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Research Article
Effect of Sodium Azide on Yield and its Components in Bread Wheat (*Triticum aestivum* L.)

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Abstract
Background and Objective: The wheat crop is considered one of the most important crops globally, especially in Egypt. It has great nutritional importance, so it was necessary to increase productivity and any genetic improvement depends on the presence of many genetic differences so that breeders can achieve this. This study aimed to use chemical mutagenic (sodium azide) to obtain the desired genetic differences in two wheat cultivars. **Materials and Methods:** Two types of bread Sids 12 and Giza 164 were treated with different concentrations of sodium azide (NaN_3) (1000, 2000, 3000, 4000, 5000 and 6000 ppm). **Results:** The highest grain/plant 78.91 g was obtained from Sis12 and 62.96 g from Giza 164 compared to the control 42.57 and 40.24 g for Sids 12 and Giza 164, respectively. Also from the results obtained, the relationship of yield was positive and significant with both grain/spike, spikelet's no./spike spikes no./plant and height/plant. On the contrary, it was negative and significant with a 1000-grain weight (-0.433). **Conclusion:** The two treatments (1000 and 2000 ppm) were the best in the Sids 12, while (1000 and 5000 ppm) were the best treatments in the Giza 164.

Key words: Sodium azide, bread wheat, height/plant, correlation, significant

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widespread and widely used cereal crop in the world, providing the nutritional needs of millions of people. Hence the importance of wheat and the attempt to genetic improvement from trying to increase productivity and trying to acquire traits that make it more resistant to unsuitable environmental conditions and this requires the provision of large genetic variance For the selection programs for this crop to succeed, therefore, it resorted to making those mutations using mutagens through which new genotypes are obtained. It determines its productivity or increases its quality. Sakin[1] showed that mutations can determine induced variation in yield and other quantitative traits such as plant height, number of fertile tillering and spike length of M_2 and M_3 generations of the wheat cultivar. Dhole *et al.*[2] two types of soybean, JS-80-21 and Bragg are treated with EMS found in Generation M_1 and M_2 increased contrast rate for most quantity characters. Begum and Dasgupta[3] has conducted a study on three genetic types of sesame that have been physically and chemically treated and their effectiveness and efficiency have been estimated in the M_2 generation. Chemical treatment was the most effective for inducing mutagenesis. Srivastava *et al.*[4] studied sodium azide-induced polygenicity in wheat variety, there was a clear change in stem length, root length and plant length. As explained by Nura *et al.*[5], chemical mutations are one of the methods that are considered an effective and wonderful tool in modifying the yield and quality characteristics of the crop. The current study aimed to make mutations in the crop characteristics and yield components of bread wheat by using mutagenic sodium azide with the possibility of entering the obtained genotypes into a breeding program to obtain new varieties.

MATERIALS AND METHODS

Study area: This research was carried out over 2 years, the first in 2018/2019 and the second in 2019/2020. The experiment was carried out at the Faculty of Agriculture in Egypt in Assiut, Al-Azhar University.

Methodology: Two Egyptian wheat cultivars were used in the mutational treatment, namely Sids 12 and Giza 164. these genotypes were obtained from the National Research Center in Cairo, Egypt. At three different concentrations of sodium azide (1000, 2000, 3000, 4000, 5000 and 6000 ppm) these chemical compositions were obtained from the Central Laboratory, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt. Five hundred soft wheat grains were soaked in distilled water for 20 hrs as a control treatment. The variables selected in this study included the obvious morphological traits, plant height (cm), spike no./plant, spikelet's no./spike, grains no./spike, weight 1000-grain (g) and grain yield/plant (g).

Sodium azide: Five hundred seeds from each variety were soaked in a prepared aqueous solution of sodium azide of six different concentrations (1000 ppm = SA_1), (2000 ppm = SA_2), (3000 ppm = SA_3), (4000 ppm = SA_4), (5000 ppm = SA_5) and (6000 ppm = SA_6) for 20 hrs. Heritability in the narrow sense was estimated utilizing components of variance and regression. This study, used parent-offspring regression as an estimate of heritability. The wheat crop was treated with the recommended treatments.

Statistical analysis: Data were analyzed using a Randomized Complete Block Design (RCBD).

Narrow sense heritability was estimated using correlation and descent regression[6].

