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Effect of gamma irradiation on quantitative traits and post harvesting analysis of groundnut (*Arachis hypogaea* L.) seed in M_1 generation

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Abstract

Groundnut (*Arachis hypogaea* L.) is a member of the family Fabaceae. It is an important monoecious annual legume, mainly grown for oilseed. Gamma irradiation is a powerful tool to induce genetic alteration and improvement in crops with beneficial mutants. The study was undertaken to evaluate the quantitative traits of gamma rays on groundnut. Genetically healthy, dried and uniform size seeds of groundnut variety of Dharani were treated with 6 doses viz., 100, 200, 300, 400, 500 and 600 Gy of gamma rays. The biological damage based on lethality and injury was estimated in the M_1 generation. The present investigation reveals that seed germination LD_{50} value recorded at 300 Gy and highest survival percentage value was obtained at 100 Gy compared to control and other treatments. In M_1 generation, the morphological and quantitative traits were decreased as the dose increases. The maximum reduction was observed at 600 Gy. In general, the higher doses showed increasing plant damage compared to control. The amino acid content was high in 500 Gy doses of gamma irradiation. The lipids, protein and carbohydrate content were high in 400 Gy compared to control and other doses. Gas chromatography-mass spectrometry (GC-MS) was used to analyse the lipid substances and the results showed that significantly more compounds were found in seeds that had received 400 Gy radiation than in untreated seeds. The current study found that gamma irradiation changes the morphology, quantitative characteristics and biochemical composition of groundnut seeds in the M_1 generation.

Keywords

Agronomic traits, biochemical, gamma irradiation, GC-MS, groundnut

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most extensively cultivated nutrient legumes in the world. It's grown widely in more than hundred countries as a global product highly regarded for unsaturated oil content (1). Groundnut possess a rich source of minerals, vitamins, fats and protein. In India and many other countries, the economic improvement role was mainly depend on oilseeds (2). This crop is currently grown on about 29.5 million ha worldwide, yielding 48.7 million tons in 2019 (3). Groundnuts are mainly self-pollinated plants with limited genetic variation because of the cleistogamous nature of flowers. Therefore, inducing mutations play an important role in developing desired traits and the generation of variations in plants (4).

Heritable variation is created by mutations, allowing crops to adapt to new environments. In nature it takes slow, less frequency and long duration for appearance of mutants (5). During the generations studies and use of genetic diversity through chemical and physical mutagenesis, a mutant selection involves the enhancement of new variety. Recombinant and transgenic plant breeding now uses this as its basis (6). Inherent diversity is a very important factor in plant breeding. Using these methods mutation breeding brought new variations possible in a short period. The most deciding factor in mutation research is to finding the proper dose for the species (7).

Gamma radiation is one of the ionising radiations and it cause the genetic material to break chromosome strands (8, 9). Gamma irradiation is usually a modification instrument for improving genetic diversity in agriculture because it has a high diffusion ability compared to other ionising radiations (10). A gamma-ray is a type of physical mutagenesis that interacts with atoms or molecules in cells to produce free radicals. The radiation doses depend upon the morphology, anatomy, biochemistry and plant physiology changes or damages of free radicals. This impact changes the bottom pairs and the disruption of hydrogen bonds among complementary strands of chromosomes (11, 12). International Atomic Energy Agency/ Mutant Variety Database (IAEA/MVD) under IAEA officially released 3402 mutant varieties released through breeding in the world. Among these mutants announced by gamma irradiation, about 79 groundnut varieties were developed under the breeding (13).

Although the peanut has insufficient variability, it has a narrow genetic basis due to its origin, lack of gene flow due to a ploy barricade, and self-pollination (14). Genetic variants that showed differences in seed protein composition had been reported in groundnut plants. In groundnut, gamma irradiation induced brought changes in the protein composition (15). Clearness of cultures in plant breeding values and varietal description could be enhanced (16).

Among the various strategies aimed at improving crop enhancement programmes, inducing mutation has contributed dramatically to creating mutant varieties with improved and attractive genetic modification of important agronomic traits. Mutagenesis has become more efficient in combination with advanced molecular biology techniques and methods that enhance crop improvement/ breeding programmes (17). These inducements also assist in extracting new gene alleles that do not occur in the germplasm (18). The study aims to investigate the effects of gamma irradiation on seed germination at 7th day, plant survival percentage at 30th day, morphology and quantitative features in the M_1 generation. Biochemical contents such as protein, amino acid, carbohydrates and lipids of M_1 generation harvesting seeds.

