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Gamma Irradiation Affects to Growth And Productivity Parameters of Feed Cowpea Seeds

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ABSTRACT

The effect of gamma was investigated by studying plant germination and growth of feed cowpea seeds criteria. Dry seeds were exposed to gamma sources at different doses ranging from 10 to 30 krad. Results were summarized as follows: all growth parameters lengths, thicknesses and fresh weight of stem and root of irradiated samples increased in comparison with the control sample during the germination period. Developed equations showed that, high relation between stem and root lengths exposed to different Gamma radiation doses (10, 20 and 30 krad) after different days of sowing (5, 10, 15 and 20 days), because of R^2 was ranged between (0.73 – 0.99), (0.85 – 1.00) and (0.96 – 0.99) for lengths, thicknesses and fresh mass of stem, respectively. There significant differences between the growth parameters and irradiation doses were used. So, it was found that, an increasing length; thickness and fresh mass of stem and root for cowpea plant by increasing irradiation doses compared with control or treatments. Meanwhile, by increasing germination period, it was noticed that, there is a decreasing percentages increase in germination parameters of cowpea seeds by increasing irradiation doses. So, we can reduce the gap of decreases the fodders.

Keywords: Gamma, Growth, Cowpea**,** Germination, Physical

INTRODUCTION

Gamma radiation considered as one of the most important, used to improving yield of many crops (e.g., rice, maize, bean, cowpea, and potato), Jawardena and Peiris (1988).

Cereals and legumes had been listed as the major sources of dietary protein for feeding the human kind. But, the increasing interest in new sources of food and in improving genetic diversity within domesticated plants, the wild plants seeds are now receiving more attention. (Vijayakumari *et al*., 1996).

The consumption of irradiated foods will be safe alternative preservation method in regions lacking proper facilities of refrigeration (FAO / IAEA, 1997). Even though, the literatures on the properties of nutritional and anti-nutritional of Vignaunguiculata seeds is available, there is a paucity of information pertaining to the gamma irradiation effect on the under-utilized legume. The biological effect of gamma radiation is mainly based on the chemical interaction with atoms or molecules in the cell, mainly water molecules, to produce free radicals (Kovacs and Keresztes, 2002).

These radicals can damage or modify important components of plant cells and have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants depending on the radiation dose (Ashraf *et al*., 2003).

Dhankhar (2003)concluded that purple stem line seeds of okra when it was subjected to gamma rays at 0.6 or 0.7 krad, some plants exhibited flat and Y-shaped branching. Cowpea has great ability to fix nitrogen of atmosphere through its root nodules, so grows well in low fertility soils with more than 85% sand, less than 0.2% organic matter and low phosphorus levels.

Nassar *et al.* (2006) found that, irradiating chamomile seeds with different doses of gamma rays (0, 20, 40, 60, 80 or 100 Gy) before sowing increased significantly the plant height and the number of branches with increasing the dose gamma irradiation. Norfadzrin *et al.* (2007) mentioned that higher gamma radiation doses especially 600 and 800 Gy had a negative effect on the morphological characteristics of tomato and okra seedlings derived from irradiated seeds. Dubey *et al.* (2007) showed an increase in plant height, number of leaves, and branches per plant when okra seeds were irradiated with different doses of gamma rays. On the other hand, the irradiation of seeds with high doses of gamma rays disturbs the synthesis of protein, hormone balance, leaf gasexchange, water exchange and enzyme activity.

Irradiation process, as an effective preservation mean of foods, had been shown to decrease antinutritional components in some seeds of protein acetous leguminous, thereby helps to produce safe food (Alothman *et al*., 2009).

Cowpea is mostly cultivated by small scale farmers, usually intercropped with various crops such as maize, beans, leaf vegetables, millet, sorghum, bananas, pigeon peas and others. The production of cowpea around the world is primarily as seed, as a vegetable (leafy greens, green pods, fresh shelled green peas, and shelled dried peas) and as cover crop. This legume consider also asa major source of protein (22-24 %), carbohydrate (50-67 %), starch, vitamins and minerals as unripe pods or dry soybean seeds (Pavadai *et al*., 2009)

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The relatively low-doses ionizing irradiation on plants and photosynthetic microorganisms are manifested as accelerated cell proliferation, germination rate, cell growth, enzyme activity, stress resistance and crop yields (El-Beltagi *et al*., 2011).

Cowpea is one of the most important food legume crops in the semi-arid tropics and contains high level of protein. Cowpea is a multipurpose crop and is grown as a grain legume mainly for dry beans and green pods and also as forage, green manure and cover crop. Salinity is one of the most important abiotic stress factors limiting plant growth and productivity(Mohamed and Gomaa, 2012). Tresina and Mohan (2012) studied gamma irradiation effect on Vignaunguiculata subsp. The physico-chemical characteristics of Unguiculata seeds (black colored seeds coat) with different radiation doses (2, 5, 10, 15 and 25 kGy) were investigated. No significant changes observed in the physico-chemical characteristics of irradiated seeds with Gamma. All doses of Gamma irradiation led to significant increase of crude protein, meanwhile the content of crude lipid, crude fiber and ash showed that dose dependent decrease. El-Beltagi *et al*. (2013) studied the possible role of γ-irradiation in alleviating soil salinity stress during plant growth was investigated. Seed irradiation with gamma rays significantly increased plant growth, photosynthetic pigments, total carbohydrate, total phenol, proline, total free amino acids and the contents of N, P, K+ , Ca+2 and Mg+2 compared to non-irradiated ones under salinity. On the other hand, irradiation with gamma rays decreased lipid peroxidation, Na+ and Cl- contents which may contribute in part to activate processes involved in the alleviation of the harmful effect of salt at all concentrations used (25, 50 and 100 mmol) except at the high concentration (200 mmol).