RESULTS

The significant results for the first and second seasons of the study were presented in Table 1. All mutations resulting from chemical mutation treatments for two cultivars of bread wheat were one Sids 12 and Giza 164, with Significantly high for all treatments in the following traits: Plant height (cm), spike no./plant, spikelet's no./spike, grains no./spike, weight 1000-grain (g) and grain yield/plant (g). Table 1 showed the characteristics of the traits. It was clear from the presented results that the mutants differed from the original plants that were not irradiated or chemically treated in the previous two types of bread wheat one-sixth 12 and Giza 164 in the above-mentioned characteristics. The results showed that all chemical treatments led to mutations in the two cultivars of Egyptian bread wheat Sids 12 and Giza 164. All of the above-mentioned traits averages were M_2 plants higher on average than M_1 plants except grains no./spike and spike no./plant. The average of the plants in M_2 was superior to the M_1 plants as well as the untreated plants. The highest plant height was obtained in the chemically treated plants in Sids 12 SA_1 and Giza 164 SA_4 genotypes with a value of 123.85 and 120.85 cm compared to control 113.55 and 107.46, respectively. Also, the highest number of spikes/plant was obtained in chemically treated plants, the genotype was Sids 12 SA_1 and Giza 164 SA_2 with a value of 22.28 and 21.45 spikes compared to the control 13.24 and 12.89 spikes/plant, respectively. Also, the highest number of spikelets/spike was obtained in chemically

Table 1: Means and variances for bread wheat genotypes under different treatments of sodium azide through generations

	Plant height (cm)				Spike no./plant				Spikelets no./spike			
	Means		Variance		Means		Variance		Means		Variance	
Treatments	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
Sids 12 SA_1	119.34	123.85	29.64**	35.57**	22.89	22.28	3.44**	5.38**	22.56	25.25	0.98	2.807*
Sids 12 SA_2	111.46	112.85	16.92**	15.88**	20.77	21.10	2.56*	2.44*	19.34	21.41	0.86	0.77
Sids 12 SA_3	112.66	116.92	11.36*	13.78*	17.55	15.88	1.05	2.44*	18.47	19.35	1.02*	1.11*
Sids 12 SA_4	113.56	118.63	26.45**	28.34**	13.89	13.08	3.03**	4.23**	20.24	23.00	0.97	1.05*
Sids 14 SA_5	115.78	119.63	17.35**	17.97**	16.77	13.08	1.99*	2.11*	21.45	23.00	1.05*	1.09*
Sids 12 SA_6	114.98	118.94	22.89**	23.89**	18.86	18.13	1.65*	2.15*	19.75	22.62	1.08	1.12*
Control	110.45	113.55	5.66	7.33	12.34	13.24	1.03	1.09	13.76	14.56	0.76	0.82
Giza 164 SA_1	109.66	120.50	12.45*	11.55*	19.56	18.84	1.98*	2.05*	17.56	22.26	0.88	0.98
Giza 164 SA_2	111.66	113.64	12.88*	18.45**	17.34	21.45	1.86*	1.97*	18.34	20.82	0.89	1.01*
Giza 164 SA_3	117.55	113.18	16.78**	17.56**	18.45	17.45	2.32*	2.46*	19.45	19.45	1.02*	1.05*
Giza 164 SA_4	116.99	120.85	17.22**	17.99**	16.34	17.38	3.11**	4.56**	16.45	21.96	1.06*	1.13*
Giza 164 SA_5	118.47	120.65	22.55**	19.44**	15.45	16.28	2.21*	2.13*	18.23	19.88	0.98	0.89
Giza 164 SA_6	115.67	120.64	19.33**	22.89**	16.99	15.33	3.45**	4.55**	19.18	21.21	1.07*	1.14*
Control	99.45	107.46	8.23	9.98	11.22	12.89	1.44	1.49	12.44	13.56	0.75	0.80

	Grains no./spike				Weight 1000-grain (g)				Grain yield/plant (g)			
	Means		Variance		Means		Variance		Means		Variance	
Treatments	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
Sids 12 SA_1	3.30	2.96	0.89*	0.92*	51.29	54.62	21.28**	31.35**	75.34	78.91	41.49**	44.45**
Sids 12 SA_2	3.18	2.90	0.79*	0.86*	51.34	53.72	34.88**	17.89**	65.77	69.68	18.45**	37.89**
Sids 12 SA_3	3.56	2.99	0.99*	1.01*	50.67	51.90	12.87**	16.88**	62.34	67.37	15.78**	34.56**
Sids 12 SA_4	4.09	3.09	1.05*	1.09*	49.45	52.64	33.67**	43.89**	63.67	68.72	32.56**	48.45**
Sids 14 SA_5	3.61	3.02	1.11*	1.15*	52.67	52.62	56.98**	60.22**	60.56	68.71	19.49**	35.46**
Sids 12 SA_6	3.02	3.24	0.97*	1.02*	50.88	53.35	43.78**	55.78**	56.66	66.37	45.32**	33.29**
Control	2.27	3.21	0.50	0.55	48.78	51.33	10.78	13.45	40.45	42.57	9.46	12.05
Giza 164 SA_1	2.62	2.97	1.06*	1.08*	50.45	52.72	22.87**	29.76**	51.44	62.96	27.98**	37.45**
Giza 164 SA_2	3.19	2.70	0.98*	1.03*	52.66	53.97	34.99**	39.96**	55.34	54.74	38.57**	47.98**
Giza 164 SA_3	3.23	2.52	1.12*	1.16*	53.76	53.27	23.44**	29.93**	59.67	56.89	28.55**	37.24**
Giza 164 SA_4	3.32	3.06	0.83*	0.95*	54.87	56.19	17.77**	20.55**	54.32	61.29	25.78**	39.94**
Giza 164 SA_5	3.89	3.01	0.89*	0.96*	51.89	58.28	70.44**	66.32**	60.23	58.22	50.48**	43.29**
Giza 164 SA_6	3.36	3.13	0.75*	0.83*	54.66	55.25	60.32**	56.77**	57.21	61.40	15.78**	37.98**
Control	2.42	2.71	0.45	0.53	50.35	53.55	15.31	17.22	38.45	40.24	11.46	12.68