Materials and Methods

Collection of seeds and mutagenic treatment

The groundnut variety Dharani (*A. hypogaea* L.) was collected for this work sourced from Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India. The gamma rays (Cobalt (Co^{60})), possessing shorter wavelengths of electromagnetic radiation with high penetrable power, were used from the Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre (BARC), Mumbai, Maharashtra, India. Well matured, selected healthy seeds of about 100 seeds were wrapped in paper and irradiated at doses of 100, 200, 300, 400, 500 and 600 Gy gamma radiations (Gray).

Petriplates study

To estimate the LD_{50} value, the treated seeds were placed on petri plates with two layers of moisture filter paper. During the 7th day after seed germination, the proportion of seeds that sprouted was recorded. The LD_{50} was calculated based on the % of seed germination.

$$Seed\ germination\ (\%) = \frac{No. of seeds\ germinated}{No. of\ seeds\ sown} X\ 100$$

Field preparation and Experimental design

The experiment was laid out as a randomised complete block design (RCBD) with three replications in agricultural field. Untreated, healthy seeds were used as control throughout the study. Overall, 100 seeds were sown in each treatment along with control in the prepared field condition. The space between rows and plants were adopted 45 cm and 15 cm respectively. All the cultivation practices such as weeding, irrigation, crop protection were practiced at regular intervals. The proportion of plants that survived 30 days after planting in the field condition was measured for survival %. At maturity, the seeds are harvested, dried and stored in room temperature. The harvested M_1 generation seeds were subjected to biochemical analyses, including the measurement of protein, amino acid, carbohydrates and lipids.

$$Plant\ survival\ (\%) = \frac{No. of seed\ survived}{No. of seeds\ germinated} X\ 100$$

M_1 Morphological and yield parameters

At the harvest stage, plant height, the number of branches per plant, the number of leaves, leaflet length, the number of pods per plant, pod length, pod yield per plant, the weight of 100 seeds, fresh and dry weight of the entire plant were all determined and calculated.

Estimation of biochemical content

Estimation of protein content (mg/gm d.wt)

For the protein measurement, 200 mg of seeds were taken and ground with a pestle and mortar with 20 % trichloroacetic acid (TCA). In a cooling centrifuge, the homogenate was spun at 12000 rpm for 30 min. The supernatant was discarded, and the pellets were suspended in 1 ml of 0.1N sodium hydroxide (NaOH) to solubilise the protein content and absorbance was recorded at 640 nm using bovine serum albumin as a standard in a UV spectrometer, following an earlier protocol (19).

Estimation of amino acid (mg/gm d.wt)

Groundnut seed sample of about 200 mg was taken and homogenised with 2 ml of ninhydrin reagent. 10 ml of isobutanol added and incubated for 5 min in a water bath at

80 °C. The extract was centrifuged for 15 min at 8000 rpm (Remi C24 plus Maharashtra India) and the supernatant was made up to 10 ml with 80 % ethanol used for the estimation of free amino acids (20) ninhydrin reagent was utilised as standard.

Estimation of carbohydrates (mg/gm d.wt)

5 ml of 2.5N HCl was added to 200 mg seed sample grained with mortar and pestle. This solution was incubated for 1 hr in test tubes in a water bath for 80 ^{0}C. Sodium carbonate was then added at a concentration of 1M. The samples were centrifuged at 5000 rpm for 5 min and the supernatant was collected and stored. From the stored samples, 100 µl was taken and 900 µl of distilled water was added. Then, 4 ml of anthrone reagent was added and heated for 8 min in a boiling water bath to get the colour from green to dark green. The sample absorbance was recorded at 630 nm. Anthrone reagent was used as blank. The carbohydrate content was analysed using glucose as standard (21).

Estimation of lipids content (mg/gm d.wt)

200 mg of dried seed sample was homogenised in a ratio of 10 ml of chloroform to methanol (2:1). The homogenate was centrifuged at 2000 rpm for 10 min. The supernatant was washed with 0.9% saline solution (NaCl) to remove the non-lipid contents and allowed for phase separation to remove the non-lipid contents. The dried lipid was weighed and quantified after the separated lower organic phase was collected in a beaker and dried in an oven at 55 °C (22).

Gas Chromatography–Mass Spectroscopy analysis of chemical components of lipids

A GC–MS analysis was conducted to understand the composition of free fatty acids various doses of treated gamma rays and control peanut samples. Clarus 680 GC was used for analysis using a fused silicon column filled with Elite-5MS (5% Biphenyls 95% dimethylsiloxane, GC L Capillary Column I.D. 30 m 0.25 mm, 250 µm df) and the components were separated by using helium carrier gas at a constant flow rate of 1 ml/min. The injector temperature was adjusted to 260 °C during chromatography. 1 µl of the extract was injected into the apparatus when the oven temperature was 60 °C for 2 min; followed by 300 °C to 10 °C per min maintained for 6 min. The conditions for Mass detection were transfer line temperature 240 °C, ion source temperature 240 °C, electronic impact in 70 eV ion modes, 0.2 second scan duration and 0.1 second scan interval. The obtaining fragments ranging from 40 to 600 Da and the component spectra were compared with the known database of component spectrum stored in the system (GC-MS NIST library 2008).

