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Effect of Chemical Mutagens on Some Morphological and Yield Components Traits of Wheat (*Triticum aestivum* L.)

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THIS INVESTIGATION was carried out to induce the mutations in bread wheat (*Triticum aestivum* L) at the Experimental and Research Farm, Faculty of Agriculture, Al-Azhar University. Two wheat geno.types were treated with different concentrations of di methyl sulfoxide and sodium azide (NaN3). The highest grain yield/ plant (81.27g and 80.56g) were obtained from Sids 14 treated with either (di- methyl sulfoxide at 2000ppm) or sodium azide at 6000ppm. The untreated plant Sids 14 gave 39.23g. The variety Sids 14 was more productive than Misr 1 induction of stable promising mutants according to the final results at M_2 especially with respect to high grain yield/ plant. In general, Sids 14 was more response to chemicals treatment for 1000 grains weight than Misr 1 and gave higher 1000 grains weight. Sids 14 di methyl sulfoxide $_1$, Sids 14 DMS_2, Sids 14 Sodium $Azide_1$, Sids 14 $Azide_2$ and Sids 14 $Azide_3$ gave (58.27,55g). The geno.types $Misr_1$ Azide $_3$ (2, 3 and 6) were short but the genotypes Sids 14 DMS_1 (3 and 7) were tall, while the genotypes Sids 14 DMS_1 (5 and 6) were very tall in both M_1 and M_2. In spite of the high 1000 grain weights variety Sids 14 gave the highest grains no./ spike 72, Sids 14 $Azide_3$ and Sids 14 DMS_1 giving 88.33 and 87.44 grains, respectively. Mutants Sids 14 $Azide_3$ and Sids 14 DMS_1 surpassed the original plants in grain no. spike by 22.68% and 21.44%, respectively. There was a significant and positive correlation between yield and spike no./ plant, spikelet no./ spike and grain/ spike across both varieties and generations. There was a low correlation coefficient between grain yield/ plant and 1000 grain weights (0.016) and the negative correlation between grain yield/ plant and plant height (cm).

Keywords: Di methyl sulfoxide, Morphological characters, Mutagens, Wheat, Yield.

Introduction

Wheat (*Triticum aestivum* L.) is the most widely grown cereal crop in the world and one of the focal mainstays of worldwide of global food security. About 651 to 730.3 million tons of wheat was produced from 217 million hectares in 2010 and 2017/2018 with productivity level of 3ton/ha^{-1}, (Braun et al., 2010 FAO, 2019). It is a dietary mainstay for millions of people as it provides 50% of the caloric and protein requirements to a major proportion of the population of the world.

The prime strategy in mutation breeding has been to improve already well acclimatized plant varieties by changing one or two major traits which limited their productivity or increase their quality. The genetic variability resulting from the induced micro-mutation allows breeding of quantitative characters (Brojevic, 1965). Sarkar (1986) indicated that estimated variation of quantitative characters was higher for the M_3 generation than those of the M_2 generation.

Chemical mutagenesis is one of the methods regarded as an effective and remarkable tool in modifying the yield and quality characters of crop plants. Alkylating agents are very effective mutagens in higher plants.

One of the useful tools for plant modification is by increasing genetic variability in many plant species, especially the self-fertilized plants, which by using mutagens such as radiation and chemical

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compounds which is described as artificial induction mutation (Sakin, 2002; Srivastava et al., 2011; Khan & Tyagi, 2013; Nura et al., 2013; AL-Nuaimi & Al-Shamma, 2014; Khan & Verma, 2015; Okaz et al., 2016; Sakr, 2016; Al-Shamma & Mohammed, 2018).

The present study aims to induce mutations for morphological characters and yield components and their quantitative associations among yield and its components with the application of promising mutants into a breeding program to get new varieties.

Materials and Methods

The present study was carried out at the Experimental Farm of the Faculty of Agriculture, Al-Azhar University, Assiut branch during 2017/2018 and 2018/2019 growing seasons. The genotype used for mutagenic treatment were Sids 14 and Misr 1. Three different concentrations of di- methyl sulfoxide (1000ppm, 2000ppm, and 3000ppm) and sodium azide (2000ppm, 4000ppm, and 6000ppm) were freshly prepared for conducting the mutagenic treatments. Five hundred seeds of wheat were soaked in distilled water for 20hrs as the control treatment. The selected variants at the present study included apparent morphological characters, for plant height, spike no./ plant, spikelet no./ spike, grain/ spike, 1000 grains weight and grain yield/ plant. Plants which have grain yield higher than the control treatment by 50% considered as mutant (M_1).

Di- methyl sulfoxide

Five hundreds seeds from each variety were soaked in prepared aqueous solution of di methyl sulfouxide of three different concentrations (1000ppm; DMS_1), (2000 ppm; DMS_2) and (3000ppm; DMS_3) for 20 hrs.

Sodium azide

Five hundreds seeds from each variety were soaked in prepared aqueous solution of Sodium azide of three different concentrations (1000 ppm; $Azide_1$), (2000ppm; $Azide_2$) and (3000ppm; $Azide_3$) for 20hrs.

