Evaluation of the performance of several local wheat cultivars for growth and estimation genetic parameters under of biofertilization

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Abstract

A field experiment was conducted to wheat (Triticum aestivum L.) in Babylon rate / Al-Musayyab Project , which is 40 km north of Babylon within longitude 44.50 and latitude 32.50 for the purpose of studying (identifying resistance genes to wheat root rot (Triticum aestivum L.) for some Iraqi cultivars and estimating their genetic features under levels of biofertilizer). The research included three factors, the first factor is planting six cultivars of wheat (Rashid, Baghdad, Furat, Baraka, Babylon and Joda), the second factor is two levels of pathogenic fungi (without, addition), and the third factor is two levels of biofertilizer (half recommendation, recommendation) for the 2021-2022 season. The experiment was conducted using a Randomized Complete Block Design (RCBD) according to the factorial experiment system. The harvest was conducted on 4/23/2024 for early cultivars and continued until 1/5/2024 The results of the statistical, genetic and molecular analysis of the data showed the following:

A significant difference was found between the cultivars, where the cultivar (Rashid) was excelled and gave the highest average in (number of grains.spike-1, grain yield, biological yield) (88.42 grains per spike) and (4.78 Mg. ha-1) and (15.61 ton ha-1) respectively. While the cultivar (Furat) was excelled and gave the highest average in (weight of a thousand grains, and protein percentage in grains) (43.62 g) and (10.32%) respectively.The treatment of Trichoderma fungus (recommendation) gave a significant increase in all studied traits, as it gave the highest average in (number of grains, weight of 1000 grains, grain yield, biological yield, harvest index, protein percentage in grains) (72.97 grains.spike-1), (41.14 g), (5.18 mg g h-1), (35.89%) and (10.97%) respectively.The treatment of Rhizoctonia fungus (without addition) gave a significant excelled in the traits (grain yield, biological yield, harvest index, protein percentage in grains) (4.48 mg g h-1), (13.49 mg g h-1), (32.47%) and (9.60%) respectively. The bi and triple interactions gave significant differences in most of the studied traits. The values of the phenotypic and genetic coefficients of variation were moderate to high for all the studied traits. The heritability was evaluated in the broad sense based on grain yield as a function of correlation with the rest of the traits, as it was high, more than 60% for the traits (number of grains, thousand-grain weight, grain yield, biological yield). The highest heritability values for the 1000-grain weight trait reached 99.43%. The expected genetic improvement as a percentage to the general average for the trait gave the grain yield trait 51.95%, while the number of grains trait gave a genetic improvement rate for the trait of 18.26%. The results of the genetic correlation showed a significant and positive correlation for the yield with the traits (number of spikes, number of grains, and thousand-grain weight) ranging between (0.94 and 0.70 for the number of grains trait) and (0.52 and 0.78 for the thousand-grain weight trait) respectively, while the environmental correlation showed a significant correlation For the product with the characteristic (grain weight) 0.69 and 0.75 respectively.

