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Assessment Effect of Mutations on Genetic Variability of Yield and Its Components in some Genotypes of Peanut (*Arachis hypogaea* L.)

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ABSTRACT

Peanut is one of the oil crops, growth patterns have made it difficult to carry out the genetic improvement. This study was conducted to bring about changes in four genotypes. by treating the seeds with different concentrations of sodium azide as a substance mutation to improve the on morphological and yield characteristics. An experiment was conducted in the experimental farm at the Agricultural Research Station in Ismailia, Oil Crops Department. Using genotypes (Giza 6, imported 360, local 302, line 34), they planted in a randomized complete block design in three replications with split plot design. The study showed that the general average of all genotypes was higher in the first mutant than in the second. Also, the concentrations of the mutagenic substance had a clear effect on the plants in the mutant generations in terms of morphological and yield component. heritability values exceeded 75% for many of the traits studied in each of the mutagenic generations. The first mutagen. values of the amount of expected genetic improvement ranged between 62.18% and 96.67% for some of the traits that were studied, where all the studied traits recorded varying values of genetic improvement through selection for genetic improvement, and it may range from 2.3 to 96.2 and from 2.5 to 106.1 in the mutant generations (first - second) respectively. Finally, it can be said that the concentration of 0.01% and 0.03% of sodium azide played an important role in causing a mutation to improve the yield characteristics of the genotypes.

Keywords: mutations, peanut, yield component

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is an important economic crop planted to obtain its seeds, which has a high content of protein and oil for use in food industries and for extracting edible oil (Juhaimi *et al.*, 2018; FAOSTAT, 2021). The cultivated area of the peanut crop in Egypt amounted to approximately165.3 thousand fed. in 2021, as it gave productivity (1.51 Ton/fed). These productivities are far below the world average (1.655 Ton/ha) due to non-availability of high potential cultivars (RR.). The low productivity of peanut in Egypt is also attributed to its cultivation in marginal and sub-marginal, due to no place in the agricultural cycle, as well as the presence of other major crops such as corn, rice, cotton and others summer crops, in addition, rainfed soils, meager or no application of fertilizers and it's sowing in utera cultivation and lack of seed of improved varieties, as well as low of genetic variability in peanut varieties.

However, peanut crop has a large genome (allotetraploid; 2n = 4x = 40) belong to the family Fabaceae and a self-pollinated crop so it has narrow genetic variability base. The increasing number of people in the world needs increase in food sources through improved agricultural production. Therefore, breeding methods for improve peanut crop varieties need genetic variation among their varieties are necessary. Hence, several methods of breeding such as selection, hybridization and induced mutations were carried to obtain the genetic variability, which achieves. the goal of breeding programs. In organisms like plants, mutations are the main source of genetic variety. (Kharkwal, 2012).

Mutagenesis an effective powerful tool, fast and a cheap method in the hands used for oligogenic and polygenic traits, causing heritable changes in the phenotype and improve morpho-physiological traits as well as quantitative traits such as yielding ability for developing new varieties (Sangle and Lad, 2020). sodium azide (NaN_3) is a heavy metal enzyme and a chemical mutagen effect on most metabolism processes and respiration systems of plant cell causing point mutations in peanut and proved to be very effective in the generation of quality mutants with high frequency (Wang *et al*., 2013; Jadhav *et al*., 2018; Okasha *et al.*, 2021). NaN_3 as a chemical mutagen had mutagenic efficiency on germination of seeds, early growth of seedling and peroxidase isozyme composition (Apparao, 2005; Abdul Rahaman *et al.*, 2013; Panda *et al.*, 2022) and it could be effective in achieving early maturing mutants of peanut and used to increase nut size, protein, fat, and other nutritious contents as well as pod yield (Animasaun *et al.*, 2014). However, an increase in concentrations of NaN_3 above 1mM will not enhance germination at pH3, but the concentrations ranging from 1mM NaN_3 and lower with pH3 will enhance germination and growth (Olise *et al.*, 2019). The chemical mutagen (NaN_3) was recommended for effective use to enhance specific characters in plants by the farmer and finally increase the possibility of isolating meaningful mutants of economic crops (Abdul Rahaman *et al.*, 2018).

There was an increase in genotypic variability for some traits like pod number, pod yield and seed yield/plant in M2 generation of peanut (Bharathi *et al.*, 2005). The effect for inducing mutation/morphological aberration was established at 0.03% of NaN_3 which increases in genetic parameters of variation, genetic advance and heritability indicate the ability

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to obtain higher yield mutants through suitable selection. Thus, yield traits like plant height, branches number/plant, pods number/plant, 100-seed weight and seeds/plant with high values of heritability and high values of genetic advance in the M3 generation offer a wide range for selection and improvement (Mensah and Obadoni, 2007; Ali *et al*. 2010 and Animasaun *et al*., 1014). High-oleic content of seeds, suitable size and shape of pods and seeds in peanut cultivars was identified in the Virginia type peanut mutant through screening of a 15 mmol/L NaN_3 mutagenized M3 population (Wang *et al.,* 2019; Nkuna *et al.,* 2021).

