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RESEARCH PAPER

SEEDING RATES OF TWO VARIETIES OF (T. aestivum L.) INFLUENCED BY PREVIOUS CROP

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A B S T R A C T:

This study was targeted to consider the influence of previous crops and different seeding rates on yield and components of bread wheat. A factorial experiment within a randomized complete block design, with three replicates, including three seeding rates (30, 35, and 40 kg.don^{-1}), and three kinds of arable land (Legume field, Vegetable field, and Wheat field) at two locations (Grdarasha research station and Gueer) for winter growing season 2021-2022. The results revealed that the varieties and the arable lands affected the wheat yield traits. The legume field recorded a maximum of 1000 grain weight (40.05g). The vegetable field recorded the highest value in spike length and number of grains. spike^{-1} (9.78 cm, 49.43) respectively, also wheat field recorded the maximum number of spike.m^{-2} (595.17) in the Grdarash location. While, the results of the Gueer location showed that the wheat field scored the highest value of the number of spikes.m^{-2}, grain yield (357.00, 4955.6). inside the bracket Hawler 4 variety recorded the maximum spike length, 1000 grain weight (9.75 cm, 38.80g) , but Hawler 2 alone recorded the maximum value on the number of grains.spikes^{-1} (48.26) separately at Grdarash location, despite of this before location Hawler 4 variety recorded the highest in the number of spikes.m^{-2}, spike length, and grain yield (353.85, 9.94 cm, 4829.6 kg.ha^{-1}) respectively. In general, the seeding rate 40 kg.don^{-1} recorded the maximum number of spikes.m^{-2} (534.06, 378.67) at the Grgarasha and Gueer location.

KEY WORDS: Bread wheat,Wheat yield, Seeding rate, Previous crop, Different arable land
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1. INTRODUCTION

The world today faces enormous challenges as a result of the increased demand for wheat crops as a result of the world's population growth, because the world population is expected to exceed 9 billion people by 2050, demand for this crop will increase by 50 % (Guilpart *et al*. 2017 and Vera *et al*. 2017). Millions of people in developing countries were lifted out of poverty and hunger as a result of the Green Revolution. However, it came at a price, including a dependency on pesticides and synthetic fertilizers (FAO,2021). Cereals, particularly wheat, have traditionally been among the most significant crops farmed worldwide. This is evident in the percentage of total cultivated land occupied by this crop, total grain output, and involvement in global commerce. The farmed area fluctuates in response to market pricing and local agriculture regulations (FAOSTAT, 2020).

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Aside from that, wheat was cultivated on 216 million ha across the world in the 2020 production, with an average grain yield of 3.55 t.ha^{-1} and a total production of 766 milion tons (FAOSTAT, 2021). So, Iraq's agricultural area is expected to be around 1.583 million hectares, with an entire production of 4.343 million Mg.ha^{-1} and a total yield of 2.744 Mg ha^{-1}(Ministry of Planning Central Statistical Organization Agricultural, 2020). Beside that, kurdistan region of wheat cultivated area is projected to be about 4520853 million hectares, through total yield production of 1925277 ton.hactares (Ministry of Agricultural, 2021).

Despite its significance and rising production, the yield of bread wheat and its quality are influenced by a variety of environmental stresses, among the key ones are poor and/or excess mineral nutrition, schedule of irrigation, or rainfall (Jonczuk and Stalenga, 2016). Grain yield is determined by the interaction of genetic and environmental variables such as soil type, time and method of sowing, seeding rate, time of irrigation, and fertilizer application. Amongst these characteristics, seeding rates and row spacing are critical for increasing grain yield (Nwry *et al*., 2021). The seeding rate is one of the most critical agronomic practices that must be arranged for optimal crop production. High seeding rate increases crop competition for essential resources such as nutrients, space, water and light, resulting in low yield and quality (Abboye *et al.*, 2020). Crop rotation is essential for maximizing crop productivity, while perhaps mitigating environmental risks associated with overapplication. Diverse crop rotations maximize the utilization of remaining soil nutrients and water, reducing the production inputs. Wheat grain yield increased by 26 % and 18 %, respectively as compared with continuous wheat. Also, several cropping techniques have been developed to address these issues. A cereal-summer fallow rotation, for example, is utilized to reduce the risk of crop failure owing to moisture shortages (Sun *et al.* 2013). Constant cropping is used for building organic matter in soil and sequestering more carbon in the soil (Bailey *et al.* 2001). Crop rotations include specialty crops to diversify typical monoculture planting (Gan *et al.* 2015). The objective of this study is to determine the effect of previous crops (legume field, vegetable field, and wheat field) on wheat yield and yield component, and study the extent to which seeding rates are affected by different arable land on wheat growth and yields in two locations.

2. MATERIALS AND METHODS

Two different soft wheat varieties (Hawler 2 and Hawler 4) have been chosen to be studied under three seeding rates (30, 35, and 40 Kg.don^{-1}). The seeds were planted in three different arable lands (Legume field, Vegetable field, and Wheat field). This study was conducted during the winter growing seasons 2021 - 2022 at two different locations, Grdarasha Research Station / College of Agricultural Engineering Sciences / Salahaddin University / Erbil (Latitude 36° 4' N and Longitude 44°2' E; 415 m above sea level, within annual rainfall (228.84 mm), and Gueer – Erbil Latitude 36 07 46 N, Longitude 43 42 38 E and altitude 409m above sea level, within the annual rainfall (230.1 mm). Before cultivating the land, representative soil samples of 2 kg weight were drawn from each experiment field at depth of (0-30 cm) also after harvesting (Table 1). All lands were ploughed with moldboard plough during November 2021 followed by a rotavator to crush clod.