*Significant at 5% level of significance and **Significant at 1% level of significance

treated plants, genotype Sids 12 SA_1 and Giza 164 SA_1 were valued at 25.25 and 22.26 spikelet/spike compared to control 13.24 and 13.56 spikelets/spike, respectively. The highest grains no./spike was obtained in the chemically treated plants in Sids 12 SA_4 and Giza 164 SA_4 genotypes with a value of 3.09 and 3.06 (g) compared to control 3.12 and 2.70 (g), respectively. Also, the highest weight of 1000-grain (g) was obtained in chemically treated plants, the genotype was Sids 12 SA_1 and Giza 164 SA_5 with a value of 54.62 and 58.28 (g) compared to the control 51.33 and 53.55 (g) respectively. The highest grain yield/plant (g) was obtained in the chemically treated plants in Sids 12 SA_1 and Giza 164 SA_1 genotypes with a value of 78.91 and 62.96 (g) compared to control 42.57 and 40.24 (g) respectively. Table 2 presents the traits under study mentioned previously for two cultivars of Egyptian bread wheat Sids 12 and Giza 164 for M_1 after applying mutagenic treatments. It is clear from the presented results that the highest values of mutations in cultivar Sids 12 are 122.89, 27.11, 26.78, 6.35, 55.78 and 79.56 for plant height (cm), spike no./plant, spikelets no./spike, grains no./spike, weight 1000-grain (g) and grain yield/plant (g) respectively. While the highest values of mutations in cultivar Giza 164 were 121.8, 23.78, 22.96, 7.54, 59.09 and 63.56 for plant height (cm), spike no./plant, spikelets no./spike, grains no./spike, weight 1000-grain (g) and grain yield/plant (g) respectively.

Table 3 shows the number of plants in M_1 and M_2 for the two cultivars. The number of plants in cultivar Sids 12 was (9 and 6), (8 and 6), (7 and 6), (9 and 6) and (8 and 6 plants) for SA_1, SA_2, SA_3, SA_4, SA_5 and SA_6 in M_1 and M_2, respectively. While the number of plants in cultivar Giza 164 was (8 and 5), (9 and 5), (8 and 5), (8 and 5) and (7 and 5 plants) for SA_1, SA_2, SA_3, SA_4, SA_5 and SA_6 in M_1 and M_2, respectively. In Table 4 the

Table 2: List of mutants chosen in M_1 generation of Sids 12 and Giza 164 cultivar in 2018/2019 of bread wheat

