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EFFECT OF CULTIVARS AND CONCENTRATIONS OF THE CHEMICAL MUTAGEN SODIUM AZIDE ON SOME GROWTH, YIELD AND QUALITY OF SORGHUM (*SORGHUM BICOLOR* L.)

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Abstract

A field experiment was carried out in Ramadi city, Al-Bofraj area, in an agricultural field belonging to one of the farmers, located on longitude 43.27 and latitude 33.47, to know the effect of different concentrations of the chemical mutagen sodium azide on some growth characteristics, yield and components of three varieties of sorghum. During the spring season 2022 and using the RCBD randomized complete block design with three replications. Where the main plots occupied the mutagen concentrations with the control treatment (0, 0.5, 1 and 1.5) Mm and took the symbols (M0, M1, M2 and M3) sequentially, while the split plots were placed in the secondary plots and included (Enqath, Buhuth-70 and Lilo) and have symbols (V1, V2 and V3) sequentially.The studied cultivars also variation with each other as a result of their genetic nature, as the cultivar Lilo recorded the lowest number of days for flowering by 50% as it was earlier than the of the cultivars by 42.33 days, while the cultivar Bohuth-70 outperformed the highest rates for the traits, plant height was 229.50 cm, number of grains per head is 2505 grain head, and the yield of the plant is 71.87 g. plant^{-1}, and the harvest index is 23.62%. While in of protein content, the Lilo cultivar superior, recording highest rate of 13.50%. Results of indicated that the M3 concentration in the flowering date was 50% superior, as it was earlier in flowering and the number of days was less, which amounted to 39.78 days, while the concentration of 1 Mm was superior in all the studied traits and recorded the highest rates, as it reached 263.89 cm in the trait of plant height and 2579 head grains in the number of grains per head And 80.64 g of plants in the grain yield and 24.78% in the harvest index.

Keywords: Cultivars, Chemical Mutagen Sodium Azide, Growth, Sorghum, *Sorghum bicolor* L.

Introduction

Compared with many other cereal crops, *Sorghum bicolor* L. Moench sorghum is a salt and drought tolerant summer crop. It ranks fifth among cereal crops in terms of nutritional importance, after wheat, barley, rice and maize, as its grains are used as the main food for humans in many African countries and some other parts of the world. It also ranks fifth for cultivated areas and production after wheat, rice, maize and barley in the world [1]. The sorghum crop is characterized by its tolerance of environmental conditions that are not suitable for the production of other summer crops, especially extreme temperatures, drought and soil salinization [2]. Recently, it has been used in the production of biofuels and has become the second largest after yellow sorghum, and sorghum seeds contain an estimated 65% of starch. And 12-10% protein and 3% fat, in addition to containing vitamins, salts and minerals necessary for the growth of the body [3,4]. Its productivity rate is still low in Iraq compared to global production, as the cultivated area globally

reached 44,500 million hectares, with an estimated productivity of 63,500 million tons. In Iraq, the cultivated area of this crop reached 34,038 hectares, with a productivity of 64,627 tons [5].

Choosing the cultivar adapted or suitable for the environment in which it is grown is one of the first basic steps to ensure a good yield. It is better when cultivating sorghum in a specific area to use several types of different ripening groups in order to obtain high stability in the productivity of the variety [6].The selection of these productive varieties in this study is the most extensive and has a wide genetic base of genetic variations .Therefore, genetic variations for these varieties must be developed through the mutation technique using chemical and physical mutagens, which is a good source for studying the different effects and creating genetic variations and using them in breeding and improvement processes in many plants to improve and develop a specific trait such as increasing production or bearing different environmental stresses [4,7]. Use of improved varieties and mutagenicity with chemical mutagens comes at the forefront of the means that lead to reaching the global production rate. Varieties differ in many growth characteristics, yield and quality. In a study conducted by [8]. It was found that the(Yss-98) genotype recorded the shortest time to reach 50% flowering of 79 days, while the (Yss-10) genotype recorded the longest period to reach that stage. Also [9] found significant differences between the genotypes included in their study, genotype (Pak-china-1) recorded the highest mean of plant height, leaf area and grain yield. Main objective , Studying the effect of different concentrations of chemical mutagen sodium azide on three cultivars of sorghum for the purpose of developing genetic variations that improve the studied traits, both quantitatively and qualitatively.