The field of both locations was divided according to the experiment layout into three blocks, one meter apart, each block consists of 6 plots with a 50 cm distance, and each plot area is 4 m^{-2} (2m length × 2m width from 9 lines of 20 cm distance in between). The seeds were sown manually on 15-16 December 2021. Several traits were recorded during the growth to the maturity-harvest stage. For each plot 1 m^{2} area was selected to study the parameters number of spikes.m^{-2}. number of spike.m^{-2}, spike length (cm) (from neck up to the spike tip without awn), number of grains.spike^{-1} (total number of grains of ten spikes divided by 10), thousand-grain weight (g), and grain yield ton.ha^{-1} (harvest 1m^{2} then converted to kg /hectare), following the equation below:

Grain yield (kg.ha^{-1}) $= \frac{\text{grain yield kg}}{\text{area harvested}}$ x 10000 (Reddy, 2004).

The collected data were subjected to a factorial experiment within Randomized Complete Block Design (RCBD), with three replicates utilizing SAS version 9.1 (SAS Institute Inc., 2003). Subsequently, Duncan's Multiple Range Test was used for means comparison at a 0.05 level of significance.

3. Results

3.1. Effect of different arable lands, seeding rates, wheat varieties and their interactions on the number of spikes.m^{-2} at both locations:

As shown in (Table 3) the data revealed that the following system of different arable lands had a significant influence on the number of spikes which exhibited superiority by recording

(595.17) at the wheat field, while, in legume and vegetable field recorded the lowest number of spike.m^{-2} (461.22 and 443.17) respectively, in the grdarasha location. while a slight increase in the number of spikes was noticed between the means of varieties but this increase was not significant. According to the presented data, Hawler 2 variety has superiority over Hawler 4 in this trait. This superiority may be due to the high adaptability of the Hawler 2 variety for Erbil conditions.

Similarly, the difference between arable lands, and the mean of seeding rates was appeared significantly on number of spike.m,$^{-2}$ which shows the maximum number 534.06 at seeding rate 40 kg.don^{-1}, 491.44 spike.m^{-2} at 35 kg.don^{-1} and 474.06 spike.m^{-2} at 30 seeding rates. Despite of the interaction between the arable lands × varieties was appeared significantly, Hawler 2 and Hawler 4 recorded the highest value of spike.m^{-2} at wheat field (606.22, 584.11) respectively. while the lowest value recorded at vegetable field (418.89) spikes.m^{-2} for Hawler 4. But the interaction between seeding rates × varieties were not affected on the number of spikes significantly.

Whereas, the interaction between the arable lands × seeding rates appeared significantly where the wheat field in seeding rate 40 kg.don^{-1} recorded the maximum spike number (664.17) and vegetable field in seeding rate 30 kg.don^{-1} recorded the lowest spike number (415.83). So that, besides this context the interaction between the three-factor interaction (arable lands × varieties × seeding rates) had a significantly affected on the number of spikes. m^{-2}, Hawler 2 gave it the highest number of spikes (687.33) in wheat field when using high seeding rates 40 kg/don. while, Hawler 4 recorded the lowest spike number (397.33) in the vegetable field at low seeding rates of 30 kg/don.

Also, it is clear in table (4) mean of the different arable lands was appear significantly affected by the number of spikes.m^{-2} which is the highest value of spikes.m^{-2} (357.00) recorded in wheat fields (332.06) in the vegetable field and (327.61) in legume fields. Likewise, the differences between varieties were noted significantly affected on the number of spikes. Hawler 4 recorded the maximum number of spike.m^{-2} (353.85) while, Hawler 2 recorded the minimum spikes.m^{-2} (323.93). Moreover, the results indicated that the seeding rates appeared significantly too, the seeding rate affect positively on the number of spikes again at 40 kg.don^{-1} seeding rate recorded maximum spikes.m^{-2} (378.67).

Additionally, among the two-factor interaction between (arable lands × varieties) effects on the number of spikes.m^{-2} were appear significantly, and Hawler 4 recorded the highest number of spikes.m^{-2} (375.33) in the wheat field while, Hawler 2 recorded the lowest value 300.89 spikes.m^{-2} in legume the field, the interaction between the seeding rates × varieties also appeared significantly, where the Hawler 4 variety recorded the highest value (389.22) spike.m^{-2} at high seeding rates 40 kg.don^{-1}. On average, the interaction between the arable lands × seeding rates was significantly affected by the number of spikes.m^{-2}, the wheat field recorded the maximum value (390.17) at 40 kg.don^{-1} of seeding rates but the legume field recorded the minimum (285.50) at 30 kg.don^{-1} seeding rates. Besides these results, the interaction between arable lands × varieties ×seeding rates had affected this characteristic significantly, which Hawler 4 recorded the highest number of spike/m^{2} (406.67) in legume field at 40 kg.don^{-1} seeding rates, and Hawler 2 recorded the lowest spike number (254.33) in legume field at 30 kg.don^{-1} seeding rates in gueer location.

