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Article

Utilizing the chemical mutagen sodium azide, we created genetic variation and estimated several genetic parameters in bread wheat

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Abstract

In this study, four cultivars of wheat (Abu Gharib, Barcelona, German, French) and three concentrations of chemical mutagenic sodium azide (0, 5Mm,10 Mm) if the grains were immersed in the concentration above from the chemical mutagenic and for two hours. The grains were planted in the field according to the Random Completely Block Design (RCBD)using the Factorial experiment system as experimental units. Each repeater contains 12 experimental unit dimensions 2.5 m X 2m, planning experimental units by 10 lines per pilot unit, the distance between the line and another 20 cm, the fertilization process has been added by adding phosphate fertilizer P2O5 and a rate of 200 (kg. ha-1) during agriculture and then add urea fertilizer with concentration (46%) N and rate 400 (kg. ha-1) on two payments when the plant arrives at the height of 7 cm. The second installment was added before flowering D4 2. The pesticide was used, and the hoeing process was conducted to control the bush. When the plants reached the stage of full maturity, random samples were taken from the plants grown in the field (10) plants from each experimental unit to study the effect of sodium azide NAN3 on some quantitative characteristics: the plant's height, the flag leaf area, the number of per spikes, the spike length, the number of per grains in spike, the weight of thousand grain and the grains yield. The results showed the presence of moral statistical differences for all studied characteristics.
The highest average appearance in the number of per spikes cultivars Barcelona was 323.2 spike while the average high for the mutagenic concentration Mm10 Mm 334.1 spike for the number of per spikes. It was the highest interference to cultivars Barcelona with Mm concentration reaching 333.1 spikes for the number of per spikes. Statistical and genetic analyses were conducted on averages to estimate each of the genetic parameters that represent the percentage of heritability in the broad sense (%H2 b.s), the coefficient of genetic variation (% GCV), the coefficient of phenotypic variation(%PCV), and the expected genetic improvement.
Various statistical parameters were estimated, including variance, standard deviation, coefficient of variation, arithmetic mean and standard error for each studied characteristic. Statistical analyses showed the effect of variance in their values, where the value of the coefficient of difference in the characteristic of the flag leaf area was 12.40%, while it decreased in the characteristic of the number of grains per spike it recorded 0.99%, while the variance recorded its highest value in the characteristic of the number of spikes, which amounted to 27.24. This value decreased in the characteristic of the grains yield 0.25.

Keywords: Triticum aestivum L., Sodium azide, Genetic variation, Spike length

Introduction

The wheat bread (Triticum aestivum L.) dialace of winter grain crops is the dietary task cultivated in many countries. The wheat comes first in terms of production and cultivated space, where its grains contain a proportion of fat estimated at 1.5 - 2.4%, a proportion of proteins 10-12.2%, a rate of starch 75.6 _77.2%, and ash about 4.6 _ 5.2% In addition to vitamins (B1, B2), some mineral salts and amino acids[8]. The planted in Iraq amounted to about 6.33 million dunums and the production of 4343,000 tons that Iraq is still suffering from its production for wheat crop[10]. A mutation is one of the reasons for genetic change that leads to a genetic variation with economically desirable specifications through the ability of mutations in the latest Change one genetic agent or several component factors for genes and express qualities in the plant[12],

One of the most common chemicals used in the events of genetic mutations is Sodium Azide (SA); it is a colorless and smelled compound with the chemical formula NAN3, A non-carcinogen. A few dangerous, Inexpensive and highly efficient and used for the first time in the treatment of wheat pills affected plant height [18]—the knowledge of genetic behavior and some statistical landmarks. A specific characteristic of great importance is determining the appropriate way of breeding and improvement. Genetic variance is a difference in the phenotypic characteristics of the resulting plants from their differences in genetic structure when cultivated in the same environment. Environmental variance Is the difference in plant characteristics in genetic installation when cultivated in two different environments [9]. Heritability is a genetic change rate to the total genetic change and environment. If the inheritability rate is high, this is due to the genetic impact on a greater environmental impact[3]. This study aims to recognize the best cultivar of wheat that can be obtained on genetic variation leading to increased production using the chemical mutagen sodium azide. It identifies the best concentration of chemical mutagen, determines the best interference between the cultivars and chemical mutagen, and estimates some genetic and statistical sights for studied characteristics.