Heritability was estimated by several methods by using different genetic populations and produced the estimations that may vary. Common methods include the variance components method and parent-offspring regression. In this investigation we used the parent- offspring regression as an estimate for heritability. All agriculture practices were applied as commonly used for growing wheat and carried out according to the recommendations set by the Ministry of Agriculture. Nitrogen, phosphorus and potassium fertilizer were added according to the recommended dose. Nitrogen fertilizer was applied in the form of Urea (46% N) at a rate of 75kg /fed. in two equal doses. The first one before the post planting irrigation and the second dose at the tillering stage before the second irrigation. Phosphorus fertilizer in the form of calcium super phosphate (15.5% P_2O_5) was added at a rate of 100kg/ fed. in one dose before planting. Potassium fertilizer in the form of potassium sulphate (48% K_2O) at a rate of 50kg/ fed was supplied in two equal doses at the same time as the nitrogen fertilizer was added. Some chemical and physical properties of the experimental site before cultivation are set out in Tables A and B.

TABLE A. Chemical properties of the experimental site before cultivation.

Depth (cm)	pH	ECE (dS/m)	Water soluble ions (mq/L)in the soil paste							Available nutrients in soil (ppm)		
			CO_3+HCO_3	Cl^-	So_4^-	Ca^{++}	Mg^{++}	Na^+	K^+	N	P	K
0-30	7.80	1.05	2.50	1.25	6.10	2.70	1.35	5.70	0.10	75	9.60	375
30-60	7.90	1.25	2.86	3.16	6.60	3,20	2.20	7.34	0.27	55	8.55	350

TABLE B. Physical properties of the experimental site before cultivation.

Depth (cm)	Percentage %			Texture class	O.M %	$CaCO_3$ %
	Sand	Silt	Clay			
0-30	25	39.60	35.00	Clay loam	1.24	3.55
30-60	25.60	40.00	33.40	Clay loam	0.70	2.25

The significance was estimated by T test by comparison between groups (comparison between mutated plants with unmutated plants).

Results and Discussion

During the first season of the investigation all mutagenic treatments induced mutants were characterized for different desired traits such as plant height, spike no./ plant, spikelet no./ spike, grain no./ spike and 1000 grains weight.

Table 1 shows the characteristics of the chosen mutants in the M_1 generation after applying the mutagen treatments. It is clear from results in Table 1, that mutants differed from the original plants of different wheat genotypes in some of the main characters, e.g. 1000 grain weight, plant height, spike no./ plant, spikelet no./ spike and grain no./ spike. The results showed that all treatments (Chemicals) have led to mutations in all wheat genotypes.

Plants obtained as in the M_1 which shows in Table 1 were planted to get a second generation. The numbers of plants which maintain the mutations in M_2 are shown in Table 2.

Results in Table 2 shows that the numbers of plants which maintain of mutations until the second generations were 46 plants among different concentrations.

The means and variances of the mutants which cached from all mutagenic treatment were calculated and compared with that of the same number of plants representing control treatment for the two main traits, i.e. plant height, spike no./ plant, spikelet no./ spike, grains/ spike and 1000 grains weight (Table 3).

Effect of mutagens on means, variance and heritability in narrow sense

All plants which maintain the mutations until M_2 were surpassed untreated plants in grain yield/ plant. The highest grain yield/ plant (81.27, 80.56 and 74.10g/plant) was obtained from Sids 14 DMS_2, Sids14 $Azide_3$ and Sids 14 $Azide_2$ but untreated plant Sids14 gave 39.23g/ plant. So, the increasing percentage from untreated plants was 107.16, 105.53 and 88.75%, respectively.

Variety Misr 1 occupied the second place in grain yield/ plant. Where, both of Misr 1 DMS_1, Misr 1 DMS_3 and Misr 1 $Azide_2$ gave 64.32, 62.46 and 62.26g. This means that Misr 1 DMS_1, Misr 1 DMS_3 and Misr 1 $Azide_2$ increased 78.91, 73.74 and 73.18.% in grain yield/ plant more than Misr 1 which gave 32.5g. This result coincides with Dhole et al. (2003), Veena & Ravikumar (2003), Ahmad (2011), Al-Shammaa (2014), Kumar & Shunmugavalli (2015), Sakr (2016) and Okaz et al. (2016).

Results in Table 3 illustrated that variety Sids 14 was more responsive to chemicals treatment and give higher 1000 grains weight than another variety. Sids 14 DMS_1, Sids 14 DMS_2, Sids 14 $Azide_1$, Sids 14 $Azide_2$ and Sids 14 $Azide_3$ gave (58.27, 55.96, 55.63, 55.88 and 55.95g, respectively) than untreated plants V_1 (51.87g) for 1000 grains weight. This means that Sids 14 DMS_1, Sids 14 DMS_2, Sids 14 $Azide_1$, Sids 14 $Azide_2$ and Sids 14 $Azide_3$ increased 43.87% more than V_1 which gave 51.87g .