Sani *et al*. (2013) mentioned that, as it was done in numerous species, the mutation induced breeding can help to develop new crop varieties in pearl millet and cowpea. This method is carried out in Niger, in the Laboratory of Plant Breeding and Biotechnology to find out varieties of pearl millet and cowpea, more drought and high temperatures tolerant. This work examines the sensitivity of these two species to gamma radiation, as a first prerequisite step, for crop improving using mutation induction technique. The LD50 was found to be 669,3Gy for millet crop and respectively 176,6 and 209,4 Gy for TN578 and IT90K 372-1-2 cowpea varieties.

Elangovan and Pavadai (2015) carried out to the study of different doses of gamma irradiation on different morpho-agronomic characteristics for bhendi seeds of varieties arkaanamika. Gamma irradiation treatment at 10, 20, 30, 40, 50, and 60 krad levels. Agronomic traits were analyzed such as days of first flower, height of plants, number of fruits per plant, fruit length, seed yield per plant, fresh weight per plant, dry weight per plant, 100 seed weight. The seed pre-soaked in distilled water for 6 h before the sown in the field. The results showed that the positive shift with respect to all parameters. High doses of gamma irradiation (40 and 50 KR) observed in moderate to high values.

This study aimed to evaluate the effect of Gamma-rays irradiation with different doses on seed germination and growth of both roots and stem of the emerging seedlings. Also, the relation between irradiation and aspects of seed vigour was studied.

MATERIALS AND METHODS

The present study was designed to study the effects of different gamma doses on morphological characters of seed germination, seedling growth of feed cowpea seeds. The experiment was carried out during season 2017 at the Laboratory of Agricultural Engineering Research Institute (AEnRI), Agricultural Research Center (ARC),Egypt. While, a Cobalt-60 Gamma cell 5000 unit at Gamma ray irradiation took place in Food Irradiation Division, Atomic Energy Authority Egyptian, Egypt.

Collection of feed cowpea Seeds

The mature seed materials of feed cowpea seeds Vignaunguiculata (L.) Walp.subsp.*Vigna*unguiculata (black coloured seed coat) were collected from, Agricultural Research Center, Egypt. After collection, the seeds were surface cleaned and physically damaged, immature and insect infested seeds were eliminated.

Seeds irradiation:

Dry seeds were divided into 4 samples (each of them 100 g) and packed in polyethylene sacks, then irradiated at different gamma irradiation doses (10, 20 and 30 krad), while one sample sack not exposed to irradiation as control, all irradiation was done with a rate of 258,8 Gy/h, All experiments were repeated three times.

In Vitro germination test:

In vitro germination test was done in Petri dish of 90 mm diameter with cotton wetted with 10 ml of distilled water for feed cowpea seeds. Each Petri dish received 20 seeds and there were 12 Petri dishes by feed cowpea seeds. Incubation took place in dark, in a growth room at ambient temperature of 25 to 36°C. The irradiated as well as un-irradiated seeds were evaluated for their germination characteristics.

Measurements of Growth characters

During three weeks after 5, 10, 15 and 20 days from sowing, the following growth parameters were recorded, using 5 random plants from each treatment; stem height (mm), stem thickness (mm), fresh mass per stem (g), root height (mm), root thickness (mm), and fresh mass per root (g).

Statistical Analysis

The statistical analyses of test results were done according to student F-test. For irradiated feed cowpea seeds were determined.

RESULTS AND DISCUSSION

Gamma radiation doses

Figs. 1, 2 and 3 illustrated that the effect of gamma radiation doses on germination parameters of feed cowpea seeds. It was noticed that after five days of sowing, by increasing gamma radiation doses from 10 to 30 krad, the growth parameters were increased (65.8 -101.86 mm), (84.38 -117.36 mm), (1.56 - 1.84 mm), (1.52 – 2.04 mm), (0.18 – 0.38 g), (0.11 – 0.34 g), compared to control sample 37.85mm, 73.83 mm, 1.16 mm, 1.25 mm, 0.06 g and 0.11 g for stem length, root length, stem thickness, root thickness, stem fresh mass, and root fresh mass, respectively.

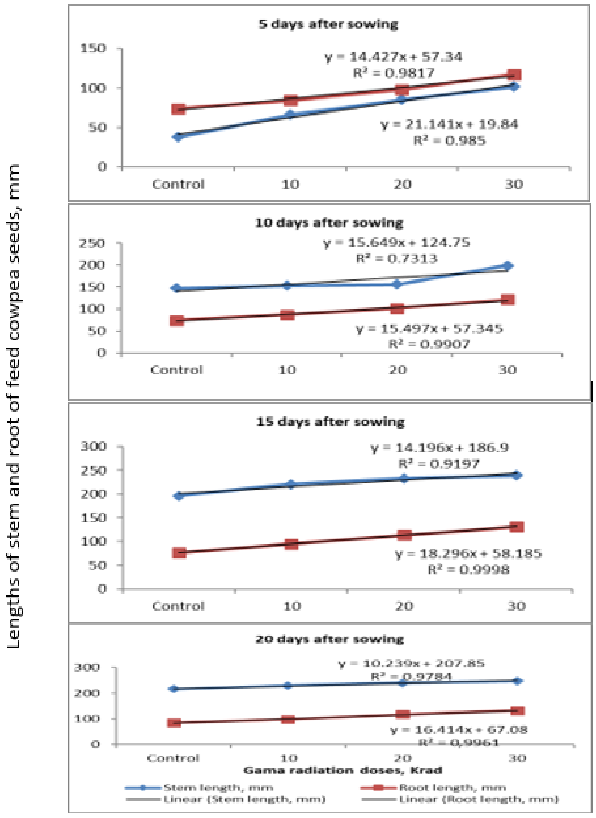

Fig. 1. Effect of gamma radiation doses on stem and root lengths of feed cowpea seeds during germination period.