3.2. Effect of different arable lands, seeding rates, wheat varieties, and their interaction on spike length (cm) at both locations:

The data in (Table 5), revealed that the difference between arable lands was affected significantly by the spike length traits, the vegetable field recorded the maximum value (9.78 cm) and the wheat field recorded the minimum value (9.00 cm), similarly, different varieties were a significant influence on this trait, Hawler 4 noted the highest spike length (9.78 cm) and Hawler 2 noted (9.03 cm), but contrary the above mean of seeding rates had not appeared significantly. Otherwise, between the interaction of (arable lands × varieties), Hawler 4 recorded the maximum spike length at the vegetable field (10.25 cm), but Hawler 2 recorded the lowest value in the wheat field (8.67 cm). whereas, like the above context the interaction between (seeding rates × varieties) showed that the length of the spike had been affected significantly. Hawler 4 at seeding rates (30,35 and 40 kg.don^{-1}) reached the highest value (10.11, 9.90, and 9.35 cm) inside the bracket. So, same to these results the interaction between the (arable lands × seeding rates) was affected significantly on this trait, where a vegetable field recorded the highest at 30 kg.don^{-1} rates (10.03 cm). Despite before, the interaction among each (arable lands × varieties × seeding rates) was significant appear so, Hawler 4 noted the maximum spike length in the vegetable field at 30 kg.don^{-1} rates (10.61 cm), whilst the minimum value was recorded by Hawler 2 at 40 kg.don^{-1} in the wheat field (8.32 cm).

Table 6 shows that the mean of different arable lands was not affected on the spike's length trait significantly, but different of the two varieties of wheat had affected significantly, Hawler 4 recorded the highest spike length (9.94 cm) while, Hawler 2 recorded the lowest value (8.87 cm). The same as the mean of different arable lands the mean of seeding rates was not influence on this trait significantly. Additionally, the interaction between each arable lands × varieties was noted that a significant effect on the spike length. Hawler 4 recorded the maximum at all the arable lands (10.10 in legume fields, 9.94 in wheat fields, and 9.78 cm in vegetable fields). Whilst, Hawler 2 recorded the minimum in the vegetable field (8.58 cm). likewise, of this interaction above the interaction between seeding rates × varieties were influenced significantly. Hawler 4 again recorded the highest value (9.90,10.18 and 9.74 cm) respectively for 30,35 and 40 kg.don^{-1} of seeding rates, But Hawler 2 recorded the lowest spike length (8.76 cm in the vegetable field. the interaction between arable lands × seeding rates, unlike before that noted the spikes length trait was not impacted significantly. Otherwise, the interaction between three-factor (arable lands × varieties × seeding rate) had appear significantly affected by this trait, Hawler 4 recorded (10.43 cm) of spike length in the legume field when using 35 kg.don^{-1} as a seeding rate in the gueer location.

3.3. Effect of different arable lands, seeding rates, wheat varieties, and their interaction on Number of grains.spike^{-1} at both locations:

The analysis showed that the mean of different arable lands was significant in the number of grains table (7). The vegetable fields and legume fields recorded the highest number of grains.spike^{-1} (49.43, 48.36) respectively and 39.88 grains.spike^{-1} in the wheat field. Additionally, the mean of different varieties affected the number of grains.spike^{-1} significantly, Also, this result agrees with the results that showed in the table 5 and 6 (spike length). As the spike length increased, the number of grains increased, and the effect was identical between both tables (length and number). The mean of seeding rates there was a slight increase but this increase had not affected significantly. Among the two-factor interaction, the interaction between (arable lands × varieties) was affected significantly, Hawler 2 recorded the maximum grains.spike^{-1} in the vegetable field 51.06 and 50.93 grains.spike^{-1} in the legume field. Also, the interaction between (seeding rates × varieties) was affected significantly by the number of grains.spike^{-1} Hawler 2 noted the highest grains.spike^{-1} (49.09) at 40 kg.don^{-1}. The interaction between (arable lands × seeding rates) also had affected significantly, the lowest value of grains.spike^{-1} was recorded in a wheat field when using 30 kg.don^{-1} (39.37). while the highest number of grains recorded in the vegetable field at 40 kg.don^{-1} with (50.92). Furthermore, the interaction between three-factor for each (arable lands × varieties × seeding rates) was influenced by the number of grains significantly. Where Hawler 2 recorded the highest (53.67 grains.spike^{-1}) in the vegetable field at 40 kg.don^{-1}. Whilst Hawler 4 recorded the lowest (33.20 grains) in wheat fields at 40 kg.don^{-1}. As opposed the data of number of grains.spike^{-1} at Grdarash location it is clear in Table (8), at Gueer location that the number of grains.spike^{-1} of the two wheat varieties was not influenced statistically by each of different arable land, seeding rate and all of the interaction among them.

3.4. Effect of different arable lands, seeding rates, wheat varieties, and their interaction on 1000 grain weight (g) at both locations:

According to the data which showed in Table (9), the mean of different arable lands was a significant effect. The legume field gave the highest 1000 grain weight (40.05g) and the vegetable field recorded (38.97g), but the wheat field gave the lowest weight (32.43g).