In spite variety Misr 1 gave the highest 1000 grains weight (42.55g). Misr 1 $Azide_1$ and Misr 1 DMS_3 gave 57.44 and 56.15g, respectively. Mutants Misr 1 $Azide_2$ and Misr 1 DMS_3 surpassed original plants in 1000 grains weight with 35% and 31.96%, respectively. This result coincides with Muhammad (1962), Dhole et al. (2003), Ahmad (2011), Okaz et al. (2016). Also, the results achieved don't agree with Galal et al. (1975), Khalil et al. (1986) and Thomas et al. (2016).

For plant height, it is clear from Tables 2 and 4 that the maximum increases in plant height in genotypes. The effect was highly noted to treatments di - methyl sulfoxide (2000) (DMS_2), (3000ppm) (DMS_3) and Sodium Azide (4000ppm) and 2000ppm) as compared to control. The variety sids 14 gave the highest plant height in M_1 and M_2 (112.6 and 119.42cm). The genotypes V_2 h_6 (2,3 and 6) were short but the genotypes Sids 14 DMS_1 (3) and Sids 14 DMS_1 (7) were tall, while the genotypes Sids 14 DMS_1 (5 and 6) were very tall in M_1 and M_2. This result coincides with Ahmad (2011) when used electric shock on wheat. Also, Hanafy et al. (2006), Sujatha (2007), Sheikh et al. (2012), Hawash & AL-Shmma (2016) and AL-Shmma & Mohammed (2018) found that the lowest plant height was obtained when exposed the seedlings to external electric field, sodium azide and heat shock.

TABLE 1. List of mutants chosen in M_1 generation of Sids 14 cultivar in 2017/ 2018.

Treatment		Trait	Grain yield/ plant (g)	Grains no./ spike	Spikelet no./ spike	Spike no./ plant	Plant height (cm)	1000-grain weight (g)
Sids 14	DMS_1	1	67.61	88.00	23.50	19.00	123.00	47.20
		2	72.00	96.00	23.50	19.00	116.00	60.60
		3	77.61	95.00	23.50	27.00	104.00	48.20
		4	86.73	98.00	21.50	27.00	120.00	55.40
		5	75.13	96.00	23.50	19.00	123.00	46.60
		6	73.40	100.00	23.50	27.00	126.00	44.00
		7	71.45	94.00	21.50	27.00	109.00	50.20
		8	73.22	97.00	21.00	22.50	123.00	50.40
		9	78.58	88.00	21.50	22.50	118.00	55.20
		10	88.35	96.00	23.50	23.00	114.00	45.80
	DMS_2	1	65.13	84.00	23.50	23.00	115.00	53.30
		2	65.25	84.00	22.00	22.00	94.00	51.00
		3	71.10	95.00	22.00	22.66	110.00	44.40
		4	59.44	84.00	23.00	22.60	117.00	59.60
		5	93.00	92.00	23.00	18.33	117.00	56.20
		6	71.30	92.00	24.00	22.00	128.00	53.60
		7	61.96	84.00	24.00	24.00	113.00	56.60
	DMS_1	1	69.58	84.00	23.00	24.00	106.00	47.00
		2	86.12	84.00	22.00	12.50	107.00	45.10
	$Azide_1$	1	80.51	90.00	21.00	12.50	119.00	55.60
		2	52.71	78.00	22.00	12.50	119.00	48.40
		3	79.71	84.00	22.50	12.50	116.00	56.20
		4	53.74	82.00	23.00	14.25	114.00	55.60
		5	88.81	88.00	22.00	14.25	119.00	54.60
		6	64.51	80.00	22.50	11.50	114.00	53.60
		7	59.51	84.00	22.50	11.50	117.00	49.20
		8	60.46	88.00	22.00	18.00	120.00	53.80
	$Azide_2$	1	60.14	92.00	23.00	18.00	116.00	47.60
		2	56.77	82.00	23.00	18.00	110.00	49.20
		3	61.57	84.00	24.50	22.00	107.00	57.60
		4	63.77	88.00	23.50	22.00	112.00	54.40
		5	68.35	92.00	22.50	22.00	115.00	44.40
		6	66.31	88.00	23.50	22.00	116.00	51.60
		7	56.55	92.00	24.00	21.00	115.00	61.80
		8	67.98	84.00	27.00	21.00	113.00	62.60
		9	88.27	84.00	24.50	24.00	116.00	60.80
	$Azide_3$	1	74.00	90.00	24.50	24.00	113.00	53.70
		2	52.40	78.00	21.50	25.00	114.00	45.80
		3	46.04	84.00	23.00	23.00	116.00	53.00
		4	50.64	82.00	22.00	23.00	118.00	48.80
		5	42.00	88.00	23.00	23.00	125.00	58.60
		6	56.35	80.00	23.00	26.00	125.00	54.00
		7	67.20	84.00	23.00	26.00	130.00	54.20
Control			36.42	75.00	21.05	14.90	112.60	43.96

TABLE 1. Cont. List of mutants chosen in M_1 generation of Misr 1 cultivar in 2017/ 2018.