Statistical analysis

Statistical analysis were investigated using SPSS 21.0 toolbox software. All growth, biochemical and quantitative features were evaluated in triplicates, with the results presented as the mean ± standard error (SEM). One-way ANOVA was used for statistical analysis. Differences with a P-value of < 0.05 were determined statistically significant.

Results and Discussion

Effect of gamma rays on seed germination on 7th day

The % of seed germination varied significantly between the higher dosages and the control. The loftiest seed germination rate or LD_{50} value, was determined at 300 Gy of gamma rays (52.32%) (Fig. 1). Similar outcomes were observed in research using several different crops (23). Gamma radiation treatments have been linked to changes in the % of seeds that germinate. The harm to early cell division caused by gamma rays lead to the % of reduction in seed germination. Findings from the winged bean, cowpea and black gram were similar (24). The soybean variety had the stunted germination rate, which could be caused by chromosomal damage, physiological damage, or a delay in mitosis (25, 26).

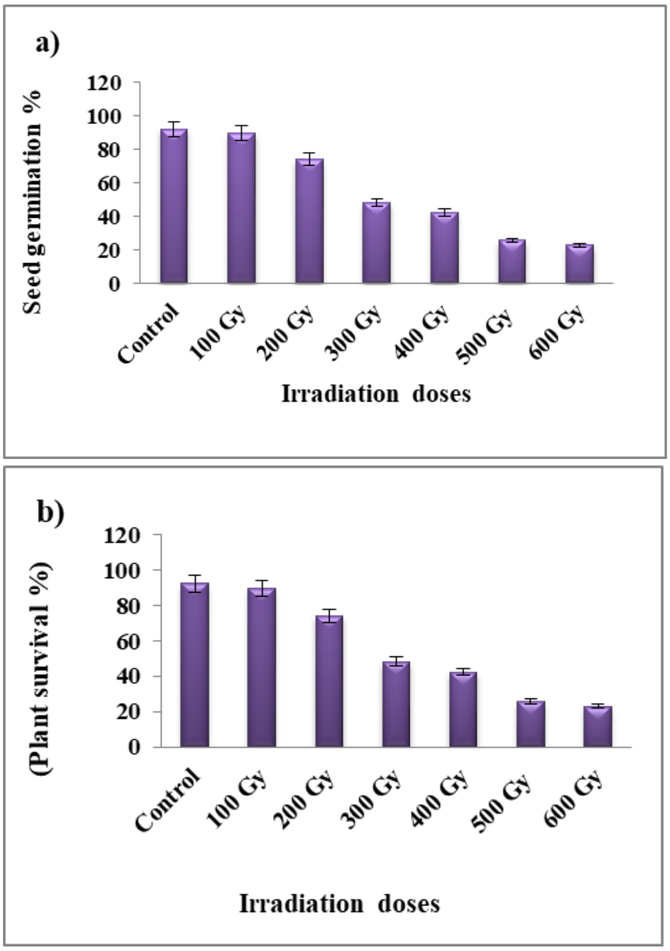


Fig. 1. Effect of gamma irradiation on seed germination **a**) seed germination, **b)** plant survival %.