Treatments	Plant height	Spike no./plant	Spikelets no./spike	Grains no./spike	Weight 1000-grain (g)	Grain yield/plant (g)
Sids 12 SA_1						
1	122.56	26.11	25.78	4.52	54.51	78.56
2	116.12	19.67	19.34	2.08	48.07	72.12
3	123.56	27.11	26.78	4.52	55.51	79.56
4	115.12	18.67	18.34	3.00	47.07	71.12
5	122.01	25.56	25.23	3.05	53.96	78.01
6	116.67	20.22	19.89	3.13	48.62	72.67
7	122.89	26.44	26.11	3.85	54.84	78.89
8	115.84	19.39	19.06	2.5	47.79	71.84
9	119.29	22.84	22.51	3.05	51.24	75.29
Sids 12 SA_2						
1	114.02	23.33	21.90	4.74	53.9	68.33
2	108.9	18.21	16.78	1.62	48.78	63.21
3	114.79	24.1	22.67	5.51	54.67	69.1
4	108.13	17.44	16.01	2.50	48.01	62.44
5	114.44	23.75	22.32	3.01	54.32	68.75
6	108.48	17.79	16.36	1.52	48.36	62.79
7	114.57	23.88	22.45	5.29	54.45	68.88
8	108.35	17.66	16.23	1.07	48.23	62.66
Sids 12 SA_3						
1	116.21	21.1	22.02	4.11	54.22	65.89
2	109.16	14.05	14.97	2.06	47.17	58.84
3	112.61	17.5	18.42	3.51	50.62	62.29
4	115.54	20.43	21.35	3.44	53.55	65.22
5	109.78	14.67	15.59	3.68	47.79	59.46
6	116.17	21.06	21.98	5.07	54.18	65.85
7	109.15	17.11	14.96	3.05	47.16	58.83
Sids 12 SA_4						
1	109.34	10.67	23.46	4.31	52.67	66.89
2	116.23	18.11	17.02	2.74	46.23	60.45
3	110.89	9.67	24.46	4.31	53.67	67.89
4	117.11	16.56	16.02	3.00	45.23	59.45
5	110.06	11.22	22.91	3.76	52.12	66.34
6	113.51	17.44	17.57	3.42	46.78	61
7	109.34	10.39	23.79	7.64	53	67.22
8	116.23	13.84	16.74	1.59	45.95	60.17
9	110.89	17.11	20.19	3.04	49.4	63.62
Sids 12 SA_5						
1	118.34	19.33	24.01	6.17	55.23	63.12
2	113.22	14.21	18.89	1.05	50.11	58
3	119.11	20.1	24.78	6.94	56	63.89
4	112.45	13.44	18.12	1.28	49.34	57.23
5	118.76	19.75	24.43	5.59	55.65	63.54
6	112.8	13.79	18.47	1.63	49.69	57.58
7	118.89	19.88	24.56	3.72	55.78	63.67
8	112.67	13.66	18.34	2.5	49.56	57.45

Table 2: Continue

Treatments	Plant height	Spike no./plant	Spikelets no./spike	Grains no./spike	Weight 1000-grain (g)	Grain yield/plant (g)
Sids 12 SA$_6$						
1	117.54	21.42	22.31	2.18	53.44	59.22
2	112.42	16.3	17.19	1.46	48.32	54.1
3	118.31	22.19	23.08	6.35	54.21	59.99
4	111.65	15.53	16.42	1.5	47.55	53.33
5	117.96	21.84	22.73	3.7	53.86	59.64
6	112	15.88	16.77	0.54	47.9	53.68
7	118.09	21.97	22.86	6.13	53.99	59.77
8	111.87	15.75	16.64	2.3	47.77	53.55
Control	110.45	12.34	13.76	2.27	48.78	40.45
Giza 164 SA$_1$						
1	112.88	22.78	20.78	5.84	53.67	54.66
2	106.44	16.34	14.34	3.6	47.23	48.22
3	113.88	23.78	21.78	6.84	54.67	55.66
4	105.44	15.34	13.34	3.6	46.23	47.22
5	112.33	22.23	20.23	5.29	53.12	54.11
6	106.99	16.89	14.89	4.05	47.78	48.77
7	113.21	23.11	21.11	6.17	54	54.99
8	106.11	16.01	14.01	2.93	46.9	47.89
Giza 164 SA$_2$						
1	114.22	19.9	20.9	5.75	55.22	57.9
2	109.1	14.78	15.78	2.63	50.1	52.78
3	114.99	20.67	21.67	6.52	55.99	58.67
4	108.33	14.01	15.01	4.14	49.33	52.01
5	114.64	20.32	21.32	6.17	55.64	58.32
6	108.68	14.36	15.36	2.21	49.68	52.36
7	114.77	20.45	21.45	6.3	55.77	58.45
8	110.55	16.23	17.23	2.08	51.55	54.23
9	109.66	15.34	16.34	1.19	50.66	53.34
Giza 164						
1	121.1	22	23	6.78	57.31	63.22
2	114.05	14.95	15.95	3.27	50.26	56.17
3	117.5	18.4	19.4	3.18	53.71	59.62
4	120.43	21.33	22.33	6.11	56.64	62.55
5	114.67	15.57	16.57	3.35	50.88	56.79
6	121.06	21.96	22.96	6.74	57.27	63.18
7	116.26	17.16	18.16	1.94	52.47	58.38
8	115.33	16.23	17.23	1.01	51.54	57.45
Giza 164 SA$_4$						
1	120.21	19.56	19.67	6.54	58.09	57.54
2	113.77	13.12	13.23	4.1	51.65	51.1
3	121.21	20.56	20.67	7.54	59.09	58.54
4	112.77	12.12	12.23	3.9	50.65	50.1
5	119.66	19.01	19.12	5.99	57.54	56.99
6	114.32	13.67	13.78	2.65	52.2	51.65
7	120.54	19.89	20	6.87	58.42	57.87