Materials and Methods

A field experiment was carried out during the summer season 2022 in the land allocated to a field belonging to a farmer in the city of Ramadi, which is located at latitude 34.28° north and longitude 45.21° east and on the left of the Euphrates River. Three cultivars of sorghum were used in the experiment (Enqath, Lilo and Bohouth-70) and have symbols (V1, V2 and V3) sequentially. The seeds were soaked in the amount of (2000 grains) of each variety with distilled water and soaked with chemical mutagen, sodium azide, and the concentrations were (0, 0.5, 1 and 1.5) Mm took symbols (M0, M1, M2 and M3) sequentially . The soaking period was 30 minutes for each Varity, then it was washed with water for 5 minutes. The Split-plot RCBD with three replications where main plots concentrations , while sup-plots cultivars . Area of the experimental unit was (3 x 3 m^2) and included 6 lines with a length of 3 meters, and the distance between one line and another was 70 and between one hole and another 0.25 cm . The number of experimental units in each replicate was 12 experimental units, and the experimental units used 36 units [13]. Sowing the seeds of sorghum varieties at a depth of 4-5 cm, at a rate of 3 seeds per hole. The thinning process was carried out two weeks after germination, where one plant was kept in the hole so that the plant density became 57,142 plants per hectare. Five random plants were taken from the median lines of each experimental unit to study the following traits [14] . Number of days from planting up to

50% flowering, leaf area of the plant (cm^2 $plant^{-1}$), dry weight of the shoot, number of grains per head (grain $head^{-1}$), harvest index (%) and grain yield (ton ha^{-1})

Results and discussion

Table (1) shows the analysis of variance for the mean squares of the studied traits in sorghum. It was noted that there were significant differences for the cultivars and the mutants and for all the traits studied, except for the trait of protein ratio, where the average of the cultivars was not significant, while the concentrations of the chemical mutagen sodium azide showed significant differences for all the studied traits. The interaction between cultivars and mutagen concentrations showed significant differences for all the studied traits.

(Table 1): Analysis of variance, Mean of sum square of the studied traits:

Source of variation	D. F	Flowering 50%	Plant height	Number of grains per head	Grain yield	Harvest Index	Percentage of Protein
Replicate	2	4.861	34.194	2767	49.278	18.411	0.5420
Concentrations (M)	3	55.516**	39604.37**	98054**	1069.547**	58.619 **	0.3773 ns
Residual	6	0.935	18.343	4473	18.36	5.493	0.3899
Cultivars (V)	2	78.028**	7817.44**	74787**	79.747**	7.668*	1.4559 *
M x V	6	82.991**	20872.04**	492973**	1834.524**	58.970**	3.2528 **
Residual 2	13	4.875	9.931	3988	8.855	2.063	0.3772

Number of days from planting to 50% flowering

Table (2) shows the effect of different concentrations of sodium azide and several cultivars of sorghum on this trait. The cultivar Lilo early flowering and it took the least number of days of sowing to reach 50% flowering, which amounted to (42.23) days, while the late cultivar Enqath in flowering and took (43.58) days non significantly from the Buhuth -70 cultivar, which recorded a number of days amounted to (43.25) days. This is due to the different genetic nature of these Lines and their different response to the prevailing environmental conditions during the growth period, and this is consistent with [9] . It is show from the same table that the control treatment had earlier flowering than the others of the concentrations to reach 50% flowering amounted to (39.78). While the late in the concentration of 1.5 mm in the highest number of days amounted to (45.56) days, and the reason for this is due to the concentration in the river water above was active in the process of photosynthesis and contributed to the acceleration of the process of development and maturity of the organs, which led to the acceleration of flowering, and this is consistent with [12]. The results of the same table also indicate that the interaction between the factors of the study

indicates the direction of the behavior of cultivars with the mutagen in early flowering 50%, with a concentration of 0.5 mm with the cultivar Lilo, which reached (36.00) days.