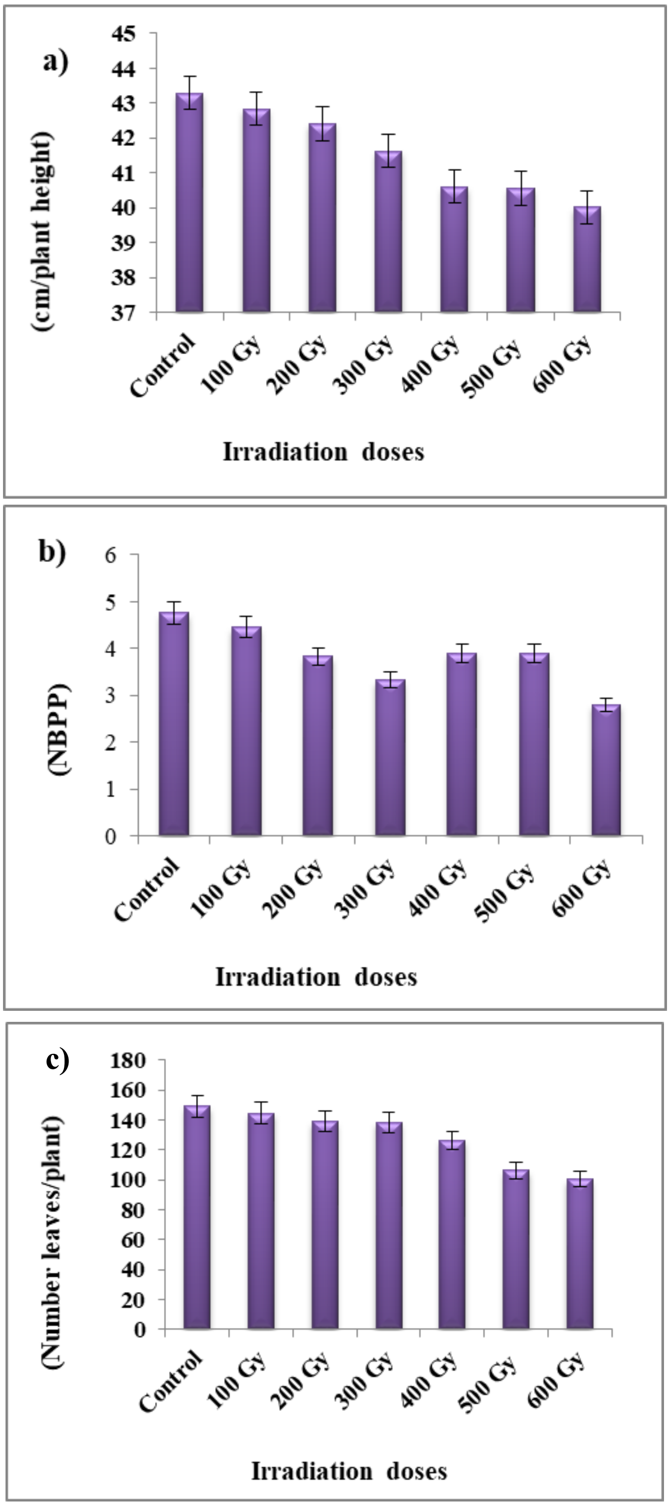
The effect of gamma irradiation on plants survival on the 30th day

In the field, the % of plants on 30th day survival gradually decreased as the dose increases (Fig. 1). When compared to the control plant (90.75), the 600 Gy gamma rays had the greatest reduction of plant survival (59.87) in the present investigation of groundnut. Physical mutagens can reduce the % of M_1 plants that survive. This frequency reflects the organ x-specific effects of mutagens (27). Plant survival % recorded in irradiation doses of cowpea plants (28). Previous study similar result also reported in sesame (29). The impact of the mutagen on the meristematic tissues of the seeds and damage to the chromosome might be the cause of plants' lower survival rate (30).

Gamma irradiation effects on the morphology and quantitative traits

Plant height (cm/plant)

In comparison to the control plants, increasing doses of gamma irradiation resulted in a reduction of plant height. The maximum decrease was reported in this currently study of groundnut at 600 Gy (40.01±0.41), where as the minimum reduction was seen at 100 Gy (42.84 ± 0.15) as compared to control (untreated) (43.29 ± 0.03) (Fig. 2). In sesame, a similar effect was obtained (31). In *Vigna mungo*, it was also reported that, with higher doses of physical and chemical treatment, the plant's height was significantly reduced (32). The physiological disturbance or chromosomal damage caused by the gamma irradiation to the plant's cells has been attributed to a decrease in plant height. The amount of biological damage expressed by gamma irradiation in groundnuts is given as a decrease in plant height (33).



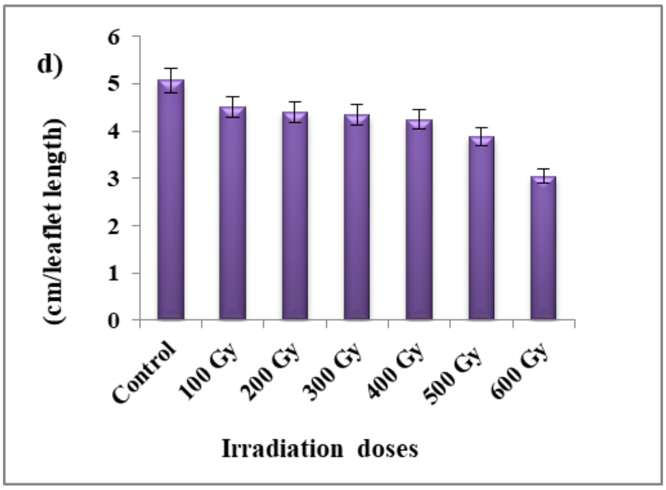


Fig. 2. Effect of gamma irradiation on morphological and quantitative traits on M_1 generation. **a)** plant height, **b)** Number of branches per plant, **c)** Number of leaves per plant, **d)** leaflet length.

