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Yield performance of four wheat cultivars under semi-arid conditions

Mahir Essa Jumaa[1]
mahir.essa.j@spu.edu.iq

Halgurd Nasraden Hassan [2]
halgoord.hassan@spu.edu.iq

Masood saber Mohammed [3]
masood.mohammed@spu.edu.iq

Yadgar Ali Mahmood [4]
yadgar.mahmood@garmian.edu.krd

[1,2,3]Department of Agricultural project, Kalar Technical College, Garmian Polytechnic University, Sulaymaniayah, IRAQ.
[4] Department of Animal Production, College of Agricultural Engineering Sciences, University of Garmian, Sulaymaniayah, IRAQ.

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Abstract

The research was conducted at Kalar Technical College – Garmian Polytechnic University in Garmian region during the growing season 2023, using randomized complete block design (RCBD) with six replications, to evaluate yield performance of four wheat cultivars i.e, (Al-Rashi, Adana99, Wafia, and Deng) under semi-arid conditions. Analysis of variance showed a significant difference between genotypes for all traits measured in this experiment ($P<0.05$). . For grain yield and number of spikes per m2, there was no significant difference between Deng, Wafla and Adana 99 (max. 343.3 for Adana99), but they had significantly higher values than Al-Rashid ($P<0.05$), while in spike length Al-Rashid had the longest spike (13.53 cm; $P<0.05$). Adana 99 had significantly the highest number of seeds per spike (48.36; $P<0.05$). For the weight of 1000 seeds, Deng, Wafia and adana 99 (max. 45.04 gm for Deng) were also able to have significantly higher weights than the local wheat cultivar Al Rashid which displayed a comparatively lower average weight for this particular characteristic, which was (37.44 g). The research recommends that Adana wheat cultivar has superior performance compared to other cultivars, making it well-suited to be cultivated in Garmian area.

Key words: wheat, cultivar, semi-arid area, yield, components
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Correspondence Author: Mahir Essa Jumaa mahir.essa.j@spu.edu.iq

Introduction

Winter wheat (*Triticum aestivum* L.) is one of the most crucial agricultural products in the world [1] .It contributes 30% of the world's grain and 45% of cereal goods, making it a key food crop [2]. A total of 4.3 million tons of wheat grain were produced in Iraq on 1.5 million hectares of cultivated land in 2019 (average on-farm yield: 2.87 t. ha^{-1}) [3]. In order to feed the estimated 10 billion people that will exist over the next 40 to 50 years[4,5,6,7 and 8], the world wheat demand must be increased by almost 60% over the current rate of 1.7% each year[9,10 and 11]. Therefore, one of the major problems over the next 30 years, in addition to the anticipated climate change, is generating increased yield potential for wheat varieties under abiotic stress conditions[12,13 and 14]. The climatic factors substantially impact crop yield production and is widely regarded as the primary cause of yield production challenges[15,16 and 17]. Around 50% of the wheat-growing land in developing nations is rain-fed, meaning it receives less than 600 mm of precipitation annually on average [18].

This water stress impacts around 99 million hectares of wheat-growing land and can lower grain yields on Average by 17–70% [19]. High warmth, irradiance, and water stress brought on by little rainfall during the most crucial growth phases of grain filling and grain formation periods are the abiotic elements in the Mediterranean region that have the greatest impact on wheat yield potential [20,21]. Under these conditions, heat stress during the grain-filling stage, uneven rainfall distribution (usually occurring in the autumn and spring), and insufficient annual rainfall (less than 1000 mm) can all significantly lower crop yield performance [22]. According to estimates, wheat production is rising by 0.5% a year, falling short of the world's demand for grain by more than two-thirds [23]. In order to significantly increase grain production per area, new wheat varieties must be created [24].

To ensure food security preservation, wheat breeding's key objectives are enhancing grain yield and establishing stability in grain production within semi-arid regions. This is achieved by developing innovative and adaptive cultivars that exhibit high throughput [25]. This research aimed to identify those cultivars that exhibit better characteristics than the local control in the semi-arid of Garmian area. The traits primarily include grain yield production and associated attributes using a set of facultative and winter wheat observation trails (16th FAWWON-IR), together with the finest local check.

