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Comparison of the performance of commercially introduced wheat varieties with approved ones in terms of water requirement and quality characteristics

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Abstract:

A field experiment was conducted in the city of Diwaniyah, located at 44.89 degrees longitude and 32.01 degrees latitude, for the 2022-2023 agricultural season. The aim was to evaluate the performance of commercially introduced wheat genotypes with approved varieties in terms of water requirements, productivity, and quality characteristics. The experiment was implemented using a split-plot method using a Randomized Complete Block Design (R.C.B.D). Five irrigation treatments were applied to the main plots (spate irrigation and 100% water ration for wheat, 90% water ration, 80% water ration, and 70% water ration). Eight cultivars were applied to the sub plots of the experimental units (Ibaa 99, Buhuth 22, Jad, Shawmbi, Afanto, Sanzio, R Arabiya, and Wafiya), with three replicates. The wheat varieties showed significant differences in their characteristics. The Wafia variety stood out, producing grains with the highest average moisture content of 9.69%. This wasn't significantly different from the Ibaa99 and Fi Sanzio varieties. Wafia also had the highest average specific weight at 83.0 kg·hectoliter^{-1} and the highest average wet gluten percentage at 30.82%.For protein, the Shaumbi variety excelled, giving the highest average grain protein percentage of 10.96%. This was a statistically significant difference compared to all other varieties.The Fi Sanzio variety grains yielded the highest extraction rate, reaching 73.58%.The water requirements significantly affected grain moisture.The L1 treatment (flood irrigation) recorded the highest average moisture percentage at 10.09%, and the highest average grain protein percentage of 10.71%.a significant difference from all other water requirements treatments. The treatment L4 resulted in the highest average specific weight of 82.45 kg·hectoliter^{-1} Grains from the L5 treatment (70% of the water requirements) showed the highest average wet gluten at 28.82%.The results also revealed a significant interaction between the two factors (variety and water requirements) in terms of grain moisture percentage. Specifically, the combination of Buhuth22 variety with the L1 flood irrigation treatment produced the highest average moisture content at 10.60%.The combination of Wafia variety with the L4 treatment yielded the highest average specific weight at 83.73 kg·hectoliter^{-1}.Finally, the combination of Shaumbi variety with L1 flood irrigation gave the highest average flour protein percentage at 11.53%, and this same combination also produced the highest average wet gluten at 35.22%.

Keywords: Commercially, wheat varieties, water requirement, production characteristics.

Introduction

The scarcity of water used for agricultural purposes is one of the most important problems facing many countries around the world today, especially Iraq. The expansion of this crop's production will increase in the coming years (Hashem, 2016).

In the face of this major challenge, much effort has been focused on addressing this problem, which is becoming more acute in various parts of the world. The decline in the water level of the Tigris and Euphrates rivers has had a significant impact on the reduction of cultivated areas. This requires screening existing varieties, identifying the most drought-tolerant varieties, and improving the environment surrounding the crop by using the best soil and crop management practices (Mohammed, 2000).

Iraq is among the countries that have focused on this aspect in specialized research centers, to develop new genetic lines with superior productivity and quality traits through breeding and improvement programs, identify those best suited to the new reality, includes adopting introduction programs as one of the methods used, to obtain the best genetic compositions in terms of coexistence with the local environment. This is done by subjecting these varieties to numerous tests and determining the stability of their traits across successive generations. Recently, several varieties have been introduced to the market, traded, and cultivated. Their high yields from their parent seeds have not been considered. This has not been done to investigate the possibility of their superior productivity traits continuing across generations (Al-Salem, 2018).

Therefore, this experiment aimed to determine the performance of some approved and commercially introduced varieties in the local environment, to determine their water requirements and the impact this has on the stability of their productivity traits.

Materials and Methods

Experimental Site:

A field experiment was conducted in a field located in the Al-Daghara District of Diwaniyah Governorate, located 14 km north of the governorate center, during the 2022-2023 agricultural season. A set of random soil samples were taken at a depth of 0-30 cm. The samples were thoroughly mixed, passed through sieves with 2 mm diameter holes, Air-dried, then ground. A single composite sample was taken to assess the physical and chemical properties of the soil (Table 1). The aim was to determine the performance of approved and commercially introduced varieties in terms of water requirements, productivity, and quality.