Materials and Methods

A field experience during the 2021 winter season was applied in a field back to a farmer in Al-Ramadi - Anbar Governorate Center in the experience to the design RCBD using the Factorial experimental land of the experiment was prepared by the plowing and softening and settlement and then divide them according to the recommended scientific recommendations Where they divided into experimental units 2.5 x 2m^2 and three replicas each repeater contains 12 experimental unit. Two thousand grains of each variety were soaked with different concentrations of chemical mutagenic sodium azide (0, 5 mm, 10 mm). Experimental units were planted by ten lines between line and another 20 cm; the fertilization process was

added by adding phosphate fertilizer P_2O_5 at a rate of 200 (kg. ha[1]) during agriculture and then adding urea fertilizer with a concentration (46%) N and a rate 400(kg. ha^{-1}) on two doses when the plant arrives at the height of 7 cm. The second dose has been added before flowering. When the plant arrived the total maturity, random samples were taken from the ten plants of each experimental unit to study the Following characteristics: plant height (cm), flag leaf area (cm^2), number of per spikes, spike length (cm), the number of per grains in spike, the weight of thousand grain(g) and grains yield (ton. ha^{-1}). Then, statistical analysis of the traits was carried out using RC B. D design with three replications and with the least significant difference test 5% in the studied traits, and the statistical parameters and genetic parameters of these traits were studied [7].

Results

Study traits

Table (1) shows the analysis of variance for the Mean of squares for the studied traits in wheat and the presence of significant differences for the cultivars and all the traits studied, While the concentrations of the chemical mutagen sodium azide showed significant differences for all the traits studied. Similarly, the interaction between the cultivars and the concentrations of the mutagen showed significant differences for all the studied traits.

Source of difference	Plant height	Flag leaf area	Number of per spikes	Spike length	Number of per grain in spike	Weight of thousand grain	Grain yield
Replicates	1.044	42.45	31.03	0.1212	6.401	2.611	**0.2174**
Cultivars	107.685 **	**493.96	**5905.44	2.5119**	250.346 **	87.223**	**17.1944****
concentration	53.190 **	**396.16	**7158.78	5.8363 **	365.730**	63.366**	**33.9139****
CM	24.18**	**187.49	**556.07	4.8363**	189.256**	4.007 *	**15.7989****
Experimental error	2.003	16.85	27.24	0.4434	5.300	1.410	**0.2509**

Table 1. Analysis of variance, Mean of sum square of the studied traits.

Plant height

It is noted from Table (2) that there are significant differences between the cultivars in the plant height, as the cultivar German recorded the highest average of 103.98cm, while the cultivar Abu Ghraib recorded the lowest average for the trait reached99.67cm.

mutant	Cultivars				
	Abu - Gharib	**Barcelona**	**German**	**French**	**Mean**
0	9593.	98.69	95.35	97.27	**96.81**
5	98.73	99.75	107.40	104.85	**102.68**
10	104.35	105.12	109.19	106.45	**106.28**
Mean	99.67	101.19	103.98	102.86	
5%LSD	C= 1.38	M= 1.19	C.M= 2.39		

Genetic parameters					
Inheritance in a broad sense %H²b.s	**genetic variance ƈ²G**	**Pheno-typic variance ƈ²P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**
94.62	35.22	37.23	5.82	5.99	**11.67**

Statistical parameters			
Variation coeffi-cient	Standard Error	Mean	variance
1.38	0.40	101.92	**2.00**

Table 2. Impact of cultivars, concentrations and interference between them in the plant height.

The same Table indicates a significant difference in interference between cultivars and mutagen concentration, as the highest value is 109.19 cm. For genetic and statistical parameters, heritability reached 94.62%. Besides, the expected genetic improvement reached 11.67%, which indicates an expected genetic improvement, while the difference coefficient reached 1.38%.