Treatment		Trait	Grain yield/ plant (g)	Grains no./ spike	Spikelet no./ spike	Spike no./ plant	Plant height (cm)	1000-grain weight (g)
Misr 1	DMS_1	1	69.76	92.00	22.50	23.34	116.00	60.60
		2	69.60	88.00	23.00	23.33	115.00	49.40
		3	63.41	88.00	22.50	23.33	117.00	43.60
		4	52.42	96.00	22.50	22.00	109.00	51.40
		5	47.11	88.00	23.00	23.00	120.00	42.60
		6	43.28	84.00	18.35	20.00	111.00	49.30
		7	47.79	92.00	19.05	20.00	115.00	48.40
		8	65.21	96.00	23.50	21.00	112.00	52.60
	DMS_2	1	60.72	96.00	23.00	22.00	117.00	44.40
		2	68.33	85.00	23.50	22.00	115.00	50.80
		3	57.77	90.00	23.00	21.00	115.00	54.60
		4	63.22	85.00	23.50	21.00	125.00	44.80
		5	76.92	80.00	23.50	21.00	125.00	48.60
		6	52.00	80.00	23.50	22.00	125.00	56.00
		7	79.74	84.00	23.50	30.00	122.00	52.60
		8	50.79	90.00	23.00	33.00	119.00	54.00
		9	47.25	80.00	23.00	31.00	119.00	50.40
	DMS_3	1	84.16	85.00	23.50	21.00	105.00	43.60
		2	51.40	80.00	23.50	21.00	100.00	42.60
		3	45.60	88.00	25.00	20.00	105.00	50.40
		4	53.40	85.00	22.50	20.00	112.00	45.00
		5	44.60	80.00	24.00	20.00	112.00	51.40
		6	51.30	80.00	23.00	20.00	110.00	64.80
		7	50.40	84.00	24.50	20.00	110.00	43.60
		8	54.60	80.00	24.50	18.00	110.00	54.00
		9	46.40	66.00	24.00	18.00	112.00	50.40
		10	52.80	63.00	24.00	18.00	111.00	45.60
	$Azide_1$	1	56.60	88.00	22.00	21.00	103.00	55.80
		2	46.80	88.00	22.00	21.00	102.00	55.60
		3	50.60	76.00	22.00	21.00	100.00	44.60
		4	58.00	84.00	22.00	21.00	100.00	43.20
		5	54.60	69.00	22.50	20.00	97.00	45.80
		6	56.00	84.00	23.00	20.00	105.00	44.20
		7	52.40	72.00	18.35	20.00	103.00	45.00
		8	45.60	84.00	22.50	20.00	110.00	45.40
		9	44.60	88.00	22.00	22.00	100.00	63.40
		10	52.40	92.00	22.00	22.00	110.00	55.60
	$Azide_2$	1	47.00	88.00	23.00	17.00	105.00	59.20
		2	53.40	84.00	22.50	17.00	120.00	50.40
		3	66.80	85.00	22.00	22.50	115.00	57.60
		4	45.60	76.00	21.50	22.50	100.00	64.80
		5	56.00	80.00	22.00	20.00	105.00	56.10
	$Azide_3$	1	52.40	80.00	22.50	21.00	100.00	54.00
		2	47.60	84.00	21.00	21.00	105.00	47.20
		3	57.80	84.00	21.50	22.00	97.00	58.00
		4	57.60	84.00	22.00	22.00	113.00	57.20
		5	46.60	84.00	22.00	24.00	104.00	41.80
		6	45.20	84.00	22.50	24.00	104.00	60.40
		7	47.80	95.00	22.00	24.00	110.00	54.20
		8	46.20	84.00	22.00	19.00	117.00	64.40
Control			34.00	66.70	21.45	15.00	109.80	43.96

TABLE2. Number of selected mutant plants in M_1 and M_2 generations.

	Chemical	
	M_1	**M_2**
Sids 14 DMS_1	10	5
Sids 14 DMS_2	7	5
Sids 14 DMS_3	8	6
Sids 14 $Azide_1$	3	2
Sids 14 $Azide_2$	9	3
Sids 14 $Azide_3$	7	3
Misr 1 DMS_1	9	4
Misr 1 DMS_2	10	4
Misr 1 DMS_3	10	3
Misr 1 $Azide_1$	10	3
Misr 1 $Azide_2$	5	6
Misr 1 $Azide_3$	8	2

TABLE 3. Means and variances for wheat genotypes under different treatments of mutagenic through generations.