Materials and methods

Weather conditions and site study

This experiment was conducted at Kalar Technical College in Garmian, a region in northern Iraq which is located at latitude 34.623239° and longitude 45.319353°, with an elevation of 216 meters above sea level during 2023 growing season at the date of sowing 15/11/2022 under rain-fed circumstances. The area is described as a hyper thermic temperature regime and semi-arid climatic conditions. Table 1 displays the comprehensive annual measurements of precipitation, temperature, and humidity for each season starting from winter 2023.

Table 1: Metrological data of the study area within the period of 2020-2023 (Data obtained from Garmian Directory of Agriculture).

Year	RH%		Temperature C^O		Rainfall
	Min	Max	Min	Max	*mm*
2020	% 11	% 95	0	47	367,1
2021	% 10	% 96	1	50	112,3
2022	% 10	% 92	2	49.5	85.1
2023	% 12	%96	1	42	305.2

Table 2:Water and Soil Properties of studied area during growing season of2022-2023.

Parameter		Water	Soil
PH		7.69	7.55
Conductivity	ds/m^{-1}	557	913
Resistance	kOhm.cm	1.812	1.109
(TDS)Total Dissolved Solids	mg/l	372	613
Temperature	C	26.4	26.2
Salinity	g/kg	0.6	0.7

At the phase of selection, during the growing season of 2023, cultivars (Adana99, Deng, AlRashid, and Wafia) were screened for yield and yield components. According to their response in grain yield, thousand-grain weight, number of seeds per spike, spike length, and number of spikes per M2. These four cultivars of wheat were compared to each other for their grain yield and yield components during the season of (November 2022 to June 2023). Plowing the land with a regular plow, at the time of the seed sowing, based on agricultural practices recommendations wheat Grain120 kg/hectare, 80 kg/hectare of Di-Ammonium Phosphate (DAP) were applied (N=18%, P=46%), and after 60 days, 100 kg/hectare of Urea were applied (N=46%) to the experiment fields in order to raise the usefulness of N during the vegetative growth stage. Also applied physical method to weed control.

Traits measurement:

The area of the experiment was 24 square meters in each field experiment. Each plot was sampled at ground level around seven to ten days after physiological maturity. Subsequently, the plant elements were partitioned into two distinct categories: ears and straws. The process included manually threshing the ears and separating the resulting mixture into grain and chaff. The weight of each sample from different plots was recorded throughout this process as grain yield based on 15% moisture content. The grains were then subjected to a drying process at a temperature of 72 °C for 48 hours to get dry matter and correct the moisture content. In relation to thousand-grain weight, a sample of five hundreds was subjected to weighing and multiplied by two. The studied characteristics were the weight of 1000 seeds (g), number of seeds per spike, number of spikes/m^2, and grain yield in kilograms per donum.

2.3. Experimental design and statistical analysis

The study was conducted utilizing the GENSTAT software using a randomized complete block design (RCBD) with six replications conducted across growing season of (2023). In conjunction with Duncan's test, the statistical method known as analysis of variance (ANOVA) was employed to assess and compare the means of distinct groups [26].The study The graphs were generated utilizing the Microsoft Excel software

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Results

Grain yield (ton.donm^{-1})

The results in Table 3 indicated that the cultivars differed significantly among themselves for the grain yield characteristic (ton.donm^{-1}) (P<0.05), and Adana99 cultivar gave the highest Average for this trait (1.15 ton.donm^{-1}). In contrast, the Al-Rashid cultivar gave less than average for this trait (0.69 ton.donm^{-1}), which differed significantly from the Deng and Wafia cultivars which were 1.07 ton.donm^{-1} for both cultivars (P<0.05; Table 4; Figure 1).

