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Research Article
Effect of Mutagens on Yield and its Components of Two Varieties of Faba Bean (*Vicia faba* L.)

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Abstract

Background and Objective: It is known that any genetic improvement depends on the presence of many genetic variations so that the plant breeder can choose the desired traits such as the trait of the crop or resistance to some diseases. Different or it can be used for selection, whether for yield, early maturity or other characteristics. This study aimed to use gamma irradiation and the chemical mutagen Dimethyl sulfoxide for the induction of genetic variation in two types of beans. **Materials and Methods:** The Giza 429 and Misr 1 genotypes were treated with three different concentrations of dimethyl sulfur oxide (1000, 2000 and 3000 ppm) and gamma radiation doses (10, 15 and 20 kr) to perform mutagenesis treatments. **Results:** In the first and second seasons of the study, all the mutations resulting from the radiological and chemical mutagenic treatments of the two Egyptian bean cultivars, Giza 429 and Misr 1, were highly significant for all treatments in the following traits: Number of branches/plant, plant height, number of pods/plant with the weight of 100 seeds (g) and seed yield/plant (g). **Conclusion:** The benefit of this research was obtained from plants that outperformed the two cultivars Giza 429 and Misr 1 and are considered among the promising plants that can be used in mixed breeding programs or direct selection for high productivity.

Key words: Mutagens, chemical mutation, gamma rays, dimethyl sulfoxide, maturity, genetic, breeding programs

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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

The bean (*Vicia faba* L.) is an important widely cultivated legume crop originating in the Mediterranean region. It is a cultivated species of the family Fabaceae. Legumes are important sources of protein, vitamins, carbohydrates, fibre and minerals[1]. Beans also contribute to farmers' income and improve soil fertility through biological nitrogen fixation[2]. Unfortunately, not many wild species of *Vicia faba* L. have been found that can be used as a source of genetic variation. Irradiation and *in vitro* mutagenic chemicals have been used successfully to improve agronomic traits, the most important of which are high yield, as well as salinity tolerance and drought tolerance in different crop plants[3]. Fouad *et al.*[4] decided that fava beans are an important leguminous crop due to their high yield potential and nutritionally dense grains. In many crops, mutations were released as new varieties. Chemical as well as radioactive (gamma) mutagens, caused genetic diversity in the germplasm of germplasm. Hacıseferoğullar *et al.*[5] conducted a study in which some chemical and physical properties of the bean (*Vicia faba* L. var. major) were determined. It was found that the effect of the phenotype and frequency of mutations depends largely on the genetic background that is produced as well as on the nature of the genes or genetic material[6] Tariq *et al.*[7] determined that most of the study measurements were negatively affected and were positively corrected using mutations. Also, the mutagenic effects of different concentrations of chemical mutations on (*Arachis hypogaea* L.) recorded negative and positive changes in the mean values of the crop characteristics in generations[8] M_1 and M_2.

The current study aimed to induce genetic variation in two types of beans using gamma irradiation and the chemical mutagen dimethyl sulfoxide.

MATERIALS AND METHODS

Study area: The present study was carried out at the Experimental Farm of the Faculty of Agriculture, Al-Azhar University, Assiut Branch during 2019/2020 and 2020/2021 growing seasons.

Methodology: The genotypes used for mutagenic treatment were Giza 429 and Misr 1. Three different concentrations of Dimethyl sulfoxide (1000, 2000 and 3000 ppm) and gamma irradiation doses (10, 15 and 20 Kr) were freshly prepared for conducting the mutagenic treatments. Two hundred seeds of faba bean were soaked in distilled water for 20 hrs as the control treatment. The selected variants at the present study included apparent morphological characters, for the number of branches/plant, number of pods/plant, days to maturity, 100-seed weight (g) and seed yield/plant (g).

Gamma irradiation doses: Two hundred bean seeds were exposed at each dose of gamma radiation (10 kr = RAT_1), (15 kr = RAT_2) and (20 kr = RAT_3) freshly to perform mutagenic treatments.

Dimethyl sulfoxide: Two hundred seeds from each variety were soaked in a prepared aqueous solution of Dimethyl sulfoxide of three different concentrations (1000 ppm = DMT_1), (2000 ppm = DMT_2) and (3000 ppm = DMT_3) for 20 hrs.

Heritability was estimated by several methods by using different genetic populations and produced 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 faba bean 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.