Therefore, the aim of the present study: is to investigate the impact of NaN_3 concentrations as a mutagenic agent on yield and yield component traits in some genotypes of peanut in addition their effect on genetic variability for these traits.

MATERIALS AND METHODS

Genetic Materials:

Four genotypes of peanut as genetic materials were used in the study. The selection of these genetic materials (peanut genotypes) was based on its economic importance as well as availability. The name, pedigree, sources and growth habit of the studied peanut genotypes are listed in Table (1).

Table 1. Genotypes studied, their sources and growth habit

Code	Gen.p. Pedigree	Sources	Growth habit
1	Unavailable	Egypt	Erect
2	Local 302	Egypt	semi spreading
3	Intro. 360	U.S. A	Erect
4	Line 34	Egypt	Erect

Studied genotypes obtained from Agricultural Research Center (A.R.C)-Giza – Egypt

Experiment Sites

The current study was executed on two Conditions, first on laboratory, and the second site at field, which was conducted at the Experimental Farm, Ismailia Research Station; Oil Crops Section- Agricultural Research Center (A.R.C) during the two successive summer sessions (2019 and 2020).

Laboratory Examination

Two different concentrations of NaN_3, 0.01 and 0.03% W/V were prepared in plastic volumetric flask by using distilled water (Dhanavel *et al.,* 2008). The seeds of selected genotypes were soaked in distilled water for about 6 hours. Then the control seeds of peanuts genotypes were removed from distilled water and air-dried for about 20 minutes. The control seeds of the peanut genotypes for each of these genotypes were soaked in the distilled water for 6 hours again, the seeds of peanuts genotypes were pre-soaked in a plastic Petri dish, which contains distilled water for six hours and air dried for about 20 minutes and then treated with freshly prepared mutagenic agent of NaN_3 solution at different concentrations 0.01% (T1) and 0.03% (T2) for 6 hrs. Dhanavel *et al.,* (2008). Then, the seeds of peanuts verities treated with NaN_3 were thoroughly washed in running tap water for ten minutes to remove excess exudates and chemicals from the seeds of peanut genotypes.

Experiments Field

In the two mutational generations; the seeds of peanut genotypes were treated with the chemical mutagenic agent in the laboratory (M1 generation) and the control seeds were sown in the first season 2019 and the M2 seeds were raised by selfing M1 plants for each peanut variety. The M2 seeds were sown in the field in the second season (2020) in plots. The area of each plot was(2.5×0.6 m). Peanut seeds (2-3 seeds) were deposited in rows 2.5 m length, 60 cm width and 20 cm spacing between plants within rows and then the plants were thinned after complete emergence (one week from planting) to one plant/hill. The recommended doses of chemical fertilizer (NPK) were applied at sowing by banding on one side of the row at 5 cm depth.

Experiments Design:

The experimental design was Randomize Complete Bloch Design (RCBD) with three replications in a spilt plot design arrangement, (two ways ANOVAs) where, the peanut genotypes located in main plots and mutation in the subplots with a respective control. The normal suggested agricultural practices for peanut production were applied at the proper time.

Characters Assessment:

SPAD chlorophyll reading: Leaf Chl. content was measured at flowering stage by a hand-held leaf Chl. meter (SPAD-502; Spectrum Technologies, Plainfield, IL) was used to measure Ch1. content on three subsamples taken per plant. The Chl. meter gives an index of total leaf Chl. content.

On the other hand, at the harvest stage, it's taken after 100 days of cultivation, ten guarded plants were randomly sampled in 5th leaf from above from each plot to provide measurements. The growth and yield characteristics of peanut genotypes were measured are follows: Plant height (cm), branch number/ plant, pod number/plant, pod weight/ plant (g), 100- pods weight (g), seeds number / The oil content percent was determined according to A.O.A.C system (1990).

Genetic Parameters Assessment:

Parameters of genotypic and phenotypic coefficient of variation, heritability, genetic gain and genetic gain percent for different characters at different mutations concentration for peanut genotypes traits under three concentrations of NaN_3in mutation generations.

Statistical Analysis:

Statistical analysis of two-ways analysis of variance (ANOVA) in M1 and M2 generations for all combined analysis of variance of the two mutational generations was applied after using the homogeneity test. To confirm the relative importance of the various characters, a set of genetic parameters; a genotypic and phenotypic coefficient of variability and heritability in broad sense were calculated according to Hallauer and Miranda (1988) a computer program Genstat 8 Rel.PL16 was used for analyzing data.

RESULTS AND DISCUSSION

Variance Analysis

Mean squares of the genotypes, mutagenesis treatment and their interactions for peanut genotypes through all assessed traits in the study summarized in Table (2). The results of the analysis of variance showed that there were significant differences in all eleven tested traits measured in the four peanut genotypes and in both mutagen doses as well as their interactions. These differences indicated the tested peanut genotypes were diverse. The current study was conducted to investigate the effects of NaN_3 mutagen on four peanut genotypes to improve yield-related traits and oil content percent. The results were in agreement with Kumar *et*

al. (2015) who reported that highly effective mutagenesis is important in mutagenesis-based breeding programs. Progressive mutagenesis is determined by many factors, including mutagen concentration, temperature, and treatment time. Although, previous studies have confirmed that polyploidy species are resistant to high-density induction of mutation compared to diploid that is because loss-of-function mutations in polyploidy is masked by genetic redundancy among homoerologists (Manal *et al*., 2009).