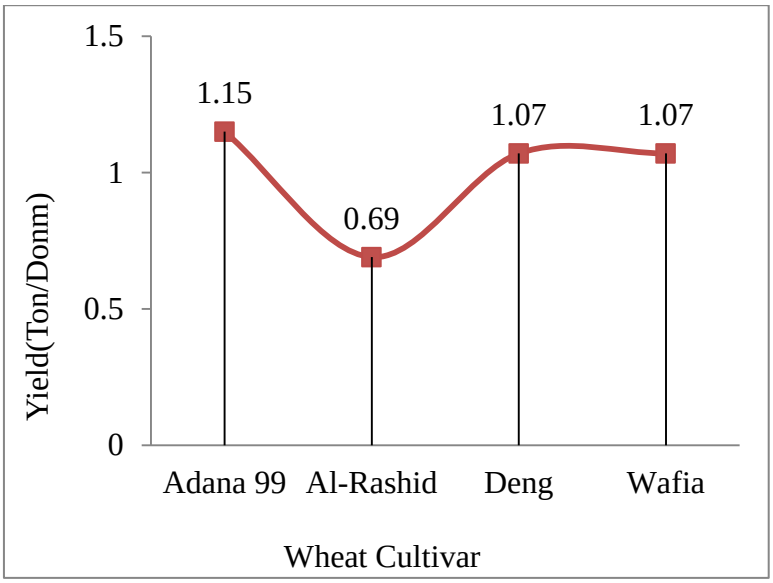

Figure 1. Grain yield of wheat varieties

Number of Spike/m^2

The results showed in Table 3 that there is a significant effect for cultivars in this capacity (P<0.05). The highest average number of spikes per m^2 was 343.3 spikes/m^2 recorded by cultivar Adana99 which was significantly differ from the other cultivars, while Al-Rashid wheat gave the lowest average for this trait (139.3 spikes/m^2; P<0.05). Deng and Wafia cultivars were mostly close to the highest average and recorded 321.5 and 285.2, respectively (Table 4 and Figure 2).

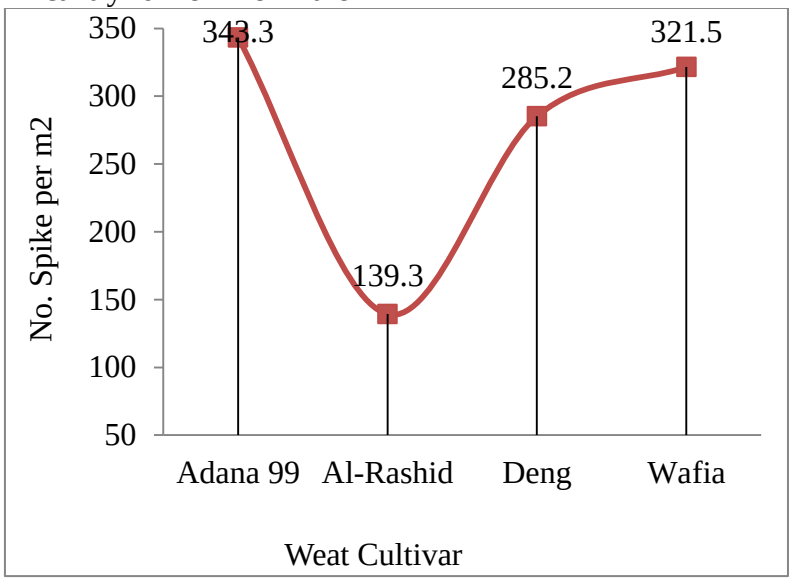

Figure 2. Mean of number of spikes per m^2 for wheat cultivars

Weight of 1000 Seeds (gm)

It is clear from the results in Table 3 that the weight of 1000 seeds was significantly differed between cultivars (P<0.05). Deng cultivar had the highest average of 1000-grain weight (45.04 gm), while the local wheat Al-Rashid gave least average for this trait (37.44 gm). Adana 99 and Wafia recorded a moderate value of 41.75 gm (Table 4; figure 3).