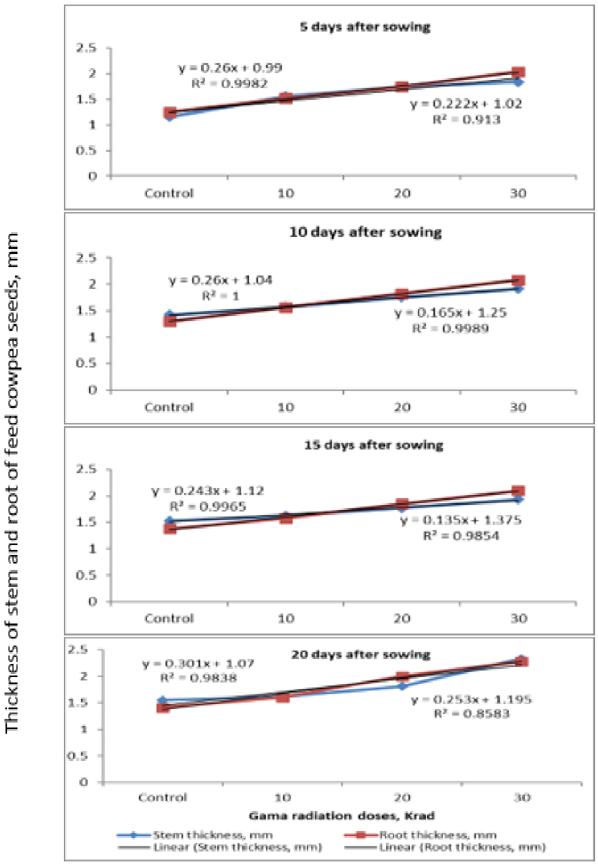

Fig. 2. Effect of gamma radiation doses on stem and root thicknesses of feed cowpea Seeds during germination period.

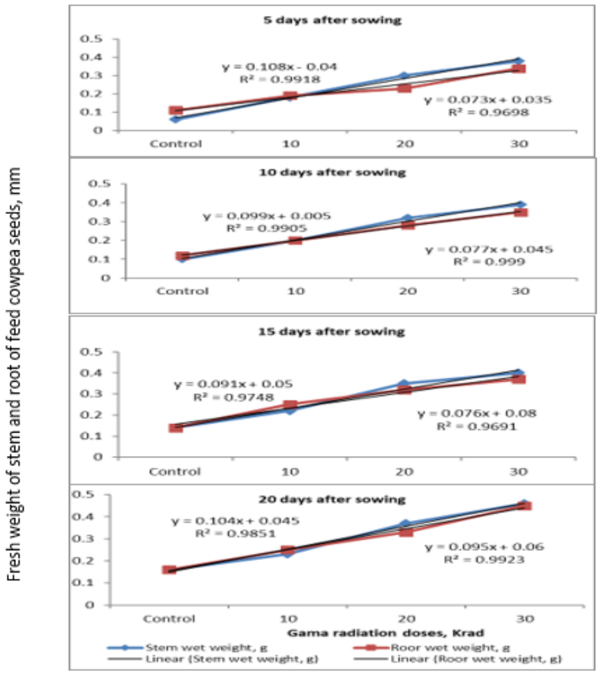

Fig. 3. Effect of gamma radiation doses on stem and root fresh masses of feed cowpea Seeds during germination period.

After ten days from sowing, by increasing gamma radiation doses (from 10 to 30 krad), the growth parameters were increased (152.99 -198.95 mm), (87.02 -121.11 mm), (1.57 - 1.91 mm), (11.56– 2.08 mm), (0.20 – 0.39 g), (0.20 – 0.35 g), compared to control sample 147.73 mm, 74.39 mm, 1.42 mm, 1.30 mm, 0.10 g and 0.12 g for stem length, root length, stem thickness, root thickness, stem fresh mass, and root fresh mass, respectively.

After fifteen days from sowing, by increasing gamma radiation doses (from 10 to 30 krad), the growth parameters were increased (220.91 -239.38 mm), (94.78 - 131.09 mm), (1.62 - 1.93 mm), (1.58 – 2.10 mm), (0.22 – 0.40 g), (0.25 – 0.37 g), compared to control sample 196.13 mm, 76.34 mm, 1.53 mm, 1.38 mm, 0.14 g and 0.14 g for stem length, root length, stem thickness, root thickness, stem fresh mass, and root fresh mass, respectively.

It was found that the after twenty days from sowing, by increasing gamma radiation doses (from 10 to 30 krad), the growth parameters were increased (230.13 -247.14 mm), (98.06 -132.66 mm), (1.62 – 2.33 mm), (1.60 – 2.28 mm), (0.23 – 0.46 g), (0.25 – 0.45 g), compared to control sample 216.35 mm, 84.38 mm, 1.55 mm, 1.41 mm, 0.16 g and 0.16 g for stem length, root length, stem thickness, root thickness, stem fresh mass, and root fresh mass, respectively.