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Introduction

Wheat (Triticum aestivum L.) is one of the most important strategic grain crops that are relied upon to reduce the food gap, which has become a global problem, as the world population is expected to reach 9 billion people by 2050, after it was about 5.5 billion people in 1994. This problem has clearly appeared in Iraq, as the self-sufficiency rate in the wheat crop did not exceed 41.21% in 2020 [4]. In order to meet the growing food need, it is necessary to think about increasing the productivity of this crop, which is still very low, as in 2019 it did not exceed 0.7 tons per hectare. Researchers have tried to increase the yield by improving soil and crop service processes and genetic improvements. The interest in soil and crop service operations through the use of fertilizers and fertilizers and others undoubtedly played a role in increasing the yield and achieving the desired goal of increasing the grain yield. The current trend includes reducing the use of chemical fertilizers due to their environmental and health damages and moving towards natural alternatives such as the use of biofertilizers that provide the required nutrients in addition to their effect in creating a biological environment that secretes some plant hormones and acids that stimulate plant growth, which is reflected in increasing the yield by increasing the fertile content of the soil, as it encourages vegetative growth because it contains many elements necessary for growth, especially minor ones, so it improves the efficiency of the roots in absorbing water and nutrients and delays aging on the leaves, which increases their efficiency in photosynthesis and increases the efficiency of the plant in its tolerance to environmental stress by increasing the activity of enzymes and their work as antioxidants such as the enzymes Catalase and Peroxidase. Plant stress can be divided into two main categories: abiotic stress and biotic stress. Abiotic stress imposed by the environment on plants may be either physical or chemical, whereas biotic stress to crop plants is a biological entity such as diseases, insects, etc. Some stresses to plants damage them such that plants exhibit various metabolic imbalances. Plants can resist from injuries if the stress is mild or short-term as the effect is temporary while severe stresses lead to death of crop plants by inhibiting flowering, seed formation and inducing senescence. The fungus Trichoderma spp. contributes to increasing overall plant growth and producing metabolites to stimulate seed germination, promote root growth, increase plant resistance to environmental stresses and increase availability of various nutrients. This is positively reflected on the quantity and quality of the crop, in addition to the high antagonism against plant pathogens and its ability to induce signals to stimulate pathways associated with defense and strengthen cell walls[16] Given the importance of wheat plants and the lack of studies on the use of biological stresses and the attempt to keep pace with modern global trends in the use of biofertilizers in agricultural production, the current study aimed to:

-1Evaluate the performance of the cultivars used in the study in terms of growth and yield.

-2The effect of adding biofertilizer in increasing the growth and yield of wheat.

-3Determine the best resistance of cultivars to root rot disease by the effect of biofertilization as well as the effect of the interaction between the study factors on the growth and yield of wheat.

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-4Estimate some genetic parameters such as variations, heritability, genetic, environmental and phenotypic correlations

Materials and methods

Implementation of the experiment

A field experiment was conducted in Al-Watifiah District, 35.5 km north of the center of Babylon Governorate, located within latitude (32.47) north and longitude (44.22) east and at an altitude of (26.00) m above sea level and an area of (930) m2. To study the effect of adding Trichoderma harzianum biofertilizer to the effect of Rhizoctonia solani biostress on the growth and yield of six wheat cultivars, namely (Rashid, Baghdad, Euphrates, Baraka, Joda and Babylon) during the winter season (2022-2023), representative soil samples were taken at a depth of (0-30) cm and from different locations of the experimental land and were mixed and blended with each other to homogenize them. A composite sample was taken from it after smoothing and drying it for the purpose of conducting some chemical and physical analyses shown in Table (1) Laboratory analyses of the soil were conducted in the laboratory

Table (1) Some physical and chemical properties of field soil before planting

trait .	Value	Unit	
pH	7.15	-	
E.C	4.0		
N	98.0	mlg kg -1 soil	
P	7.95	mlg kg -1 soil	
K	231.0	mlg kg -1 soil	
	2.8	Clay	g kg -1 soil
	38.8	Silt	
	58.4	Sand	
	Sandy Loam Soil	Soil texture	

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Experimental Factors

The experiment included studying three factors

The first factor is the cultivars: It included six cultivars, which are (Rashid, Baghdad, Furat, Baraka and Joudah) .The second factor is the pathogenic fungus: It is represented by the pathogenic fungus Rhizoctonia solani (Infection and without infection) (C0,C1) , The third factor is the biofertilizer: represented by the biofungus Trichoderma harzianum (added and without added) ,(B1,B2.(

Experimental design

A factorial experiment was applied using the Randomized Complete Block Design (R.C.B.D.) and with three replicates. The treatments, numbering (24) treatments and three replicates, were distributed randomly within each sector, thus the total experimental units became 72 units.