Table (1): Some chemical and physical properties of the experimental soil before planting.*

Items		Value	Unit
Chemical properties	pH	7.80	-
	ECe	5.30	dS m^{-1}
	Available nitrogen	0.02	mg gm^{-1}
	Available Phosphorus	2.40	
	Available Potassium	10.60	
Physical properties	Sand	22.00	gm kg^{-1} soil
	Silt	37.50	
	Clay	40.50	
Soil texture		Silty loam	

*The analyses were conducted in the laboratory of the Diwaniyah Agriculture Directorate/Ministry of Agriculture.

Experimental Factors:

The experiment included the study of two factors:

First: Five irrigation levels distributed across the main plots:

L1: Spate irrigation treatment.

L2: Wheat water ration treatment.

L3: 90% of the water ration.

L4: 80% of the water ration.

L5: 70% of the water ration.

Irrigation was carried out using Shatt Al-Daghara water and a plastic pipe network connected to an electric submersible pump, equipped with a meter to measure the amount of water added to each experimental unit and each stage of plant growth (Al-Saeedi, 2012), varied rates were applied according to plant needs (Table 2).

Table (2) Irrigation levels during the growing season.

Irrigation levels	Ratio (%)	Flood irrigation	Water requirement for wheat crop (L. m^{-2})	70% of the water ration (L. m^{-2})	80% of the water ration (L. m^{-2})	90% of the water ration (L. m^{-2})
L1	18.67	-	70.23	35.39	50.56	63.19
L2	25.41	-	95.59	48.17	68.82	86.01
L3	29.51	-	111.01	55.95	79.92	99.89
L4	18.67	-	70.23	35.39	50.56	63.19
L5	7.70	-	28.96	14.59	20.85	23.69
Total			376.02	189.49	270.71	335.97

Second: Wheat varieties: The experiment included eight varieties of soft wheat placed in secondary panels, namely the variety Aba 99 and Buhuth 22 (varieties approved by the Ministry of Agriculture), and the introduced varieties Jad, Shaumbi, Ufanto, Vi Sanzio, Arabiya R, and the variety Wafih (commercial varieties), (Table 3).

Table (3) Varieties and genotypes used in the experiment.

No.	Varieties	Field symbol	Equipment supplier	Source
1	**Ibaa 99**	**V1**	Agricultural Research Department, Projects Division	Approved
2	**Buhuth 22**	**V2**	Agricultural Research Department, Projects Division	Approved
3	**Jad**	**V3**	Commercial agricultural companies	Germany
4	**Shawmbi**	**V4**	Commercial agricultural companies	USA
5	**Afanto**	**V5**	Commercial agricultural companies	Italy
6	**Sanzio**	**V6**	Commercial agricultural companies	Italy
7	**R Arabiya**	**V7**	Commercial agricultural companies	Italy
8	**Wafiya**	**V8**	Commercial agricultural companies	Frensh

Experimental Design:

Based on the nature of the factors involved in the experiment and the soil type, the experiment was conducted using a split-plot method using a randomized complete block design (R.C.B.D) with three replicates, Each replicate contained 40 experimental units. Irrigation treatments were placed in the main plots, and cultivars were placed in the sub plots.

Agricultural Operations:

The experimental land was plowed twice perpendicularly with a rototiller, after irrigation, it was then smoothed using disc harrows. The soil was then leveled using a leveling machine. The number of experimental units reached 120, with three replicates, each replicate contained 40 experimental units. The dimensions of each experimental unit were 1×1 m, it included five lines, each 1 m long, with a distance of 20 cm between each line. The distance between each experimental unit was 50 cm. The distance between replicates was 2 m. A 2 m gap was left between the main plots.

Wheat seeds were planted in late November, at a seed quantity of 120 kg ha^{-1} (Guidance Bulletin, 2012), in rows. Fertilizer recommendations were added to the application of urea (46%) as a nitrogen source, at a quantity of 200 kg N ha^{-1}, in four equal batches. The first was applied during the emergence, branching, elongation, and lining stages. Phosphate fertilizer was added in the form of triple superphosphate (P) at a rate of 80 kg ha^{-1} in a single batch before planting (Jadoua, 1995). Potassium fertilizer was also added in the form of potassium sulfate (42%), in two equal batches, the first after emergence and the second at the branching stage, at a rate of 60 kg ha^{-1} (Al-Taher, 2005). Irrigation and weeding were carried out as needed.