From previous data, it was noticed that all growth parameters of feed cowpea seeds such as stem length, root length, stem thickness, root thickness, stem fresh mass, and root fresh mass were increased compared with control sample during germination period.

Relation between stem and root lengths and gamma radiation doses after different days of sowing as follows equation, the coefficients of the relation are shown in table (1):

$$Ys \text{ or } Yr = \alpha x + \beta$$

Where:

Ys: Stem length (mm)

Yr: Root length (mm)

x: Gamma radiation dose (10, 20, and 30 krad)

Table 1. The parameters of linear regression equations between stem and root lengths and gamma radiation doses

Days after sowing (day)	Ys (mm)		Yr (mm)	
	α	β	α	β
5	14.427	57.340	21.141	19.840
10	15.649	124.750	15.497	57.345
15	14.196	186.900	18.296	58.185
20	10.239	207.850	16.414	67.080

There was found high relation between stem and root lengths at different Gamma radiation doses (10, 20 and 30 krad) after different days of sowing (5, 10, 15 and 20 days), because of R^2 was ranged between (0.73 – 0.99).

Relation between stem and root thicknesses and gamma radiation doses after different days of sowing as follows equation, the coefficients of the relation are shown in table (2):

$$Ys \text{ or } Yr = \alpha x + \beta$$

Where:

Ys: Stem thickness (mm)
Yr: Root thickness (mm)
x: Gamma radiation dose (10, 20, and 30 krad)

Table 2. The parameters of linear regression equations between stem and root thickness and gamma radiation doses

Days after sowing (day)	Ys (mm)		Yr (mm)	
	α	β	α	β
5	0.260	0.990	0.222	1.020
10	0.260	1.040	0.165	1.250
15	0.243	1.120	0.135	1.375
20	0.301	1.070	0.253	1.195

There was found high relation between stem and root thicknesses at different Gamma radiation doses (10, 20 and 30 krad) after different days of sowing (5, 10, 15 and 20 days), because of R^2 was ranged between (0.85 – 1.00).

Relations between stem and root fresh mass and gamma radiation doses after different days of as follows equation , the coefficients of the relation are shown in table (3):

$$Ys \text{ or } Yr = \alpha x + \beta$$

Where:

Ys: Stem mass (g)
Yr: Root mass (g)
x: Gamma radiation dose (10, 20, and 30 krad)

Table 3. The parameters of linear regression equations between stem and root fresh mass and gamma radiation doses

Days after sowing (day)	Ys (mm)		Yr (mm)	
	α	β	α	β
5	0.108	0.040	0.073	0.035
10	0.099	0.005	0.077	0.045
15	0.091	0.050	0.076	0.080
20	0.076	0.080	0.095	0.060

There was found high relation between stem and root fresh mass and different gamma radiation doses (10, 20 and 30 krad) after different days of sowing (5, 10, 15 and 20 days), because of R^2 was ranged between (0.96 – 0.99).

Effect of gamma irradiation of feed cowpea seeds on germination parameters compared to control sample:

Effect of irradiation processing on stem parameters compared to control sample during germination period as shown in Figs. 4, 5 and 6.

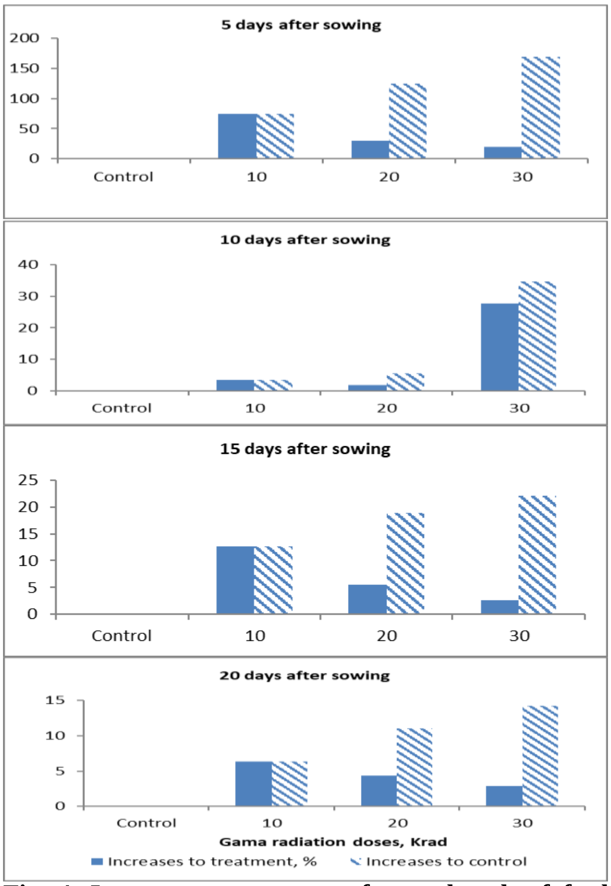

Fig. 4. Increases percentages of stem length of feed cowpea seeds compared to treatments and control during germination period.