Leaf area

Table (3) indicated that there are significant differences between the cultivars in the flag leaf area, as the cultivar Abu-Gharib recorded the highest average, reaching 34.51cm2, while the cultivar Barcelona recorded the lowest average for the trait reached 31.32 cm2. The same Table indicates that there are significant differences in interference between cultivars and concentration of mutagen with the highest value at 36.33cm^2; as for genetic and statistical parameters, heritability reached 90.48 % due to the high value of genetic variance reached 160.16and low value of environment variance it reached 16.85, expected genetic improvement reached 74.96%. In comparison, the difference coefficient reached 12.40%.

mutant	Cultivar				
	Abu - Gharib	Barcelo-na	German	French	Mean
0	32.79	30.41	31.72	32.47	**31.85**
5	34.40	31.55	32.22	34.15	**33.08**
10	36.33	32.01	34.24	34.65	**34.31**
Mean	34.51	31.32	32.73	33.76	
5%LSD	C=4.01		M=3.47	C.M= 6.95	

Genetic parameters					
Inheritance in a broad sense %H^2b.s	genetic variance σ^2G	Phenotypic variance σ^2P	genetic variation coefficient % GCV	coefficient of phenotypic variation %PCV	Expected genetic improvement %ΔG
90.48	160.16	177.01	38.26	40.22	**74.96**

Statistical parameters			
Variation coeffi-cient	**Standard Error**	**Mean**	**variance**
12.40	1.18	33.08	**16.85**

Table 3. Impact of cultivars, concentrations and interference between them in the leaf area.

Number of spikes

Table (4) showed a significant difference between the cultivars in the number of spikes, as the cultivar Abu-Gharib recorded the highest average of 333.1. In contrast, the cultivar Barcelona recorded the lowest average for the trait, reaching 323.2. The Table below indicates significant differences in interference between cultivars and mutagen concentration as the highest value spike. As for genetic and statistical parameters, the expected genetic improvement reached 27.72%. This is due to the high value of the heritability, which reached 98.63%, while the genetic and phenotypic difference coefficient reached 13.55% and 13.64% sequentially, while the difference coefficient reached 1.59%. It is clear that this trait has a significant difference between concentrations of chemical mutagen where the concentration 10 Mm gave the highest value was 334.1 spike, the reason is due to the increased number of tillers[1].

mutant	**Cultivars**				
	Abu - Gha-rib	**Barcelo-na**	**German**	**French**	**Mean**
0	322.7	312.5	316.5	318.6	**317.6**
5	334.1	325.3	328.1	326.0	**328.4**

10	342.4	331.7	332.14	330.0	**334.1**
Mean	333.1	323.2	325.6	324.9	
5%LSD	C=5.10	M=4.41	C.M= 8.83		

Genetic parameters					
Inheritance in a broad sense %H²b.s	**genetic variance Ƈ²G**	**Phenotypic variance Ƈ²P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**
98.63	1959.4	1986.64	13.55	13.64	**27.72**

Statistical parameters			
Variation coefficient	Standard Error	Mean	variance
1.59	1.51	326.7	**27.24**

Table 4. Impact of cultivars, concentrations and interference between them in the number of spikes.

Spike length

It is noted from Table (5) that there are significant differences between the cultivars in the spike length, as the cultivar Barcelona recorded the highest average of 10.70 cm, while the cultivar French recorded the lowest average for the trait by 9.59 cm. It is clear from table data that this trait has a significant difference between concentrations of chemical mutagen, where the concentration of 10 Mm gave the highest value of 10.75 cm. The same results indicate significant differences in interference between cultivars and mutagen concentration, as the highest value is 11.86 cm. As for genetic and statistical parameters, its heritability reached 60.84%, expected genetic improvement reached 13.21%, which indicates an expected genetic improvement, and the difference coefficient reached 6.58%.

	Cultivars				
Cultivars mutant	**Abu - Gharib**	**Barcelona**	**German**	**French**	**Mean**
0	9.92	9.93	8.83	8.8	**9.37**
5	10.6	10.33	9.76	9.96	**10.16**
10	10.58	11.86	10.56	10.03	**10.75**
Mean	10.36	10.70	9.71	9.59	
5%LSD	C=0.65	M= 0.56	C.M=1.12		

Genetic parameters					
Inheritance in a broad sense %H²b.s	**genetic variance Ƈ²G**	**Phenotypic variance Ƈ²P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**

60.84	0.68	1.13	8.22	10.54	**13.21**
Statistical parameters					
Variation coefficient	**Standard Error**	**Mean**	**variance**		
6.58	0.19	10.1	**0.44**		

Table 5. Impact of cultivars, concentrations and interference between them in the spike length cm.