Table 2: Continue

Treatments	Plant height	Spike no./plant	Spikelets no./spike	Grains no./spike	Weight 1000-grain (g)	Grain yield/plant (g)
8	113.49	12.84	12.95	2.18	51.37	50.82
9	116.94	16.29	16.4	3.27	54.82	54.27
Giza 164 SA_5						
1	121.03	18.01	20.79	6.45	54.45	62.79
2	115.91	12.89	15.67	3.33	49.33	57.67
3	121.8	18.78	21.56	7.22	55.22	63.56
4	115.14	12.12	14.9	4.56	48.56	56.9
5	121.45	18.43	21.21	6.87	54.87	63.21
6	115.49	12.47	15.25	2.91	48.91	57.25
7	121.58	18.56	21.34	7	55	63.34
8	115.36	12.34	15.12	1.78	48.78	57.12
Giza 164 SA_6						
1	118.23	19.55	21.74	5.92	57.22	59.77
2	112.11	13.43	15.62	3.2	51.1	53.65
3	119	20.32	22.51	6.69	57.99	60.54
4	111.34	12.66	14.85	3.97	50.33	52.88
5	118.65	19.97	22.16	6.34	57.64	60.19
6	112.69	14.01	16.2	2.38	51.68	54.23
7	117.67	18.99	21.18	5.36	56.66	59.21
Control	99.45	11.22	12.44	2.42	50.35	38.45

Table 3: Number of selected mutant plants in M_1 and M_2 generations

Treats	M_1	M_2
Sids 12 SA_1	9	6
Sids 12 SA_2	8	6
Sids 12 SA_3	7	6
Sids 12 SA_4	9	6
Sids 12 SA_5	8	6
Sids 12 SA_6	8	6
Giza 164 SA_1	8	5
Giza 164 SA_2	9	5
Giza 164 SA_3	8	5
Giza 164 SA_4	9	5
Giza 164 SA_5	8	5
Giza 164 SA_6	7	5

Table 4: Variations and parent-offspring regression in mutated plants derived from sodium azide treatments