Number of branches per plant

All irradiated doses of groundnut showed gradual reduction in the number of branches per plant. The maximum reduction was observed at 600 Gy (2.8 ± 0.28) while the minimum reduction was observed at 100 Gy (4.46 ± 0.007) when compared with control (4.76 ± 0007) (Fig. 2). The mutagenic treatment in M_1 generation of sesame, the number of branches per plant indicated a negative shift (34). The same results were reported in black gram and in cowpea (35).

Number of leaves per plant

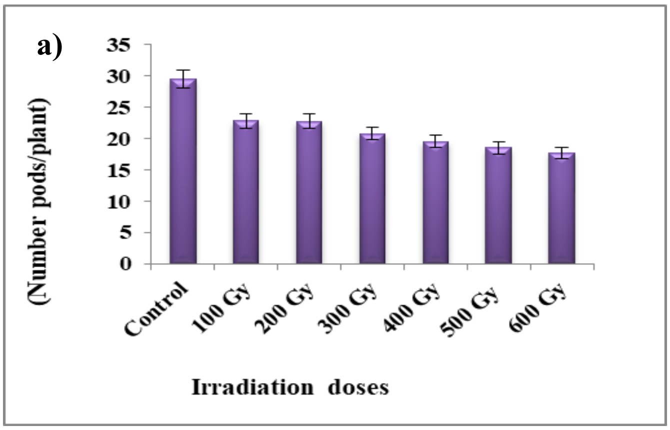
The declined in number of leaves per plant of groundnut was recorded at all irradiation doses. Maximum reduction of leaves in the present study was observed in 600 Gy (100.34 ± 7.21), while a lower number of leaves were observed in 100 Gy (144.40 ± 6.77) when compared to control (148.93± 7.25) (Fig. 2). In comparison to the control, all of the mutagenic treatments showed a decrease in the number of leaves per plant. In cowpea plants, the high number of leaves was recorded at 5 Gy of gamma rays, while the least number of leaves was observed at 40 Gy (28). Using gamma irradiation, previous research has found inherited variations in the number of leaves of peanut plant (36).

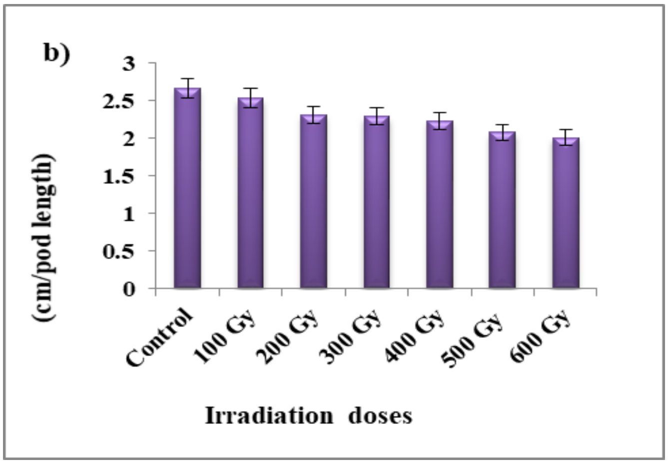
Leaflet length per plant (cm/plant)

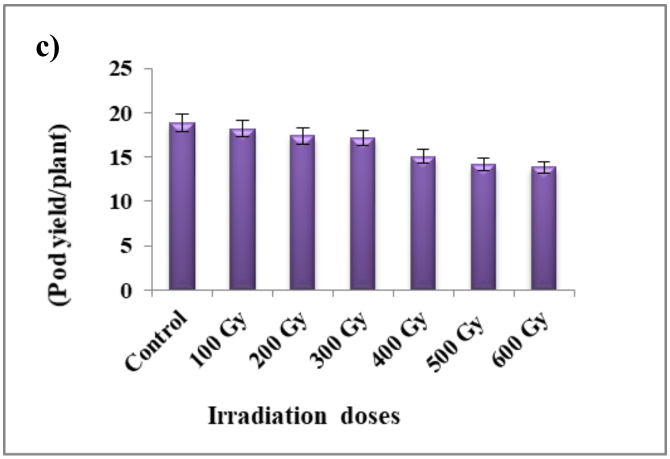
The gradual loss in leaflet length of groundnut was found at 600 Gy (3.04 cm ± 0.21), while the minimum reduction was recorded at 100 Gy (4.51 cm ± 0.14) when compared to untreated plant (5.07 cm ± 0.25) (Fig. 2). The high number of leaflet length was observed in the control and the low number of leaves was found in the black gram 600 Gy treatments (37).