RESULTS

In the first and second seasons of the study, all the mutants resulting from radiological and chemical mutagenic treatments in Table 1 for two Egyptian bean cultivars, Giza 429 and Misr 1, were highly significant for all treatments in the following traits: Number of branches/plant, plant height, number of pods/plant By weight of 100 seeds (g) and seed yield/plant (g). Table 1 shows that, all the mean traits in the second mutagenic generation were higher than the first mutagenic generation except for plant height and 100-seed weight, the mean of M_2 was less than the mean of M_1. Also, it is clear from the presentation of Table 2 that, the number of plants obtained from M_2 from M_1 plants that maintain mutations in M_2 was 65 plants between the different concentrations of radioactive and chemical mutations for two Egyptian bean cultivars, Giza 429 and Misr 1.

It is evident from Table 3 that all the averages of the cultivar Misr 1 for the traits under study in M_2 were above the mean of the treatments in M_1 except for the plant height and 100-seed weight where the mean M_2 was lower than the mean M_1. All treated traits were averaged across all radiological or chemical mutagenesis coefficients. Whereas, all plants that maintained the mutations in M_2 outperformed

Table 1: Means and variances for faba bean genotypes under different treatments of mutagenic through generations

	No. of branches/plant				Plant height (cm)				No. of pods/plant			
	Mean		Variance		Mean		Variance		Mean		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
Misr 1												
DMT_1	3.3	3.62	30.17**	13.73**	149.53	145.84	18.14**	3.42**	44.93	47.45	8.76**	5.95**
DMT_2	3.28	3.56	22.11**	6.24**	142.12	139.16	38.34**	45.21**	41.65	44.61	7.19*	7.37**
DMT_3	3.36	4.02	41.51**	56.57**	148.33	145.83	21.04**	21.63**	45.57	48.07	13.56**	18.92**
RAT_1	3.3	4.13	31.26**	12.69**	147.01	148.79	18.71**	3.45*	46.63	51.20	8.98**	3.34*
RAT_2	4.3	3.95	25.44**	10.84**	149.57	146.43	41.32**	14.12**	49.21	49.27	76.29**	34.88**
RAT_3	4.14	4.85	38.25**	59.27**	148.69	148.58	19.06**	15.37**	47.17	48.10	13.27**	12.81**
Control	2.70	3.10	-	-	159.87	157.88	-	-	37.28	39.04	-	-
Giza 429												
DMT_1	3.90	4.23	27.79**	10.80**	147.24	146.18	17.87**	10.77**	46.20	47.71	8.54**	7.57**
DMT_2	2.77	3.23	22.88**	37.58**	146.19	140.11	47.49**	81.08**	44.88	44.56	8.80**	18.01**
DMT_3	3.97	4.38	42.81**	19.68**	147.23	145.83	12.25**	18.60**	47.60	48.07	14.26**	11.40**
RAT_1	3.67	4.68	13.38**	8.46**	150.53	148.43	36.54**	14.02**	49.05	50.57	10.48**	8.85**
RAT_2	4.14	2.75	36.05**	4.82*	148.55	146.43	16.64**	35.26**	47.92	49.27	15.33**	4.99*
RAT_3	5.34	6.30	36.25**	16.18**	149.12	148.91	18.90**	13.43**	49.33	50.09	8.07**	10.73**
Control	3.12	4.09	-	-	158.87	157.88	-	-	40.28	40.54	-	-

	100-seed weight (g)				Seed yield/plant (g)			
	Mean		Variance		Mean		Variance	
Treatments	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
Misr 1								
DMT_1	60.56	56.90	4.60*	4.41*	77.52	80.52	106.20**	19.68**
DMT_2	60.68	57.72	2.73	4.77*	75.06	78.02	69.62**	34.88**
DMT_3	61.13	58.63	3.31*	6.81*	80.92	83.42	21.12**	20.10**
RAT_1	61.90	63.97	4.05*	6.87*	75.10	83.26	107.03**	11.19**
RAT_2	61.89	63.71	2.84	6.70*	85.03	81.20	76.29**	23.28**
RAT_3	60.69	63.57	3.09*	6.22*	81.94	83.88	35.73**	12.42**
Control	66.90	65.32	-	-	69.39	69.04	-	-
Giza 429								
DMT_1	60.05	57.46	4.77*	4.34*	78.89	81.52	106.03**	36.99**
DMT_2	59.57	57.91	2.44	4.10*	73.42	76.34	88.49**	41.78**
DMT_3	60.80	58.63	2.75	3.91*	82.16	83.42	32.81**	17.77**
RAT_1	61.82	63.39	4.13*	2.07	82.86	82.86	88.34**	24.15**
RAT_2	61.55	63.71	3.71*	2.88	82.46	81.2	94.10**	20.40**
RAT_3	62.95	63.81	2.63	3.34*	83.33	83.57	19.62**	15.18**
Control	66.98	67.32	-	-	70.12	71.98	-	-

