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Effect of Gamma Irradiation of Seeds on Growth and Yield of Mungbean (*Vigna Radiata*) In Egypt

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ABSTRACT

Two Field experiments were carried out at the Agricultural Experiments and Researches Station, Bahteem, A.R.C, Egypt, during the two growing seasons of 2013 and 2014 gamma rays affection for evaluating some mung bean genotypes. Seeds of four lines and two local varieties of mung bean. (Vigna radiata L. Wilczek) were subjected to three different doses of gamma irradiation (20, 40 and 60 Gy) to evaluate the effect on yield attributing characters. The experiment was arranged in a randomized complete block design with three replications. Results showed that mung bean lines were differed significantly in most of its traits. Fam.1 line scored the largest values for most studied traits as compared with other mung bean lines under the study during 2013 and 2014 seasons.

Also results revealed that gamma irradiation significantly affected the most mentioned parameters. The greatest values for plant height (66.18 cm), number of branches (2.17), No. of pods/plot (1008.83), seed weight (684.19) was obtained from radiated seeds with D20 and D40 Gy, in 2013 season, while, in 2014 season the greatest value for that previous traits were (107.83 cm), (3.08), (1468.83) and (397.48) respectively, recorded from radiated seeds with D60 and D00. On the other hand, the lowest values for most traits were obtained from radiated seeds with 20 Gy and no-radiated treatment.

Results indicated that the interaction effect between mung bean lines and gamma doses radiation significantly affected mung bean traits. Fam.1 line that radiated with D20 Gy and D40 Gy gave the significant greatest values for most traits in 2013 and 2014 seasons. While, the lowest values for most mung bean traits were recorded by growing seeds of Fam.5 line which radiated with D00, D20 and 40 Gy in both two of seasons.

Key words: Vigna radiata, Gamma radiation, Seed yield, Lines, Varieties.

I. INTRODUCTION

The mung bean (*Vigna radiata* L. Wilczek) is a new introduced summer pulse crop in Egypt with short growing season (almost three months) grown principally for its protein – rich edible seeds, [15, 16,17]. The mung bean is native to the India. Burma area of South East Asia. From Asia, it spread into Middle East, the pacific Islands, East Africa, Australia and Americas, but Asia continues to be the region for major production. Protein in the seeds averages around 24%, [11]. Fruitful efforts have been made by Egyptian investigators to benefit from mung bean as a pulse crop to be cultivated under local conditions. Mung bean is a self-pollinated diploid plant having 2n = 2x = 22 chromosomes with a genome size of 579 Mb/1C. Its short life span (55-90 days) and a capacity to restore soil fertility (through nitrogen fixation) make it a valuable crop in various cropping systems, particularly wheat-rice cropping system, [18]. Mung bean belongs to the Asian

Vigna subgenus *Ceratotropis*, having South Asia as its center of diversity [24]**;** [26]. The genus *Vigna* is composed of more than 150 species originating mainly in Africa and Asia [21]**;** [26]. It is a genetic resource owing to its stress (salt)-resistant genetically diverse germplasm that could be of practical value for salinity-based breeding programs [25]. Intra-specific variations among the close wild relatives of Asian *Vigna* stay on priority in crop improvement programs [9].

In Egypt, this crop might be a promising source of human and animal food especially during summer season. Lastly, it matures quickly (about 70-90 days) and it does not compete with the main winter crops as wheat or berseem (*Trifolium alexandrenum*). Hence, mung bean should be considered in the future a promising crop especially in the reclaimed lands. This crop is a new introduced one in several countries i.e. Australia and China [1]. Induction of plants with gamma ray irradiation is one way in improving plant genetic diversity. Gamma ray irradiation at low dose levels or (micro mutation) is less influencing changes in quantitative characters of plants and chromosomes compared with the macro mutation using gamma ray irradiation at high doses.

Gamma rays belong to ionizing radiation and interact with atoms or molecules to produce free radicals in cells. These radicals can damage or modify important components of plant cells and have been reported to affect the morphology, anatomy, biochemistry and physiology of plants differentially depending on the irradiation level. [10]**;** [3]**.**

[23] reported that gamma rays represent one of the important physical agents, used to improve the yield of many plants (e.g., rice, maize, mung bean, and cowpea). Gamma irradiation has been found to be very useful for both sterilizations and for the preservation of foods [2]. [19] observed that two varieties of mung bean (K851 and Sona) were found to have a maximum petiole length in plants treated with a lower dose of gamma irradiation.