Again, it was noticed that the variety had a significant effect on 1000 grain weight. Hawler 4 was superior it gave (38.80g) to that Hawler 2 (35.50 g). but unlike that the mean of seeding rates there was a slight difference but this difference was not significant. Among the two-factors interaction (arable lands × varieties) had significantly affected 1000 grain weight. where Hawler 4 gave the highest grain weight (41.67 g) in the legume and vegetable field while Hawler 2 recorded the lowest grain weight in the wheat field (31.25 g).
It was also affected by the interaction between the (seeding rates × varieties). Hawler 4 at seeding rates 30,35 $kg.don^{-1}$ recorded (39.63,39.46) respectively, it was higher than Hawler 2 gave the lowest value (34.75g) when using 30 $kg.don^{-1}$ seeding rates.

Additionally, the interaction between (Arable land × seeding rate) had a significant effect on 1000 grain weight. The highest weight was found in legume and vegetable fields at all seeding rates. while, wheat fields recorded less weight of 1000 grain for all seeding rates (30,35, and 40 $kg.don^{-1}$), (32.88, 34.08, and 30.33g) inside the bracket. these results are due to the difference in the kind of arable land. There is also a significant interaction between the three-factors (arable lands × varieties × seeding rates). Hawler 4 noted 42.38g in the legume field at 30 $kg.don^{-1}$ was the maximum and Hawler 2 in the wheat field at 40 $kg.don^{-1}$ recorded the minimum of 1000 grain weight (29.84g). Completely different from what was recorded in Grdarash location, at all the different arable lands, the mean of varieties and mean of seeding rates had not significantly affected 1000 grain weight. Also, the interaction between two-factor and three-factor interaction was not statistically influenced significantly (Table 10).

3.5. Effect of different arable lands, seeding rates, wheat varieties, and their interaction on Grain yield $kg.ha^{-1}$ at both locations:

Table (11) represent the grain yield of wheat at different arable land, we notice that the legume field gave the highest grain yield (6269.4 $kg.ha^{-1}$), after that (6088.9 $kg.ha^{-1}$) in the vegetable field and the lowest grain yield obtained in a wheat field (5038.9 $kg.ha^{-1}$). This reason due to the availability of macronutrients in this location especially N content led to an increase in wheat grain yield in the legume field. Unlike that, the mean of different wheat varieties and different seeding rates was not affected significantly on grain yield ($kg.ha^{-1}$). Generally, the interaction between two-factors of (arable lands × varieties) was significant. Hawler 4 and Hawler 2 recorded the highest grain yield in the legume field and vegetable field. While the lowest grain yield was obtained in the wheat field for both varieties Hawler 4 and Hawler 2 (5266.7, 4811.1 $kg.ha^{-1}$) inside the bracket.

So, these two varieties were equal in the grain yield in the vegetable field beside that Hawler 2 noted the highest in the legume field (6155.6 $kg.ha^{-1}$) and lowest in the wheat field (5266.7 $kg.ha^{-1}$). Despite the interaction between the (seeding rates × varieties), there was a non-significant difference between them. Although the interaction between (arable lands × seeding rates) had affected the total yield significantly. As shown the legume field recorded the highest value (6716.7 $kg.ha^{-1}$) at a seeding rate of 40 $kg.don^{-1}$. The interaction between each (arable lands × varieties × seeding rates) our results indicated that there was a significant impact on this trait, Hawler 2 in the legume field at 40 $kg.don^{-1}$ seeding rates recorded the highest value (6783.3 $kg.ha^{-1}$) while, Hawler 4 in wheat field at 40 $kg.don^{-1}$ of seeding rate recorded the lowest grain yield (4233.3 $kg.ha^{-1}$). this variance in the field by presenting and retaining fertilizer content which is analyzed before sowing. As for the Gueer location, the results were recorded in Table (12), explaining that mean of different arable lands influenced grain yield significantly, wheat field recorded the highest value of 4955.6 $kg.ha^{-1}$, and 4313.9 $kg.ha^{-1}$ in vegetable field and 4202.8 $kg.ha^{-1}$ in legume field.

The mean between the two wheat varieties appeared significantly, Hawler 4 recorded 4829.6 $kg.ha^{-1}$ it was highest than Hawler 2 that's gave 4151.9 $kg.ha^{-1}$. unlike the above, the mean of seeding rates had a slight increase but statistically not reached significance. While the interaction between (arable lands × varieties) appeared significantly, Hawler 4 gave the maximum yield in the wheat field of 5344.4 $kg.ha^{-1}$, while Hawler 2 in the legume field gave the lowest value of 3650.0 $kg.ha^{-1}$. Additionally, the interaction between (seeding rates × varieties), Hawler 4 recorded the highest yield of 5027.8 $kg.ha^{-1}$ at 40 $kg.don^{-1}$ of seeding rates. while Hawler 2 recorded the lowest value 3850.0 $kg.ha^{-1}$ at 30 $kg.don^{-1}$ of seeding rates. But also, opposite that before, the interaction between (arable lands × seeding rates) were not affected on it significantly, although had a clear increase in the wheat field for all seeding rates. While the interaction between (arable lands × varieties × seeding rates) was significant. So, Hawler 4 noted the maximum grain yield of 5483.3 kg.ha^{-1} in the legume field at 40 kg.don^{-1} of seeding rates, while Hawler 2 noted the minimum grain yield of 3300.0 kg.ha^{-1} in the legume field at 35 kg.don^{-1} of seeding rates in the gueer location.

