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Response of several genotypes of bread wheat *Triticum aestivum* L. to levels of silica fertilizer

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Abstract

A field experiment was carried out at the Agricultural Research and Experiment Station in the Sayada area of the College of Agriculture – at the University of Kirkuk for the winter season 2021/2022 by randomizing complete block design with a split-plot system with 30 experimental units per block to stndy the effect of spraying three levels of silica fertilizer (0, 2, and 4) $ml.l^{-1}$ and ten wheat genotypes which are (Wafia, Al-Fayadh, Abu Ghraib 3, Baghdad, Jihan 99, Adana, Sham 6, Bora, Al-Rashid, and Monnellsa). The results showed that there were significant differences between the levels of silica fertilizer in all the studied traits, where (4 $ml.l^{-1}$) of silica with Sham6 was superior in the traits of the biological yield (19.79 $ton.ha^{-1}$), the interaction was significant for all the studied traits, where the genotype was superior in relation to the interaction levels of spraying with silica fertilizer of (0 $ml.l^{-1}$) silica with the genotype (Baghdad1) was superior in the number of effective tillers (514.67 m^{-2}) The number of spikes (454.10 $spikes.m^{-2}$) and the protein percentage (16.35) also exceeded the concentration of (4 $ml.l^{-1}$) silica with the genotype (Baghdad1) in the weight of 1000 grains (48.86).

Key words: silica fertilizer, genotypes, bread wheat.
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Introduction

Wheat (*Triticum eastivum* L.) is one of the most important cereal crops used for human nutrition in the countries of the world, as it is an essential source of daily energy that humans need [1]. Providing bread has become one of the goals that most countries of the world seek to achieve for their people because it is one of the main pillars of the stability of that country [2] and its grains contain a high percentage of carbohydrates, proteins and starch, which makes them perform a major task in global trade and balancing the global economy [3]. The cultivated area of wheat crop in Iraq in 2020 was estimated at (37.856 thousand hectares), an increase of (10.4%) compared to what it was in the winter season 2020, and the average yield per dunum was estimated on the basis of the total cultivated area (178.812 hectares), and the average yield of acres was estimated on the basis of the cultivated area in irrigated lands (279.608 dunums-1 hectare) (Ministry of Planning, 2020.(Iraq is one of the original habitats for the emergence of wheat, and despite the availability of the main production factors, the productivity of this crop is still low compared to the global average and developed countries [4].

Silicon is the second most abundant element in the earth's crust, and many studies have shown that the use of silicon has significantly increased plant growth, and the positive effects of silicon are more pronounced when plants are exposed to multiple pressures, including biotic and abiotic stresses .

The use of silicon increases the drought tolerance of wheat plants [5], as silicon is highly valued in crops and reduces the effect of biotic and abiotic stresses, drought and salinity [6] .Differences and discrepancies between genotypes are important factors for plant breeders, as they represent the raw material on which the test is based. [7] .(Varieties are one of the important factors that lead to an increase in production, as good varieties with a high ability to invest primary resources lead to an increase in production capacity [8] (Iraq suffers from low productivity of the wheat crop, despite being one of the first habitats of its origin, and this decline may be due to the failure to follow the correct management methods and cultivate varieties with desirable genetic traits that suit their cultivation areas to obtain the highest grain yield. There are many factors that contribute significantly to increasing the productivity of the crop, and the most important of these factors are good varieties adapted to the conditions of the region, which contribute significantly to increasing the productivity of the crop [9]

Objectives of the study.

1. This study aims to evaluate the response of several genetic structures of the wheat bread crop and select the most suitable for cultivation under the conditions of the study area where the characteristics of the yield and its components.

2. Study the response of these spelt genotypes to spraying with different levels of silica fertilizer to ten genotypes of bread wheat.