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Agricultural operations

The experimental land was plowed with a rotary plough, then leveling and smoothing operations were conducted. The experimental land was divided into three sectors, each sector containing 24 panels, each of which was 2x3 m in size. The cultivation was in lines with a distance of 20 cm between each line, leaving 1 m between treatments to ensure that the biofertilizer and pathogenic fungi were not transferred, and at a planting depth of 3 cm. The cultivation was conducted on 11/21/2022 for the first season, and the second season was planted on 12/4/2023, with a seed quantity of 160 kg/hectare for the selected cultivars [14] The experimental land was fertilized with urea fertilizer. Crop service operations such as irrigation and weeding were conducted whenever necessary, and weeds were controlled manually, taking into account keeping the experimental land almost free of weeds .

12-3traits studied:

-1Number of seedlings According to the number of seedlings from each experimental unit for each plant taken randomly (before the full flowering stage.(

-2Area of the flag leaf cm2

Calculated as an average of ten flag leaves of the main stems randomly selected from the median lines of each experimental unit when flowering was complete according to the following equation:

Leaf length X maximum width X 0.95

-3Plant height (cm(

Plant height was measured when flowering was complete for ten plants randomly from each experimental unit, and calculated

From the distance from the soil surface to the top of the spike without the spike

-4Spike length (cm(

Estimated by the distance between the base of the spike to the end of the terminal spike excluding the spike as an average for a random sample of ten spikes from each experimental unit from the median lines.Statistical Analysis

The data were analyzed according to the ANOVA method, using the GENSTATE12 program, and the averages of the coefficients were tested according to the least significant difference L.S.D, and under the probability level of 0.05 [9[

12-3 Genetic Analysis

Genetic, Environmental and Phenotypic Variances (G2σ, E2σ, P2σ(

The analysis of phenotypic, genetic and environmental variances was estimated according to the method explained by [21] After that, each of the following was calculated:

Since:

G 2σ: Genetic Variance

E2σ: Environmental Variance

P2σ: Phenotypic Variance

Heritability and Expected Genetic Advance

It was estimated according to the method explained by [15] as follows:

Since:

:Heritability in the broad sense

:Genetic Variance of the trait

:Phenotypic Variance of the trait

Since:

G.A represents the expected genetic improvement

H2B.S heritability in the broad sense

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Standard deviation of phenotypic variance

K is the intensity of selection and is equal to 2.06 when 5% of the plants are selected

The expected genetic improvement was estimated according to the method explained by [12[

E.G.A represents the expected genetic improvement as a percentage of the overall mean for the trait. G.A represents the expected genetic improvement

Represents the mean of the trait

Estimation of the values of the coefficients of phenotypic and genotypic different coefficients

The values of the coefficients of phenotypic and genotypic different coefficients were calculated according to the method explained by [12] as follows:

Where:

P.C.V is the coefficient of phenotypic variation

G.C.V is the coefficient of genetic variation

Phenotypic, Genotypic and Environmental Correlations

The phenotypic, genetic and environmental correlations were found between the pairs of the studied traits, after analyzing each of the traits under study and for both sites. In addition, an analysis of the common variance was conducted between the trait of the resultant and the other traits, as well as between the pairs of traits from the values of the expected squares averages and in the manner explained by Walter (1975), as it was Phenotypic, genetic and environmental according to the following equations:

Results and discussion

Number of seedlings per plant

The results in Table (2) show that wheat cultivars differed significantly in the number of seedlings trait, where the Furat cultivar excelled by giving the highest average of (8.33) seedlings per plant, which was significantly excelled on the rest of the cultivated cultivars, and Rashid recorded the lowest average of (4.08) seedlings in the first season. As for the second season, the Baghdad cultivar excelled the cultivated cultivars significantly, giving the highest average of the number of seedlings of (7.42) seedlings , while the Rashid cultivar gave the lowest average of (4.08) seedlings . The reason for the difference in this trait between cultivars may be attributed to the difference in their genetic nature in terms of their ability to shoot. These results agreed by[7,20] .reached, who indicated that cultivars differed among themselves in the number of seedlings trait.