(Table 2):Effect of cultivars and chemical mutagen sodium azide on 50% flowering

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	37.00	39.67	42.67	39.78
M1	45.67	46.33	36.00	42.67
M2	50.33	40.00	42.33	44.22
M3	41.33	47.00	48.33	45.56
Average	43.58	43.25	42.33	
L.S.D. 5%	V=1.91	V*M=3.228	M=1.115	

Plant height cm

Table (3) indicates a significant difference between cultivars in the plant height characteristic, as the cultivar Bohuth-70 gave a height of (229.50) cm, while the cultivar Enqath recorded the lowest plant height of (183.50) cm. This is due to the genetic differences of the cultivars, as well as to the cultivars' difference in the number of nodes and internodes, In addition to their difference in their content of hormones that work to elongate the cells, the long varieties contain more hormones than the short varieties, and this is consistent with what was reached [12 and 14]. The same table indicates in plant height that there are significant differences between the concentrations of the mutagen, as the concentration (1 Mm) gave the highest rate of (263.89) cm, while the lowest rate for this characteristic was in the control treatment, which recorded 128.67 cm. The reason for this is due to the fact that the above concentration caused genetic variation in the cultivars and led to activating the photosynthesis process, increasing the division of living cells, and encouraging the growth of meristematic tissues of the plant [15 and 17]. It is also noted from the same table that there is a significant effect of the overlap, as the highest rate of increasing the behavior of the trait was due to plant height in the Enqath cultivar with a concentration of (1 Mm), which amounted to (336.00) cm.

(Table 3):- Effect of cultivars and chemical mutagen sodium azide on Plant high

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	122.00	129.67	134.33	128.67
M1	121.00	304.67	320.33	248.67
M2	336.00	312.33	143.33	263.89
M3	155.00	171.33	151.33	159.22
Average	183.50	229.50	187.33	
L.S.D. 5%	V=2.727	V*M=6.12	M=4.94	

Number of grains per head

Table (4) The cultivars differed significantly among in the number of grains per head, as the cultivar Bohuth-70 recorded the highest rate of (2505) grains / head. While the cultivar Lilo gave a lower rate for this trait, which amounted to (2364) grains / head . Difference in number of grains per head is affected by the different genotype more than the environmental effect . Increasing the height of the head and increasing its diameter led to an increase in the number of grains in the head. This result is consistent with what was reached by [18]. The same table indicates that there are significant differences between the concentrations of the mutagenic sodium azide, where the concentration (2Mm) gave the highest average, amounting to 2579 grains of head. While the concentration of 1.5 mm gave the lowest rate for this characteristic, amounting to 2324 grains of head. The reason for this is due to the fact that the concentration of 1 mm caused genetic variation in the cultivars. It was also observed through the results of the trait that there were significant differences in the overlap between the cultivars and the concentrations of the chemical mutagen, as the cultivar Enqath with a concentration of 1 Mm recorded the highest rate of behavior of the trait towards the significant increase, which amounted to 3198 grains of head.

(Table 4):Effect of cultivars and chemical mutagen sodium azide on number of grains per head

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	2217	2841	2322	2460
M1	2239	2809	2325	2458
M2	3198	2178	2361	2579
M3	2332	2191	2448	2324
Average	2496	2505	2364	
L.S.D. 5%	V=54.7	V*M=109.3	M=77.1	

Grain yield (g. plant^{-1})

Table (5) indicates that the cultivars differed significantly in the characteristic of grain yield. The cultivar Bohuth-70 gave the highest rate of 71.87 g. plant^{-1}, which non-significantly from the cultivar Enqath, which recorded an average of 71.11 gm of plant, while the lowest rate for this trait amounted to 67.08 g. plant^{-1} in Lilo cultivar. Cause for this is the genetic differences between the varieties, in addition to the superiority of the Bohuth-70 variety in some growth and yield characteristics, which was positively reflected on the final grain yield [10,11]. Results in the same table also indicated that there were significant differences in the concentrations of the mutagenic sodium azide with the control treatment, as the concentration of 2 Mm gave the highest rate of grain yield, which amounted to 80.61 g plant^{-1}. This is due to the effect of the stimulating mutagen on the biometabolism of the plant [15, 16]. While the lowest rate for this characteristic was 55.38 g. plant^{-1} at a concentration of (1.5Mm), which indicates that very high concentrations caused a

clear decrease in grain yield due to the high concentrations of the mutagen, which affected the activity of the processes metabolism, which reflected negatively on yield components and other growth traits. The results of the same table indicate that there is a significant difference in the seed yield between the study factors, as the treatment (Buhuth -70 × M2) gave a clear increase in the behavior of the seed yield, which amounted to 116.88 g plant^{-1}.