Table 2. Mean squares of morphological, physiological and reproductive traits of peanut genotypes for combined analysis

Characters	Source of variance	Replications	Gen.ps.	Error	NaN_3 concentration	Gen.ps.× NaN_3.	Error
	Degree of freedom.	2	3	6	2	6	15
SPAD. Values		0.83	47.3***	0.61	9.5**	29.0***	1.25
Plant height (cm).		2.22	60.2	19.5	648.3***	183.1***	13.1
Branches number pl^{-1}		1.25	7.5*	0.9	13.6**	12.7***	1.83
Pods number pl^{-1}		4.53	846.1**	40.4	887.2***	318.1***	43.3
pods. weight pl^{-1} (g).		3.52	4065.2***	65.8	1955.9***	3319.5***	72.7
100- pod weight (g)		88.9	768.1*	100.9	370.5**	409.3***	57.7
Seeds number pl^{-1}		91.0	3112.5***	68.1	730.3***	1813.1***	55.8
Seeds weight pl^{-1} (g).		6.88	2368.4***	32.8	214.7*	1446.9***	114.6
100 seeds weight		110.8	180.3*	60.7	197.4*	424.4**	65.7
Oil -seed percent		5.21	10.81	3.48	18.9*	85.1***	4.63
pods yield ardab fad^{-1}		3.38	16.29*	2.13	72.6***	50.35***	3.62

Mean Performance of Quantitative traits and Oil Content in the M1 and M2 Generations

Chlorophyll SPAD reading

The results showed that the high content of chlorophyll in mutated T1 (0.01) and T2 (0.03) peanut plants over control plants through the reading of SPAD values, especially (four peanut genotypes) in M1 and M2 generations (Table 3). On the other hand, each genotype responded differently to the combined effects of the (two treatments) throughout each generation. In the M1 generation, Giza 6 had the highest general mean (47.8) and gen.p.360 had the lowest general mean (41.8). In the M2 generation, gen.p. 34 had the highest general mean (46.4) and gen.p.302 had the lowest (41.4). These findings revealed various amounts of SPAD in four different genotypes of peanut mutant plants. It's possible that the difference in SPAD values is the result of mutations that happen at various genomic loci and NaN_3 concentrations (Al-Qurainy, 2009). These results contrasted with that of Okasha *et al*. (2021), who reported that the mean SPAD values decreased when NaN3 concentrations increased in M1 and M2 compared to control. Similar to this, earlier investigations revealed that genotype influences the sensitivity to chemical mutagens (Ali *et al*, 2010 and Kumar *et al*., 2015

Table 3. SPAD values of four treated peanut genotypes with three NaN_3 concentrations in mutational generations

Characters	Concentrations	Generations	Giza 6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
SPAD values	Control	M1	45.4	40.6	44.5	42.2	43.0
		M2	42.4	41.6	42.3	45.5	42.9
	T1 (Con. 0.01)	M1	47.5	44.6	43.5	46.3	45.4
		M2	45.3	44.5	36.1	47.4	43.4
	T2 (Con. 0.03)	M1	50.4	40.3	45.7	45.4	45.4
		M2	45.9	40.6	45.7	46.4	44.5
	X`	M1	47.8	41.8	44.5	44.6	
		M2	44.4	42.2	41.4	46.4	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		0.90	1.01	1.16	0.96	1.75	2.15

Growth characteristics:

The results of stem height trait are presented in Table (4) and showed that M1 had a lower overall mean than M2, regardless of whether the mutagen dose was modest or high. The average of each genotype reacted uniformly to the combined effects of the three treatments over the course of each generation. In both generations, gen.p.302 had the greatest general mean while Peanut gen.p (34) had the lowest T1 and T2 mutated plants displayed a high value of the plant height compared to control plants for all peanut genotypes, but decease in Giza 6 excluding M2 mutated plants of T1 (62.2cm), This finding indicates that mutagenic inhibition of mitosis and expression of plant hormone synthesis genes can cause plant height reduction (Cheng *et al.*, 2019). On the other hand, peanut gen.p.302 had higher values in both generations at both mutagen doses. This may indicate that plant growth hormones induced by these NaN_3 concentrations are maintained throughout the vegetative growth period of gen.p.302. Nevertheless, this finding is similar to the report by Animasaun *et al.* (2014), which stated that plant height was positively affected by these high concentrations of NaN_3 mutagen.

The results of branch number/plant showed that the means of all four peanut genotypes were significantly impacted by both low and high dosages of mutagens when compared to the general means of the control peanut plants in both of M1 and M2, although they had negative reactions to the high mutagen concentration (Table 4). The highest increases of the mean values in the M1 generation at low dose gen.p.360 (9.9) and gen.p.34 (8.3) when compared to the control respective. However, when comparing gen.p.302 and gen.p.360 to the control the largest increase in branches number per plant was observed in M2 generation at a low dose of mutagen (9.7 and 8.5). The peanut gen.p.360 increased at the same dose in both generations, probably due to rapid cell division, elongation and synthesis of plant hormones or nucleic acids (Khursheed *et al.*, 2019). This finding result is consistent with Kavera and Nadf (2017) and Raina *et al.* (2022).