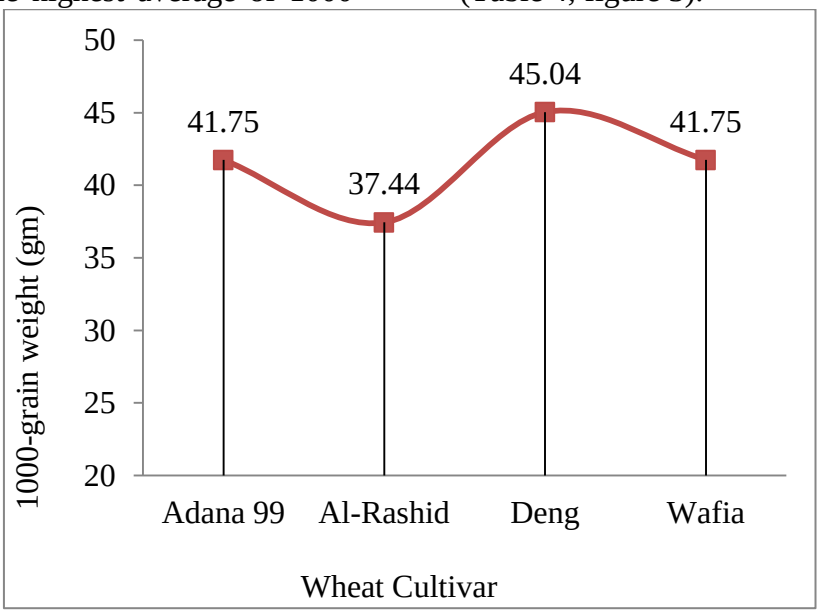

Figure 3. Mean of 1000-grain weight for wheat cultivars

number of seeds per spike

It was found from the results in Table 3 that there is a high significant different between cultivars for the number of seeds/spike (P<0.01). Adana 99, gave the highest average for this trait reaching 48.36 grains/Spike, while the lowest mean for this trait was 29.95 grains/spike recorded by Al-Rashid cultivar (Figure 4). Deng and Wafia recorded (32.86 and 31.36, respectively) which were more close to the lowest side of seed number per spike (Table 4; Figure 4).

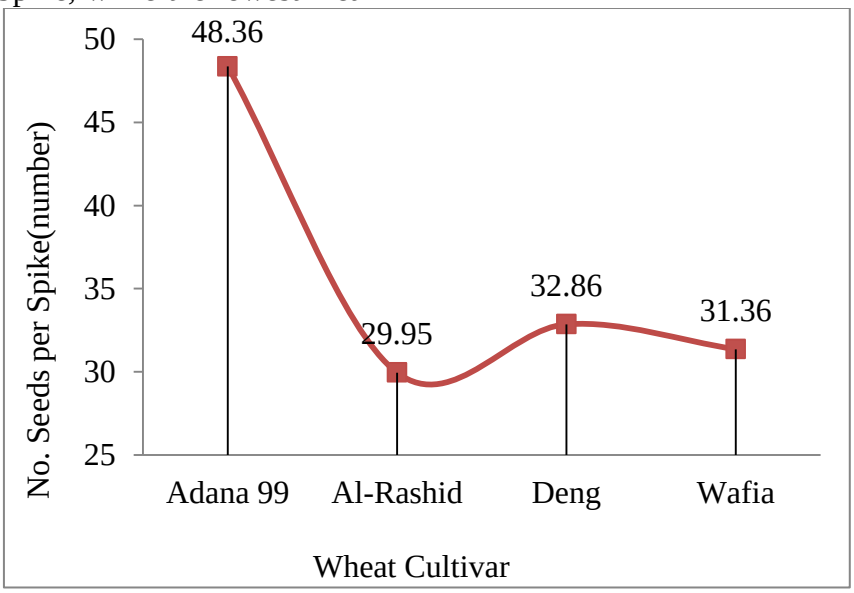

Figure 4. Mean of number of seeds/Spike for wheat cultivars

Spike length (cm)

The results in Table 3 indicate that there were significant differences in the characteristic of the spike length, and the cultivar Al-Rashid gave the tallest spike for this trait, which was 13.53 cm, and it was significantly differed from the other cultivars (Adana99, Deng and Wafia) ($P<0.05$; Table 4). The Deng cultivar gave the shortest spike for this trait, which was 9.61cm (Table 4; Figure 5). Adana 99 and Wafia recorded slightly taller than shortest cultivar Deng by 10.24 and 10.04 cm, respectively (Figure 5).