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

Table 2: Number of selected mutant plants in M_1 and M_2 generations

Treats	M_1	M_2
Misr 1DMT$_1$	5	5
Misr 1DMT$_2$	5	5
Misr 1DMT$_3$	6	5
Misr 1RAT$_1$	6	6
Misr 1RAT$_2$	6	4
Misr 1RAT$_3$	6	6
Giza 429 DMT$_1$	7	6
Giza 429 DMT$_2$	9	6
Giza 429 DMT$_3$	6	5
Giza 429 RAT$_1$	6	6
Giza 429 RAT$_2$	5	4
Giza 429 RAT$_3$	7	7

the untreated plants in seed/plant yield. The highest seed yields/plant of 83.88, 83.42, 83.26 and 81.2 g/plant obtained from Misr1 RAT$_3$, Misr1 DMT$_3$, Misr1 RAT$_1$ and Misr1 RAT$_2$ compared to the comparison group 71.98 g/plant. The highest number of branches/plant in the second generation of genetic mutations was 4.85, 4.13, 4.02 and 3.95 branches/plant, Misr1 RAT$_3$, Misr1 RAT$_1$, Misr1 DMT$_3$ and Misr1 RAT$_2$ compared to the untreated control 3.10 branch/plant. While the highest number of pods/plant was Misr1 RAT$_1$, Misr1 RAT$_2$, Misr1 RAT$_3$ and Misr1 DMT$_3$ with a mean of 51.20, 49.27, 48.10 and 48.07 pods compared to the untreated

Table 3: A List of selected mutations in the M_1 and M_2 generations, differences and regression between parents and offspring in the transgenic plants derived from radiological and chemical treatments of variety Misr 1 in 2018/2019 of Egyptian fava beans

	No. of branches/plant		Plant height (cm)		No. of pods/plant		100-seed weight (g)		Seed yield/plant (g)	
Items	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
DMT_1										
1	4.10	4.50	151.13	147.83	60.83	48.31	151.13	57.53	60.83	84.48
2	3.10	3.30	151.02	144.34	63.35	46.73	151.02	56.83	63.35	79.09
3	2.80	3.20	148.26	144.86	59.17	44.58	148.26	55.77	59.17	75.46
4	3.40	3.90	150.32	147.82	62.03	51.51	150.32	59.53	62.03	85.06
5	3.10	3.20	146.93	144.33	57.42	46.13	146.93	54.82	57.42	78.49
Mean	3.30	3.62	149.53	145.84	44.93	47.45	60.56	56.9	77.52	80.52
DMT_2										
1	2.60	2.90	141.09	128.49	62.86	45.63	141.09	57.34	62.86	70.43
2	3.20	3.50	150.17	137.59	59.83	40.57	150.17	59.36	59.83	78.89
3	4.10	4.30	146.75	147.87	57.23	48.31	146.75	57.53	57.23	83.91
4	3.30	3.70	140.89	144.35	62.92	45.93	140.89	54.83	62.92	78.29
5	3.20	3.40	144.23	137.49	56.56	42.62	144.23	59.52	56.56	78.57
Mean	3.28	3.56	142.12	139.16	41.65	44.61	60.68	57.72	75.06	78.02
DMT_3										
1	3.50	-	150.26	-	62.58	-	150.26	-	62.58	-
2	4.20	5.60	141.19	151.35	62.96	54.41	141.19	61.09	62.96	87.66
3	4.10	4.70	150.04	147.96	59.73	48.21	150.04	60.28	59.73	86.75
4	2.70	3.10	146.69	137.59	57.18	42.67	146.69	59.36	57.18	78.99
5	3.30	3.90	142.77	147.84	58.44	49.21	142.77	57.53	58.44	85.51
6	2.50	2.80	142.02	144.39	64.00	45.83	142.02	54.88	64.00	78.19
Mean	3.36	4.02	148.33	145.83	45.57	48.07	61.13	58.63	80.92	83.42
$RADT_1$										
1	2.50	4.90	148.58	153.15	59.07	50.33	148.58	62.85	59.07	86.51
2	2.80	3.90	142.95	150.09	61.62	49.28	142.95	62.58	61.62	81.64
3	3.20	5.30	152.25	143.55	64.58	55.23	152.25	65.53	64.58	88.06
4	3.10	3.30	130.15	144.35	59.00	53.62	130.15	64.12	59.00	87.15
5	2.90	4.20	149.44	149.04	59.1	48.24	149.44	63.87	59.1	80.61
6	4.50	3.20	148.59	152.53	59.07	50.52	148.59	64.86	59.07	75.58
Mean	3.3	4.13	147.01	148.79	46.63	51.2	61.9	63.97	75.1	83.26
$RADT_2$										
1	2.70	-	152.3	-	62.01	-	152.3	-	62.01	-
2	3.20	-	155.65	-	65.39	-	155.65	-	65.39	-
3	5.70	3.40	149.09	141.11	62.16	46.86	149.09	61.77	62.16	76.66
4	3.10	3.90	152.2	142.07	61.89	50.34	152.2	63.84	61.89	79.87
5	4.30	4.40	148.97	153.68	59.49	51.82	148.97	63.34	59.49	87.42
6	5.20	4.10	143.06	148.86	61.73	48.04	143.06	65.88	61.73	80.85
Mean	4.3	3.95	149.57	146.43	49.21	49.27	61.89	63.71	85.03	81.2
$RADT_3$										
1	3.80	6.80	148.99	155.63	59.98	56.59	148.99	65.37	59.98	89.84
2	4.90	5.90	151.13	152.48	60.83	50.43	151.13	64.82	60.83	88.97
3	3.10	3.30	151.02	144.85	63.35	49.74	151.02	62.74	63.35	82.54
4	3.70	3.00	148.26	146.77	59.17	44.78	148.26	65.07	59.17	81.12
5	5.10	6.00	150.32	153.27	62.03	52.44	150.32	62.96	62.03	88.74
6	3.90	4.10	146.93	149.21	57.42	50.76	146.93	59.73	57.42	85.45
Mean	4.14	4.85	148.69	148.58	47.17	48.1	60.69	63.57	81.94	83.88
Control	2.70	3.10	159.87	157.88	37.28	39.04	66.90	65.32	69.39	69.04