Table 4. Mean values of stem height and branches number/plant of four peanut treated genotypes with three NaN3 concentrations in mutational generations

	Concentrations	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Stem height (cm).	Control	M1	63.3	52.4	45.9	46.4	52.0
		M2	57.7	47.2	43.9	51.5	50.1
	T1 (Con. 0.01)	M1	49.1	59.3	61.5	54.1	56.0
		M2	62.2	65.9	65.7	51.3	61.3
	T2 (Con. 0.03)	M1	51.9	52.4	58.3	44.5	51.8
		M2	54.4	66.8	72.6	62.0	63.9
	X`	M1	54.8	54.7	55.2	48.3	
		M2	58.1	59.9	60.7	54.9	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		1.94	3.13	3.62	5.10	4.27	6.52
	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Branches number pl^{-1}	Control	M1	7.8	6.8	9.7	7.4	7.9
		M2	9.4	7.0	7.8	10.2	8.6
	T1 (Con. 0.01)	M1	5.9	9.9	5.8	8.3	7.5
		M2	3.8	8.5	9.7	6.9	7.2
	T2 (Con. 0.03)	M1	7.5	6.9	4.1	4.2	5.7
		M2	5.7	7.5	4.7	4.7	5.7
	X`	M1	7.1	7.9	6.5	6.6	
		M2	6.2	7.6	7.5	8.5	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		0.79	1.17	1.19	1.08	1.60	2.12
Gen.p.= Genotype				M.= Mutations			

Yield and yield component traits:

The pod number per plant is one of the most significant characteristics influencing yielding capacity (Table 5). However, in the M1 generation, this trait changed depending on the peanut genotype and treatment concentration of sodium azide (NaN3).

Table 5. Mean values of pod number, pods weight and100 pods weight/plant of four peanut treated genotypes with three NaN_3 concentrations in mutational generations.

Characters	Concentrations	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Pods number pl^{-1}	Control	M1	61.0	66.0	62.0	66.4	63.8
		M2	74.0	73.0	69.7	57.0	68.4
	T1 (Con. 0.01)	M1	81.0	71.7	53.0	76.0	70.4
		M2	87.0	80.7	69.7	77.3	78.7
	T2 (Con. 0.03)	M1	75.0	95.7	96.0	64.0	82.7
		M2	93.0	96.7	96.0	56.3	85.5
	X`	M1	72.3	77.8	70.3	68.8	
		M2	84.7	83.4	78.4	63.6	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		6.39	5.69	8.81	7.33	12.6	11.04
	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Pods. weight pl^{-1} (g)	Control	M1	122.8	93.5	101.7	124.9	110.7
		M2	172.6	144.6	163.2	130.2	152.7
	T1 (Con. 0.01)	M1	198.7	104.2	91.6	121.9	129.1
		M2	188.4	166.4	141.3	151.3	161.9
	T2 (Con. 0.03)	M1	104.2	130.5	146.5	107.2	122.1
		M2	151.5	225.4	218.3	116.4	177.9
	X`	M1	141.9	109.4	113.3	118.0	
		M2	170.8	178.8	174.3	132.6	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		6.65	7.38	11.35	9.36	14.1	14.25
	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
100- pod weight (g)	Control	M1	161.4	171.5	175.1	185.5	173.4
		M2	220.3	228.3	238.5	250.3	234.3
	T1 (Con. 0.01)	M1	216.8	196.7	162.3	191.7	191.9
		M2	227.6	234.7	233.5	246.5	235.6
	T2 (Con. 0.03)	M1	141.1	185.4	153.8	163.5	160.9
		M2	208.8	231.4	246.9	214.5	225.4
	X`	M1	173.1	184.6	163.7	180.3	
		M2	218.9	231.5	239.6	237.1	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		8.04	6.58	13.07	11.59	16.74	14.12
Gen.p.= Genotype				M.= Mutations			

For instance, the treatments T2 mutant plants, which produced an average of 95.7 and 96.7 pods number per plant respectively, in gen.p.360 as well, which produced an average of 96 in gen.p.302 in the same high dose at both generations