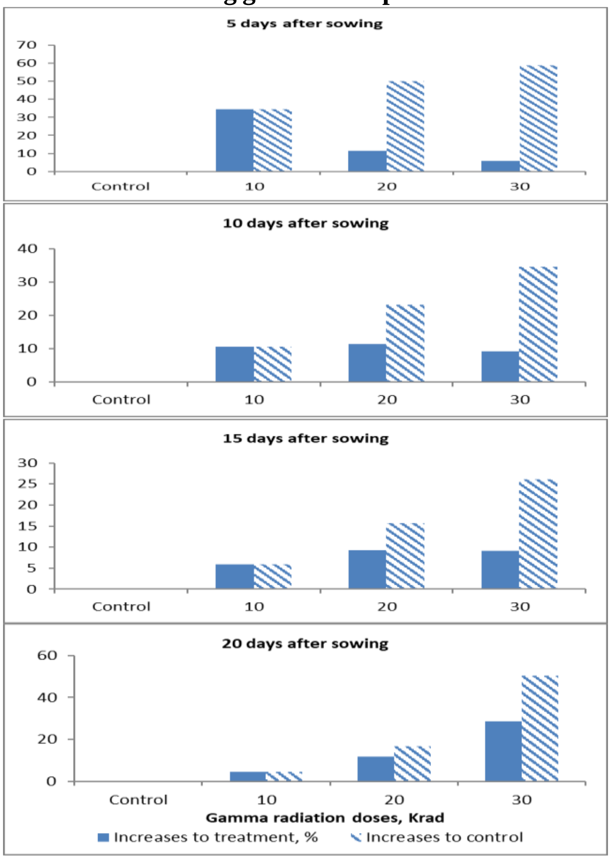

Fig. 5. Increases percentages of stem thickness feed cowpea seeds compared to treatments and control during germination period.

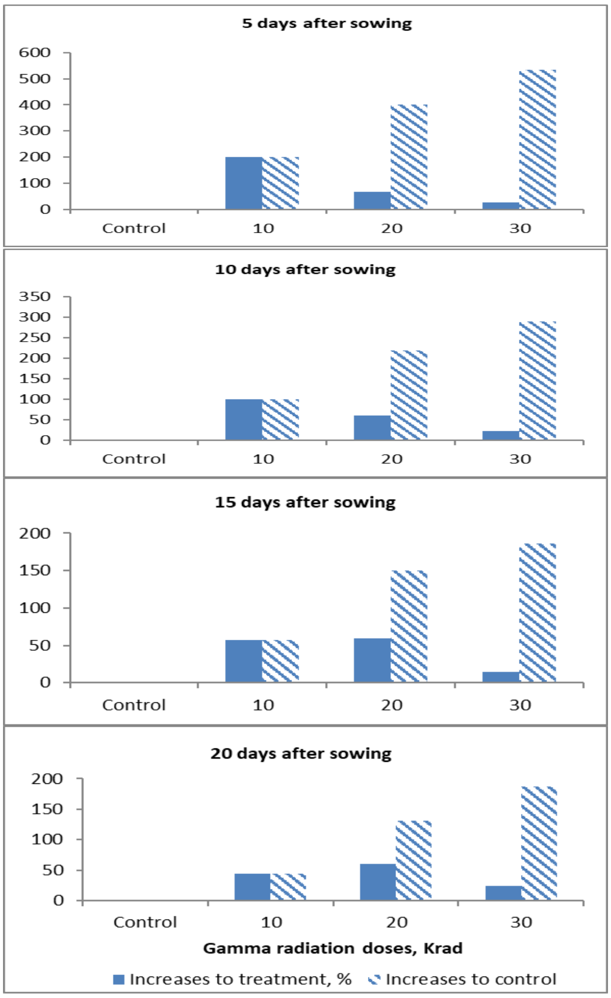

Fig. 6. Increases percentages of stem fresh mass feed cowpea seeds compared to treatments and control during germination period.

Effect of irradiation doses of seeds on stem length compared to control sample:

It was noticed that, there is an increasing percentage in stem length of feed cowpea plant as follows: (73.9, 125.1 and 169.1 %), (3.5, 5.4 and 34.6 %),(12.6, 18.8 and 22.1 %), (6.3, 11.1 and 14.3 %) at increases of irradiation doses (10, 20 and 30 krad) compared to control sample for germination period 5, 10, 15 and 20 days after sowing, respectively. That means improvements of germination stage and increasing vegetation productivity.

Effect of irradiation doses of seeds on stem thickness compared to control sample:

It was found that, there is an increasing percentage increase in stem thickness of feed cowpea plant as follows: (34.8, 50.0 and 58.62 %), (10.56, 32.23 and 34.5 %),(5.88, 15.68 and 26.14 %),(4.51, 16.77 and 50.32 %) at increases of irradiation doses (10, 20 and 30 krad) compared to control sample for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on stem fresh mass compared to control sample:

It was found that, there is an increasing percentage increase in stem fresh mass of feed cowpea plant as follows: (200.0, 400.0 and 533.0 %), (100.0, 220.0 and 290.0 %), (57.14, 150.33 and 185.71 %), (43.75, 131.25 and 187.5 %) at increases of irradiation doses (10, 20 and 30 krad) compared to control for germination period 5, 10, 15 and 20 days after sowing, respectively.

From pervious results, it was showed that there is an increasing percentages increase in length, thickness and fresh mass of stem for feed cowpea plant percentage, and this related to increase of germination enzyme activity according to increase of irradiation doses seeds. Meanwhile, by increasing germination period, it was noticed that, there is a decreasing percentage increase in germination parameters of feed cowpea seeds by increasing irradiation doses, and this related to increase of germination enzyme activity at first germination period (5 days after sowing). While, decreasing of germination enzyme activity by increasing germination period (10, 15 and 20 days after sowing) according to increase of irradiation doses seeds. Also, food elements consumption rate from inside seeds were increased at first germination period, while decreased by increasing germination periods.

Effect of gamma irradiation on stem parameters compared to others treatments:

Effect of irradiation processing on stem parameters compared to others treatments during germination period as shown in Figs. 4, 5 and 6.