The number of grains in the spike

It is noted from Table (6) that there are significant differences between the cultivars in the number of per grains in spike, as the cultivar German recorded the highest average with 2.73 grains, while the cultivar Abu Ghraib recorded the lowest average for the trait reached62.43 grain. The same Table indicates that there are significant differences in interference between cultivars and concentration of mutagen as the highest value grain; as for genetic and statistical parameters, heritability reached 93.91%, and expected genetic improvement reached 27.17%, which indicates an expected genetic improvement, while the difference coefficient reached 0.99%.

mutant	**Cultivars**				
	Abu - Gharib	**Barcelona**	**German**	**French**	**Mean**
0	53.47	61.34	66.40	58.17	**59.85**
5	68.34	68.47	72.45	63.36	**68.16**
10	65.47	71.01	79.34	69.14	**71.24**
Mean	62.43	66.94	72.73	63.56	
5%LSD	C= 2.25	M= 1.94	C.M=3.89		
	Genetic parameters				
Inheritance in the broad sense %H^2b.s	**genetic variance σ^2G**	**Phenotypic variance σ^2P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**
93.91	81.68	86.98	13.61	14.04	**27.17**
Statistical parameters					
Variation coefficient	Standard Error	Mean	**variance**		
0.99	0.66	66.41	**5.3**		

Table 6. Impact of cultivars, concentrations and interference between them in the number of per grains in spike.

The weight of a thousand grain

Table 7 showed significant differences between the cultivars in the weight of a thousand grains, as the cultivar Barcelona recorded the highest average of 39.76 g. In contrast, the cultivar Abu–Garib recorded the lowest average for the trait, reaching g. It is clear from the weight of a thousand grains that there is a significant difference between concentrations of chemical mutagen, where the concentration of 10 Mm gave the highest value of 36.74 g. The same Table indicates that there are significant differences in interference between cultivars and concentration of mutagen as the highest value g; asAs for genetic and statistical parameters, expected genetic improvement reached 30.62% due to the high value of the heritability it reached 95.30%, while genetic and phenotypic difference coefficient reached 15.23%,15.60 % sequentially. In comparison, the difference coefficient reached 3.38%.

mutant	**Cultivars**				
	Abu - Gharib	**Barcelona**	**German**	**French**	**Mean**
0	30.28	35.40	32.03	32.17	**32.47**
5	34.33	41.59	34.21	34.46	**36.15**
10	34.57	42.28	35.51	34.59	**36.74**
Mean	33.06	39.76	33.92	33.74	
5%LSD	C=1.16	M= 1.00		C.M= 2.01	

	Genetic parameters				
Inheritance in a broad sense %H^2b.s	**genetic variance σ^2G**	**Phenotypic variance σ^2P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**
95.30	28.60	30.01	15.23	15.60	**30.62**

Statistical parameters			
Variation coefficient	**Standard Error**	**Mean**	**variance**
3.38	0.34	35.12	**1.41**

Table 7. The impact of cultivars, concentrations and interference between them in the weight of a thousand-grain.

Grain yield

It is noted from Table (8) that there are significant differences between the cultivars in the grains yield, as the cultivar Barcelona recorded the highest average It reached8.67 (ton. ha^{-1}). In contrast, the cultivar Abu Ghraib recorded the lowest average for the trait, reaching 6.90 (ton. ha^{-1}). It is clear from the grains yield table that there is a significant differ-

ence between concentrations of chemical mutagen, where the concentration of 10 Mm gave the highest grains, yield was 8.72(ton. ha^{-1}). The same Table indicates a significant difference in interference between cultivars and the concentration of mutagen as the highest value (ton. ha^{-1}). As for genetic and statistical parameters, heritability reached 95.75%, and expected genetic improvement reached 62.61%. This indicates an expected genetic improvement; the difference coefficient reached 6.55%.