in comparison at control plants. The pattern was slightly different in Giza 6, Comparing the M1 generation in T1 and M2 in T2 mutant plants produced hight pods number per plant (81.0& 93.0) than the control plants which possessed 61.0 and 74.0, in respectively. the mean values of Giza 6, gen.p.360, and gen.p.302 were showed a significant improvement. Contrarily, the peanut gen.p.34 had fewer pods number on average per plant (56.3) at high mutagen concentrations of sodium azide (NaN3) in M2. Most essentially observed that high doses of the mutagen increased the average number of pods per plant in the peanut genotypes tested at both generations, except gen.p. 34. However, this is considered a vital trait from a breeder's point of view. This property enhancement may be due to the physiological effects of high doses of the mutagens and their hydrolysis products. A previous study was carried out on peanut genotypes reported similar results (Chen *et al*., 2020). The data in (Table 5) demonstrated the average both of pod weight per plant and 100 –pods weight in gen.p.302, which responded favorably to high doses of mutagen compared to control plants in the M1 and M2 except M1 in 100 –pods weight (153.8), However, low dosages of mutagen in M1 and M2 had a beneficial effect on Giza 6, whereas excessive amounts had the opposite effect. Both mutagen dose had an advantageous effect on gen.p.360 in high dose of pod weight per plant (130.5&225.4) while T1 postive effect in 100 –pods weight (196.7 & 234.7) in both generations. Average pods weight per plant responded favorably to gen.p.34 at high dose but decreased value at high dose in both generations for the average weight of 100 pods (Table 5). Indeed, these disparate results imply that various plants react to mutagenesis treatments at particular dosages or concentrations in different ways. To draw meaningful conclusion, it may be necessary to compare how various mutagens affect various crop growth metrics (Manal *et al*., 2009).

The results of the average values of the seed number/plant, seeds weight per plant and 100-seeds weight are variable in M1 and M2 plants (Table 6). The findings demonstrated that gen.p.360 and gen.p.302 displayed greater levels of these traits of M1 and M2 generations in T2 mutant plants, compared to control plants But, these traits were compared in Giza 6 the mean values in T2 mutated plants were lower T1 compared to control in number/plant, seeds weight per plant .In addition , Giza 6 and gen.p.360 had high values of the average in T1,while, gen.p.302 had positive effect in high dose compared to control plants in 100-seeds weight, while the peanut gen.p.34 mutant plants from T2 exhibited fewer number of seeds per plant and seed weight per plant than control plants as well (M2 in T1) and (M1 in T2) at seed number/plant. On the other hand, the average weight of 100 seeds was larger in T1 mutant plants (102.7 g and 93.7) but, in T2 mutant plants scored (109.6 g , 87.3 g) , in respectively in the M1 and M2 generations.

Table 6. Mean values of seed number, seeds weight and 100 seeds weight/plant of four peanut treated genotypes with three NaN_3 concentrations in mutational generations

Characters	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Seed number pl^{-}	Control	M1	115.7	83.0	104.7	124.3	106.9
		M2	106.0	114.0	131.0	112.3	115.8
	T1 (Con. 0.01)	M1	139.7	75.7	96.0	116.7	107.0
		M2	121.0	104.0	118.3	117.3	115.2
	T2 (Con. 0.03)	M1	86.7	103.0	190.3	97.3	119.3
		M2	97.0	132.0	192.3	94.7	129.0
	X`	M1	114.0	87.2	130.3	112.8	
		M2	108.0	116.7	147.2	108.1	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		4.60	6.47	9.79	9.52	10.73	13.02
Seed weight pl^{-1} (g).	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
	Control	M1	106.3	66.6	88.3	122.6	95.9
		M2	100.7	87.4	109.9	117.2	103.8
	T1 (Con. 0.01)	M1	122.7	77.4	74.4	112.7	96.8
		M2	114.6	95.8	117.5	104.5	108.1
	T2 (Con. 0.03)	M1	83.7	97.9	160.5	99.4	110.4
		M2	90.2	105.4	168.7	84.8	112.3
	X`	M1	104.2	80.6	107.7	111.6	
		M2	101.8	96.2	132.1	102.2	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		7.73	9.26	2.35	6.60	13.03	16.26
100 seeds weight	Concentration	Generations	Giza 6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
	Control	M1	67.4	72.5	86.2	88.3	78.6
		M2	78.6	80.9	101.1	91.2	88.0
	T1 (Con. 0.01)	M1	88.9	93.3	82.5	102.7	91.9
		M2	103.9	91.9	80.5	93.7	92.5
	T2 (Con. 0.03)	M1	75.0	87.2	105.6	109.6	94.4
		M2	91.9	91.1	113.8	87.3	96.1
	X`	M1	77.1	84.3	91.4	100.2	
		M2	91.5	88.0	98.5	90.8	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		6.21	7.02	5.34	8.99	11.14	13.58

Gen.p.= Genotype M.= Mutations

This may be due to physiological and biological processes related to yield, such as hormonal balance and enzymatic activity. In addition, mutagenic toxicity has been reported to damage cellular components and alter enzymatic

activity at the molecular level (Ali *et al*., 2010; Chen *et al*., 2020). In contrast, the peanut gen.p302 and gen.p.360 responded positively to high-dose mutagens for seed yield traits possibly due to the predominant frequency of the desired mutations in the treated plants. Therefore, increases in polygenic traits and seed yield could by simply result from changes in inherited traits or mutations at structural loci. The current study is in agreement with previous results reports of mutagenized peanut cultivars that recorded a significant increase in seed yield (Manal *et al*., 2009; Animasaun *et al*., 2014). Although, seed yield (Ardab/Fadden) is a complex trait involving additive effects of multiple genes and it is difficult to identify the mutant genes that control performance improvement (Chen *et al.,* 2020; Raina *et al.*, 2022). The results of this investigation were showed that both doses of mutagens enhanced yield (Ardab/ Fadden) in peanut genotypes of generations M1 and M2, with the exception of gen.p.34 and Giza6 which increased at T1 (Table 7)., since control plants are supposed to be genetically similar and any differences found therein can only be the result of environmental factors, which was the expected result. The present study is in coherence with Manal *et al.* (2009) and Ali *et al.* (2010).