Traits studied:

Qualitative characteristics of wheat grains
1. Moisture grain content (%)
2. Specific gravity
3.Flour protein percentage (%)
4. Flour extraction percentage (%)
5. Wet gluten percentage (%)

Results and Discussion:

Moisture grain content(%):
It was noted from the results in Table (4) that the wheat varieties differed significantly among themselves in this trait, as Wafiya variety were superior and gave the highest average moisture content of 9.69%, without a significant difference with the varieties Aba99 and Sanzio, while the grains of the variety R Arabia gave the lowest average moisture content of 7.43%, without a significant difference with a number of varieties. The variation in moisture content among wheat varieties may be attributed to the growth environment, the chemical composition of the wheat grain, and the degree of grain hardness. Genetic factors also influence the moisture content of the wheat grain, in addition to the microscopic nature of the wheat grain. Ijaz et al. (2001) showed that wheat grains have living tissues and a microscopic nature. Therefore, the moisture content is greatly affected by the prevailing climatic conditions, such as humidity and temperature during the harvest period. These factors are related to

the hardness of the grain, as soft grains are characterized by their higher moisture content compared to hard wheat grains. These results were consistent with the findings of Ali et al (2018), who showed that wheat varieties differ in the moisture content of their grains. The results in Table (4) showed that the water ration had a significant effect on grain moisture, as the highest average moisture percentage was recorded with treatment L1 (flood irrigation), reaching 10.09%, with a significant difference from all other water ration treatments, while treatment L4 (80% of the water ration) showed the lowest average, reaching 8.28%, without a significant difference from treatment L5 (90%) of the water ration. The reason for the decrease in grain moisture with the small amount of irrigation water may be attributed to the decrease in the moisture percentage in the grains originally, as this trait is affected by humidity and temperature in the growth environment. As for the interaction between the two factors, the results in Table 4 showed that there was a significant interaction in the grain moisture percentage. The combination (variety Buhuth 22 x treatment L1 irrigation) gave the highest average moisture content of 10.60% without significant difference from a number of combinations, while the combination (variety Jad x treatment L5 70% of the water requirement) gave the lowest average for this trait of 6.20% without significant difference from a number of combinations.

Table (4) Effect of water rationing, varieties, and their interaction on Moisture grain content(%)

Varieties	Irrigation levels					Mean
	L1	L2	L3	L4	L5	
V1	10.20	9.45	8.65	10.05	9.73	9.61
V2	10.60	7.95	6.70	9.30	9.90	8.89
V3	9.70	9.85	9.50	6.70	6.20	8.39
V4	10.05	8.96	9.06	6.60	9.25	8.78
V5	9.20	9.56	9.23	6.55	6.55	8.22
V6	10.50	6.60	10.06	10.05	8.90	9.22
V7	10.50	6.70	6.65	6.80	6.50	7.43
V8	10.00	9.58	9.30	10.20	9.36	9.69
Mean	10.09	8.58	8.64	8.28	8.30	
$L.S.D_{0.05}$	L		V		L×V	
	0.31		0.40		0.89	

Specific weight (hctoliter kg^{-1})

The results in Table (5) showed that the cultivars differed significantly among themselves in this trait. The "Wafiya" cultivar stood out, producing the highest average specific weight, reaching 83.0 kg hctoliter-1, with no significant difference from the "R" cultivar. Meanwhile, the "Jad" cultivar recorded the lowest average specific weight, reaching 80.18 kg hctoliter-1.

The variation in specific weight among cultivars may be due to differences in the chemical composition of the grains. It has been suggested that a high protein content in the grains has an effect on specific weight. These results are consistent with Aydin et al. (2004), who indicated that cultivars with a high protein content have a relatively lower specific weight than cultivars with a lower protein content.

The results in Table (5) also showed that the water ration had a significant effect on the specific weight of the grains. Treatment L4 (80% of the water ration) gave the highest average specific weight of 82.45 $kg.h^{-1}$, with no significant difference from treatment L3 (90% of the water ration), while the grains of treatment L5 (70% of the water ration) recorded the lowest average of 81.07 kg.h-1. The reason for the superiority of treatment L4 (80% of the water ration) may be due to the fact that it achieved a balanced moisture rate in the grain compared to the irrigation treatment and 100% water ration, as water was abundant and the moisture content in the grain was high compared to the rest of the grain components, which were subsequently lost during the moisture loss stage, leaving a negative impact on the specific weight. Also, comparing it to treatment L5 (70% of the water ration) where the moisture content in the grain decreased due to the decrease in The water content in the tissues, and both conditions negatively affected the specific gravity of the grains.