Material and method

The field experiment was carried out at the Agricultural Research and Experiments Station in the Sayada area, Faculty of Agriculture, University of Kirkuk, during the winter season (2021-2022), according to the Split-plot system within the design of the complete random sectors (R.C.B.D And three repeats agricultural operations were conducted on the land of the experiment of tillage and settlement and then divided the land into three repeaters of the first factor was spraying with silica fertilizer and three levels (0, 2 and 4) ml.l-1 and symbolized by

S2, S1, S0 Respectively, it was placed in the main pieces, and the spraying was done twice at the beginning of the elongation phase after 15 days, and the second factor includes 10 genotypes of bread wheat and the secondary pieces were placed, namely (Wafia, Fayyad, Abu Ghraib 3, Baghdad 1, Jihan 99, Edna, Sham 6, Boritalia, Rashid, Mona Lisa .(The cultivation was carried out in the form of land lines on 30 experimental units and each experimental unit on 4 lines, the length of the line 3 and the distance between one line and another 0.25 using a seed rate of 350 grains M-2 for each line, and planting was carried out on 15/11/2021 in the form of lines, and the fertilization process was carried out in the field with 320 kg.E-1 Dab fertilizer (N18%, P2O246%), and then (200) kg urea (N46%) was added as a second batch in the stage Branching and broadleaf bushes were controlled with pesticide D.2.4 at a concentration of 125 ml with 100 liters-1 water, and the thin-leaved bush was controlled by Topek pesticide 5/3/2022 at a concentration of (500) ml with 100 liters-1 of water, as well as adding fertilizers as needed and according to fertilizer recommendations [10] .(It was harvested on 29/5/2022 and the statistical analysis was carried out according to the above design to find out the differences between the cultivated varieties and genotypes and in the way explained by [11] and it was harvested on 2/6/2022 as well as the use of (SAS, Opstat and Excel).

Results and discussion

1. Plant height

Table (1) shows that there are significant differences between the concentrations of fertilizer and genetic structures and the overlap between them in affecting the characteristic of plant height, the first concentration of fertilizer (without addition) was recorded to give the highest rate of the trait of 72.41 cm and a significant difference from the second concentration (4 ml / l-1), which gave the lowest rate of the trait of 70.36 cm, and these results agree with [12] .(As for the genetic structures, they differed significantly from each other in their impact on this trait, as the genetic structure exceeded the lowest rate of 75.93 cm compared to the genotype of Boritalian, which gave the lowest rate of the trait of 65.73 cm, and the difference between the genetic structures may be due to the genetic nature of the varieties and the instability of the necessary period from cultivation to maturity, which affects the length of the vegetative growth period of the genotype ، We agree with[13], [14], [15].

As for the interaction between the two study factors, the genetic makeup of Qayad outperformed at the level of comparison by giving the highest rate of trait of 79.93 cm and a significant difference from the rational genetic structure at the concentration (4 ml / l-1), which recorded the lowest rate of 60.56 cm.

2. Flag leaf area ($cm^2.leaf^{-1}$)

It appears from Table (2) that the addition of several levels of silica fertilizer has significantly affected the characteristic of the area of the flag leaf, as the concentration of fertilizer 4 ml.l-1 gave the highest average of 24.77 cm 2 / sheet and a significant difference from the concentration of fertilizer 2 ml / liter and an average of 23.54 cm 2 / leaf, and this may be due to the role of silicon in increasing photosynthesis rates, which leads to an increase in the area of the flag leaf, and we agree with [12]. The results of the statistical analysis indicate that there are significant differences between Baghdad 1 at a rate of 25.78 cm 2 / leaf and a significant difference from the genetic makeup Mona Lisa, who gave the lowest rate of the trait of 23.22 cm 2 / leaf, and this may be due to the difference in varieties in

Table (1) Effect of spraying silica fertilizer and genotypes and the overlap between them in the characteristic of plant height (cm):