Oil content percent trait:

Results of oil content percent in M1 and M2 generations are illustrated in (Table 7). It was found that a low dose caused a positive effect on the average of the oil content percent in gen.p.360 and gen.p.34, but a high dose caused a positive effect on the average (58.7&59.1)and (55.3&54.9) respectively of the oil content percent in the peanut gen.p.302(60.4&60.8). This finding is similar to the report by Wang *et al.* (2007), which revealed that mutagenesis treatment can either increase or decrease the oil content percentage of peanuts. As a result, finding, the oil content of peanut seeds is a complex and polygenic trait that responds to environmental factors that take place as a plant develops.

Table 7. Mean values of oil content percent and yield (ardab fad^{-1}) of four peanut treated genotypes with three NaN_3 concentrations in mutational generations

Characters	Concentrations	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
Oil content percent	Control	M1	43.5	51.9	43.5	43.1	45.5
		M2	51.4	47.5	52.5	51.5	50.7
	T1 (Con. 0.01)	M1	51.4	58.7	45.9	55.3	52.8
		M2	51.2	59.1	47.2	54.9	53.1
	T2 (Con. 0.03)	M1	46.5	51.6	60.4	47.4	51.5
		M2	50.1	50.4	60.8	49.3	52.7
	X`	M1	47.2	54.1	50.0	48.6	
		M2	50.9	52.4	53.5	51.9	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		2.51	1.86	3.81	2.15	5.11	3.52
Yield.ardab fad^{-1}	Concentration	Generations	Giza6	Gen.p. 360	Gen.p. 302	Gen.p. 34	X`
	Control	M1	10.5	12.0	13.4	16.6	13.1
		M2	12.4	15.1	14.0	17.9	14.9
	T1 (Con. 0.01)	M1	21.5	16.8	14.4	18.2	17.7
		M2	23.7	20.4	15.9	19.1	19.8
	T2 (Con. 0.03)	M1	14.9	22.4	18.8	10.1	16.5
		M2	13.8	22.4	20.3	12.6	17.3
	X`	M1	15.6	17.1	15.5	14.9	
		M2	16.6	19.3	16.8	16.6	
	LSD.0.05 %	M.		Gen.p.		M.* Gen.p.	
		M1	M2	M1	M2	M1	M2
		1.48	1.65	2.34	1.68	3.05	3.04

Gen.p.= Genotype M.= Mutations

Low and High Mutagen Dosages Affect the Genetic Behavior of Plant Traits

Phenotypic and genotypic coefficients of variation

The variability in crops is classified as genetic and non-genetic, including phenotypic and genotypic coefficients of variation. Because it serves as the foundation for selection, understanding the level of genotype in crop species is crucial. The data in (Table 8) are the calculated phenotypic and genotypic coefficients of variability (PCV and GCV) for eleven studied traits that were examined in this study. The GCV values varied from 3.68% to 39.83% and from 2.87% to 35.06% in the M1 and M2 generations, in respectively. The PCV values also ranged from 4.25% to 40.54% and from 4.19 to 36.78% in the M1 and M2 generations, in respectively. Obviously, the values of PCV and GCV were higher than in the M1 generation than those in the M2 generation. As the performance, stability of the mutants becomes pronounced in subsequent generations (M2, M3, etc.) through increased recombination and eradication of cytological mutations. Although less important in terms of obtaining stable genetic mutations, var Thus, a much larger PCV exhibits a strong environmental masking effect, which may complicate genetic improvement through mutant genotype selection. While GCV was more or less equal to PCV for pods weight/plant, 100 pods weight, and seeds yield (seeds number/plant, seed weight/plant, and 100 seed weight) as well as oil seed percentage. However, the seed traits of peanut crop are highly variable traits and are susceptible to environmental factors. This finding showed that the genetic factors have a significant impact on these traits. The results are consistent with these reported by each of Ali *et al.* (2010) and Chen *et al.* (2020)

Heritability

Heritability in broad sense describes the reliability of a phenotypic value as a breeding guide that was includes both

additive and non-additive gene activities. Thus, characters with high heritability can be improved more quickly by selection than characters with low heritability, as they are affected by environmental factor in the current study, recorded heritability values exceeded 56.39 & 29.31% for all examined traits in both of M1 and M2 generations, Notably, the treatment T2 mutant plants in the M2 generation had higher heritability scores (96.36%) as well in the M1 generation the treatment T1 mutant plants, at high NaN3 concentrations, the mutagenized plants exhibited high heritability values of 96.67%. These traits are influenced by fewer environmental factors and can be easily selected for high additive effects (Table 8) These findings were detected before with the same crop or with other crops such as Eid *et al*., (2009); Kaveraand and Nadaf (2017).