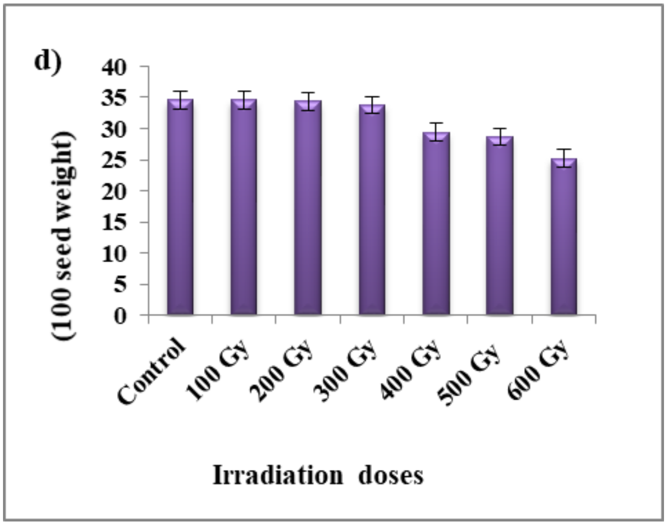
Number of pods per plant

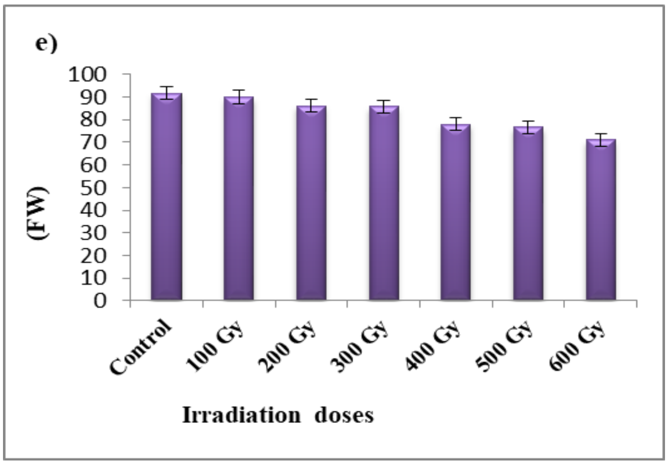
Number of pods per plant in groundnut of this study showed a gradual reduction of mean performance, while the high reduction was observed at 600 Gy (17.75 ± 1.01) and the minimum reduction at 100 Gy (22.83 ± 2.15) compared to control (29.53 ± 2.18) (Fig. 3). Similar findings in the quantity of pods per plant yield in *Vigna unguiculata* of M_1 generation, decrease in gamma radiation treatment (35). The average number of pods per plant decreased in the higher dose 600 Gy, with the number of pods per plant being higher in the lower dosage simultaneously the control group had a higher mean number of pods per plant (36).











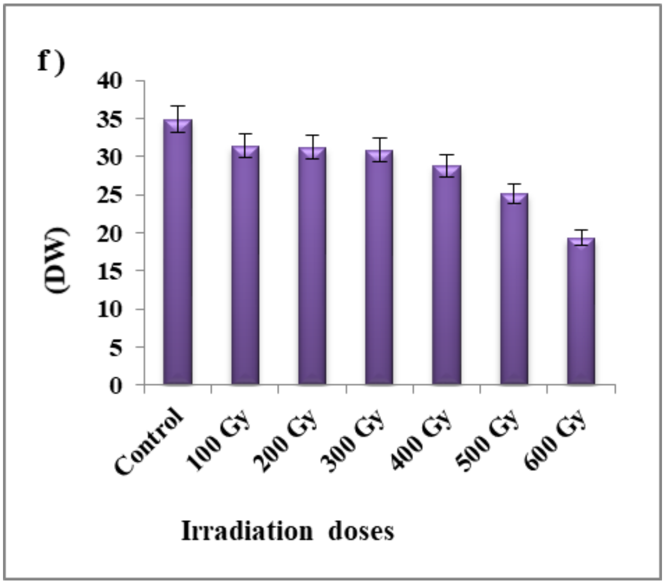


Fig. 3. Effect of gamma irradiation on morphological and quantitative traits on M_1 generation. **a**) Number of pods per plant, **b**) Pod length, **c**) Pod yield per plant, **d**) 100 seed weight, **e**) Fresh weight, **f**) Dry weight.