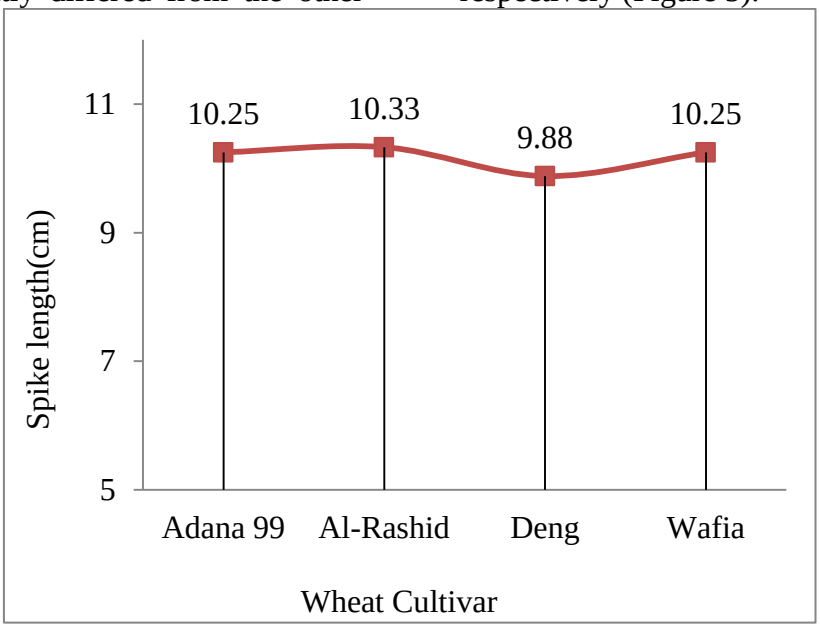

Figure 5. Mean of spike length for wheat cultivars

Table 3: Analysis of variance and mean square of studied traits

Source of variation	d.f.	Mean Square				
		Wight of 1000 seeds	Seed_Spike	Spike_length	Spike_m2	Yield_Donm
Block	5	81.65	64.77	0.450	1769.2	0.246
Treatment	3	58.29*	669.85**	19.454**	50624.1**	0.255*
Error	15	16.01	33.43	0.545	959.4	0.052
P value		0.037	<.001	<.001	<.001	0.014

* significant at level of 0.05 , ** significant at level of 0.01

Table 4: Comparison between cultivars mean using LSD test at 0.05 level of probability

Wheat Spices	Wight 1000 seed	Seed_Spike	Spike_length	Spike_m^2	Yield_Donm
Adana 99	41.75 ab	48.36 a	10.25 a	343.3 a	1.15 a
Al-Rashid	37.44 b	29.95 b	10.33 a	139.3 c	0.69 b
Deng	45.04 a	32.86 b	9.88 a	285.2 b	1.07 a
Wafia	41.75 ab	31.36 b	10.25 a	321.5 ab	1.07 a
	6.66	*9.62*	*4.79*	*51.54*	0.38
D value	*5.99*	*8.66*	*4.31*	*46.41*	0.34
	4.92	*7.10*	*3.54*	*38.06*	0.28

Discussion

Grain yield and yield components can considered as key traits in breeding program and developing new cultivar process in wheat under specific environment condition. In this study, Adana 99 had a potential to give the best grain yield compaired to others. The superiority of the Adana99 cultivar in terms of grain yield is due to the superiority of this variety in yield components, These results are consistent with the findings of some studies [27,28], which indicated the effect of yield components on grain yield. However, Adana 99 had the lowest number of spikes per m2, this may due to the ability of this cultivar to convert all tillers into fertile tiller with ear depending on its ability to produce the largest amount of photosynthesis materials [29], which depend on a number of specifications that this varies possesses [30]. There was a wide range in thousand seed weight from the highest (Deng) to lowest (Al-Rashid) may due to genetic difference in the physical and chemical characteristics [31] which leads to increase the readiness of nutrients and thus increasing growth and increase the weight of grain by photosynthesis and thus increase its mobile products downstream sink from the source and thus increase the weight of the grain[32].