Treatment \ Trait		Grain yield/ plant (g)				Weight 1000-grain (g)				Plant height (cm)			
		Means		Variance		Means		variance		Means		Variance	
		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 14	DMS_1	76.41	61.95	39.74*	164.27*	51.2	58.27	23.79*	7.115	118.15	126.23	28.627*	47.570*
	DMS_2	69.69	81.27	107.58*	19.87*	50.7	54.67	35.63 *	3.501*	110.25	129.38	11.959*	29.946*
	DMS_3	65.77	72.4	68.39*	25.73*	48.81	55.96	41.36 *	12.644*	110.45	127.28	23.147*	22.965*
	$Azide_1$	67.15	68.49	162.84*	36.70*	50.08	55.63	42.67 *	15.285*	119.5	127.23	16.350*	39.486*
	$Azide_2$	67.15	71.1	81.87*	47.64*	53.31	53.88	65.23 *	0.682*	113.6	128.52	9.540*	16.439*
	$Azide_3$	59.82	80.56	112.13*	23.40*	48.2	55.95	46.96 *	4.00*	119.95	126.28	28.840*	53.918*
	Control	36.42	39.23	5.95	6.58	43.96	51.87	2.89	2.944	112.6	119.42	6.24	1.959
Misr 1	DMS_1	55.97	64.32	101.08*	25.75*	49.65	53.5	27.45*	6.402*	108.75	118.9	21.087*	20.657*
	DMS_2	56.5	58.91	145.56*	35.18*	50.68	55.2	15.00 *	8.071*	118.4	117	18.540*	26.840*
	DMS_3	65.2	62.46	115.23*	70.12*	48.28	56.15	41.069 *	2.919*	114.47	120.33	21.427*	20.181*
	$Azide_1$	53.77	62.26	20.43*	177.58*	49.86	57.44	44.856*	5.026*	102.7	117.77	17.210*	29.365*
	$Azide_2$	55.76	54.23	57.49*	109.57*	48.33	53.44	21.697 *	4.006*	111.5	116.57	54.00*	26.154*
	$Azide_3$	52.15	46.55	22.97*	77.59*	49.9	54.34	69.097*	1.858*	108.73	113.33	50.047*	10.698*
	Control	34	35.95	15.25	2.5	40.17	42.55	4.38	1.053	109.8	6.36	112.2	6.437

TABLE 3. Cont. Means and variances for wheat genotypes under different treatments of mutagenic through generations.

Treatment	Trait	Spike no./ plant				Spikelets no./ spike				Grains no./ spike			
		Means		Variance		Means		Variance		Means		Variance	
		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 14	DMS_1	22.9	16.33	12.84*	13.28*	22.65	24.71	1.385*	1.346*	94.9	87.44	15.790*	26.35*
	DMS_2	20.5	21.96	1.60*	2.195*	23.35	24.61	0.853*	2.807*	90	84.93	20.20*	10.062*
	DMS_3	21.39	18.16	4.092*	17.138*	22.9	25.07	1.240*	2.959**	86.5	83.83	47.05*	8.305*
	$Azide_1$	12.55	18.04	0.926*	13.759*	22.25	24.38	0.495	1.950*	83	86.33	17.80*	11.222*
	$Azide_2$	20.47	17.47	4.662*	5.868*	23.85	25.61	1.919*	1.664*	84.82	83	21.06*	18.728*
	$Azide_3$	23.55	18.53	9.897*	4.518*	22.8	24.33	0.826*	1.324**	89	88.33	14.41*	12.550*
	Control	14.9	14.33	1.29	0.222	21.05	22	0.755	0.22	75	72	13.76	7.359
Misr 1	DMS_1	20.45	15.77	4.714*	10.50*	22.09	24.66	6.911*	1.269*	91	80.13	7.40*	56.648*
	DMS_2	26.06	15.71	31.632*	8.680*	23.25	24.88	0.145	2.235*	88	80.22	31.61*	13.293*
	DMS_3	22.51	17.67	4.018*	7.229*	23.85	25.09	0.719*	1.324*	80.71	78.16	7.632*	45.805*
	$Azide_1$	21.25	16.61	0.787*	5.583*	21.83	25.28	2.929*	1.442*	84.57	79.25	15.673*	24.248*
	$Azide_2$	22	16.26	25.70*	6.062*	22.1	26.28	0.623*	0.585*	80.71	73.55	25.918*	32.135*
	$Azide_3$	22.2	15.93	1.884*	4.462*	21.95	24.62	0.355	1.200*	82.28	82	8.489*	30.888*
	Control	15	11.66	0.696	1.2	21.45	23	0.489	0.523	66.4	66.75	7.84	8.437

Concerning spikes no./ plant, the maximum increase in spikes no./ plant in genotypes according to treatment with di- methyl sulfoxide (2000ppm; DMS_2), (3000ppm; DMS_3) and Sodium Azide (4000ppm) was highly noted compared to control. This means that Sids 14 DMS_2, Sids 14 DMS_3 and Sids 14 $Azide_3$ was increased 53.24, 31.40 and 26.72%, respectively more than V_1 which gave 14.33% . Variety Misr 1 occupied the second place in spikes no./ plant, which was V2h3 gave 17.67%. So, $V2h_3$ surpassed untraded plants with 51.54%. This result coincides with Ahmad (2011) and Hawash & Al-Shamma (2016) when used electric shock on wheat.