-: They are plants that are not selected in M_2

control 39.04 pods/plant. As for the trait of height and weight of 100 seeds, they were higher in the first mutant generation and started declining in the second mutant generation. However, the mean control was higher in value than the first and second mutational generations. It can be seen in Table 4 that, all the averages of the cultivar Giza 429 for the traits under study were higher in M_2 than the average of the treatments in M_1 except for the plant height and 100-seed weight where the mean M_2 was lower than the average. Means M_1. All treated traits were averaged across all radioactive or chemical mutagenic coefficients, all plants that maintained mutations in M_2 outperformed untreated

Table 4: A List of selected mutations in the M_1 and M_2 generations, differences and regression between parents and offspring in the transgenic plants derived from radiological and chemical treatments of variety Giza 429 in 2018/2019 of Egyptian fava beans

	No. of branches/plant		Plant height (cm)		No. of pods/plant		100-seed weight (g)		Seed yield/plant (g)	
Items	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
DMT_1										
1	2.10	3.80	44.76	147.83	69.56	48.31	130.82	57.53	59.67	84.48
2	2.90	4.00	39.25	144.34	77.57	46.73	139.77	56.83	61.54	79.09
3	2.70	3.70	43.45	144.86	64.31	44.58	147.08	55.77	58.15	75.46
4	3.30	5.00	48.22	147.82	83.82	51.51	150.08	59.53	59.74	85.06
5	3.10	3.60	45.64	144.33	78.45	46.13	146.46	54.82	56.94	78.49
6	2.50	5.30	43.58	147.92	59.15	49.01	142.65	60.25	59.32	86.55
7	2.10	-	41.43	-	77.38	-	139.74	-	61.73	-
Mean	3.9	4.23	147.24	146.18	46.2	47.71	60.05	57.46	78.89	81.52
DMT_2										
1	3.50	2.20	48.32	128.49	83.43	45.63	150.13	57.34	59.84	70.43
2	2.80	3.60	43.82	137.59	79.39	40.57	140.89	59.36	59.56	78.89
3	5.60	-	54.49	-	87.74	-	153.53	-	63.27	-
4	4.20	4.20	48.13	147.87	86.67	48.31	150.18	57.53	62.52	83.91
5	3.20	2.80	46.64	144.35	79.44	45.93	141.75	54.83	59.64	78.29
6	4.20	3.60	49.24	137.49	85.54	42.62	150.07	59.52	59.76	78.57
7	3.80	3.00	43.27	144.86	74.18	44.28	146.95	58.88	60.02	68.16
8	4.10	-	49.34	-	85.52	-	152.16	-	61.86	-
9	3.00	-	48.09	-	80.45	-	148.9	-	61.39	-
Mean	2.77	3.23	146.19	140.11	44.88	44.56	59.57	57.91	73.42	76.34
DMT_3										
1	4.20	-	53.27	-	86.8	-	152.06	-	63.77	-
2	3.00	5.70	47.78	151.35	80.15	54.41	148.58	61.09	59.07	87.66
3	5.00	4.10	50.24	147.96	87.78	48.21	152.25	60.28	64.58	86.75
4	4.90	3.30	41.36	137.59	79.68	42.67	141.88	59.36	63.65	78.99
5	3.20	4.90	50.34	147.84	85.94	49.21	152.2	57.53	61.86	85.51
6	3.00	3.90	47.77	144.39	80.58	45.83	148.59	54.88	59.07	78.19
Mean	3.97	4.38	147.23	145.83	47.6	48.07	60.8	58.63	82.16	83.42
$RADT_1$										
1	3.00	5.10	50.49	153.15	85.6	50.33	152.3	62.85	62.01	85.52
2	5.20	3.50	49.52	150.09	79.33	49.28	148.75	62.58	61.08	80.45