Regarding spike length and seed number per spike, Adana 99 recorded the highest number of seeds but reasonably short spikes in contrast with Al-Rashid which had longest spike with least number of seeds. This may due to the space between spikelets and the rate of fertility in each spike. The efficiency of the photosynthesis process has also a great role in increasing the product from the assimilation materials, which provided an appropriate opportunity to reduce the state of competition among them [33]. These traits may also be more genetically controlled than the environment which led to make difference in the length of the spike and number of seeds [34,35].

Conclusion

From the results we obtained, we conclude the following:

1- Cultivar Adana 99 gave the highest grain yield production and it had the potential for improving yield and highlighting the importance of selecting adaptable cultivars for semi-arid environment of Garmian region than other varieties (Al-Rashid, Deng and Wafia).

2- Cultivar Al-Rashid gave the longest record for the trait of spike length but lowest number for grain yield trait. It is recommended to utilize spike length characteristic in this cultivar to be improved in terms of number of seeds per each spike in breeding programs

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أداء إنتاجية أربعة أصناف من القمح تحت الظروف شبه الجافة

ماهر عيسى جمعه[1]
mahir.essa.j@spu.edu.iq
هەلگورد نصرالدين حسن [2]
halgoord.hassan@spu.edu.iq
مسعود صابر محمد [3]
masood.mohammed@spu.edu.iq
يادگار على محمود [4]
yadgar.mahmood@garmian.edu.krd

[1،2،3] قسم إدارة المشاريع الزراعية، كلية كلار التقنية، جامعة كرميان، السليمانية، إقليم كوردستان، العراق
[4] قسم الإنتاج الحيواني، كلية علوم الهندسة الزراعية، جامعة كرميان، السليمانية، إقليم كردستان، العراق

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الملخص

أجري البحث في كلية كلار التقنية – جامعة كرميان التقنية في منطقة كرميان خلال الموسم الزراعية 2023، باستخدام تصميم القطاعات الكاملة العشوائية (RCBD) بستة مكررات، لتقييم أداء إنتاجية أربعة أصناف من القمح وهي (الرشيد، ادنة 99، وافية و دنگ) في ظل ظروف شبه جافه. أظهر تحليل التباين وجود فرق معنوي بين التراكيب الوراثية لجميع الصفات المقاسة في هذه التجربة (P<0.05). . بالنسبة لمحصول الحبوب وعدد السنابل لكل م2، لم يكن هناك فرق معنوي بين دنگ ووافية وادنة 99 (الحد الأقصى 343.3 لادنة99)، ولكن كانت لديهم قيم أعلى بكثير من الرشيد (P<0.05)، بينما في طول السنبلة وكان الرشيد صاحب أطول ارتفاع (13.53 سم، P <0.05). كان لدى أضنة 99 أعلى عدد ملحوظ من البذور لكل سنبلة (48.36؛ P<0.05). بالنسبة لوزن 1000 بذرة، تمكنت أيضًا دنگ ووافية وادنة 99 (بحد أقصى 45.04 جرام لدنگ) من الحصول على أوزان أعلى بكثير من صنف القمح المحلي الرشيد الذي أظهر متوسط وزن أقل نسبيًا لهذه الخاصية المحددة، والتي كانت (37.44 جم). ويوصي البحث بأن صنف قمح أضنة يتمتع بأداء متفوق مقارنة بالأصناف الأخرى، مما يجعله مناسباً للزراعة في منطقة كرميان.

الكلمات المفتاحية: القمح، الصنف، المنطقة شبه الجافه، الانتاج، المكونات.