Pod length

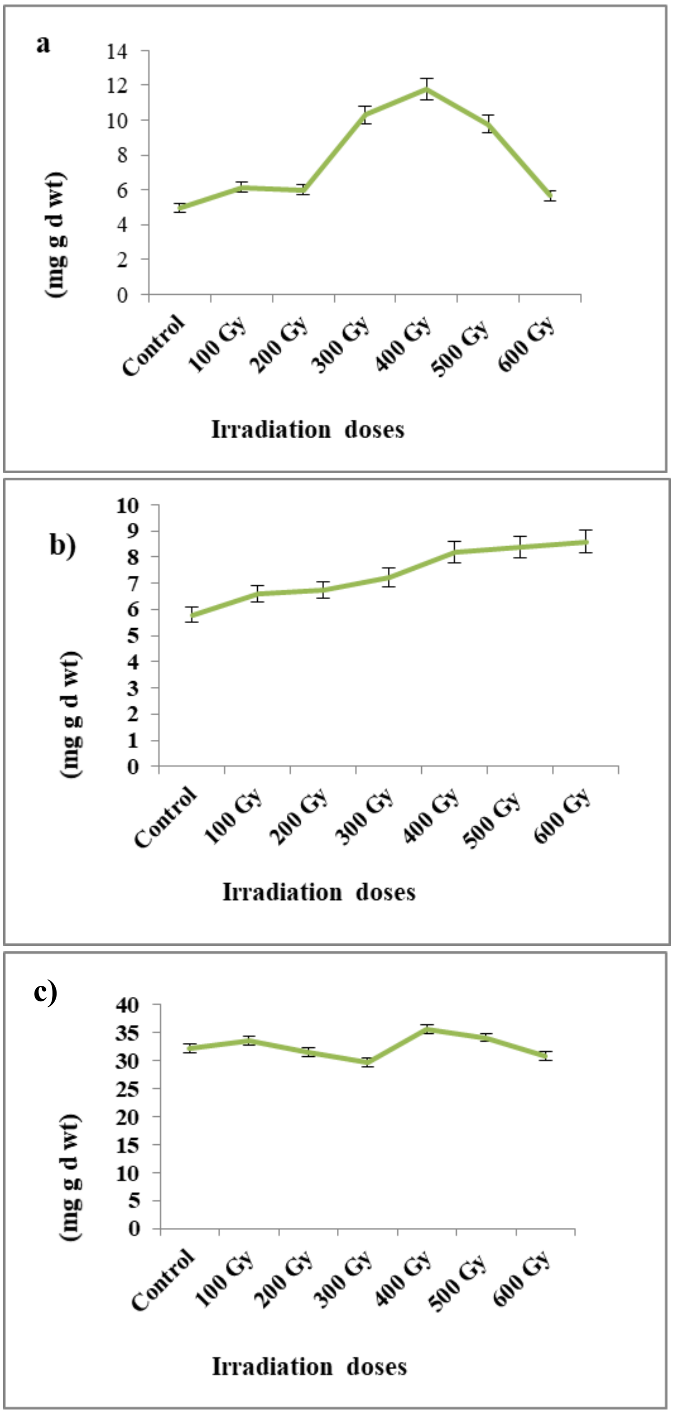
In this investigation of groundnut the mean pod length gradually decreased in 100 Gy (2.53 ± 0.14) and peaked at 600 Gy (2.01 ± 0.06) when compared to control (2.66 ± 0.11) (Fig. 3). Similar findings were stated that, in various dosages, a progressive drop in mean performance was seen for pod length per plant, with 600 Gy showing the greatest loss when compared to control of gamma irradiation doses in groundnut (38). Irradiation reduced certain polygenic features in the M_1 generation, such as pod length recorded by (39).

Pod yield per plant (gm/plant)

Every dose generally resulted in a decreased in the number of pod yield per plant in groundnut, when compared to control (18.87 g ± 0.10), there was a minimum decreased in pod yield at 100 Gy (18.18 g ± 0.04) and maximum decreased in pod yield at 600 Gy (13.84 g ±0.12) was observed in this findings (Fig. 3). The physiological disturbance or chromosomal damage caused by mutagens to the plants' cells has been connected to the reduction in pod production per plant, quantitative and yield characteristics (32).

Seed weight per plant (gm/plant)

When compared to an untreated plants (34.59 ± 0.14) of groundnut seeds of this study, 100 seeds weight was maximum decreased at 600 Gy (25.21 ± 0.20) and minimum decreased observed at 100 Gy (34.55 ± 0.20) (Fig. 4). The previous report stated that, the substantial reduction in the weight of 100 seeds was found at 600 Gy (25.21) in comparison to the control (34.59). Seed yield per plant diminished when the mutagenic treatment dose was increased, confirming recent results on peanuts using gamma radiation and sodium azide soybean treated seeds (40).