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Table (2) Effect of pathogenic fungi Rhizoctonia and biotrophic fungi Trichoderma on growth characteristics of wheat crop for Number of seedlings per plant

AXB	C		B	A
	C1	C0		
3.33	2.67	4.00	B1	A1
4.83	4.00	5.67	B2	
5.67	4.33	7.00	B1	A2
7.17	6.00	8.33	B2	
5.67	5.33	6.00	B1	A3
11.00	10.00	12.00	B2	
3.83	3.67	4.00	B1	A4
8.33	7.00	9.67	B2	
4.50	3.67	5.33	B1	A5
5.33	4.67	6.00	B2	
4.33	3.67	5.00	B1	A6
5.17	4.00	6.33	B2	
0.779	1.101		LSD	
A X C				
4.08	3.33	4.83	A1	
6.42	5.17	7.67	A2	
8.33	7.67	9.00	A3	
6.08	5.33	6.83	A4	
4.92	4.17	5.67	A5	
4.75	3.83	5.67	A6	
0.551	0.779		LSD	
4.56	3.89	5.22	B1	
6.97	5.94	8.00	B2	
0.318	0.450		LSD	
	4.92	6.61	Average	
	0.318		LSD	

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Area of the flag leaf cm2

The data in Table (3) indicate a significant effect of the cultivars, as the Furat cultivar excelled by recording the highest average of (68.72 cm2) for the seasons, respectively, while the Rashid cultivar recorded the lowest average for this trait, reaching (50.76 cm2) for the seasons, respectively. The reason for the difference in the cultivars in this trait may be attributed to the excelled of the cultivars with a significant increase over each other in the number of flag leaf, or the reason for this difference between the cultivars may be attributed to the nature of their genetic environment and their interaction with the surrounding environmental conditions, and thus their difference in growth traits, including the area of the flag leaf. This result agreed with what was[8,13] in their experiment on wheat cultivars, which indicated significant differences between wheat cultivars in the trait of leaf area.

Table (3) Effect of pathogenic fungi Rhizoctonia and biotrophic fungi Trichoderma on growth characteristics of wheat crop for Area of the flag leaf cm2

AXB	C		B	A
	C1	C0		
44.72	37.87	51.56	B1	A1
56.81	59.28	54.34	B2	
60.59	56.24	64.94	B1	A2
70.44	73.45	67.42	B2	
61.50	52.11	70.89	B1	A3
75.94	76.55	75.32	B2	
47.85	41.94	53.76	B1	A4
61.93	68.37	55.49	B2	
62.10	59.99	64.21	B1	A5
71.20	71.34	71.06	B2	
44.46	35.76	53.16	B1	A6
60.69	65.20	56.18	B2	
2.568	3.631		LSD	
A X C				
50.76	48.58	52.95	A1	
65.51	64.85	66.18	A2	
68.72	64.33	73.10	A3	
54.89	55.16	54.63	A4	

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66.65	65.66	67.64	A5
52.58	50.48	54.67	A6
1.816	2.568		LSD
B*C			
53.54	47.32	59.75	B1
66.17	69.03	63.30	B2
1.048	1.482		LSD
	58.18	61.53	Average
	1.048		LSD

Plant height (cm(

Table (4) show that the Rashid cultivar excelled the other cultivars in giving the highest average plant height of (128 cm) compared to the Baraka cultivar, which recorded the lowest average (99.17 cm). In the second season, the Babylon cultivar excelled by giving the highest height of 108 cm, while the Baghdad cultivar gave the lowest height of 100 cm. The reason may be due to the difference in genetic factors between the cultivars included in the study and the difference between them in the number of nodes and the length of the internodes, especially the upper internodes, which are important traits in distinguishing cultivars. The difference in the results of the two seasons may be attributed to environmental conditions, especially the somewhat moderate temperatures during the second season compared to the first season. This result is consistent [4,5,7] [10] who indicated that wheat cultivars differ among themselves in the trait of plant height due to the influence of genetic and environmental factors.