In spite variety Sids 14 gave the highest grains, no./ spike (72). Sids 14 $Azide_3$ and Sids 14 DMS_1 gave 88.33 and 87.44, respectively. Mutants Sids 14 $Azide_3$ and Sids 14 DMS_1 surpassed original plants in grains, no./ spike with 22.68% and 21.44%, respectively.

Misr 1 occupied the second place in grains no./ spike. In genotypes the effect was highly noted to treatments with Sodium Azide (6000 ppm; $Azide_3$), Di methyl sulfoxide (1000ppm; DMS_1), and (2000ppm; DMS_2) as compared to control. This means that Misr 1 $Azide_3$, Misr 1 DMS_1 and Misr 1 DMS_2 increased 82.00, 80.13 and 80.22 more than Misr 1 which gave 66.00. Mutants Misr 1 $Azide_3$, Misr 1 DMS_1 and Misr 1 DMS_2 surpassed original plants in grains, no./ spike with 24.24, 21.40 and 21.54%, respectively. This result coincides with Hassan et al. (2001) Dhole et al. (2003), Solanki, & Waladia (2004), Ahmad (2011), Sheikh et al. (2012), Okaz et al. (2016), and Irfac & Nawab (2001).

All plants which maintain the mutations until M_2 were surpassed untreated plants in spikelets no./ spike. The highest spikelets no./ spike (26.28 and 25.61g) were obtained from Sids 14 $Azide_3$ and Misr 1 $Azide_2$ but untreated plant Misr 1 gave 23.00. This means Sids 14 $Azide_2$ and Misr 1 $Azide_2$ increased 14.26 and 17.41% in spikelets no./ spike. This result coincides with Dhole et al. (2003), Ahmad (2011), Sheikh et al. (2012), Okaz et al. (2016) and Hawash &Al-Shamma (2016).

TABLE 4. The means of morphological variations and parent-offspring regression in mutated plants derived from chemicals treatments.

Genotype		Traits	1000- grains weight		Plant height		Spike / plant		Spikelet/ spike		Grains/ spike		Grains yield/ plant	
			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 14	DMS_1	1	47.2	57.7	123	117.67	19	16.33	23.5	25.67	88	95.33	67,61	68.55
		2	60.6	56	116	128.00	19	10.00	23.5	24.67	96	84.00	72,00	47,04
		3	48.2	53.4	104	128.33	27	12.33	23.5	23.67	95	82.00	77,61	54,01
		4	55.4	60.23	120	114.33	27	9.00	21.5	26.00	98	87.33	86,73	47,34
		5	46.6	59.55	123	133.00	19	14.33	23.5	25.33	96	84.67	75,13	72,27
		6	44	61.23	126	134.00	27	15.67	23.5	23.67	100	81.33	73,40	78,02
		7	50.2	59.82	109	128.33	27	23.00	21.5	24.00	94	89.33	71,45	73,00
	DMS_2	3	51	55.6	94	134.33	22	22.33	22	23.67	92	82.00	73,22	75,00
		6	56.2	57.05	117	125.00	18.33	21.33	23	25.67	84	74.22	78,58	85,00
		8	53.6	52.2	128	121.33	22	18.67	24	25.67	92	86.00	88,35	83,80
	DMS_3	1	47	53.02	106	123.33	24	10.00	23	22.33	88	88.00	65,13	66,00
		2	45.1	53.93	107	128.33	12.5	16.00	22	26.50	96	90.67	65,25	78,23
		10	52.33	61	110	121.10	16.55	25.67	23	26.66	84	84.67	71,10	74,00
	$Azide_1$	2	48.4	53.1	119	128.33	12.5	24.00	22	25.66	84	82.00	59,44	66,00
		6	56.6	53.3	119	115.00	14.25	14.33	23	25.00	95	82.00	93,67	62,63
		7	53.6	61.12	114	128.33	11.5	15.33	22.5	23.33	84	82.00	71,30	76,83
	$Azide_2$	1	47.6	53.37	116	133.33	18	15.00	21	27.00	92	82.67	61,96	66,18
		2	49.2	55.12	110	128.33	18	17.00	22	25.33	92	88.67	69,58	83,08
		4	57.6	55	112	130.00	22	16.67	24	25.33	84	81.67	86,12	74,88
	$Azide_3$	1	53.7	53.88	113	121.67	24	18.00	24.5	24.67	84	80.00	80,51	77,59
		2	45.8	56.55	114	120.00	25	19.00	21.5	23.67	84	82.67	52,71	88,82
		3	53	54.55	116	126.66	23	17.67	23	23.00	90	79.67	79,71	76,79
		6	48.8	59	118	130.00	23.34	14.67	22	25.00	78	91.33	53,74	79,03
Misr 1	DMS_1	1	60.6	50.6	116	121.67	23.33	16.00	23.34	22.33	84	92.00	88,81	74,48
		2	49.4	52.21	115	115.67	23.33	12.00	23.33	24.67	82	80.00	64,51	66.11
		3	43.6	57.75	117	115.00	22	15.67	23.33	24.67	88	90.00	59,51	65,00
		4	51.4	47.95	109	116.67	23	10.67	22	26.33	80	82.67	60,46	62,00
		6	42.6	50.25	120	116.67	20	14.00	23	25.33	92	91.33	60,14	64,25
		7	49.3	51.32	111	121.67	20	22.33	20	24.33	88	80.00	56,77	71,00
		8	48.4	52.8	115	125.00	22	14.67	21.5	23.00	88	77.33	61,57	59,89

TABLE 4 Cont. The means of morphological variations and parent-offspring regression in mutated plants derived from chemicals treatments .