Table 8. Parameters of genotypic and phenotypic coefficient of variation for different characters at three different mutations concentration, heritability, genetic gain and genetic gain percent for peanut traits under three concentrations of NaN_3 in mutation generations

Characters	Generations	Concentration	GCV%	PCV%	H^2%	GS	GS%
SPAD values	M1	Control	4.88	5.53	77.67	3.8	8.9
		T1(Con. 0.01)	3.68	4.25	75.01	3.0	6.6
		T2(Con. 0.03)	8.99	9.26	94.32	8.2	18.0
	M2	Control	3.73	4.60	65.86	2.7	6.2
		T1(Con. 0.01)	11.36	11.60	95.87	9.9	22.9
		T2(Con. 0.03)	5.81	6.41	82.03	4.8	10.8
Plant height (cm).	M1	Control	14.86	16.87	77.58	14.0	27.0
		T1(Con. 0.01)	9.81	10.14	93.59	10.9	19.5
		T2(Con. 0.03)	10.83	11.12	94.93	11.3	21.7
	M2	Control	11.42	12.72	80.54	10.6	21.1
		T1(Con. 0.01)	10.62	12.37	73.69	11.5	18.8
		T2(Con. 0.03)	11.36	13.36	72.31	12.7	19.9
No. of branches pl^{-1}	M1	Control	15.36	17.12	80.49	2.3	28.4
		T1(Con. 0.01)	24.87	29.40	71.57	3.2	43.3
		T2(Con. 0.03)	29.31	35.34	68.80	2.9	50.1
	M2	Control	16.27	18.91	74.05	2.5	28.8
		T1(Con. 0.01)	34.79	36.78	89.43	4.9	67.8
		T2(Con. 0.03)	17.45	32.23	29.31	1.1	19.5
No. of pods pl^{-1}	M1	Control	4.10	4.60	79.68	4.8	7.5
		T1(Con. 0.01)	16.80	18.41	83.29	22.2	31.6
		T2(Con. 0.03)	17.36	22.38	60.14	22.9	27.7
	M2	Control	10.93	12.42	77.49	13.6	19.8
		T1(Con. 0.01)	7.78	11.46	46.10	8.6	10.9
		T2(Con. 0.03)	21.95	24.47	80.44	34.7	40.5

Con. Table 8. Parameters of genotypic and phenotypic coefficient of variation for different characters at three different mutations concentration, heritability, genetic gain and genetic gain percent for peanut traits under three concentrations of NaN_3in mutation generations

Characters	Generations	Concentration	GCV%	PCV%	H^2%	GS	GS%
Pods weight pl^{-1} (g)	M1	Control	13.73	14.61	88.23	29.4	26.6
		T1(Con. 0.01)	36.88	37.86	94.88	95.5	74.0
		T2(Con. 0.03)	15.86	17.57	81.47	36.0	29.5
	M2	Control	12.26	12.75	92.45	37.1	24.3
		T1(Con. 0.01)	12.04	13.81	76.03	35.0	21.6
		T2(Con. 0.03)	29.50	30.05	96.36	106.1	59.6
100- pods weight (g)	M1	Control	5.12	6.81	56.39	13.7	7.9
		T1(Con. 0.01)	11.21	12.73	77.54	39.0	20.3
		T2(Con. 0.03)	10.73	13.24	65.75	28.9	17.9
	M2	Control	5.24	6.12	73.39	21.7	9.2
		T1(Con. 0.01)	2.87	4.19	46.77	9.5	4.0
		T2(Con. 0.03)	7.29	8.32	76.68	29.6	13.1
No. of seeds pl^{-1}	M1	Control	16.52	17.08	93.53	35.2	32.9
		T1(Con. 0.01)	25.52	25.96	96.67	55.3	51.7
		T2(Con. 0.03)	39.83	40.54	96.51	96.2	80.6
	M2	Control	8.84	9.94	79.07	18.8	16.2
		T1(Con. 0.01)	6.24	7.27	73.59	12.7	11.0
		T2(Con. 0.03)	35.06	35.79	96.00	91.3	70.8
Seeds weight pl^{-1} (g).	M1	Control	24.74	25.83	91.75	46.9	48.8
		T1(Con. 0.01)	25.09	25.71	95.26	48.8	50.5
		T2(Con. 0.03)	30.61	31.64	93.59	67.3	61.0
	M2	Control	11.24	14.46	60.43	18.7	18.0
		T1(Con. 0.01)	7.38	11.95	38.17	10.2	9.4
		T2(Con. 0.03)	34.03	35.08	94.10	76.3	68.0

Con. Table 8. Parameters of genotypic and phenotypic coefficient of variation for different characters at three different mutations concentration, heritability, genetic gain and genetic gain percent for peanut traits under three concentrations of NaN_3 in to mutation generations