Effect of irradiation doses of seeds on stem length compared to others treatments:

It was noticed that, there is an decreasing percentage increase in stem length of feed cowpea plant as follows: (73.9, 29.40 and 19.50 %), (3.5, 1.9 and 27.6 %),(12.63, 5.50 and 2.6 %), (6.3, 4.3 and 2.9 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (stem length at 10 krad and control sample), (stem length at 20 and 10 krad), (stem length at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on stem thickness compared to others treatments:

It was found that, there is an decreasing percentage increase in stem thickness of feed cowpea plant as follows: (34.48, 11.54 and 5.75 %), (10.56, 11.46 and 9.14 %),(5.88, 9.26 and 9.04 %),(4.51, 11.73 and 28.73 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (stem thickness at 10 krad and control sample), (stem thickness at 20 and 10 krad), (stem thickness at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on stem fresh mass compared to others treatments:

It was found that, there is an decreasing percentage increase in stem fresh mass of feed cowpea plant as follows: (200.0, 66.67 and 26.67 %), (100.0, 60.0 and 21.88 %),(57.14, 59.09 and 14.29 %),(43.75, 60.87 and 24.32 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (stem fresh mass at 10 krad and control sample), (stem fresh mass at 20 and 10 Krad), (stem fresh mass at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation processing on root parameters compared to control sample:

Effect of irradiation processing on root parameters compared to control sample during germination period were drawled in Figs. 7, 8 and 9.

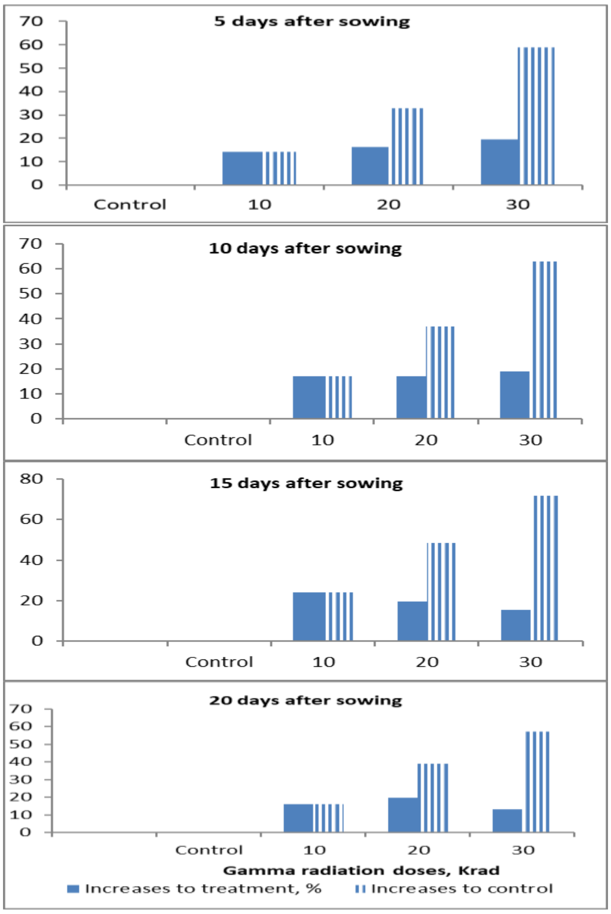

Fig. 7. Increases percentages of root length feed cowpea seeds compared to treatments and control during germination period.

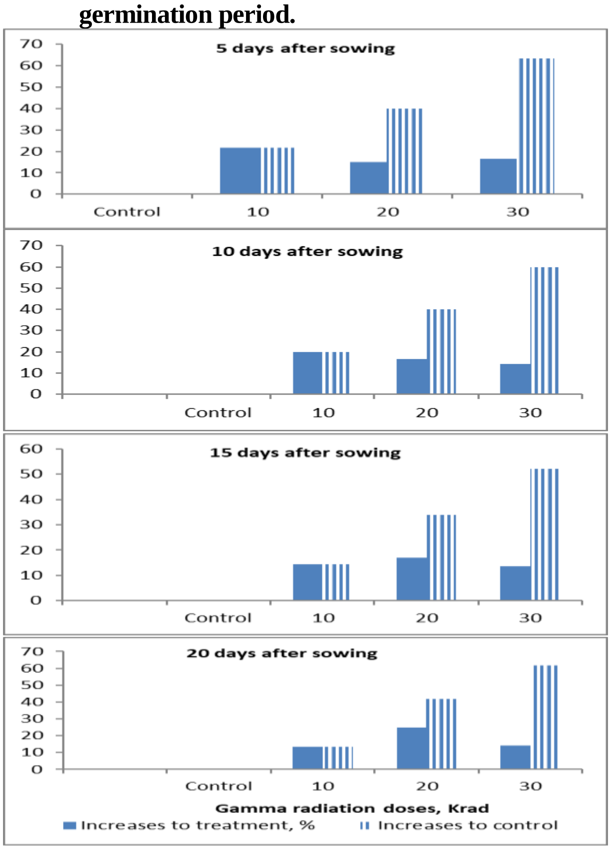

Fig. 8. Increases percentages of root thickness feed cowpea seeds compared to treatments and control during germination period.