3	3.50	3.50	56.61	143.55	89.86	55.23	155.65	65.53	65.39	76.45
4	7.10	5.60	50.24	150.39	88.78	46.71	152.29	61.36	64.63	86.8
5	6.00	3.90	48.83	144.35	81.63	53.62	143.94	64.12	61.83	80.55
6	4.80	6.50	43.35	149.04	79.69	48.24	141.89	63.87	63.64	87.78
Mean	3.67	4.68	150.53	148.43	49.05	50.57	61.82	63.39	82.86	82.86
$RADT_2$										
1	6.10	-	51.37	-	87.67	-	152.2	-	61.89	-
2	5.20	2.00	49.52	141.11	79.33	46.86	148.75	61.77	61.08	76.66
3	3.50	2.60	56.61	142.07	89.86	50.34	155.65	63.84	65.39	79.87
4	2.10	7.70	44.76	153.68	69.56	51.82	130.82	63.34	59.67	87.42
5	2.90	2.70	39.25	148.86	77.57	48.04	139.77	65.88	61.54	80.85
Mean	4.14	2.75	148.55	146.43	47.92	49.27	61.55	63.71	82.46	81.20
$RADT_3$										
1	3.30	6.40	48.22	152.93	83.82	51.12	150.08	62.64	59.74	86.23
2	3.10	4.10	45.64	148.86	78.45	49.63	146.46	63.55	56.94	79.44
3	2.50	8.50	43.58	155.63	59.15	56.59	142.65	65.37	59.32	89.84
4	2.10	7.90	41.43	152.48	77.38	50.43	139.74	64.82	61.73	88.97
5	2.70	4.80	43.54	144.85	67.42	49.74	147.22	62.74	61.24	82.54
6	3.50	5.40	48.32	146.77	83.43	44.78	150.13	65.07	59.84	81.12
7	2.80	7.00	43.82	153.27	79.39	52.44	140.89	62.96	59.56	88.74
Mean	5.34	6.3	149.12	148.91	49.33	50.09	62.95	63.81	83.33	83.57
Control	3.12	4.09	158.87	157.88	40.28	40.54	66.98	67.32	70.12	71.98
Narrow heritability		41.63		45.54		50.82		47.45		51.87

-: They are plants that are not selected in M_2

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

Traits	No. of branches/plant	Plant height (cm)	No. of pods/plant	100-seed weight (g)	Seed yield/plant (g)
No. of branches/plant	-	0.333	0.717**	0.454	0.543*
Plant height (cm)		-	0.256	0.451	-0.595**
No. of pods/plan			-	-0.434	0.987**
100-seed weight (g)				-	-0.344
Seed yield/plant (g)					-

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

plants in seed/plant yield. The highest seed yield/plant was 83.57, 83.42, 82.86 and 81.52 g/plant obtained from Giza 429 RAT_3, Giza 429 DMT_3, Giza 429 RAT_1 and Giza 429 DMT_1 compared to the control which gave a value of 71.98 g/plant (Table 1). The highest number of branches/plant in the second generation of genetic mutations was 6.3, 4.68, 4.38 and 4.23 branches/plant Giza 429 RAT_3, Giza 429 RAT_1, Giza 429 DMT_3 and Giza 429 DMT_1 compared to the untreated control 4.09 branch/plant (Table 1). The best treatments that gave the highest number of pods/plant were Giza 429 RAT_1, Giza 429 RAT_3, Giza 429 RAT_2 and Giza 429 DMT_3 with an average of 50.57, 50.09, 49.27 and 48.07 pods compared to the untreated control 40.54 pods/plant (Table 1). As for the trait of height and weight of 100 seeds, they were higher in the first mutant generation and started to decrease in the second mutant generation. However, the mean control was higher in value than the first and second mutant generations.