Table (4) Effect of pathogenic fungi Rhizoctonia and biotrophic fungi Trichoderma on growth characteristics of wheat crop for Plant height (cm(

AXB	C		B	A
	C1	C0		
126.67	119.00	134.33	B1	A1
129.33	121.00	137.67	B2	
106.17	102.00	110.33	B1	A2
116.17	110.67	121.67	B2	
110.17	104.33	116.00	B1	A3
118.83	117.67	120.00	B2	
95.50	89.67	101.33	B1	A4
102.83	103.33	102.33	B2	
99.50	91.33	107.67	B1	A5
106.83	100.33	113.33	B2	
100.33	100.00	100.67	B1	A6
103.00	101.33	104.67	B2	
2.374	3.357		LSD	

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A X C			
128.00	120.00	136.00	A1
111.17	106.33	116.00	A2
114.50	111.00	118.00	A3
99.17	96.50	101.83	A4
103.17	95.83	110.50	A5
101.67	100.67	102.67	A6
1.154	1.631		LSD
B*C			
106.39	101.06	111.72	B1
112.83	109.06	116.61	B2
0.666	0.942		LSD
	105.06	114.17	Average
	0.666		LSD

Spike length (cm(

The data in Table (5) showed a significant difference between the cultivars in this trait. The Rashid cultivar was significantly excelled and recorded the highest average of (18.08 cm) for the first season, and Baghdad 16.29 cm for the second season, compared to the Furat cultivar, which recorded the lowest average of (11.08 cm). The reason for the difference between the cultivars in spike length is attributed to the difference in their genetic composition. This result is consistent with the results of , who indicated that wheat cultivars differed significantly among themselves in the spike length trait due to the difference in the genetic nature of each cultivar. For the pathogenic fungus treatment, the treatment without adding 14.25 cm was excelled for the two consecutive seasons. As for the biological fungus treatment, the treatment containing the full recommendation for the biological fungus was excelled by giving the highest average of (14.19) for the seasons compared to the treatment with half the recommendation for the biological fungus, which reached (11.92) for the seasons.[6[

Table (5) Effect of pathogenic fungi Rhizoctonia and biotrophic fungi Trichoderma on growth characteristics of wheat crop for Plant height (cm(

AXB	C		B	A
	C1	C0		
15.67	13.67	17.67	B1	A1
20.50	20.00	21.00	B2	
11.00	10.33	11.67	B1	A2
13.17	10.67	15.67	B2	
10.00	9.00	11.00	B1	A3
12.17	11.00	13.33	B2	
10.17	8.00	12.33	B1	A4

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12.33	11.33	13.33	B2	
13.50	13.00	14.00	B1	A5
15.17	14.00	16.33	B2	
11.17	10.33	12.00	B1	A6
11.83	11.00	12.67	B2	
1.690	2.390		LSD	
A X C				
18.08	16.83	19.33	A1	
12.08	10.50	13.67	A2	
11.08	10.00	12.17	A3	
11.25	9.67	12.83	A4	
14.33	13.50	15.17	A5	
11.50	10.67	12.33	A6	
1.195	1.690		LSD	
B*C				
11.92	10.72	13.11	B1	
14.19	13.00	15.39	B2	
0.775	0.976		LSD	
	11.86	14.25	Average	
	0.775		LSD	

Estimation of some genetic parameters

Estimation of the coefficients of phenotypic and genetic variation, the percentage of heritability, genetic improvement and expected genetic improvement

The results of Table (6) show the values of the coefficients of phenotypic and genetic variation for the Trichoderma treatment for the first season based on the grain yield as a function of the correlation with the rest of the traits. Accordingly, the values of the coefficients of phenotypic and genetic variation varied between low for the traits of low less than 10% for the studied traits of 1000-grain weight (7.95, 7.93) for the coefficients of phenotypic and genetic variation for the above traits, respectively, and medium for the traits (grain yield and biological yield), (24.21, 24.13), (12.72, 12.48), for the coefficients of phenotypic and genetic variation for the above traits, respectively, and high for the traits (number of grains per spike) (30.58, 30.28) For the