As for the interaction between the two factors, it was noted from the results in Table 5 that the combination (variety Wafia x treatment L4) produced the highest average specific gravity, reaching 83.73 kg.h-1, without a significant difference from several combinations. Meanwhile, the combination (variety Shaombe x treatment L5) recorded the lowest average specific gravity, reaching 78.86 kg.h-1, without a significant difference from several combinations.

Table (5) The effect of the water ration, the varieties, and the interaction between them on the Specific gravity (hctoliter kg^{-1})

Varieties	Irrigation levels					Mean
	L1	L2	L3	L4	L5	
V1	82.20	82.06	82.66	83.06	82.20	82.44
V2	80.40	80.33	80.33	82.60	79.33	80.20
V3	79.40	80.60	80.40	81.00	79.50	80.18
V4	79.76	80.06	81.26	81.13	78.86	80.24
V5	82.26	83.06	82.93	83.86	81.66	82.76
V6	81.66	82.73	82.80	83.46	81.56	82.44
V7	82.26	83.46	83.06	82.80	82.60	82.84
V8	83.33	83.26	83.33	83.73	82.93	83.32
Mean	81.42	81.95	82.10	82.45	81.07	
$L.S.D_{0.05}$	L		V		L×V	
	0.19		0.35		0.76	

Flour protein percentage (%):

The results of the statistical analysis in Table (6) indicated a significant effect of the varieties, water ration, and the interaction between them on the protein percentage in flour (%). The results in Table (6) showed that the grains of the genetic compositions differed significantly in their protein content, as the protein content of the grains of the Shawmbe variety was distinguished and gave the highest average percentage of grain protein, reaching 10.96%, with a significant difference from all varieties, while the grains of the Ovanto variety recorded the lowest average, reaching 10.03%, with a significant difference from the rest of the varieties. The reason for the superiority of the grains of the Shawmbe variety in grain protein may be attributed to the low weight of its grains, Table (14), and in line with the inverse relationship between the quantity and quality of the crop, as with the increase in the weight of the grain, its size increases and its protein concentration decreases due to the drying that occurs as a result. This result was consistent with the results in Table (6) that the water ration had a significant effect on the percentage of grain protein, as the L1 treatment (sea irrigation) gave the highest average percentage of grain protein, reaching 10.71%, while the grains of the L4 treatment (80% of the water ration) recorded the lowest average, reaching 10.13%, with a significant difference from the rest of the varieties. Transactions, and this may be attributed to the genetic aspect and its role in determining the percentage of protein in the variety or genetic composition, which is under the control of a genetic controller. As for the interaction between the two factors, significant differences were found in the percentage of grain protein in most varieties when exposed to water rationing. The combination (variety in Sanzio x treatment L1 irrigation) was superior and gave the highest average grain protein of 11.68%, while the lowest average protein percentage was recorded in the grains of the combination (variety R Arabia x treatment L5 70% of the water ration) of 8.43%, without a significant difference from a number of combinations. This result was similar to the results of the factors when they were alone. This can be attributed to the combined action of the two factors together, which changed the form of the response from what it was under the influence of each factor independently of the other. Therefore, it is difficult to know the nature and effect of the response accurately except by referring to the genetic controller, which is the variety, which is usually characterized by a semi-constant percentage of grain protein, while clarifying the role of irrigation irrigation in raising the weight of the grain, which means an increase in drying, which reduces the percentage of protein in the grains of the variety or genetic composition.

Table (6) The effect of water stress, varieties and their interaction on Flour protein percentage (%)

Varieties	Irrigation levels					Mean
	L1	L2	L3	L4	L5	
V1	10.85	10.53	10.45	10.91	11.06	10.76
V2	10.53	9.37	10.16	10.10	10.03	10.03
V3	10.65	11.31	10.24	9.38	10.44	10.40
V4	11.66	10.52	11.51	10.08	11.03	10.96
V5	10.39	10.51	10.24	9.94	10.56	10.33
V6	10.41	9.86	10.38	10.10	10.03	10.16
V7	10.54	9.51	10.39	10.09	10.43	10.16
V8	10.63	10.38	10.59	10.44	10.50	10.51
Mean	10.71	10.25	10.49	10.13	10.51	
$L.S.D_{0.05}$	L		V		L×V	
	0.12		0.16		0.35	

Flour extraction percentage (%)