4. Discussion

As reported in the results of the tables we noted that the number of spikes varied according to the previous crop planted. Cultivation of wheat after wheat led to an increase in the number of spikes by 29% compared to the previously planted with legumes and vegetables.We also note a direct relationship between the number of spikes and seeding rates, where increasing the seeding rate to 40 kg.don led to an increase in the number of spikes.m^{-2}. As well as for the interaction between arable land and seeding rates. When comparing the two locations, the same effect was observed, but in the Gueer location, there were significant differences between varieties, Hawler 4 superior over Hawler 2. These results are in agreement with Jadoua and Haider (2012) who found that the capacity of genotypes to generate spikes varies, and this attribute is influenced by a variety of variables, including genetic factors and environmental conditions. Al-Hiti and Al- Ubaidi (2021); Mutlu (2022) noted that high seeding rates performed better by having the largest average number of spikes, whereas low density had the least spikes. El-Hawary *et al.* (2019); Al-Mashhadani (2020); Al-Hamdani (2020) showed that increasing the seeding rate resulted in an increase in the number of spikes per unit area. Al-Hiti and Al- Ubaidi (2021); Al-Najjar (2020); Cheyed *et al*. (2020) indicated that there are considerable variances in the number of spikes between the genotypes. plant^{-1}. Yang *et al*. (2019); Zhao *et al.* (2020); Wang *et el.* (2021) they found that increases in seeding pace might control tiller numbers and improve the number of better tillers, resulting in higher yields. Otteson (2008) who reported that individual genotypes of wheat responded differently to spike length for various kinds.

Khan *et al*. (2001) described that in terms of spike length, several types have diverse genetic potential. Unlike this result with Hadi *et al*. (2020); Darwesh (2007); Kahrariyan *et al*. (2013) showed that the length of the spike of two species of wheat was not affected. Hadi *et al*. (2020) described that significant variances in the quantity of wheat grains plant^{-1} occurred owing to wheat variety differences, Hawler 2 cultivar produced 1.14 times more wheat grains. spike^{-1} against Hawler 4 variety. Al-Fahdawi (2021) indicated that in terms of grain number per spike, there were considerable variances across genotypes. While, Al-Hiti and Al-Ubaidi (2021) showed that a substantial impact on grain.spike^{-1} the greatest average of grains per spike increase in the (Babel-32) genotype with plant density (160 kg. ha^{-1}) was 41.89 grains.spike^{-1}. Gaweda and Haliniarz (2021) explained that after cultivation of soybean crop 1000 grain wheat were greatest. Wang et al. (2021) reported that with increasing seeding rate 1000 grain weight reduced.

Al-Hiti and Al-Ubaidi (2021) they found that the increase in plant density per unit area leads to increased competition among crop plants for growth requirements, and thus lower efficiency of the process of photosynthesis and dry manufactured materials that are transferred to the sinks (grains), and these manufactured materials will be distributed over a greater number of spikes as a result of the high rate of seeding, and the weight of the grain decreases. Anderson (2008); Babulicová (2016) found that wheat production considerably when fore-crops were pulses or a pulse-cereal blend compared to fore-crop wheat, and it was established that greater wheat yield was obtained when fore-crop was field pea compared to barley. Sieling and Christen (2015) they found that larger grain yield following a prior pea crop than after a winter wheat crop. Angus *et al*. (2015) found that the wheat yield increases after legume crops as compared to cultivating wheat before legume crops.

Al-Hiti and Al-Ubaidi (2021) result also indicated that the favorable effect of increasing plant density on grain production was demonstrated by the seeding rate (180 kg.ha^{-1}) outperforming and recording the greatest average of 8.898 Mg.ha^{-1}, while the low density (140 kg.ha^{-1}) recorded the lowest average (7.343 Mg.ha^{-1}). The explanation for the improvement in yield with increased seeding rate might be related to an increase in the number of spikes per unit area, which was reflected favorably in the rise in grain production. Agenbag (2012) who obtained that wheat yields are better when produced in a crop rotation system with a monoculture one. In addition, grain yield improved as seeding rates increased from 80 to 140 $kg.ha^{-1}$, with the maximum grain yield reported (4.95 and 4.99 $t.ha^{-1}$) (Intsar *et al.*, 2019). The pulse-intensified rotation improved rotational benefits, but only on a local scale, with the majority of the advantages happening in a wheat crop planted shortly after a pulse crop. The remainder of the wheat yield rise after a pulse or wheat crop cultivated in a pulse-intensified rotation was inexplicable (Niu *et at.*, 2017). Al-Hiti and Al-Ubaidi (2021); Al-Hamdani and Al-Jubouri (2020); Al-Dhahi and Taweel (2021) they indicated that genotypes significantly affected the grain yield.

Table (1): Some physicochemical properties of the experiment of the soil at both location before sowing and after harvesting.