Both radiological and chemical mutagenesis therapies increased the quantitative differences between homozygous genotypes. A significant increase in quantitative variance was found for most traits in both the M_1 and M_2 generations. These are significant increases of about twice the value compared to untreated plants or more. The amounts of variance induced by radiotherapy were higher than those caused by mutagenic chemotherapy. A medium increase in plant height to a slight increase in the weight of 100 seeds was detected. The values (Table 4) represent the narrow heritability of 41.64, 45.53, 50.82, 47.45 and 51.87 for the number of branches per plant, plant height, number of pods per plant, 100-seed weight and seed yield per plant. M_2 generation, respectively.

Correlation data for different traits are presented in Table 5. It was seen from the study of the association between the traits understudy in the M_2 group. The yield showed a significant and positive high relationship with the number of pods per plant and the number of branches per plant (0.987) and (0.743), respectively. It had low binding to 100-seed weight (0.451). The relationship between seed yield/plant and plant height was significant and negative. The results also showed that radioactive and chemical effects led to an increase in seed yield in Egyptian fava beans, where the increase ranged between 38.57 and 83.42 g compared to the untreated control, which was 71.98 and 69.04 g, respectively. The results of that study also showed that the radioactive and chemical influence led to a decrease in the weight of 100 seeds, which ranged between 63.97 and 61.13 g, compared to the control that was 66.90 and 67.32 g, respectively, but the observations in the weight of 100 seeds began to increase again in the second generation of mutations In radioactive treatments, while it remained defective in the second mutational generation in chemical treatments.

DISCUSSION

The results showed that the radioactive and chemical effects led to an increase in the number of pods/plants in faba beans, where the increase ranged between 51.20 and 48.17 pods compared to the untreated effects, which were 39.04 and 40.54 pods, respectively. Also showed that the radiological and chemical influence led to a decrease in the weight of plant height, which ranged between 50.53 and 49.32 cm, compared to the control, which was 159.87 and 158.87 cm, respectively. The radiological and chemical effects led to an increase in the number of branches/plants, where the increase ranged between 6.30 and 4.38 branches compared to the untreated effects, which were 4.09 and 3.10 branches, respectively. It was one of the most important results in support of the results obtained. The results of a study conducted by Sonia Mejri *et al.*[2] showed that, it was supportive of studies that confirm the suggestion that gamma irradiation stimulates genetic diversity in the germplasm of faba beans.

A recent study was conducted in Egypt at the Ismailia Research Station of the Agricultural Research Center during the summer seasons 2001 and 2002 to generate new genetic diversity in groundnut using gamma-ray doses in an attempt to improve the yield and yield components with doses of 0, 100, 200, 300 and 400 Gy of gamma rays (Cobalt-60 source) mean squares due to doses and genotypes and the interaction between them were significant for most traits studied in generations[3] M_1 and M_2.

Fouad *et al*.[4] explained that genetic diversity is very useful to increase the yield potential of the bean crop through developing the variety in conditions of open pollination to increase genetic gains. Mutations are among these important ways. Tămaş *et al*.[6] study in which two genotypes were taken, *Vicia faba* L. Mutagenesis treatments were applied with gamma rays, in seven doses, to dried seeds. The following traits were tracked: Plant height, number of pods/plant and seed/plant weight. The study revealed highly significant differences in plant height, number of seeds/plant and their weight. Tariq *et al*.[7] determined that genetic variations were induced by diethyl sulfate (DES) and sodium azide (SA) in *Vicia faba* L. (Fabaceae). Mensah *et al*.[8] studied the mutagenic effects of different concentrations of sodium azide (0.01-0.05%) on peanuts, the traits studied include, plant height, number of branches per plant, pods/plant, seeds/pods, seeds/plant and 100 seed weight in generations M_1 and M_2. Significant and positive changes were recorded for these traits. Khan and Goyal[9] mutated two mungbean species using EMS and gamma rays as mutagens. Selection studies were conducted to improve yield and generate genetic variation in different quantitative traits, i.e., branches per plant, pods per plant and seed yield per plant. The mean values in the traits increased significantly. High values of heritability and genetic progression of mutations indicate that further improvement can be made in future generations. Sakr *et al*.[10] demonstrated that mutant breeding is a tool to induce new genetic diversity to improve important agricultural traits. By investigating during the 2017/2018 and 2018/2019 seasons of safflower in the experimental and research farm at the Faculty of Agriculture, Al-Azhar University, Assiut, Egypt. Three mutagenic treatments such as dimethyl sulfoxide, electric shock and gamma rays were used for the isolation, chemical mutation was more effective than other mutations to induce mutant genotypes. Gehan[11] showed in 2011 that treating seeds of Helianthus annuus cultivars in sodium azide solutions at concentrations of 0, 100, 200, 300, 400 and 500 ppm for 4 hrs. Genetic variation in vegetative and flowering growth was introduced as new models.