Genotypes	Fertilizer concentrations $(ml.L)^{-1}$			Modifier compositions
	0	2	4	Genetic
Waifa	68.16 d-i	70.57 c-g	75.30 a-c	71.34 bc
Fayyad	79.93 a	69.85 c-g	69.16 c-i	72.98 ab
Abu Ghraib3	67.56 e-i	65.24 g-j	67.39 e-i	66.73 d
Baghdad 1	69.58 c-g	70.24 c-g	67.28 f-i	69.03 cd
Jihan99	79.23 a	70.26 c-g	68.94 c-i	72.81 ab
Edna	77.24 ab	77.95 ab	72.59 b-f	75.93 a
Sham6	74.60 a-d	77.60 ab	74.51 a-d	75.57 a
Bora	63.34 h-j	63.19 ij	70.68 c-g	65.73 d
Rashid	73.89 a-e	71.94 d-f	60.56 j	68.80 cd
Mona lisa	70.57 c-g	70.87 c-g	77.20 ab	72.88 ab
Rate of fertilizer concentrations	72.41 a	70.77 b	70.36 b	

. *Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test.

their genetic composition and their difference in the length of the growing season and the extent of their ability to interact with soil and climate conditions, and this is commensurate with the results of [16], [14]**.(**As for the interaction between the two study factors, it was found that there were high significant differences between the average coefficients, as the genetic structure exceeded Abu Ghraib 3 at the fertilizer concentration of 4 ml / l-1 by giving the highest rate of 28.06 cm 2 / leaf compared to the genetic makeup Mona Lisa when there was no fertilizer, which gave the lowest rate of 21.56 cm 2 / leaf, and we agree with [17].

Table (2) The effect of spraying with silica fertilizer and genetic structures and the overlap between them on the characteristic of the area of the flag leaf $(cm^2.leaf)^{-1}$

Genotypes	Fertilizer concentrations $(ml.L)^{-1}$			Modifier compositions
	0	2	4	Genetic
Waifa	24.29 b-i	23.41 e-j	25.44 b-d	24.38 bc
Fayyad	26.15 a-c	22.11 ij	22.88 g-j	23.71 bc
Abu Ghraib3	22.96 f-j	23.53 e-j	28.06 a	24.85 ab
Baghdad 1	26.20 a-c	25.97 a-d	25.17 b-g	25.78 a
Jihan99	26.00 a-d	23.67 d-j	24.23 b-i	24.63 ab
Edna	24.76 b-h	22.06 ij	26.64 ab	24.48 bc
Sham6	26.17 a-c	22.19 ij	25.34 b-f	24.56 ab
Bora	23.88 c-j	25.19 b-g	22.46 h-j	23.85 bc
Rashid	23.79 c-j	24.09 c-i	22.64 h-j	23.51 bc
Mona lisa	21.56 j	23.23 e-j	24.88 b-h	23.22 c
Rate of fertilizer concentrations	24.57 a	23.54 b	24.77 a	

*Similar letters indicate that there are no significant differences between the values at a significant level of 0.05%

3. Spike length (cm)

Table (3) shows that the addition of several concentrations of silica fertilizer has affected the average length of the spike, as we note a significant increase when the fertilizer is present at a concentration of (4 ml / l-1), which gave the highest rate of the trait of 9.896 cm compared to the level of comparison (0 ml / l-1), which gave the lowest rate of the trait of 9.450 cm.

This may be due to the increase in the plant's benefit from the available growth elements through the importance of the role of silicon in increasing the size of the vegetative system and the accumulation of dry matter accumulated inside the plant on the one hand، Improving the performance of the root system and increasing its efficiency in absorbing water and nutrients and reducing the effect of sodium on the plant on the other hand, these results are consistent with the findings of [18], [19]. It is also clear from the table that there are significant differences between the genetic structures in their impact on the average spike length trait, the genetic structure of Baghdad 1 exceeded at a rate of 10.17 cm, while the genetic structure recorded the lowest rate of this trait of 9.32 cm, and this may be due to the variation in the nature of the genetic structures, which affected the length of the necessary period from planting to the appearance of the ears, and this was reflected in the length of the spikes, and we agree with these results with [16], [20], [7]. As for the overlap between the levels of fertilization and genetic structures in their impact on this trait, it was shown from the results of the same table that there are high significant differences between the averages of the transactions, as the genetic structure exceeded Fayyad at the fertilizer level (4 ml / l-1) in giving an average of the trait of 11.11 cm, while the genetic structure gave Sham6 at the fertilizer level (0 ml / l-1) the rate of the trait was reduced by 8.53 cm .