Arable lands	EC Ds/m	pH	N %	P PPM	K PPM	O.M %	Soil texture
Soil of Grdarash location / before sowing							
Legume field	0.4	7.96	0.18	15	192	1.18	Silty clay L
Vegetable field	1.1	7.67	0.05	30.5	200	1.22	Silty L
Wheat field	0.3	7.85	0.08	15.5	142	1.48	Silty L
Soil of Gueer location / before sowing							
Legume field	1.6	7.69	0.3	13.5	136	1.54	Silty clay L
Vegetable field	0.8	7.79	0.09	19	176	1.1	Silty clay L
Wheat field	0.7	7.92	0.21	22.5	260	1.35	Silty L
Soil of Grdarash location / after harvesting							
Legume field	0.50	7.6	0.023	10.01	8	1.47	clay Loam
Vegetable field	0.40	7.7	0.039	10.27	10	1.33	Clay Loam
Wheat field	0.60	7.3	0.015	8.43	9	1.41	clay
Soil of Gueer location / after harvesting							
Legume field	0.70	7.6	0.031	8.69	11	1.03	clay Loam
Vegetable field	0.40	7.6	0.015	10.54	15	1.59	Loam
Wheat field	0.70	7.9	0.041	12.12	14	1.93	clay Loam

Table 2. Meteorological data for both location Grdarash and Gueer for growing season 2021-2022.

Month	Max. TC	Min. TC	Avg. of Temperature	Avg. RH %	Avg. of rainfall mm
	Grdarash Location				
11/2021	29.54	8.14	18.84	56.55	6.60
12/2021	24.22	0.68	12.45	59.45	74.42
1/2022	17.02	3.16	10.09	67.27	56.13
2/2022	23.73	2.56	13.14	52.47	30.22
3/2022	25.84	0.21	13.02	50.25	14.48
4/2022	34.24	6.6	20.42	30.16	31.75
5/2022	40.13	11.50	25.81	30.56	15.24
	Gueer Location				
11/2021	24.3	9.6	16.95	46	3.7
12/2021	16	4.5	10.25	69	101.2
1/2022	12.1	2.9	7.5	71	43.0
2/2022	18.2	5.7	11.95	56	27.4
3/2022	17.3	5.7	11.5	52	14.1
4/2022	28.6	12.9	20.75	43	22.9
5/2022	31.7	16.8	24.25	38	17.8
11/2021	24.3	9.6	16.95	46	3.7

*Data source: Meteorological Directory- Erbil province.

Table 3. Effect of different arable lands, seeding rates, wheat varieties and their interaction on number of spikes m^{-2} at Grdarash location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	452.11 b	474.89 a	452.00 c	416.67 ef	461.22 b
		35				469.33 c-f	
		40			440.33 c	470.33 c-f	443.17 b
	Hawler 4	30	470.33 b	473.22 a		487.33 c-f	
		35			491.33 bc	411.33 ef	595.17 a
		40				512.33 cf	
Vegetable field	Hawler 2	30	467.44 b	512.56 a	415.83 c	434.33 def	Mean of varieties
		35				510.67 c-f	508.59 a
		40			467.00 c	457.33 cf	
	Hawler 4	30	418.89 b	470.33 a		397.33 f	491.11 a
		35			446.67 c	423.33 ef	
		40				436.00 def	Mean of seeding rates
Wheat field	Hawler 2	30	606.22 a	538.33 a	554.33 b	573.67 abc	474.06 b
		35				557.67 bcd	
		40			567.00 b	687.33 a	491.44 ab
	Hawler 4	30	584.11 a	529.78 a		535.00 b-e	
		35			664.17 a	576.33 abc	534.06 a
		40				641.00 ab	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 4. Effect of different arable lands, seeding rates, wheat varieties and their interaction on number of spikes m^{-2} at Gueer location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	300.89 c	289.22 d	285.50 d	254.33 d	327.61 b
		35				277.00 cd	
		40			308.33 bcd	371.33 ab	332.06 ab
	Hawler 4	30	354.33 ab	323.56 cd		316.67 bcd	
		35			389.00 a	339.67 abc	357.00 a
		40				406.67 a	
Vegetable field	Hawler 2	30	332.22 ab	314.44 cd	304.67 cd	303.67 bcd	Mean of varieties
		35				335.33 abc	323.93 b
		40			334.67 bcd	357.67 ab	
	Hawler 4	30	331.89 bc	348.78 bc		305.67 bcd	353.85 a
		35			356.83 ab	334.00 abc	
		40				356.00 ab	Mean of seeding rates
Wheat field	Hawler 2	30	338.67 abc	368.11 ab	329.00 bcd	309.67 bcd	306.39 b
		35				331.00 abc	
		40			351.83 abc	375.33 ab	331.61 b
	Hawler 4	30	375.33 a	389.22 a		384.33 abc	
		35			390.17 a	372.67 ab	378.67 a
		40				405.00 a	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 5. Effect of different arable lands, seeding rates, wheat varieties and their interaction on spike length (cm) at Grdarash location.