Al-Shammaa[12] conducted a study evaluating the role of chemical mutagens in causing genetic variation in quantitative and qualitative traits. It was concluded from this study that soaking the seeds in a nitrous acid mutagenic solution for 24 hrs was effective in causing genetic variation in bean cultivars. It is useful in breeding programs either by selection or crossbreeding. Fatima *et al*.[13] examined the effect of chemical mutagenic sodium azide (SA), hydrazine hydrate (HZ) and maleic hydrazine (MH) on the morphological differences of peanuts. All mutants showed a significant decrease in plant height and number of branches per plant compared with the control plants that gave the highest plant height and number of branches per plant.

Okaz *et al*.[14] demonstrated that mutant breeding is a tool to induce new genetic diversity to improve important agricultural traits. By investigating safflower. Three mutagenic treatments such as dimethyl sulfoxide, electric shock and gamma rays were used for the isolation, chemical mutation was more effective than other mutations to induce mutant genotypes.

While some of the results do not agree with my results Lima *et al*.[1] found that irradiation doses 0.0, 0.5, 1.0, 2.5, 5.0 and 10.0 kGy, the results showed no significant differences in the content of the sample. The relationship between seed yield/plant and the number of pods/plant was highly significant and positive. The relationship between seed yield/plant and the number of branches/plant was significant and positive. The relationship between seed yield/plant and plant height was highly significant and negative. It was one of the most important results in support of the results obtained Barakat *et al*.[15] studied the correlation in bread wheat (*Triticum aestivum* L.). There was a significant and positive correlation between yield, spike number/plant, spike/spike number and grain/spike across both cultivars and generations. There was a low correlation coefficient between grain yield/plant and 1000 grain weights. El-Said *et al*.[16] found that the correlation coefficients were positive and significant between seed yield/plant and plant height and significantly between seed yield/plant and the number of pods per plant, while it was negative and significant between seed yield/plant and 100-seed weight. Jesus *et al*.[17] determined that the tonic properties of fungi were improved by irradiation with gamma doses at dose rates of 0, 20, 40, 60, 80, 160, 250 and 350 kGy. Hammam *et al*.[18] studied the correlation in wheat and found that the correlation was positive and significant between grain yield, spike length, number of stalks per plant and number of grains per spike, while the correlation was negative between grain yield, plant height and weight of 1000 grains.

The study showed that it was possible to improve the yield, the number of pods and the number of branches of the plant in Egyptian fava beans compared to the parents who did not deal with the mutations, but some traits showed an opposite response to the crop, namely the plant height and the weight of 100 seeds, compared to the parents who were not treated. With mutagens, it has also been observed that radioactive mutagens have a higher effect than chemical mutagens. It was noted that Giza 429 cultivar had the highest response to mutagens, whether radioactive or chemical, compared to the Misr1 cultivar.

CONCLUSION

One of the most important points that were obtained in this study is that the crop characteristics were improved by gamma rays, especially the dose 20, which gave very satisfactory results. Also, the use of the chemical mutagen ethyl methyl sulfonate gave a satisfactory product at a concentration of 2000 and 3000 ppm. Hence, it can be said that the use of radioactive or chemical mutations is one of the effective tools for genetic improvements in the bean crop.

SIGNIFICANCE STATEMENT

This study discovers that it is possible to bring about genetic changes inherited through the offspring in the faba bean crop through gamma rays as well as the chemical mutagen ethyl methyl sulfonate, which can be useful for improving crop characteristics and trying to reach the highest productivity through different breeding programs, because the improvement of any character in this The crop must have a large number of genetic variations and these mutagenic materials, whether radiological or chemical, were given a large amount of these differences that can be worked on in many areas of this crop.