Characters	Generations	Concentration	GCV%	PCV%	H²%	GS	GS%
100 -seeds weight	M1	Control	12.40	14.13	76.98	17.6	22.4
		T1(Con. 0.01)	8.42	10.68	62.18	12.6	13.7
		T2(Con. 0.03)	16.14	19.02	72.01	26.6	28.2
	M2	Control	10.66	13.71	60.47	15.0	17.1
		T1(Con. 0.01)	9.36	12.04	60.48	13.9	15.0
		T2(Con. 0.03)	11.34	14.57	60.55	17.5	18.2
Oil content percent	M1	Control	8.92	10.45	72.88	7.1	15.7
		T1(Con. 0.01)	9.56	11.83	65.25	8.4	15.9
		T2(Con. 0.03)	12.23	12.63	93.83	12.6	24.4
	M2	Control	4.22	4.56	85.79	4.1	8.1
		T1(Con. 0.01)	9.45	9.78	93.43	10.0	18.8
		T2(Con. 0.03)	9.81	11.38	74.29	9.2	17.4
pods Yield.ardab fad^{-1}	M1	Control	18.45	22.17	69.29	4.2	31.6
		T1(Con. 0.01)	16.08	18.16	78.43	5.2	29.3
		T2(Con. 0.03)	30.54	34.15	79.99	9.3	56.3
	M2	Control	14.86	17.48	72.24	3.9	26.0
		T1(Con. 0.01)	15.60	17.39	80.46	5.7	28.8
		T2(Con. 0.03)	26.73	30.02	79.33	8.5	49.1

Genetic gain by selection (GS) and its percentage (GS %)

All studied traits recorded different values of genetic gain by selection (GS), whereas ranging from 2.3 to 96.2 and from 2.5 to 106.1respectively in M1 and M2 generations, in respectively. Notably, the treatment T2 mutant plants in the M2 generation had higher GS scores than those in the M1 generation (Table 8). On the other hand, when genetic gain by selection is expressed as a percentage (GS %) (Table 8), in the M1 generation, the highest value was 80.6 % for seeds number/plant at the low mutagen dose, but the lowest value was 6.6 % for of SPAD values at the low mutagen dose as well. In the M2 generation, the dose of mutagen successfully increased the GS value of pods weight per plant and the GS% of seed number per plant; the highest value was 70.8 % for the number of seeds per plant at the high mutagen dose, whereas the lowest value was 4.0 for 100 –pods weight at T1. An increase in genetic parameters can result from the pleiotropic effects of mutagens or newly mutated genes. This finding was supported by an excellent study, which carried out by Raina *et al*. (2022).

CONCLUSION

Based on using NaN3 mutagen is particularly important method with peanut genotypes, which very narrow natural gene pools, It can aside according few point economic and agricultural reprehensive by some characteristics such as SPAD valum, pods weight/plant, seeds number/plant, seeds weight/plant and oil seed percentage along with high GCV and high heritability coupled with high values of genetic gain by selection in M2 generation that provide a good rang of ability to induce desirable mutations of polygenic traits with effective selection and enrichment. In addition, this work is currently underway on the molecular characterization of these induced mutants and mutations. This allowed us to select them as new germplasm and breeding material for use in the peanut breeding program in the future.

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تقييم تأثير الطفرات على التباين الوراثي للمحصول ومكوناته في بعض أصناف الفول السوداني

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الملخص

الفول السوداني من محاصيل الزيت ، ذو طبيعة نمو خاصة تسبيت في صعوبة إجراء التهجين وبالتالى يصعب التحسين الوراثي فيه ولذلك تم اجراء هذه الدراسة البحثية لاحداث تغيرات في أربعة تراكيب وراثية . من خلال معاملة البذور بتركيزات مختلفة من مادة ازيد الصوديوم كمادة مستحثة للطفور لتحسين الصفات المحصولية. تم تنفيذ التجارب في المزرعة البحثية التابعة لمحطة البحوث الزراعية بالإسماعيلية لتحديد تأثير فاعلية أزيد الصوديوم على الصفات المورفولوجية والمحصولية باستخدام أربعة تراكيب وراثية (صنف جيزة 6 ، مستورد 360 ، محلى 302 ، سلاله 34)، تم إستخدام تصميم القطع المنشقة في ثلاثة مكررات. أظهرت الدراسة أن المتوسط العام لجميع التراكيب الوراثية كان الأعلى في الجيل المطفر الأول عن الجيل المطفرالثاني. كما أن تركيزات المادة المطفره كان لها تأثيرواضح على النباتات فى الاجيال المطفرة فى الصفات المورفولوجية والمحصولية.تجاوزت قيم التوريث 75٪ للعديد من الصفات المدروسة في كل من الاجيال المطفرة ، و كانت للنباتات الطافرة بالتركيز المنخفضة درجات وراثية أعلى في الجيل المطفر الثانى من مثيلاتها في الجيل المطفر الأول. تراوحت قيم مقدار التحسن الوراثى المتوقع ما بين 62.18٪ و 96.67٪ لبعض الصفات التي درست، حيث سجلت جميع الصفات المدروسة قيماً متباينة للتحسن الجيني عن طريق الانتقاء التحسين الوراثي، وقد تتراوح من 2.3 إلى 96.2 ومن 2.5 إلى 106.1 في أجيال المطفر(الاول- الثانى) على التوالي. وأخيرا يمكن القول أن تركيز 0.01٪ و 0.03٪ من أزيد الصوديوم لعب دوراً مهماً في إحداث طفرة لتحسين الصفات المحصولية للتراكيب الوراثية للفول السوداني .

الكلمات الدالة :الطفرات -الفول السودانى – المحصول ومكوناته