Genotype		Traits	1000- grains weight		Plant height		Spike/ plant		Spikelet/ spike		Grains/ spike		Grains yield/ plant	
			M1	M2	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
Misr 1	DMS_2	1	44.4	57.1	117	119.67	22	13.67	22	24.33	96	68.67	63,77	53.59
		2	50.8	44	115	125.00	21	15.00	22	25.00	88	84.00	68,35	55.42
		3	54.6	58.8	115	118.33	21	21.67	21	24.00	84	82.67	66,31	57.80
		4	44.8	52.87	125	113.33	21	13.67	21	27.50	92	80.00	56,55	54.66
		5	48.6	48	125	116.67	22	14.00	21	26.33	96	81.33	67,98	57.61
		6	56	52.2	125	111.67	30	17.33	22	24.33	96	78.67	88,27	711. 8
		7	52.6	48.5	122	115.00	21	15.67	30	24.00	85	73.33	104,13	55.72
	DMS_3	1	43.6	50	105	116.67	21	17.67	21	24.33	90	82.67	52,40	73.02
		2	42.6	55.1	100	120.00	20	23.33	21	26.00	85	82.00	46,04	51.00
		3	50.4	50	105	116.67	20	16.67	20	26.00	80	80.00	50,64	66.67
		4	45	55	112	121.67	20	17.00	20	25.67	80	67.33	42,00	62.96
		5	51.4	58.55	112	126.67	20	19.00	20	26.00	84	81.00	56,35	90.11
		6	54	48.11	110	120.00	20	15.00	20	24.00	90	74.33	67,20	53.64
		7	43.6	48.6	110	120.00	21	12.33	20	23.67	80	80.00	39,76	47.95
Misr 1	$Azide_1$	1	55.8	49	103	113.33	21	19.00	21	24.00	85	81.33	69,60	75.72
		2	55.6	58.54	102	121.67	21	14.67	21	25.67	80	74.67	63,41	64.11
		3	44.6	59.4	100	121.67	21	15.67	21	24.33	88	75.33	52,42	70.11
		4	43.2	50.1	100	118.33	20	9.33	21	27.00	85	71.33	47,11	33.36
		6	45.8	49.31	97	118.33	20	17.00	20	24.67	80	80.00	43,28	67.06
		7	44.2	54.3	105	113.33	17	14.67	22	26.00	80	79.33	47,79	63.18
	$Azide_2$	1	59.2	47.62	105	121.53	17	19.33	23	25.33	84	70.67	84,37	65.06
		4	50.4	52	120	118.33	22.5	10.67	22.5	25.67	80	68.67	60,72	38.09
		5	57.6	44.1	115	121.67	22.5	19.00	22	25.67	66	69.00	53,64	57.82
		7	64.8	49	100	116.17	20	11.33	21.5	26.66	63	83.33	57,77	46.28
		10	56.1	51	105	115.67	21	15.67	22	27.00	88	80.00	78,61	63.92
	$Azide_2$	1	54	50.1	100	114.33	21	8.67	22.5	25.00	88	88.00	76,92	38.21
		2	47.2	55	105	110.33	22	9.33	21	23.33	63	83.33	32,45	42.78
		3	58	50.3	97	111.33	22	14.67	21.5	25.33	88	80.00	79,74	59.02
		4	57.2	55.32	113	114.00	24	14.67	22	25.33	88	88.00	80,74	71.40
		5	41.8	55.1	104	117.33	24	14.67	22	24.00	84	88.00	47,25	71.12
		6	60.4	46.1	104	111.33	19	13.00	22.5	25.33	84	63.00	84,16	37.76
Sids14 control			43.96	51.87	112	119.42	14.33	14.90	22.0	21.05	72.00	75.00	39.23	36.42
Misr 1 control			40.17	42.55	109	112.2	11.66	15.00	23.0	21.45	66.75	66.4	35.95	34.00
Regression coefficient				0.78	-----	0.80	00--	0.21	-----	0.69	-----	0.83	------	0.93

Mutagen treatments have mostly increased the quantitative variations among the homozygous genotypes. Significant increase in quantitative variation was found for most of the characters in both M_1 and M_2 generations. These significant increases reached about two folds of the untreated populations or more. The amounts of the induced variations were similar using the two chemical mutagens. Significant increase was detected for plant height, spike no./ plant, spikelet no./ spike, grain no./ spike, 1000 grains weight and grain yield/ plant. These results agreed with Geetha & Vaidyanathan (1998), Hajduch et al. (1999), Ahmed (2011), Sheikh et al. (2012), Khursheed et al. (2015), and Okaz et al. (2016) when used electric shock, sodium azide and di methyl sulfoxide on wheat and safflower.