Table (3) The effect of spraying with silica fertilizer and genetic structures and the overlap between them in the characteristic of spike length (cm):

Genotypes	Fertilizer concentrations $(ml.L)^{-1}$			Modifier compositions
	0	2	4	Genetic
Waifa	8.81 e-g	10.28 a-e	8.88 d-g	9.32 b
Fayyad	8.75 fg	9.64 b-g	11.11 a	9.83 ab
Abu Ghraib3	9.17 c-g	9.42 b-g	9.93 a-g	9.50 ab
Baghdad 1	10.62 a-c	9.07 d-g	10.82 ab	10.17 a
Jihan99	9.38 b-g	9.35 b-g	9.63 b-g	9.46 ab
Edna	10.19 a-f	10.05 a-f	9.07 d-g	9.77 ab
Sham6	8.53 g	9.54 b-g	10.34 a-d	9.44 ab
Bora	10.15 a-f	9.63 b-g	9.86 a-g	9.88 ab
Rashid	9.36 b-g	9.57 b-g	9.60 b-g	9.51 ab
Mona lisa	9.51 b-g	10.16 a-f	9.70 a-g	9.79 ab
Rate of fertilizer concentrations	9.450 b	9.666 ab	9.896 a	

. *Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test

4. Number of spikes (m2)

Table (4) shows that the addition of silica fertilizer did not lead to significant differences in its effect on the characteristic of the number of spikes / m2.while the results of the statistical analysis indicated

that there were significant differences between the genotypes and when the overlap between the levels of fertilizer and genetic structures in their effect on this trait، . As we note a significant superiority of the genetic structure Baghdad 1 by giving it the highest rate of the number of spikes / m2, which amounted to 448.00 spikes / m2, while the genetic structure Fayyad gave the lowest rate for this trait, which amounted to 425.95 spikes / m2 and this may be due to the difference in the nature of the genotypes and the extent of their response to climate and soil conditions, and these results fit with the findings with [8], [16].

It is clear from Table (5) that the genetic structure of Baghdad 1 was superior at the level of comparison of fertilizer at the highest rate of 454.10 spikes / m2 and a significant difference from the rational genetic structure at the level (2 ml / l-1), which gave the lowest rate of the trait of 420.47 spikes / m2.

Table (4) The effect of spraying with silica fertilizer and genotypes and the overlap between them in the characteristic of the number of spikes.

Genotypes	Fertilizer concentrations ($ml.L^{-1}$)			Modifier compositions
	0	2	4	Genetic
Waifa	448.42 a-c	440.86 b-f	438.18c-h	442.48 ab
Fayyad	420.64 j	428.94 f-j	428.27 g-j	425.95 e
Abu Ghraib3	427.97 g-j	431.24 e-j	449.26 ab	436.15 bd
Baghdad 1	454.10 a	449.72 ab	440.18b-g	448.00 a
Jihan99	430.73 e-j	441.36 b-f	424.54 ij	432.21 ed
Edna	441.94 b-e	436.79c-i	434.72 d-i	437.81 bd
Sham6	432.89 d-i	427.13 h-j	444.63a-d	434.88 cd
Bora	441.04 b-f	436.51 c-i	439.85b-g	439.13 bc
Rashid	429.71 e-j	420.47 j	428.29 g-j	426.15 e
Mona lisa	441.25 b-f	448.66 a-c	435.29 d-i	441.73 ab
Rate of fertilizer concentrations	436.87 a	436.17 a	436.32 a	

. *Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test

5. Number of spike grains

Table (5) shows that there are no significant differences between the levels of fertilizer in its effect on this trait, while the genotypes differ significantly in the effect on the number of grains in the spike as shown in Table (5). The superiority of the genetic structure Fayyad by giving the highest rate of the trait amounted to 49.85 grains / spike and a significant difference from the genetic structure of the lowest which gave the lowest rate of this trait amounted to 47.30 grains / spike and this may be due to the genetic nature that controls the behavior of genetic structures and the level of their ability to interact with the conditions of the region, the results were consistent with the findings of [21], [16] . The results extracted from the statistical analysis indicate that there are significant differences when overlapping between the two study factors, as the genotype of Boritalian at the level of fertilizer 2 ml / L-1 gave the highest rate of trait of 52.68 grains / spike, while the genetic structure gave Jihan99 at the level of comparison the lowest rate of 42.30 spike tablets.