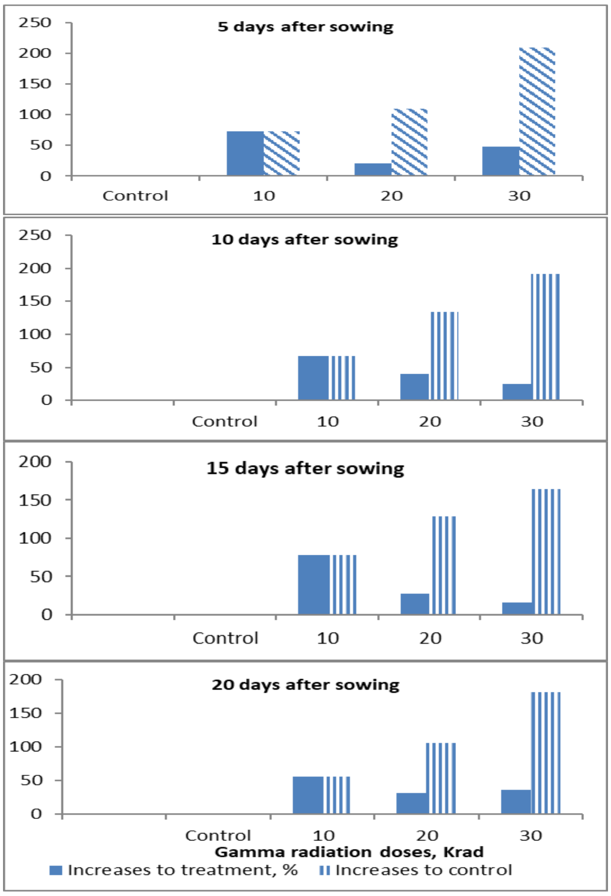

Fig. 9. Increases percentages of root fresh mass feed cowpea seeds compared to treatments and control during germination period.

Effect of irradiation doses of seeds on root length compared to control sample:

It was noticed that, there is an increasing percentage increase in root length of feed cowpea plant as follows: (14.29, 32.28 and 59.96 %), (16.98, 36.89 and 62.80 %),(24.16, 48.66 and 71.27 %), (16.21, 39.09 and 57.22 %) at increases of irradiation doses (10, 20 and 30 krad) compared to control sample for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on root thickness compared to control sample:

It was found that, there is an increasing percentage increase in root thickness of feed cowpea plant as follows: (21.6, 40.0 and 63.2 %), (20.0, 40.0 and 60.0 %),(14.49, 34.06 and 52.17 %), (13.48, 41.48 and 61.70 %) at increases of irradiation doses (10, 20 and 30 krad) compared to control sample for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on root fresh mass compared to control sample:

It was found that, there is an increasing percentage increase in root fresh mass of feed cowpea plant as follows: (72.73, 109.09 and 209.09 %), (66.67, 133.33 and 191.67 %),(78.57, 128.57 and 164.29 %), (56.25, 106.25 and 181.25 %) at increases of irradiation doses (10, 20 and 30 mass) compared to control for germination period 5, 10, 15 and 20 days after sowing, respectively.

From pervious results, it was showed that there is an increasing percentages increase in length, thickness and fresh mass of root for feed cowpea plant percentage, and this related to maybe increasing of germination enzyme activity according to increase of irradiation doses seeds. Meanwhile, by increasing germination period, it was noticed that, there is a decreasing percentage increase in germination parameters of feed cowpea seeds by increasing irradiation doses, and this related to maybe increasing of germination enzyme activity at first germination period (5 days after sowing). While, decreasing of germination enzyme activity by increasing germination period (10, 15 and 20 days after sowing) according to increase of irradiation doses seeds. Also, food elements consumption rate from inside seeds were increased at first germination period, while decreased by increasing germination periods.

Effect of gamma irradiation on root parameters compared to others treatments:

Effect of irradiation processing on root parameters compared to others treatments during germination period were drawled in Figs. 7, 8 and 9.

Effect of irradiation doses of seeds on root length compared to others treatments:

It was noticed that, there is an decreasing percentage increase in root length of feed cowpea plant as follows: (14.29, 16.21 and 19.68 %), (16.98, 17.02 and 18.93 %),(24.16, 19.74 and 15.51 %), (16.21, 19.68 and 13.04 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (root length at 10 krad and control sample), (root length at 20 and 10 Krad), (root length at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on root thickness compared to others treatments:

It was found that, there is an decreasing percentage increase in root thickness of feed cowpea plant as follows: (21.60, 15.13 and 16.57 %), (20.0, 16.67 and 14.29 %),(14.49, 17.09 and 13.51 %), (13.48, 25.00 and 14.00 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (root thickness at 10 krad and control sample), (root thickness at 20 and 10 krad), (root thickness at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

Effect of irradiation doses of seeds on root fresh mass compared to others treatments:

It was found that, there is an decreasing percentage increase in root fresh mass of feed cowpea plant as follows: (72.73, 21.05 and 47.83 %), (66.67, 40.00 and 25.00 %),(78.57, 28.00 and 15.63 %), (56.25, 32.00 and 36.36 %) at increases of irradiation doses (10, 20 and 30 krad) compared to (root fresh mass at 10 krad and control sample), (root fresh mass at 20 and 10 krad), (root fresh mass at 30 and 20 krad), for germination period 5, 10, 15 and 20 days after sowing, respectively.

From pervious results, there was increasing rate in the increase of length, thickness and fresh mass of stem and root for feed cowpea plant by increasing irradiation doses, and this related to may be increasing of germination enzyme activity according to increase of irradiation doses. Meanwhile, by increasing germination period, there was decreasing rate in the increase in germination parameters of feed cowpea seeds by increasing irradiation doses, and this related to may be decreasing of germination enzyme activity by increasing germination period after 5 days (10, 15 and 20 days after sowing) according to increase of irradiation doses. Also, food elements consumption rate from inside seeds were increased at first germination period, while decreased by increasing germination periods.