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coefficients of phenotypic and genetic variation of the above traits, in sequence and in general, the results of the values of the coefficients of phenotypic and genetic variation differed, and this is due to the difference in the values of phenotypic and genetic variation. The results of the same table indicate the values of the heritability ratio in the broad sense based on grain yield as a function of the correlation with the rest of the traits, being less than 40% low, 40-60% medium and more than 60% high, as it was high more than 60% for all traits (number of grains, thousand grain weight, grain yield, biological yield) (93.16, 98.02, 99.43, 99.33, 96.30%) for the above traits in succession, as the highest heritability values for the trait of 1000 grain weight reached 99.43%. In general, the high values of heritability in the broad sense for the studied traits indicate the importance of genetic variation as one of the components of phenotypic variation and an indication of the low impact of environmental variation, which gives an idea to plant breeders to conduct selection for these traits as the best method. The results of the same table show that the expected genetic improvement as a percentage of the average trait, as the spike length trait gave the highest expected genetic improvement percentage of 83.56%, while the 1000-grain weight trait gave the lowest genetic improvement percentage of the trait of 16.29%. As for the rest of the traits, the values of genetic improvement ranged between 61.76% for the number of grains trait. [1,11. [

Table (6) Values of the coefficients of phenotypic and genetic variation, the heritability percentage and the expected genetic improvement in the first season (Trichoderma environment(

Charac. / Genetic Param.	High plant	Num .branches	Length spike	Leaf area
P.C.V	9.078	30.823	44.164	12.725
G.C.V	8.972	27.931	42.327	12.282
Heritability	97.661	82.117	91.853	93.168
Genetic advance	18.264	52.141	83.566	24.422

Estimation of genetic correlation

It is noted from the results of Table (7) the values of genetic correlations for the studied traits for the first season based on grain yield as a function of correlation with the rest of the traits, as grain yield was positively and significantly genetically correlated with the traits (spike length, number of spikes, number of grains, thousand grain weight) (0.50, 0.60, 0.59, 0.60) for the above traits in succession. Positive significant correlation indicates the possibility of improving the yield through the trait that shows a high significant correlation and is considered as evidence for selection for plant breeders.[2,19.) [

As for the values of genetic correlations for the studied traits based on grain yield as a function of correlation with the rest of the traits, if grain yield was positively correlated

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with all the studied traits (number of spikes, number of grains, thousand grain weight) (0.66, 0.36, 0.94) for the above traits in succession .

Estimation of environmental correlation

It is noted from the results of Table (8) the values of environmental correlations for traits based on grain yield as a function of correlation with the rest of the traits, as grain yield was positively environmentally correlated with the trait (number of grains) (0.02). It was also negatively environmentally correlated with the trait (weight of 1000 grains) (0.69 -) for the above traits in succession. The positive significant correlation indicates the possibility of improving the yield through the trait that shows a high significant correlation and is considered as evidence for selection for plant breeders[3, 17. [

Estimation of phenotypic correlation

The phenotypic correlation of the studied traits for the first season was estimated based on grain yield as a function of correlation with the rest of the traits, as yield was positively phenotypically correlated with the traits (number of grains, weight of a thousand grains) (0.59, 0.60) for the above traits in succession. The positive correlation indicates the possibility of improving the yield through the trait that shows a high correlation and is considered as selection evidence for plant breeders. It is concluded from the results of genetic, phenotypic and environmental correlation that the increase in spike length, number of grains and thousand grain weight resulted in an increase in yield and these traits can be used as selection evidence to improve wheat crop productivity through selection[18.[

Table (7) Genetic correlation values for the studied traits

	High plant	Num .branches	Length spike	Leaf area
High plant				
Num .branches	0.895			
Length spike	-0.006	-0.222		
Leaf area	0.255	0.045	0.888	

Table (8) Phenotypic correlation values for the studied traits

	High plant	Num .branches	Length spike	Leaf area
High plant				
Num .branches	0.779			
Length spike	0.004	-0.188		
Leaf area	0.258	0.035	0.861	

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Table (9) Environmental correlation values for the studied traits

	High plant	Num .branches	Length spike	Leaf area
High plant				
Num .branches	-0.351			
Length spike	0.212	0.043		
Leaf area	0.377	-0.038	0.529	

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