Table (5) The effect of spraying with silica fertilizer and genotypes and the overlap between them in the characteristic of the number of spike grains:

Genotypes	Fertilizer concentrations (ml.L)$^{-1}$			Modifier compositions
	0	2	4	Genetic
Waifa	49.25 a-g	47.92 c-i	45.63 h-j	47.60 b
Fayyad	50.40 a-f	48.48 b-i	50.68 a-d	49.85 a
Abu Ghraib3	50.43 a-e	44.08 jk	49.47 a-g	47.99 ab
Baghdad 1	49.27 a-g	47.12 d-j	49.41 a-g	48.60 ab
Jihan99	42.30 k	51.21 a-c	48.73 b-i	47.41 b
Edna	46.97 e-j	47.31 d-j	47.62 d-i	47.30 b
Sham6	48.94 b-h	49.31 a-g	46.40 g-j	48.22 ab
Bora	46.84 f-j	52.68 a	45.22 i-k	48.25 ab
Rashid	48.47 b-i	46.36 g-j	51.68 ab	48.84 ab
Mona lisa	49.00 b-h	47.27 d-j	46.27 g-j	47.51 b
Rate of fertilizer concentrations	48.189 a	48.178 a	48.114 a	

*Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test.

6. Grain yield (tons. h^{-1})

Table (6) shows that there are no significant differences between the averages of the coefficients when adding silica fertilizer in the effect on the characteristic of the grain yield in the plant, as for the genetic structures, the results of the table itself indicate a significant effect on this trait ،As for the genetic structures, the results of the table itself indicate a significant effect on this trait, as the genetic structure exceeded morally faithful and gave the highest rate of 5.89 tons / e-1 compared to the genetic structure Fayyad, which gave the lowest rate of 5.02 tons / h-1, and this may be due to the difference in the area of the flag leaf, the number of spikes and the weight of the spike, and these results are in line with [16], [22].

As for the overlap between fertilizer levels and genotypes in influencing this trait, we note from Table (6) the superiority of the genetic structure and fulfillment at the level of comparison by giving the highest rate of 6.41 tons / h-1 and a significant difference from the genetic structure Baghdad 1 at the fertilizer level (4 ml / liter-1) by giving the lowest rate of the trait of (4.28 tons / h $^{-1}$

7. Biological yield (tons. h^{-1})

Table (7) shows that there is no significant difference when adding silica fertilizer in the effect on the biological yield of the plant, and the results of the statistical analysis indicated that there are clear differences between the genetic structure involved in the study, as it is clear from Table (7) The occurrence of superiority of the genetic structure Sham 6 in giving an average trait of 18.62 tons / h and a significant difference from the genetic structure of Bor Italian, which gave the lowest rate of the trait of 15.14 tons / h and the reason for the superiority of Sham 6 in that trait may be due to the increase in some components of growth and agree with these results with the [23], [24].

Table (6) The effect of spraying with silica fertilizer and genotypes and the overlap between them on the characteristic of grain yield tons. h^{-1}:

Genotypes	Fertilizer concentrations ($ml.l^{-1}$)			Modifier compositions
	0	2	4	Genetic
Waifa	6.41 a	5.96 a-d	5.30 c-g	5.89 a
Fayyad	5.28 c-g	5.46 c-g	4.31 h	5.02 d
Abu Ghraib3	5.27 c-g	5.73 a-f	5.50 b-g	5.50 ac
Baghdad 1	6.03 a-c	6.25 ab	4.28 h	5.52 ac
Jihan99	5.58 b-g	5.66 a-f	5.44 c-g	5.56 ac
Edna	5.43 c-g	5.17 a-f	4.83 gh	5.32 bc
Sham6	5.30 c-g	5.13 e-f	5.06 fg	5.16 cd
Bora	5.90 a-e	5.75 a-f	5.29 c-g	5.65 ab
Rashid	5.11 e-g	5.25 c-g	5.49 b-g	5.28 bc
Mona lisa	5.64 b-f	5.20 d-g	5.50 b-g	5.45 bc
Rate of fertilizer concentrations	5.599 a	5.614 a	5.102 a	

*Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test.