Tables 4, 5 and 6 show that the relationship between length, thickness and fresh mass of stem and irradiation doses of feed cowpea seeds. It was noticed that, there is significant differences between the treatments were used. Because of the calculated F values were more than tabled F values. So, it was found that, the irradiation processing feed cowpea seeds by gamma radiation has positive effect on length, thickness and fresh mass of stem.

Table 4. Anova of stem length

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	34395.454	3	11465.151	4.5727726	0.0234158	
Within Groups	30087.177	12	2507.2647			
Total	64482.631	15				
t	1.782		LSD	2233.9729		

Table 5. Anova of stem thickness

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.7548688	3	0.2516229	12.081524	0.0006159	3.4902948
Within Groups	0.249925	12	0.0208271			
Total	1.0047938	15				
t	1.782		LSD	0.0185569		

Table 6. Anova of stem wet weight

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.984025	3	0.3280083	4.5027741	0.0245281	3.4902948
Within Groups	0.87415	12	0.0728458			
Total	1.858175	15				
t	1.782		LSD	0.0649056		

Tables 7, 8 and 9 show that the relationship between length, thickness and fresh mass of root and irradiation doses of feed cowpea seeds. It was noticed that, there is significant differences between the treatments were used. Because of the calculated F values were more than tabled F values. So, it was found that, the irradiation processing feed cowpea seeds by gamma radiation has positive effect on length, thickness and fresh mass of root.

Table 7. Anova of root length

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4967.7531	3	1655.9177	32.914225	4.521E-06	3.4902948
Within Groups	603.7211	12	50.310092			
Total	5571.4742	15				
t	1.782		LSD	44.826292		

Table 8. Anova of root thickness.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.3544	3	0.4514667	81.101796	3.098E-08	3.4902948
Within Groups	0.0668	12	0.0055667			
Total	1.4212	15				
t	1.782		LSD	0.0049599		

Table 9. Anova of root wet weight.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.13665	3	0.04555	31.686957	5.529E-06	3.4902948
Within Groups	0.01725	12	0.0014375			
Total	0.1539	15				
t	1.782		LSD	0.0012808		

CONCLUSION

Results of the effects of different gamma radiation doses on seeds germination were summarized as follows:

All growth parameters of feed cowpea seeds such as lengths, thicknesses and fresh weight of stem and root for irradiated samples were increased compared with control sample during germination period. Developed equations showed that there was strong relationship between all growth parameters and gamma radiation doses after different days from sowing. The R^2 was ranged between (0.73 – 0.99), (0.85 – 1.00) and (0.96 – 0.99) for lengths, thicknesses and fresh mass of stem and root with irradiation doses, respectively. There was significant differences between the growth parameters with different irradiation doses used (F calculated values more than tabulated F values). So, it was found that, the irradiation process of feed cowpea seeds by gamma radiation has positive effect on all growth parameters. There was increasing rate in the increase of length, thickness and fresh mass of stem and root for feed cowpea plant by increasing irradiation doses. Meanwhile, by increasing germination period, there was decreasing rate in the increase in germination parameters of feed cowpea seeds by increasing irradiation doses.

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تأثير أشعة جاما على عوامل النمو والإنتاجية في بذور لوبيا العلف

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الملخص

تهدف الدراسة إلي معرفة تأثير أشعة جاما علي بذور لوبيا العلف من خلال قياس عوامل إنبات بذور اللوبيا العلف. تعرضت البذور الجافة لمصدر جاما بجرعات مختلفة تراوحت من 10 إلى 30 كيلوراد بالهيئة المصرية للطاقة الذرية. وتتلخص النتائج على النحو التالي: اتضح أن معاملات النمو (أطوال وسمك ووزن طازج للساق والجذر للعينات المشععة) زادت بالمقارنة مع عينة الكنترول (بدون تشعيع) خلال فترة الإنبات. وأظهرت المعادلات المستنبطة العلاقة بين الأطوال والسمك والوزن الطازج للساق والجذر بأشعة جاما تتحقق بعد أيام مختلفة من بداية البذر ، حيث وجدت علاقة عالية بين أطوال الساق والجذر وجرعات إشعاع جاما المختلفة (10 ، 20 ، 30 كيلوراد) بعد أيام مختلفة من البذر (5 ، 10 ، 15 و 20 يوما) ، ونسبR2 تراوحت بين (0.73 - 0.99) ، (0.85 - 1.00) و (0.96 - 0.99) للأطوال والسمك والوزن الطازج للساق والجذر مع جرعات التشعيع على التوالي. توجد فروق ذات دلالة إحصائية بين معاملات النمو وجرعات التشعيع. وكانت قيم F المحسوبة أكبر من قيم F الجدولية. وجد أن معالجة التشعيع لبذور اللوبيا بأشعة جاما لها تأثير إيجابي على الطول ؛ سمك ووزن الساق والجذر لنبات لوبيا العلف.وقد وجد أن هناك زيادة في نسب الطول إلي القطر. سماكة ووزن الجذع والجذر لنبات اللوبيا عن طريق زيادة جرعة التشعيع مقارنة مع التحكم . وفي الوقت نفسه ، مع زيادة فترة الإنبات ، لوحظ أن هناك زيادة بنسب متناقصة في معاملات إنبات بذور لوبيا العلف عن طريق زيادة جرعات التشعيع.

الكلمات الدالة : جاما ، النمو ، لوبيا ، الإنبات ، الطبيعية