mutant	**Cultivars**				
	Abu - Gharib	**Barcelona**	**German**	**French**	**Mean**
0	5.12	6.79	6.71	5.94	**6.14**
5	7.87	9.26	8.11	7.10	**8.09**
10	7.71	9.96	9.33	7.87	**8.72**
Mean	6.90	8.67	8.05	6.97	
5%LSD	C= 0.48	M= 0.42		C.M=0.84	

Genetic parameters					
Inheritance in a broad sense %H²b.s	**genetic variance ƈ²G**	**Phenotypic variance ƈ²P**	**genetic variation coefficient % GCV**	**coefficient of phenotypic variation %PCV**	**Expected genetic improvement %ΔG**
95.75	5.64	5.90	31.06	31.74	**62.61**

Statistical parameters			
Variation coefficient	**Standard Error**	**Mean**	**variance**
6.55	0.14	7.65	**0.25**

Table 8. The impact of cultivars, concentrations and interference between them in the grains yield.

Dissuasion

The variation of plant height in study cultivars is due to the difference between the cultivars and their genetic variation in the length of the phalanges, one of the characteristics that distinguished the cultivars, which agreed with [8]. It is clear from the plant height table that there is a significant difference between concentrations of chemical mutagen, where the concentration of 10 Mm gave the highest plant height was 106.28cm; this is due to the effect of chemical mutagen to increase the production of an increase in auxin and the gibberellins that work on the elongation of the plant [14].

The significant variation in leaf area is due to the difference between the cultivars and their natural variance in genetic installation, which agreed with [the 4] findings. It is clear from the flag leaf area table that there is a significant difference between concentrations of chemical mutagen where the concentration of 10 Mm gave the highest flag leaf area was 34.31 cm^2, and the reason for this is that the high concentration of chemical mutagen causes an in-

crease in cell division and leaf expansion[16].

The difference between the cultivars in number per spike is attributed to their variance in genetic installation, which agrees with the result of [6].

The difference between the number of spikes is due to the difference between the cultivars and their genetic nature, and This is the result agreed with[13]**.** On the other hand**, a** significant difference between concentrations of chemical mutagen is due to its chemical effect on enzymes responsible for metabolic reactions by plants, especially in growth areas, to increase their division and their elongation, and they are reflected in the increase in the spike length[5]**.**

The significant difference between the cultivars in spike length trait is attributed to their variation cultivars in the genetic installation, which is agreed with[17]**.** It is clear from Table 2 (plant height) that there is a significant difference between concentrations of chemical mutagen, where the concentration of 10 Mm gave the highest value of 71.24 grain, and this is due to the interaction of genetic factors with environmental factors**.**

This difference in the weight of a thousand grains is due to the efficiency of the cultivars in the ability to benefit from the products of photosynthesis. This is the result agreed with[11]**.** The reason for this is due to the effect of chemical mutagen in the content of photosynthesis pigments, which led to an increase in the products of photosynthesis and their transfer from the places of manufacture to the grains[1] for the same study trait.

The reason for the variation of the cultivar's grain yield is due to the different genetic nature of the varieties, which agreed with[15], while the reason for this is that the high concentration of chemical mutagen leads to an increase in the products of photosynthesis and an increase in the number of grains in the spike[19].

Conclusion

The study's results indicate that the use of chemical mutagenics has caused genetic variation in the genotypes, which was positively reflected in the studied traits, where we notice an increase in the rates of traits with an increase in the concentration of the mutagen as the characteristics of the yield and its components followed one direction with the growth characteristics in the higher concentration of the mutagen sodium azide. Therefore, we recommend the adoption of a concentration of 10% with the use of higher concentrations to know the ideal concentration at which the highest genetic variation occurs. We also note that the varieties have variations among themselves due to the effect of the chemical mutagen on them. The Barcelona variety excelled in the highest rate for the two characteristics of the weight of 1000 grains and the grain yield, while the German variety recorded the highest rate in the number of grains per spike; therefore, we note a broad genetic variance for these varieties using the mutagenic sodium azide. Thus, we recommend the adoption of the Barcelona and German varieties in other studies to know the stability of these varieties.

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