The results of Table (7) showed that wheat varieties differed significantly in flour extraction rates. The Sanzio variety yielded the highest extraction rate, reaching 73.58%, while the Jad variety yielded the lowest average flour extraction rate, reaching 70.30%. The variation in extraction rates between varieties is attributed to the nature of genetic growth, the efficiency of photosynthesis, and the accumulation of dry matter, especially during the grain filling stage, which is reflected in the starch content of the grain, the specific gravity, and the average grain weight. Al-Kanani (2004) stated that the nature of the chemical composition of the seed, its weight, the size of the shells, and the presence of shrivelled, wrinkled, and light seeds affect flour extraction rates. This result is consistent with what was reported by Al-Azzawi (2017), who found differences in flour extraction rates between different wheat varieties. The results of Table (7) showed that the water ration had a significant effect on the flour extraction rates, as treatment L1 (spate irrigation) was distinguished and gave the highest average of 72.10% with a significant difference from the rest of the treatments, while treatment L5 (70% of the water ration) recorded the lowest average of 70.75% in the second season. The reason for the high extraction rate for the spate irrigation treatment L1 may be due to the absence of the phenomenon of grain atrophy as a result of the increase in the percentage of endosperm in the grain due to the abundance of water in the growth area and not being exposed to water shortages in the stage of filling and physiological maturity.

Table (7) The effect of water tension, varieties and their interaction on the Flour extraction percentage (%)

Varieties	Irrigation levels					Mean
	L1	L2	L3	L4	L5	
V1	71.65	70.44	70.87	70.46	70.31	70.74
V2	71.24	70.13	70.96	71.25	70.26	70.77
V3	70.92	70.56	70.19	69.90	69.94	70.30
V4	71.46	69.00	71.37	69.73	70.07	70.32
V5	70.88	72.03	70.90	70.57	70.52	70.98
V6	74.75	73.78	73.48	73.04	72.85	73.58
V7	73.02	70.85	73.14	71.09	71.67	71.95
V8	72.88	71.27	72.12	70.63	70.42	71.46
Mean	72.10	71.00	71.63	70.83	70.75	
$L.S.D_{0.05}$	L		V		L×V	
	0.57		0.68		ns	

Wet gluten percentage (%):

The results of Table (9) showed that wheat varieties differed significantly among themselves in this characteristic, as the flour of the Wafiya variety was distinguished by giving the highest average percentage of wet gluten, reaching 30.82%, while the lowest average of wet gluten was recorded by the Sanzio variety, reaching 25.24%. The variation in the varieties' wet gluten content may be attributed to the difference in the genetic composition of the varieties and their difference in the percentage of protein in the grains of the varieties and their difference in the percentage of protein in the grains. Perhaps the reason for the superiority of the Wafiya variety in the wet gluten content is due to the nature of the genetic composition, as the low ash percentage was a definite reason for the increase in wet gluten due to the inverse relationship between them. These results were consistent with what was indicated by Al-Azzawi (2017). The significant effect of water rationing on wet gluten content was found in the L5 treatment (70% water ration) with the highest average wet gluten content, reaching 28.82%, with no significant difference from the L1 treatment (water ration). Meanwhile, the L3 treatment (90% water ration) recorded the lowest average wet gluten content, reaching 27.58%. Regarding the interaction between water rationing and cultivars, the results showed a significant effect on this trait. The combination (Cultivar Shawmby x Treatment L1 Water ration) yielded the highest average wet gluten content, reaching 35.22%, with no significant difference from a number of combinations. The combination (Cultivar Vi Sanzio x Treatment L1 Water ration) yielded 22.81%.

Table (8) The effect of water rationing, varieties and their interaction on the Wet gluten percentage (%)

Varieties	Irrigation levels					Mean
	L1	L2	L3	L4	L5	
V1	28.32	28.84	23.97	27.50	24.56	26.64
V2	24.55	25.61	27.14	27.97	29.20	26.98
V3	30.69	26.56	28.44	28.59	29.63	28.78
V4	35.22	27.44	30.04	26.46	29.60	29.75
V5	29.88	29.85	30.06	27.86	32.70	30.07
V6	22.81	26.08	25.47	25.73	26.13	25.24
V7	25.70	28.61	28.03	29.10	28.73	28.03
V8	31.53	31.91	27.50	33.10	30.06	30.82
Mean	28.59	28.11	27.58	28.29	28.82	
$L.S.D_{0.05}$	L		V		L×V	
	0.50		0.747		1.60	

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