Thus, the present investigation is an attempt to through to light more information about the effect of different doses of gamma irradiation (20, 40, and 60Gy) on growth, and yield of four lines of mung bean plant in Egypt.

II. MATERIALS AND METHODS

The current investigation was carried out at the Agricultural Experiments and Researches Station, Bahteem, A.R.C, Egypt, during the two growing seasons of 2013 and 2014 in order to evaluation of some mung bean genotypes using three different doses of gamma irradiation (20, 40 and 60 Gy) as well as zero Gy as control treatment. Seeds of mung bean were sown on 10 th July 2013 in the first season and replicated on 5 th July 2014 in the second one to provide the experimental plant materials.

In the present study, four lines of mung bean crop (*Vigna radiata L. Wilckzek*) Fam.1, Fam.4, Fam.5 and Fa.21 differ in morphological properties and its orign were studied to evaluate under Egyptian conditions, (Table 1) as well as two local varieties (V.2010 and Kawmy-1) as a control treatment.

Table (1): Bedegree of four lines and two local varieties of mung bean under study according to Genetical Resources Research Department, Field Crop Researches Institute, A.R.C, Bahteem Station, Qalubia governorate, Egypt.

No.	Line code	Orign	Testa color	Hilum color	Testa shape	Pod color	Seed Size	Seeding rate kg/fed
1	**Fam.1**	**Line 63**	Light Green	White	Smooth	Black	Small (2-3 g)	20
2	**Fam.4**	**Line 80**	Light Green	White	Smooth	Black	Medium (4-5 g)	25
3	**Fam.5**	**Line 83**	Yellow	White	Smooth	Black	Small (2-3 g)	20
4	**Fam.21**	**V.C 2719**	Dark Green	White	Rough	Black	Big (6-7 g)	30
Local varieties (Control)								
1	**V.2010**		Green	White	Smooth	Beige	Medium (4-5 g)	25
2	**Kawmy-1**		Green	White	Smooth	Black	Big (6-7 g)	30

The experiment was arranged in a randomized complete block design (RCBD) with three replicates. Each replicates divided into eighteen plots, each contained one treatment. The plot was three ridges, three meters long, 50 cm apart, and hills were spaced at 20 cm distance. Seeds were hand affair (dry seed in dry soil then irrigation) sown in the two sides of the ridge with 2-3 seeds per hill.

All plots were irrigated by surface irrigation system, Mohaya irrigation was done after 15 day from

sowing date, after that, every 15-17 day intervals for all genotypes according to region conditions.

Regarding, the hoeing process was done during two seasons as following: First and second hoeing was done after 40 and 65 day from planting date respectively for each mung bean lines and two local varieties under study. While, herbicide was done during two seasons, Gysabrain herbicide that was applied after planting and before sowing irrigation of mung bean plants at the rate of one kg/Fed., it was added by spraying (1kg/ 200 liter of water/fed).

Both of the two experiments were harvested on 22th September and 17 th September 2013 and 2014 respectively.

Studied attributes:

At harvest time, the following measurements were recorded:

❖ Six random plants samples were taken from each plot to determine the following traits :

- Plant height (cm)
- Number of branches per plant

❖ All plants for each plot were harvested to measurements the two following traits:

- Number of pods per plot, was measured by the total number of pods for each plot.
- Seed weight (g) per plot, it was determined by weighting the total seed yield of each plot.

Statistical analysis:

Statistical analysis was done following analysis of variance techniques (ANOVA) as outlined by [13]. The mean values were compared at 5% level of significance using least significant differences (L.S.D) test, using **GENSTAT software**.

III. RESULTS AND DISCUSSION

A. Plant height (cm) and number of branches/plant

A.1.Variances between mungbean lines and local varieties

Data illustrated in Table (2) showed that plant height (cm) and Number of branches/Plant traits as affected by the variances between four lines (Fam.1, Fam.4, Fam.5, Fam.21) comparing with two local varieties (Kawmy-1, V.2010) for mung bean plants during the growing seasons of 2013 and 2014. Results revealed that, there was a significant differences between four lines of mung bean plant under study. Fam.1 line scored the highest plant height (79.65 and 112.20 cm) during 2013 and 2014 seasons, respectively. On the other hand, the shortest plant height recorded by Fam.4 line (47.78 cm) in 2013 season and Fam.21 line (86.38 cm) in 2014 season, as compared with other mung bean lines and two local varieties under study.