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REFERENCES

1. Lima, K.S.C., L.B. Souza, R.L.O. Godoy, T.C.C. França and A.L.S. Lima, 2011. Effect of gamma irradiation and cooking on cowpea bean grains (*Vigna unguiculata* L. Walp). Radiat. Phys. Chem., 80: 983-989.
2. Mejri, S., Y. Mabrouk, M. Voisin, P. Delavault, P. Simier, M. Saidi and O. Belhadj, 2012. Variation in quantitative characters of faba bean after seed irradiation and associated molecular changes. Afr. J. Biotechnol., 11: 8383-8390.
3. Azzam, C.R. and W. El-Sawy, 2005. Variation induced via gamma radiation in peanut (*Arachis hypogaea* L.) and its assessment by protein finger printing. Egypt. J. Plant Breed, 9: 237-256.
4. Fouad, M., H. Jinguo, D. O'Sullivan, X. Zong, A. Hamwieh, S. Kumar and M. Baum, 2018. Breeding and genomics status in faba bean (*Vicia faba*). Plant Breed., 138: 465-473.
5. Hacıseferoğullar, H., I. Gezer, Y. Bahtiyarca and H.O. Menges, 2003. Determination of some chemical and physical properties of Sakiz faba bean (*Vicia faba* L. var. *major*). J. Food Eng., 60: 475-479.
6. Elena, T., R. Sestraş and L. Muntean, 2005. Variability of productivity elements at *Vicia faba* L. genotypes after gamma-ray treatment on M_3 generation. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 33: 55-58.
7. Bhat, T.A., M. Sharma and M. Anis, 2007. Comparative analysis of mitotic aberrations induced by diethyl sulphate (DES) and Sodium Azide (SA) in *Vicia faba* L. (Fabaceae). Pak. J. Biol. Sci., 10: 783-787.
8. Mensah, J.K. and B. Obadoni, 2007. Effects of sodium azide on yield parameters of groundnut (*Arachis hypogaea* L.). Afr. J. Biotechnol., 6: 668-671.
9. Khan, S. and S. Goyal, 2009. Improvement of mungbean varieties through induced mutations. Afr. J. Plant Sci., 3: 174-180.
10. Sakr, H.G., I.N. Abd El-Zaher, M.H. Haridy, A.M.A. Okaz, 2020. Effect of recurrent mutagenesis on some induced genotypes in safflower (*Carthamus tinctorious* L.). Arch. Agric. Sci. J., 3: 78-93.
11. Mostafa, G.G., 2011. Effect of sodium azide on the growth and variability induction in *Helianthus annuus* L. Int. J. Plant Breed. Genet., 5: 76-85.
12. Al-Shamma, L.M.J., 2014. Using chemical and physical mutagens for induction of genetic variation in the quantitative and qualitative traits of three cultivars of faba beans (*Vicia faba* L.). J. Al-Nahrain Univ., 17: 132-142.
13. Al-Nuaimi, F.K.G. and L.M.J. Al-Shamma, 2015. Effect of chemical mutagens on some morphological traits of *Vicia faba* L. Cv. aqadulce. Iraqi J. Sci., 56: 2506-2512.
14. Okaz, A.M.A., M.S.H. Ahmad and H.G.H. Sakr, 2016. Induced mutations in some safflower genotypes. Assiut. J. Agric. Sci., 47: 377-390.
15. Ahmed, B.H., M.H. Haredy and Y.A.M. Khlifa, 2020. Effect of chemical mutagens on some morphological and yield components traits of wheat (*Triticum aestivum* L). Egypt. J. Agron., 42: 137-149.
16. El-Said, R., M. Haridy, I. Abd-El-Zaher, 2021. Selection for seed yield in segregating population (Misr 1 x Giza 3) of faba bean (*Vicia faba* L.). Arch. Agric. Sci. J., 3: 319-332.
17. Aguilar-Luna, J.M.E., S. López-López and J.M. Loeza-Corte, 2020. Susceptibility of fungi, mainly chocolate spot (*Botrytis fabae* sard.), to gamma irradiation in the faba bean crop (*Vicia faba* L.). Bioagro, 33: 29-40.
18. Hammam, O.K., I.N. Abd-El Zaher, M.H. Haridy and K.A.I. Al-Aref, 2020. Estimate of combining ability and correlation for yield and its components in bread wheat (*Triticum aestivum* L.). Arch. Agric. Sci. J., 3: 1-12.