	Plant height (cm)		Spike no./plant		Spikelets no./spike		Grains no./spike		Weight 1000-grain (g)		Grain yield/plant (g)	
Treatments	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
Sids 12 SA_1												
1	122.56	124.56	26.11	26.78	25.78	25.78	4.52	3.23	54.51	55.98	78.56	79.56
2	116.12	119.45	19.67	17.67	19.34	20.34	2.08	2.88	48.07	50.34	72.12	75.56
3	123.56	124.89	27.11	27.98	26.78	27.46	4.52	3.24	55.51	57.39	79.56	80.78
5	122.01	126.54	25.56	22.56	25.23	26.45	3.05	2.43	53.96	55.34	78.01	80.98
7	122.89	125.78	26.44	18.45	26.11	27.89	3.85	2.89	54.84	55.98	78.89	79.56
9	119.29	121.90	22.84	20.23	22.51	23.56	3.05	3.11	51.24	52.66	75.29	76.99
Sids 12 SA_2												
1	114.02	116.55	23.33	24.24	21.9	22.77	4.74	3.85	53.9	54.44	68.33	70.07
2	108.9	111.45	18.21	19.35	16.78	17.56	1.62	2.11	48.78	50.46	63.21	69.55
3	114.79	109.44	24.1	22.11	22.67	23.45	5.51	3.55	54.67	55.45	69.1	70.33
5	114.44	108.55	23.75	22.22	22.32	23.35	3.01	2.76	54.32	55.67	68.75	70.45
7	114.57	117.88	23.88	21.78	22.45	23.98	5.29	3.06	54.45	55.77	68.88	69.34
8	108.35	113.23	17.66	16.89	16.23	17.35	1.07	2.05	48.23	50.50	62.66	68.35
Sids 12 SA_3												
1	116.21	117.98	21.1	22.24	22.02	23.44	4.11	3.25	54.22	55.09	65.89	69.56
2	109.16	119.34	14.05	16.89	14.97	16.67	2.06	2.01	47.17	49.56	58.84	65.44
3	112.61	119.56	17.5	14.89	18.42	19.98	3.51	2.92	50.62	51.45	62.29	67.89
5	109.78	116.98	14.67	12.45	15.59	16.78	3.68	2.67	47.79	49.99	59.46	65.45
6	116.17	115.56	21.06	14.89	21.98	22.55	5.07	4.02	54.18	50.56	65.85	69.56
7	109.15	112.09	17.11	13.89	14.96	16.65	3.05	3.09	47.16	54.77	58.83	66.34
Sids 12 SA_4												
1	109.34	116.98	10.67	11.34	23.46	24.44	4.31	3.08	52.67	53.33	66.89	70.33
3	110.89	114.67	9.67	12.56	24.46	25.55	4.31	3.22	53.67	54.87	67.89	70.45
4	117.11	119.45	16.56	17.35	16.02	18.34	3.00	2.66	45.23	49.76	59.45	68.46
5	110.06	120.35	11.22	12.89	22.91	24.11	3.76	2.34	52.12	53.33	66.34	68.09
7	109.34	118.90	10.39	10.02	23.79	23.98	7.64	4.27	53	53.44	67.22	69.78
9	110.89	121.45	17.11	14.34	20.19	21.59	3.04	2.55	49.40	51.12	63.62	65.22
Sids 12 SA_5												
1	118.34	120.23	19.33	20.45	24.01	25.55	6.17	4.03	55.23	56.02	63.12	67.88
3	119.11	121.77	20.1	19.34	24.78	25.54	6.94	3.85	56.00	56.08	63.89	65.89
4	112.45	115.34	13.44	16.87	18.12	19.22	1.28	2.56	49.34	51.55	57.23	66.05
5	118.76	119.34	19.75	20.23	24.43	25.99	5.59	3.98	55.65	55.99	63.54	67.09
6	112.8	114.87	13.79	16.34	18.47	19.95	1.63	2.44	49.69	50.23	57.58	65.12
8	112.67	122.08	13.66	15.56	18.34	19.45	2.50	2.56	49.56	50.22	57.45	66.16
Sids 12 SA_6												
1	117.54	119.34	21.42	22.45	22.31	23.35	2.18	2.23	53.44	54.22	59.22	65.19
3	118.31	124.56	22.19	20.34	23.08	24.23	4.35	4.22	54.21	55.09	59.99	64.88
5	117.96	119.34	21.84	18.98	22.73	23.67	3.70	2.78	53.86	54.08	59.64	62.48
6	112	119.45	15.88	16.96	16.77	17.99	2.54	2.11	47.9	49.05	53.68	61.11
7	118.09	121.98	21.97	17.87	22.86	24.42	6.13	3.95	53.99	54.09	59.77	62.09
8	111.87	118.91	15.75	16.46	16.64	19.88	2.30	2.55	47.77	49.78	53.55	62.01
Giza 164 SA_1												
1	112.88	114.67	22.78	23.09	20.78	21.25	4.23	3.23	53.67	54.45	54.66	55.26
3	113.88	115.45	23.78	21.12	21.78	22.56	4.17	3.45	54.67	55.89	55.66	57.35
5	112.33	113.78	22.23	23.45	20.23	21.98	3.24	2.65	53.12	54.56	54.11	56.67
7	113.21	114.88	23.11	21.12	21.11	22.89	2.26	2.04	54	55.88	54.99	55.56
8	106.11	109.44	16.01	18.45	14.01	15.44	2.93	2.15	46.9	49.04	47.89	48.88
Giza 164 SA_2												
1	114.22	116.33	19.9	20.23	20.9	21.22	3.75	3.11	55.22	56.66	57.9	58.56
3	114.99	115.55	20.67	18.45	21.67	22.33	5.52	3.25	55.99	56.09	58.67	59.45
4	108.33	110.49	14.01	16.34	15.01	16.87	2.02	2.01	49.33	50.23	52.01	53.67
8	110.55	112.85	16.23	17.22	17.23	18.99	2.08	2.11	51.55	52.22	54.23	57.44
9	109.66	110.66	15.34	15.09	16.34	17.82	2.19	2.11	50.66	51.16	53.34	55.34