Arable lands	Varieties	Seeding rate kg.don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	9.12 bc	8.98 b	9.68 ab	9.02 bcd	9.44 ab
		35				9.11 a-d	
		40			9.38 abc	9.22 a-d	9.78 a
	Hawler 4	30	9.77 ab	10.11 a		10.35 ab	
		35			9.27 abc	9.64 a-d	9.00 b
		40				9.32 a-d	
Vegetable field	Hawler 2	30	9.31 bc	9.05 b	10.03 a	9.44 a-d	Mean of varieties
		35				8.84 bcd	9.03 b
		40			9.53 abc	9.66 a-d	
	Hawler 4	30	10.25 a	9.90 a		10.61 a	9.75 a
		35			9.79 ab	10.22 ab	
		40				9.92 abc	Mean of seeding rates
Wheat field	Hawler 2	30	8.67 c	9.07 b	8.93 bc	8.49 cd	9.55 a
		35				9.19 a-d	
		40			9.52 abc	8.32 d	9.48 a
	Hawler 4	30	9.34 bc	9.35 ab		9.37 a-d	
		35			8.56 c	9.84 a-d	9.21 a
		40				8.80 bcd	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 6. Effect of different arable lands, seeding rates, wheat varieties and their interaction on spike length (cm) at Gueer location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	8.92 bc	9.01 b	9.53 a	9.02 c-f	9.51 a
		35				8.73 def	
		40			9.58 a	9.03 b-f	9.18 a
	Hawler 4	30	10.10 a	9.90 a		10.05 a	
		35			9.43 a	10.43 a	9.53 a
		40				9.82 abc	
Vegetable field	Hawler 2	30	8.58 c	8.76 b	9.11 a	8.59 ef	Mean of varieties
		35				8.15 f	8.87 b
		40			9.18 a	9.01 c-f	
	Hawler 4	30	9.78 a	10.18 a		9.63 a-d	9.94 a
		35			9.25 a	10.22 a	
		40				9.49 a-e	Mean of seeding rates
Wheat field	Hawler 2	30	9.11 b	8.85 b	9.72 a	9.42 a-e	9.45 a
		35				9.41 a-e	
		40			9.66 a	8.51 ef	9.47 a
	Hawler 4	30	9.94 a	9.73 a		10.03 ab	
		35			9.20 a	9.90 abc	9.29 a
		40				9.89 ab	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 7 . Effect of different arable lands, seeding rates, wheat varieties and their interaction on number of grains spike^{-1} at Grdarash location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	50.93 a	47.72 ab	47.52 ab	49.53 abc	48.36 a
		35				50.80 ab	
		40			47.80 ab	52.47 a	49.43 a
	Hawler 4	30	45.79 ab	44.43 ab		45.50 a-d	
		35			49.77 ab	44.80 a-d	39.88 b
		40				47.07 a-d	
Vegetable field	Hawler 2	30	51.06 a	47.96 ab	51.35 a	52.60 a	Mean of varieties
		35				46.90 a-d	48.26 a
		40			46.02 ab	53.67 a	
	Hawler 4	30	47.80 ab	43.33 b		50.10 abc	43.53 b
		35			50.92 a	45.13 a-d	
		40				48.17 a-d	Mean of seeding rates
Wheat field	Hawler 2	30	42.78 b	49.09 a	39.37 c	41.03 b-d	46.08 a
		35				46.17 a-d	
		40			43.12 bc	41.13 b-d	45.64 a
	Hawler 4	30	36.99 c	42.81 b		37.70 ed	
		35			37.17 c	40.07 cde	45.95 a
		40				33.20 e	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 8. Effect of different arable lands, seeding rates, wheat varieties and their interaction on number of grains spike^{-1} at Gueer location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	51.58 a	53.90 a	53.43 a	53.87 a	52.36 a
		35				49.23 a	
		40			52.15 a	51.63 a	51.54 a
	Hawler 4	30	53.14 a	52.02 a		53.00 a	
		35			51.50 a	55.07 a	53.23 a
		40				51.37 a	
Vegetable field	Hawler 2	30	52.23 a	51.98 a	49.98 a	50.80 a	Mean of varieties
		35				50.13 a	52.85 a
		40			52.27 a	55.77 a	
	Hawler 4	30	50.84 a	54.04 a		49.17 a	51.90 a
		35			52.37 a	54.40 a	
		40				48.97 a	Mean of seeding rates
Wheat field	Hawler 2	30	54.74 a	52.68 a	55.47 a	57.03 a	52.96 a
		35				56.57 a	
		40			54.62 a	50.63 a	53.01 a
	Hawler 4	30	51.72 a	49.64 a		53.90 a	
		35			49.62 a	52.67 a	51.16 a
		40				48.60 a	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 9. Effect of different arable lands, seeding rates, wheat varieties and their interaction on weight of 1000 grain at Grdarash location.