As for, number of branches/plant, results showed that, Fam.1 line recorded the largest value (2.33 and 3.50) during 2013 and 2014 seasons respectively, compared with other three lines only, at the same time, the two local varieties (V.2010 and kawmy-1) scored the largest values (3.67, 4.00 and 3.00, 3.67) for the two seasons, respectively. While, Fam.5 line recorded the lowest values (1.50 and 2.00) for the same traits at the same two seasons.

Table (2): plant height and No.of branches/plant as affected by variances between mung bean lines during 2013 and 2014 seasons.

Treatments		Plant height (cm)		Number of branches/Plant	
Mungbean genotypes		Season 2013	Season 2014	Season 2013	Season 2014
Lines	**Fam.1**	79.65	112.2	2.33	3.50
	Fam.4	47.78	93.71	1.58	2.08
	Fam.5	61.75	103.63	1.50	2.00
	Fam.21	58.67	86.38	2.00	3.33
Local varieties	**V.2010**	69.70	98.00	3.00	3.67
	Kawmy.1	72.50	101.0	3.67	4.00
LSD at 5%		**16.68**	**14.55**	**NS**	**1.18**

A.2. Effect of the different doses of gamma rays

Results in Table (3) cleared that the highest plant height (66.18 cm) was obtained from radiated seeds with D20 Gy, in 2013 season, but the differences between them not reached to the significant level (5%), while D60 Gy scored the highest plant height (107.83 cm) in 2014 season, as compared other doses of gamma radiation and the differences between them reached to the significant level (5%). On opposite of, the shortest plant height (59.04 cm and 91.24 cm) was obtained from radiated seeds with D40 Gy and D00 Gy (non-radiated seeds), respectively in 2013 and 2014 seasons.

Data also, showed that the largest values (2.17 and 3.08) for Number of branches per plant was obtained from

radiated seeds with D40 Gy, in the first season, and D00Gy in the second season. On contrary, the lowest values (1.67 and 2.42) were determined from radiated seeds with D20 Gy, in the first season, and D60 Gy in the second season, as compared to other three doses of gamma radiation, but the differences between them not reached to the significant level (5%).

Similar results confirmed by [14] who found that the radiation doses of 5, and 10 Kr has slightly reduced plant height while other doses had no considerable effect on plant height. In addition, [8] reported that the relatively low gamma irradiation doses increased plant height, number of leaves, number of branches and dry weight per plant .While irradiating with the dose of 40 Gy decreased these characters compared to un-irradiated control. [12]concluded that the plant heights, stem girth, number of leaves per plant, and pod length decreased as the doses of irrays increased. However, internode length increased with increasing doses of irrays. Meiotic analysis revealed the presence of various types of chromosomal abnormalities at all phases. Meiotic aberrations increased according to the doses of irrays. Moreover [7] found that 1kr gave the highest significant values for plant height, number of leaves and number of branches per plant, on the contrary 4-kr dose gave sever reduction for the same characters.

Table (3): Effect of the different doses of gamma rays on plant height (cm) and No. of branches for mung bean plant during 2013 and 2014 seasons.

Gamma irradiation doses (Gy)	Plant height (cm)		Number of branches/Plant	
	Season, 2013	Season , 2014	Season, 2013	Season , 2014
D00	61.73	91.24	1.75	3.08
D20	66.18	97.25	1.67	2.5
D40	59.04	99.58	2.17	2.92
D60	60.91	107.83	1.83	2.42
LSD at 5%	**NS**	**14.55**	**NS**	**NS**

A.3. The interaction effect between mung bean lines and gamma rays

Data given in Table (4) indicate that interaction effect between mungbean lines and gamma doses radiation significantly affected mung bean plant height and number of branches per plant. The direction of the results shows that growing seeds of Fam.1 line that radiated with D40 Gy and D60 Gy gave the significant greatest values of plant height (85 and 124 cm) in 2013 and 2014 seasons, respectively as compared with the other treatments. On the other side, the shortest plant height were recorded by growing seeds of Fam.4 line which radiated with D40 Gy (41.97cm) and Fam.21 line that not radiated (D00) by gamma rays (75.50 cm), in 2013 and 2014 seasons, respectively.

It is clear from Table (4) that the growing seeds of Fam.1 line that radiated with D40 Gy and non-irradiated (D00 Gy) by doses of gamma rays scored the greatest values for number of branches per plant (2.67 and 4.33) in 2013 and 2014 seasons, respectively, as compared with the other treatments. While Fam.4 line and Fam.5 line that irradiated with 20 Gy gave the lowest number of branches for mung bean plant (1.00 and 1.00) during the seasons of 2013 and 2014, respectively.