As for the overlap between fertilizer levels and genetic structures to influence the biological quotient characteristic, the genotype Sham6 outperformed at the fertilizer level 4 ml / L-1 at a rate of 19.79 and a significant difference from the rest of the harmonic coefficients, and these results were in agreement with [25].

Table (7) The effect of spraying with silica fertilizer and genotypes and the interaction between them in the characteristic of the biological yield ton . h^{-1}:

Genotypes	Fertilizer concentrations ($ml.L^{-1}$)			Modifier compositions
	0	2	4	Genetic
Waifa	15.72 ab	18.46 ab	17.81 ab	17.33 ad
Fayyad	15.17 b	15.47 b	16.58 ab	15.74 cd
Abu Ghraib3	16.43 ab	17.36 ab	15.09 b	16.29 bd
Baghdad 1	19.02 ab	15.02 b	15.45 b	16.50 ad
Jihan99	18.05 ab	18.75 ab	17.92 ab	18.24 ab
Edna	17.47 ab	17.76 ab	18.35 ab	17.86 ac
Sham6	18.02 ab	18.05 ab	19.79 a	18.62 a
Bora	14.94 b	15.43 b	15.86 ab	15.14 d
Rashid	17.56 ab	15.49 b	15.51 b	16.18 bd
Mona lisa	15.98 ab	18.00 ab	18.85 ab	17.61 ad
Rate of fertilizer concentrations	16.839 a	16.984 a	17.124 a	

.*Similar letters indicate that there are no significant differences between the values at a significant level of 0.05% according to the Dunkin' multi-range test.

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أستجابة عدة تراكيب وراثية من حنطة الخبز *Triticum aestivum* L. لمستويات من سماد السيلكا

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المستخلص

نفذت تجربة حقلية في محطة البحوث والتجارب الزراعية في منطقة الصيادة التابعة لكلية الزراعة–جامعةكركوك للموسم الزراعي الشتوي2022/2021 بتصميم القطاعات العشوائية الكاملة بنظام الواح المنشقة طاع لمعرفة تأثير الرش ثلاث مستويات من سماد السيلكا(0و2و4) مل.لتر$^{-1}$وعشرة تراكيب وراثية من حنطة الخبزوهي(وفيةوالفياض وابوغريب3وبغداد1وجيهان99وادنه وشام6وبورايطالية والرشيد ومونااليزا)..وقد أظهرت النتائج وجود اختلافات معنوية بين مستويات سماد السيلكا في جميع الصفات المدروسة، أذ تفوقت تركيز (4مل.لتر$^{-1}$) سيلكا مع التركيب الوراثي شام6 في صفة الحاصل البايولوجي(19.79 طن.هـ$^{-1}$) تفوقت تركيز (0مل.لتر$^{-1}$) سيلكا مع التركيب الوراثي رشيد في صفة حاصل الحبوب(6.41طن.هـ$^{-1}$).كما كانت التداخل الثنائي معنوية لجميع الصفات المدروسة حيث تفوق التركيب الوراثي بالنسبة لتداخل مستويات الرش بسماد السيلكا فقد تفوقت توليفة (0مل.لتر$^{-1}$) سيلكا مع التركيب الوراثي(بغداد1) في صفات عدد الاشطاء الفعالة (514.67شطأ.م$^{-2}$) وعدد السنابل(454.10سنبلة.م$^{-2}$)ونسبة البروتين(16.35)كما تفوق تركيز (4مل.لتر$^{-1}$) سيلكا مع التركيب الوراثي (بغداد1) في صفة وزن 1000حبة(48.86) .

الكلمات المفتاحية: سماد السليكا، تراكيب وراثية، حنطة الخبز.