(Table 5):Effect of cultivars and chemical mutagen sodium azide on Grain yield (g. plant^{-1})

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	86.52	56.02	63.71	68.75
M1	98.24	59.83	67.96	75.34
M2	48.64	116.88	76.32	80.61
M3	51.05	54.76	60.32	55.38
Average	71.11	71.87	67.08	
L.S.D. 5%	V=2.575**	V*M=5.969**	M=4.943**	

Harvest Index %

It was noted from Table (6) that there was a significant effect of cultivars on the characteristics of the harvest index, as the research-70 variety recorded the highest rate of 23.62%, which did not differ significantly from the Enqath variety, while the harvest index decreased in the Lilo variety and recorded the lowest rate of 22.20% due to the reason for this. to the genetic differences of the cultivar. Results in the same table also indicate that the concentrations of the mutagen, sodium azide, differed and had a significant effect on the same characteristic, as it was found that the concentration 1Mm recorded the highest rate for this amounting to 24.78%. While the response by increasing the concentrations of the mutagen caused a clear decrease in this trait and reached 19.34%, which means that the high concentrations of the mutagen are negatively affected by the harvest index [16,20]. Also, the results of the overlap in the same table differed significantly among the study factors, as the treatment (V2 x 1 mm) gave rate of 31.08%.

(Table 6):Effect of cultivars and chemical mutagen sodium azide on Harvest Index%

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	27.26	21.99	22.13	23.79
M1	29.16	22.07	22.43	24.55
M2	19.13	31.08	24.13	24.78
M3	18.58	19.36	20.09	19.34
Average	23.53	23.62	22.20	23.12

L.S.D. 5%	V=1.243	V*M=3.113	M=2.704

Percentage of Protein%

The results of Table 7 showed that there were significant differences in the protein percentage in the seeds with the effect of three sorghum cultivars, as the Lilo cultivar recorded the highest rate of protein percentage in the seeds amounted to 13.50%, while the lowest rate reached 12.83% in the cultivar Enqath, and this result is a clear response to the genetic variation of the cultivars on these trait in addition to the influence of environmental conditions [11,19]. The percentage of protein in the seeds of the same table was non-significantly affected by the concentrations of the chemical mutagen sodium azide. While the results in the same table confirmed a significant effect of the interaction between the study factors in the characteristic, as the treatment (V3 x M0) superiority highest rate of 14.67%.

(Table 7): Effect of cultivars and chemical mutagen sodium azide on Percentage of Protein%

Varieties / Concen.	Enqath	Buhuth-70	Lilo	Average
M0	11.75	13.13	14.67	13.19
M1	12.51	12.07	13.85	12.81
M2	14.02	13.10	12.61	13.24
M3	13.03	13.77	12.88	13.22
Average	12.83	13.02	13.50	13.12
L.S.D. 5%	V=0.532	V*M=1.047	M=0.720ns	

Conclusion

It is clear from the above results that the cultivars used in the study have variation genetically, in addition to the effect of the chemical mutagenic sodium azide, which caused a clear variation in the cultivars with its different concentrations through the studied traits. It was found that the use of high concentrations of the mutagen caused a clear decrease in the rates of the trait as a result of the high toxicity of the mutagen on the metabolic processes. The results of the study confirmed in most of the studied traits that the mutagen in the concentration of 1Mm caused the creation of genetic variation among the cultivars and for most of the traits, which contributed to the high rates of the studied traits. The concentration of 1 mm recorded the highest rates in the characteristics of plant height, number of grains per head, grain yield and harvest index. And when there was an overlap between the cultivars and the chemical mutagen, it was observed that the cultivar Bohuth-70 with (1Mm) mutagen recorded the highest rates and for most of the traits.

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