Table 4: Continue

Treatments	Plant height (cm) M_1	Plant height (cm) M_2	Spike no./plant M_1	Spike no./plant M_2	Spikelets no./spike M_1	Spikelets no./spike M_2	Grains no./spike M_1	Grains no./spike M_2	Weight 1000-grain (g) M_1	Weight 1000-grain (g) M_2	Grain yield/plant (g) M_1	Grain yield/plant (g) M_2
Giza 164 SA_3												
1	121.1	122.34	22	19.23	23	23.87	4.31	3.35	57.31	58.33	63.22	64.44
3	117.5	119.12	18.4	17.06	19.4	20.17	3.18	2.89	53.71	54.02	59.62	60.11
4	120.43	121.13	21.33	19.45	22.33	23.67	4.11	3.23	56.64	57.76	62.55	60.33
6	121.06	123.89	21.96	17.03	22.96	23.09	6.74	3.67	57.27	58.09	63.18	62.34
8	115.33	117.78	16.23	14.11	17.23	18.98	1.01	2.13	51.54	52.77	57.45	59.22
Giza 164 SA_4												
1	120.21	121.32	19.56	16.21	19.67	20.34	4.54	3.13	58.09	59.32	57.54	58.34
3	121.21	122.88	20.56	15.88	20.67	21.21	3.72	2.87	59.09	59.11	58.54	60.17
5	119.66	120.09	19.01	17.33	19.12	20.06	5.99	3.34	57.54	58.08	56.99	57.75
7	120.54	121.78	19.89	17.33	20	20.05	3.51	3.17	58.42	59.54	57.87	58.88
9	116.94	116.92	16.29	14.67	16.4	17.75	3.27	2.56	54.82	55.34	54.27	55.98
Giza 164 SA_5												
1	121.03	122.45	18.01	15.25	20.79	21.33	4.45	3.77	54.45	55.89	62.79	63.02
3	121.8	123.45	18.78	17.02	21.56	22.39	4.22	3.24	55.22	56.45	63.56	63.98
5	121.45	118.45	18.43	15.92	21.21	22.67	4.87	3.17	54.87	55.67	63.21	60.77
7	121.58	118.98	18.56	17.22	21.34	22.77	5.00	3.04	55	57.56	63.34	60.18
8	115.36	119.93	12.34	11.22	15.12	16.88	2.78	2.45	48.78	50.67	57.12	59.05
Giza 164 SA_6												
1	118.23	119.34	19.55	16.04	21.74	22.45	3.51	2.67	57.22	58.44	59.77	60.16
3	119	118.22	20.32	18.45	22.51	23.99	4.72	3.22	57.99	58.66	60.54	61.45
5	118.65	115.67	19.97	17.66	22.16	23.05	4.34	3.07	57.64	58.94	60.19	60.98
6	112.69	115.65	14.01	12.35	16.2	17.31	2.38	2.90	51.68	52.43	54.23	57.57
7	117.67	118.44	18.99	16.23	21.18	22.08	5.36	3.45	56.66	57.77	59.21	60.48
Control (Sids 12)	110.45	113.55	12.34	13.24	13.76	14.56	2.27	3.21	48.78	51.33	40.45	42.57
Control (Giza 164)	99.45	104.22	11.22	12.89	12.44	13.56	2.42	2.71	50.35	53.55	38.45	40.24
Narrow heritability		45.44		48.56		46.66		30.25		49.56		53.37

Numbers that are not mentioned in the sequence were not selected in the second mutational generation

Table 5: Correlation coefficient for yield and its components traits in M_2 generations

Traits	Plant height (cm)	Spike no./plant	Spikelets no./spike	Grains no./spike	Weight 1000-grain (g)	Grain yield/plant (g)
Plant height (cm)	-	0.410	0.682**	0.505*	0.523**	0.544**
Spike no./plant		-	-0.556**	-0.651**	-0.696**	0.813**
Spikelets no./spike			-	-0.434	0.987**	0.725**
Grains no./spike				-	-0.344	0.536**
Weight 1000-grain (g)					-	-0.433
Grain yield/plant (g)						-

*Significant at 5% level of significance and **Significant at 1% level of significance

highest degree of heritability in the narrow sense was 53.37, 49.56, 48.56, 46.66 and 45.44 for grain yield/plant (g), weight 1000-grains (g), spike number/plant, number of spikes/spike and height plant (cm) respectively, while the lowest value was 30.25 in the number of grains/spike in the second mutational generation.

To confirm the importance of the study, the correlation in M_2 between the traits mentioned previously was studied in Table 5. Through this study, it was found that the relationship was significant and positive between yield with the plant height (cm), spike no./plant, spikelets no./spike and the grains no./spike (0.544**), (0.813**), (0.725**) and (0.536**) respectively. Whereas, it had a low correlation with weight 1000-grain (g) (0.433). On the contrary, a significant and negative correlation was found between the yield and the number of spikes/plant. Through this study, we can say a promising study because it led to the yield in Sids 12 to 83.42 g and also led to an increase in the yield in Giza from 164-71.98 g compared to the control 42.57 and 40.24 g, respectively.

DISCUSSION

Among the results obtained after chemical treatment, the plant height (cm) reached 123.85 and 120.85 cm in Sids 12 and Giza 164 compared to the control 113.55 and 104.22 cm, respectively. It was also found that the value of spike/plant number, which ranged (22.28 and 21.45 spikes) in Sids 12 and Giza 164, compared to the control, which was 13.24 and 12.89 spikes, respectively. On the contrary, the chemical effect led to a decrease in the weight of grain number/spike, which ranged (from 3.20 and 3.13 g) for each Sids 12 and Giza 164 compared to the control, which was 3.24 and 3.15 g, respectively.

The chemical effects led to an increase in the weight of 1000-grain (g), where the increase ranged (from 51.90-54.62 g) and (52.72-58.28 g) for Sids 12 and Giza 164 compared to the untreated effects, which were 51.33 and 53.55 g, respectively. The chemical effects led to an increase in the grain yield/plant (g), where the increase ranged (from 66.37-78.91 g) and (54.74-62.96 g) for Sids 12 and Giza 164 compared to control plants, whose value was 42.57 and 40.24 g, respectively. It was found that there is a satisfactory increase in the weight of 1000 grains and the grain yield of the plant and through these two traits, Egyptian wheat can be genetically improved. It is noted in this study that there is a clear and satisfactory improvement in these two characteristics.

