B., Z., Svecnjak, and A., Pospisil, (2000). Grain yield and yield components of winter wheat grown in two management systems. Die Bodenkultur, 51(3): pp.145-150.

Zaheer, A., N.S., Kisana, M.Y., Mujaih, A., Iftkhar, S.Z., Mustafa and A., Majid, (2000). Effect of population density on yield and yield components of wheat. Pakistan Journal of Biological Science, 3(9): pp.1389-1390.

تاثير الكثافة النباتية والا صناف على حاصل الحنطة ومكوناته لحنطة الخبز *Triticum aestivum L.* تحت ظروف المطرية في كردستان العراق

ريزين غريب نورى　　　شه نك حسيب عبدالقادر　　　شوانه احمد حسين

قسم التقنيات الحياتية وعلوم المحاصيل كلية علوم الهندسة الزراعية، جامعة السليمانية

الخلاصة

الكلمات المفتاحية: أصناف الحنطة ، مسافات بين الخطوط ، كميات بذار,الحاصل ومكوناتها.

تم تنفيذ البحث في حقول كلية علوم الهندسة الزراعية - جامعة السليمانية في بكرجو – السليمانية- عراق، خلال موسم النمو 2016-2017 لتقييم تأثير ثلاثة مسافات بين الخطوط (10، 15 و20) سم وثلاث كميات بذار (160، 200 و240) كجم/هـ لصنفين من حنطة الخبز (أدنة 99 و آراس) وتأثير تداخلها على حاصل الحبوب ومكوناته. تم إجراء التحليل الإحصائي لكل صفة من خلال تجربة عاملية طبقت بإستخدام تصميم القطاعات العشوائية الكاملة CRBD وبثلاثة مكررات. تم أجراء المقارنات بين المتوسطات باستخدام إختبار أقل فرق معنوي L.S.D عند مستوى المعنوية 5٪. تم قياس ارتفاع النبات، عدد السنابل/م2، طول السنبلة، وزن السنبلة، عدد السنيبلات/السنبلة، عدد الحبوب/السنبلة، وزن الحبوب/السنبلة، وزن 1000 حبة، دليل الحصاد، الحاصل البيولوجي، وحاصل الحبوب. أظهرت النتائج أن المسافات بين الخطوط لها تأثير معنوي على الصفات المدروسة، حيث أعطت 10 سم أعلى القيم لجميع الصفات باستثناء عدد السنابل/م2 وطول السنبلة ودليل الحصاد والتي تم الحصول عليها عند إستخدام 15 سم كمسافة بين الخطوط. كان تأثير الأصناف معنويا على معظم الصفات باستثناء عدد السنابل/م2، وطول السنبلة، والحاصل البيولوجي. أعطى الصنف Adana-99 أعلى القيم لجميع الصفات المدروسة، باستثناء طول السنبلة عند إستخدام كمية بذار 200 كجم/هـ، كان كمية البذار تأثير كبيرعلى الصفات المدروسة حيث أعطى إستخدام 160 كجم/هـ أعلى القيم لاغلب الصفات، كذلك 240 كجم/هـ أعطت أعلى القيم لعدد السنابل/م2 والحاصل البيولوجي. بموجب النتائج المستحصلة، يجب أن يزرع الصنف ادنة-99 بمعدل بذار 160 كجم /هـ و بمسافة 10 سم بين الخطوط في بكرجو بمنطقة السليمانية تحت ظروف مضمونة الأمطار.