This trend are in harmony with previous results reported by [19] who observed that two varieties of mung bean (K851 and Sona) were found to have a maximum petiole length in plants treated with a lower dose of gamma irradiation. [14] who found that the radiation doses of 5 and 10 Kr have slightly reduced plant height while other doses had no considerable effect on plant height.

Table (4): The interaction effect between lines and gamma irradiation on plant height (cm) and number of branches/plant of mung bean plant in 2013 and 2014 seasons.

Treatments		Plant height (cm)		Number of branches/Plant	
Lines	**Gamma rays (Gy)**	**Season 2013**	**Season 2014**	**Season 2013**	**Season 2014**
Fa.1	**D00**	71.93	101.80	2.33	4.33
	D20	78.03	107.00	2.33	3.00
	D40	85.00	116.00	2.67	3.67
	D60	83.63	124.00	2.00	3.00
Fa.4	**D00**	52.47	86.00	1.33	2.67
	D20	49.47	99.00	1.33	1.00
	D40	41.97	92.33	2.33	2.00
	D60	47.23	97.50	1.33	2.67
Fa.5	**D00**	66.40	101.67	1.33	1.67
	D20	68.90	102.33	1.00	2.67
	D40	56.13	105.00	1.67	2.00
	D60	55.57	105.50	2.00	1.67
Fa.21	**D00**	56.10	75.50	2.00	3.67
	D20	68.30	80.67	2.00	3.33
	D40	53.07	85.00	2.00	4.00
	D60	57.20	104.33	2.00	2.33
LSD at 5%		**33.36**	**29.10**	**NS**	**2.83**

B. Number of pods/Plot and seed weight/plot

B.1. Variances between mung bean lines:

Results presented in table (5) showed that, significant differences between mung bean lines were noticed for Number of pods per plot trait. Fam.1 line significantly favored number of mung bean pods per plot (1252.42 and 1906.92) as compared to other three lines under study, but it did not surpass the two local varieties (V.2010 and kawmy-1) in 2013 season only. The Fam.1 line was significantly pronounced it superiority reflected on increase its Number of pods per plot trait by (135.56 % and 750.05%) as compared to Fam.4 line and V.2010, which scored the lowest value (531.67 and 224.33) for that trait in 2013 and 2014 seasons.

As for, seed weight/plot results concluded that, Fam.1 line significantly favored mung bean seed weight (1029.36, 465.07 g/plot) as compared to other three lines and V.2010 local variety under study, but it did not surpass the local variety (kawmy-1) in both seasons. The Fam.1 line was significantly pronounced superiority reflected on increase its seed weight trait by (212.09 %, 301.61% and 160.67%) as compared by Fam.5 line and local variety (V.2010), which gave the lowest values (329.82, 178.41 and 115.80 g/plot) for that trait in 2013 and 2014 seasons, respectively.

Table (5): Number of pods/Plot and seed weight/plot as affected by variances between mung bean lines during 2013 and 2014 seasons.

Treatments		Number of pods/Plot		Seed weight (g/plot)	
Mungbean genotypes		**Season 2013**	**Season 2014**	**Season 2013**	**Season 2014**
Lines	**Fa.1**	1252.42	1906.92	1029.36	465.07
	Fa.4	531.67	1130.25	356.20	388.13
	Fa.5	819.25	857.92	329.82	178.41
	Fa.21	630.08	1241.75	550.71	331.89
Local varieties	**V.2010**	1676.33	224.33	1561.70	115.80
	Kawmy.1	1741.00	1610.00	1605.87	473.00
LSD at 5%		**200.15**	**280.02**	**179.09**	**115.19**

B.2. Effect of the different doses of gamma rays

As shown in Table (6) related to number of pods/plot and seed weight/plot for mung bean as affected by four different doses of gamma rays (D00, D20, D40, D60), it can be concluded that, number of pods/plot was significantly affected by the different doses of gamma

rays, the greatest values for number of pods/plot (1008.83 and 1468.83) were obtained from radiated seeds with D20 Gy and D60 in 2013 and 2014 seasons, respectively. While the lowest values for that trait (664.17 and 1140.67) were obtained from radiated seeds with D40 Gy and D20 Gy, respectively in 2013 and 2014 seasons.

Also results, added that significant differences between the different doses of gamma irradiation for mung bean seed weight (g/plot), the greatest values for mung bean seed weight (684.19, 397.48 g/plot) were obtained from radiated seeds with D20 Gy, and D60 in 2013 and 2014 seasons, on contrary, the lowest mungbean seed weight (481.65, 269.49 g/plot) was obtained from radiated seeds with D40 Gy and D00 Gy (non-irradiated seeds) in 2013 and 2014 seasons, respectively.