Reddy & Revathi (1992) found that the mutation frequency increased with duration, concentration of the mutagen treatment, and it was higher when treating seeds of barley and wheat individually and in combination with gamma ray, 0.5 ethyl methane sulphonate (EMS) and sodium azide.

The parent-offspring regression coefficients values (Table 4) represent heritability in narrow sense reached 0.78, 0.80, 0.20, 0.69, 0.83 and 0.93 for plant height, spike no./ plant, spikelet no./ spike, grain no./ spike, 1000 grains weight and grain yield of M_2 generation, respectively. This result coincides with Okaz et al. (2016).

Correlation studies of yield and its component traits

Correlation data for different traits are presented in Table 5. Correlation studies were observed for yield and its component traits in M_2 population. Yield showed significant and positive correlation with spike no./ plant, spikelet no./ spike and grains/ spike. While, it had low correlation coefficient between grain yield/ plant and 1000 grains weight (0.016) and negative correlation between grain yield/ plant and plant height. It is also suggested that yield components can reliably be used as indirect selection criteria to improve grain yield in wheat. These results agreed with Abd- El Salam (2015) and Koubisy (2015).

Conclusion

The prime strategy in mutation breeding has been to improve already well acclimatized plant varieties by changing one or two major traits which limited their productivity or increase their quality. The genetic variability resulting from the induced micro- mutation allows breeding of quantitative characters. Chemical mutagenesis is one of the methods regarded as an effective and remarkable tool in modifying the yield and quality characters of crop plants. There was a significant and positive correlation between yield and spike no./ plant, spikelet no./ spike and grain/ spike across both varieties and generations. There was a low correlation coefficient between grain yield/ plant and 1000-grains weights (0.016) and the negative correlation between grain yield/ plant and plant height (cm).

TABLE 5. Correlation coefficient for yield and its components traits in M_2 generation

Traits	Plant height	No. of spikes/ plant	1000-kernel weight	Spike/ spikelet	Grains/ spike	Grains yield/ plant
Plant height	---	0.299	0.381	-0.152	0.145	-.048
No. of spikes/plant	------	----	0.202	-0.010	0.008	0.957**
1000-kernel weight			----	-0.010	0.311	0.016
spikelet/ spike				-----	0.995*8	0.980**
No. of grains/ spike					------	0.976*

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تأثير المطفرات الكيميائية علي بعض الصفات المورفولوجية والمحصولية في قمح الخبز

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أجرى هذا البحث بالمزرعة التجريبية البحثية بكلية الزراعة جامعة الأزهر- فرع أسيوط خلال موسمين 2017 /2018 ، 2019/2018 لمعرفة تأثير اثنين من المطفرات الكيميائية الداي ميثيل سلفوكسيد و الصوديوم آزيد على بعض الصفات المظهرية والمحصوليه لصنفين من قمح الخبز وتم استخدام الصوديوم آزيد بتركيزات (2000، 4000، 6000) جزء فى المليون ، واستخدم الداى ميثيل سلفوكسيد بتركيزات (1000، 2000، 3000 جزء فى المليون.

أكدت النتائج أن الصنف سدس 14 كتركيب وراثي كان أكثر استجابه لاستحداث الطفرات عن الصنف مصر1 فيما يتعلق بمحصول الحبوب على النبات ووزن الألف حبة وطول النبات وعدد الحبوب بالسنبلة.

أعلى النباتات من حيث محصول الحبوب على النبات Sids 14 DMS_2; Sids 14 Azid 3 (74.10 و 80.56 و 81.27جرام) . وزن الألف حبة تم الحصول عليها من نباتات Sids 14 DMS_1, Sids 14 DMS_3, Sids 14 Azide $_1$, Sids 14 Azide $_2$, Sids 14 Azide3 3 58.27و55.95 و 55.63و 55.88 و 55.95 على الترتيب بينما أطول النباتات تم الحصول عليها من نباتات Sids 14 DMS_2 و, Sids 14 Azide $_2$ و Sids 14 DMS_3 و, Sids 14 Azide $_2$ كالتالي (129.38و 128.52و 127.28و 127.23) علي الترتيب. بينما على عدد حبوب / السنبلة تم الحصول عليه من نباتات Sids 14 DMS_1 Sids 14 Azide $_3$ (88.33 و 87.44) على الترتيب.

أوضحت النتائج أنه يوجد إرتباط معنوي موجب بين صفة المحصول والصفات (عدد السنابل / النبات ، عدد السنيبلات / السنبلة، عدد الحبوب في السنبلة) بينما وجد إرتباط ضعيف بين صفة المحصول وصفة وزن الألف حبة، وإرتباط سالب مع صفة طول النبات.