Arable lands	Varieties	Seeding rate $kg.don^{-1}$	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	38.43 ab	34.75 b	39.35 a	36.31 a-e	40.05 a
		35				38.27 abc	
		40			40.14 a	40.70 ab	38.97 a
	Hawler 4	30	41.67 a	39.63 a		42.38 a	
		35			40.66 a	42.02 ab	32.43 b
		40				40.62 abc	
Vegetable field	Hawler 2	30	36.81 bc	36.01 ab	39.34 a	37.45 a-d	Mean of varieties
		35				36.33 a-e	35.50 b
		40			38.98 a	36.65 a-e	
	Hawler 4	30	41.13 a	39.46 a		41.23 ab	38.80 a
		35			38.58 a	41.64 ab	
		40				40.51 abc	Mean of seeding rates
Wheat field	Hawler 2	30	31.25 d	35.73 ab	32.88 b	30.47 ed	37.19 a
		35				33.43 cde	
		40			34.08 b	29.84 e	37.73 a
	Hawler 4	30	33.61 cd	37.32 ab		35.28 a-e	
		35			30.33 b	34.72 b-e	36.52 a
		40				30.82 ed	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 10. Effect of different arable lands, seeding rates, wheat varieties and their interaction on weight of 1000 grain at Gueer location.

Arable lands	Varieties	Seeding rate $kg.don^{-1}$	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	41.60 a	41.48 a	42.99 a	43.45 a	41.91 a
		35				38.92 a	
		40			40.20 a	42.43 a	41.11. a
	Hawler 4	30	42.23 a	42.06 a		42.54 a	
		35			42.55 a	41.47 a	41.85 a
		40				42.67 a	
Vegetable field	Hawler 2	30	40.24 a	40.90 a	40.77 a	39.55 a	Mean of varieties
		35				41.35 a	40.10 a
		40			41.22 a	39.82 a	
	Hawler 4	30	41.98 a	42.10 a		41.99 a	42.25 a
		35			41.34 a	41.09 a	
		40				42.67 a	Mean of seeding rates
Wheat field	Hawler 2	30	41.15 a	40.60 a	41.54 a	41.45 a	41.77 a
		35				42.43 a	
		40			43.07 a	39.57 a	41.50 a
	Hawler 4	30	42.54 a	42.60 a		41.64 a	
		35			40.92 a	43.72 a	41.60 a
		40				42.27 a	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 11. Effect of different arable lands, seeding rates, wheat varieties and their interaction on grain yield kg ha^{-1} at Grdarash location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	6155.6 a	5677.8 a	5683.3 abc	5483.3 ab	6269.4 a
		35				6200.0 ab	
		40			6408.3 ab	6783.3 a	6088.9 a
	Hawler 4	30	6383.3 a	5677.8 a		5883.3 ab	
		35			6716.7 a	6616.7 a	5038.9 b
		40				6650.0 a	
Vegetable field	Hawler 2	30	6088.9 a	5833.3 a	6283.3 ab	6433.3 a	Mean of varieties
		35				5750.0 ab	5837.0 a
		40			5950.0 abc	6083.3 ab	
	Hawler 4	30	6088.9 a	5983.3 a		6133.3 ab	5761.1 a
		35			6033.3 abc	6150.0 ab	
		40				5983.3 ab	Mean of seeding rates
Wheat field	Hawler 2	30	5266.7 ab	6000.0 a	5066.7 bc	5116.7 ab	5677.8 a
		35				5550.0 ab	
		40			5366.7 abc	5133.3 ab	5908.3 a
	Hawler 4	30	4811.1 b	5622.2 a		5016.7 ab	
		35			4683.3 c	5183.3 ab	5811.1 a
		40				4233.3 b	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Table 12. Effect of different arable lands, seeding rates, wheat varieties and their interaction on grain yield kg ha^{-1} at Gueer location.

Arable lands	Varieties	Seeding rate kg don^{-1}	A×V	S×V	A×S	A×V ×S	Mean of Arable lands
Legume field	Hawler 2	30	3650.0 c	3850.0 b	3816.7 a	3316.7 b	4202.8 b
		35				3300.0 b	
		40			3883.3 a	4333.3 ab	4313.9 ab
	Hawler 4	30	4755.6 ab	4572.2 ab		4316.7 ab	
		35			4908.3 a	4466.7 ab	4955.6 a
		40				5483.3 a	
Vegetable field	Hawler 2	30	4238.9 c	3927.8 b	4091.7 a	4016.7 ab	Mean of varieties
		35				3783.3 ab	4151.9 b
		40			4258.3 a	4916.7 ab	
	Hawler 4	30	4388.9 abc	4888.9 ab		4166.7 ab	4829.6 a
		35			4591.7 a	4733.3 ab	
		40				4266.7 ab	Mean of seeding rates
Wheat field	Hawler 2	30	4566.7 abc	4677.8 ab	4725.0 a	4216.7 ab	4211.1 a
		35				4700.0 ab	
		40			5083.3 a	4783.3 ab	4408.3 a
	Hawler 4	30	5344.4 a	5027.8 a		5233.3 ab	
		35			5058.3 a	5466.7 a	4852.8 a
		40				53.333 ab	

*Note: Within the individual factor and their interaction, the values that share the same alphabet do not differ significantly according to the DMRT, 1955 at α 5%. A= Arable lands, V = varieties, S= Seeding rate.

Conclusion

The exciting results in this research fact to the importance of selecting the previous crops in a crop rotation system, which has positive impact on the wheat yield and components. The difference between the genotypes in both locations causes the genetic nature variance and to responed the conditions, Hawler 4 variety surpassed on Hawler 2 variety in all the studied traits. But the plant density slightly affects the wheat components traties.

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