Hussain *et al.*[7] conducted a study to investigate the effect of sodium azide (SA) in the M_2 generation of Brassica napus. The result showed an increase in plant height, stem diameter, the number of branches/plant, the number of leaves/plant, the number of seeds and the weight of 1000 seeds. While it led to the days being late for flowering and late in the days of maturity. Mensah and Obadoni[8] studied the mutagenic effects of different concentrations of sodium azide on peanuts and it had an effective and positive effect in increasing the mean and the studied traits include, Plant height, pods/plant, seed/plant and 100 seed weight in generations M_1 and M_2. Bhat *et al.*[9] showed through their study on fava beans that genetic differences can be obtained through the following chemical compounds Diethyl Sulphate (DES) and Sodium Azide (SA). Khan and Goyal[10] showed that further improvement can be made through the use of radioactive as well as a chemical mutagen in two types of mung bean in the yielding traits. Haridy *et al.*[11] showed that the study conducted on faba bean showed that it was possible to obtain pathological mutations concerning plant height and yield when using two types of mutants, one radioactive and the other chemical. Mostafa[12] explained that when treating Giza cultivars 1 and 102 with different concentrations of the chemical mutagen, sodium azide at concentrations led to genetic variation and new genotypes were obtained. In the crop of *Helianthus annuus*. Al-Shamma[13] conducted studies in which he showed that chemical mutants were able to cause genetic variation in quantitative and qualitative traits in faba bean cultivars. Okaz *et al.*[14] studies on the safe flower were conducted using three chemical and radioactive treatments and the chemical boom was more effective than other mutations to urge genetic patterns to reach a new structure. Sakr *et al.*[15] showed that the use of mutagens has an important role in improving the quantitative and descriptive characteristics by using different types of mutagens. The results were satisfactory in all but the chemical mutagens outperformed others. Srivastava *et al.*[4] showed that when using sodium azide on a variety of wheat, the ability to cause genetic mutations were inherited. It was found from the study that the best concentration that could cause mutations in the components of the crop was 0.02%. They also showed, through the use of sodium azide, that it can cause inherited morphological changes and the ability to improve the components of the crop. There was also an increase in estimates of the coefficient of genetic and genotypic variance, heritability in the broad sense and expected genetic progression. Al-Nuaimi *et al.*[16] studied the effect of chemical mutagenic and they were sodium azide (SA), hydrazine Hydrate (HZ) and maleic hydrazine (MH) at concentrations (0.01, 0.03, 0.05%) and morphological differences were obtained in peanut traits. Ahmed *et al.*[17] studied (*Triticum aestivum* L.) and the results obtained when studying the correlation between traits were significant and positive for both the spikes no./plant and the spikes on./spike with grain yield, on the contrary, the correlation was negative and significant between grain yield and weight 1000. Hammam *et al.*[18] studied (*Triticum aestivum* L.) and the results that were obtained when studying the correlation between the traits were positive and significant for both the trait the spikes on./plant and the trait of grains no./spike with the trait of grain yield, on the contrary, The correlation was negative and significant between the trait of grain yield and weight 1000 traits and the trait of plant height. The results of a study conducted by Ahmed[19] studied to urge the mutations in the bread wheat (*Triticum aestivum* L.). The sodium azide was more efficient and more effective than Dimethyl sulfoxide. El-Said *et al.*[6] studying the genetic correlation that has an effective role in the selection process, found that the correlation was significant and positive between yield and plant height, on the contrary, it was significant and negative between yield and weight of 100 seeds in faba bean. Through this study, the status of the crop can be improved in Egyptian wheat, where a genetic tract was obtained after chemical treatment in the M_2 generation, where these structures exceeded the parents, the Sids 12 was more affected by the bridge of Giza 164 when using the chemotherapy.

CONCLUSION

In this study, very satisfactory results were obtained. Also especially in improving a single plant crop status as well as weighing 1000 tablets and was the best concentration was 1000 and 2000 ppm of sodium increase. Thus, it can be said that the use of chemical mutations is one of the effective gender enhancements in Egyptian wheat grain.

SIGNIFICANCE STATEMENT

This study on Egyptian wheat showed that it is possible to achieve beneficial genetic changes through chemical mutations, in particular by increasing sodium, especially the concentration of 1000 and 2000 volumes per million. Through these desirable genetic changes, one can reach a variety of Egyptian wheat with superior productivity. Indeed, those promising compositions were introduced. Education programs and work are underway.

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