The results are quite in line with [4] who found that the dose of 5 Kr increased the mean square values for number and weight of pods per plant. On the other hand, the increasing of dose level gave the lowest mean square values for most studied characters. Also, [20] described that gamma rays affect leaf canopy and seed yield of mung bean especially those having a larger area of leaf are highly exposed to photosynthesis which results in greater yield rate. [22] reported that screened out the high yielding mutants in chemical mutagens induced progeny of *Vigna radiate*, a where reported the increase in number of pods produced per plant and total seed yield at lower doses of chemical mutagens in *Vigna radiata*. [6] found that used induced mutations for improvement of agronomic characters with dose of 10 Gy and identified mutant plants with early maturity, 100 seeds weight (30 % over control) and better branch growth and mutation studies.

Table (6): Effect of the different doses of gamma rays on Number of pods/Plot and seed weight/plot for mung bean plant during 2013 and 2014 seasons.

G**amma irradiation doses (Gy)**	**Number of pods/Plot**		**Seed weight (g/plot)**	
	Season 2013	**Season 2014**	**Season 2013**	**Season 2014**
D00	876.25	1142.58	555.14	269.49
D20	1008.83	1140.67	684.19	327.28
D40	664.17	1384.75	545.11	369.24
D60	684.17	1468.83	481.64	397.48
LSD at 5%	**200.15**	**280.02**	**179.09**	**115.19**

B.3. The interaction effect between lines and gamma rays

Results in Table (7) concluded that growing seeds of Fam.1 line that radiated with D20 Gy and D40 Gy gave the significant greatest values for number of pods/plot (1357.00 and 2634.67) in both seasons. On the other hand, growing seeds of Fam.5 line that irradiated with D40 Gy in 2013 and 2014 seasons scored the lowest values for that trait (328.67 and 650.00) and the differences between them reached to the significant level (5%).

It is worthy to mention that growing seeds of Fam.1 and Fam.4 lines that radiated with D20 and 60 Gy gave the significant greatest values seed weight (1167.27, 632.47 g/plot) in 2013 and 2014 seasons. The Fam.1 and Fam.4 lines were significantly pronounced their superiority reflected on increase its seed weight trait by (426.98%, 490.70%) as compared with Fam.4 and Fam.5 lines that non radiated by gamma rays, which gave the lowest values (221.50 and 181.23 g/plot) for that trait in 2013 and 2014 seasons, respectively.

Similar results confirmed by [4] who concluded that dry seeds of four pea varieties were treated with gamma rays (0, 5, 10 and 15 Kr) on**,** the dose of 5 Kr increased the mean square values for number and weight of pods per plant. On the other hand, the increasing of dose level gave the lowest mean square values for most studied characters. [22] reported on screened out the high yielding mutants in chemical mutagens induced progeny of *Vigna radiata* that has increase in number of pods produced per plant and total seed yield at lower doses of chemical mutagens in *Vigna radiata*. In addition, [20] described that gamma rays affect leaf canopy and seed

yield of mung bean**,** especially those having a larger area of leaf are highly exposed to photosynthesis which results in greater yield rate.

Table (7): the interaction effect between lines and gamma irradiation on Number of pods/Plot and seed weight/plot for mungbean plant in 2013 and 2014 seasons.

Treatments		Number of pods/Plot		Seed weight (g/plot)	
Lines	**Gamma rays (Gy)**	**Season 2013**	**Season 2014**	**Season 2013**	**Season 2014**
Fa.1	**D00**	1179.00	1781.67	971.40	355.87
	D20	1357.00	1454.67	1167.27	376.87
	D40	1301.67	2634.67	1089.33	630.77
	D60	1172.00	1756.67	889.43	496.77
Fa.4	**D00**	383.00	768.67	221.50	275.37
	D20	785.00	957.33	512.77	328.63
	D40	495.67	1010.67	434.93	316.07
	D60	463.00	1784.33	255.60	632.47
Fa.5	**D00**	1155.00	811.33	436.10	181.23
	D20	1044.33	765.67	382.37	228.83
	D40	328.67	650.00	223.67	196.50
	D60	749.00	1204.67	277.13	107.07
Fa.21	**D00**	788.00	1208.67	591.57	265.50
	D20	849.00	1385.00	674.37	374.80
	D40	530.67	1243.67	432.50	333.63
	D60	352.67	1129.67	504.40	353.63
LSD at 5%		**664.29**	**719.10**	**363.86**	**263.15**

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