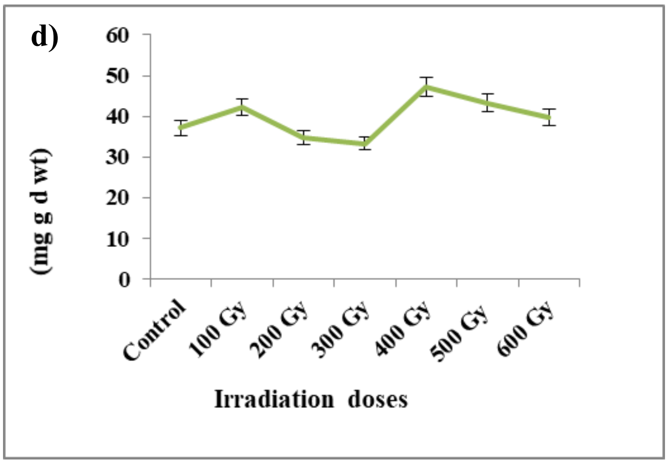


Fig. 4. Effect of gamma irradiation on **a**) Protein, **b**) amino acid, **c**) carbohydrates and **d**) lipid content in M_1 generation seeds.

Fresh weight and dry weights (gm/plant)

In our studies higher dosages of physical mutagenic treatments, the fresh and dry weight of entire plant was dramatically reduced. The maximum weight reduction was observed at 600 Gy gamma radiation (fresh weight: 74.32± 0.63; dry weight: 23.84± 0.43) and minimum reduction observed at 100 Gy (fresh weight: 89.92 ±0.14; dry weight: 31.40 ± 0.23) compared to control (fresh weight: 91.72± 0.83; dry weight: 34.83± 0.34) (Fig. 3). Previous research has found that gamma ray crop characteristics can change inheritance in the fresh and dry weights per plants of black gram decreased when the treatment of dosages was increased (36). In this study reduction in fresh and dry weights of groundnut plant might be due to recorded plant stature or recorded moisture contents in plant due to applied gamma radiation stress. This wide range of phenotypic variation is currently being caused by the enormous amount of genetic variation present among recognized types, which is the source of changeable genetic material. Furthermore, for all characteristics, genotypic variance exceeded environmental variance. Variation in phenotypic expression in varieties is primarily due to genetic causes, with a negligible contribution from environmental influences.

Effects of gamma irradiation on biochemical characteristics

Seed protein content (mg gm d wt)

Generally, seed protein content was gradually increased with gamma rays compared to control. The maximum increased was observed at 400 Gy (11.77). The minimum protein content was observed at 600 Gy (5.66) when compared to control (4.98) (Fig. 4). Such observation was reported by previous work in soybean (41). Samples irradiated at high doses displayed higher total soluble protein content as compared to non-irradiated samples. Radiation produced oxidative damage in biological systems by speeding up the synthesis of free radical in seeds. In enzyme repair pathways, the fundamental damage caused by gamma radiation is changed (42). In plant cells, gamma radiation has been demonstrated to have a major impact on cell metabolism and protein production (43). Higher gamma radiation resulted in increased total soluble protein content, as the result revealed gamma dosage and protein concentration has a direct connection (44). In the soybean trial, the 100 Gy dosage resulted in an 11.0 % increase in total soluble protein content than non irradiated seeds. It was also shown that as the gamma dosage was raised, the amount of carbonyl groups in oxidative proteins role altered considerably (45).

Amino acid content (mg gm d wt)

In general, gamma rays increased steadily the amino acid content as compared to control. At 600 Gy, the maximum increased was observed (8.59). The lowest amino acid level was observed at 100 Gy (6.59) when compared to control (5.78) (Fig. 4). The rise in total soluble amino acid content found as a result of ionising radiation exposure is consistent with previous research (46). At a dosage of 0.10, an increase in essential and non-essential amino acids in irradiated soybeans. Different dosages of gamma radiation had diverse impacts on plant biochemical features, such an increase also observed in our study with the total quantity of soluble proteins and soluble amino acids content. The influence of ionising radiation on total amino acid content is dependent on a number of parameters, including the sensitivity of the exposed system, the kind of particular functional tissue and even other circumstances, such as water soaking following irradiation, was stated detailed in the works of (47). The presence of amino acids, such as proline, may help to defend against desiccation and the negative consequences of solute build up a role in protecting against desiccation and the harmful effects of build up of solutes (48).

Carbohydrate content (mg gm d wt)

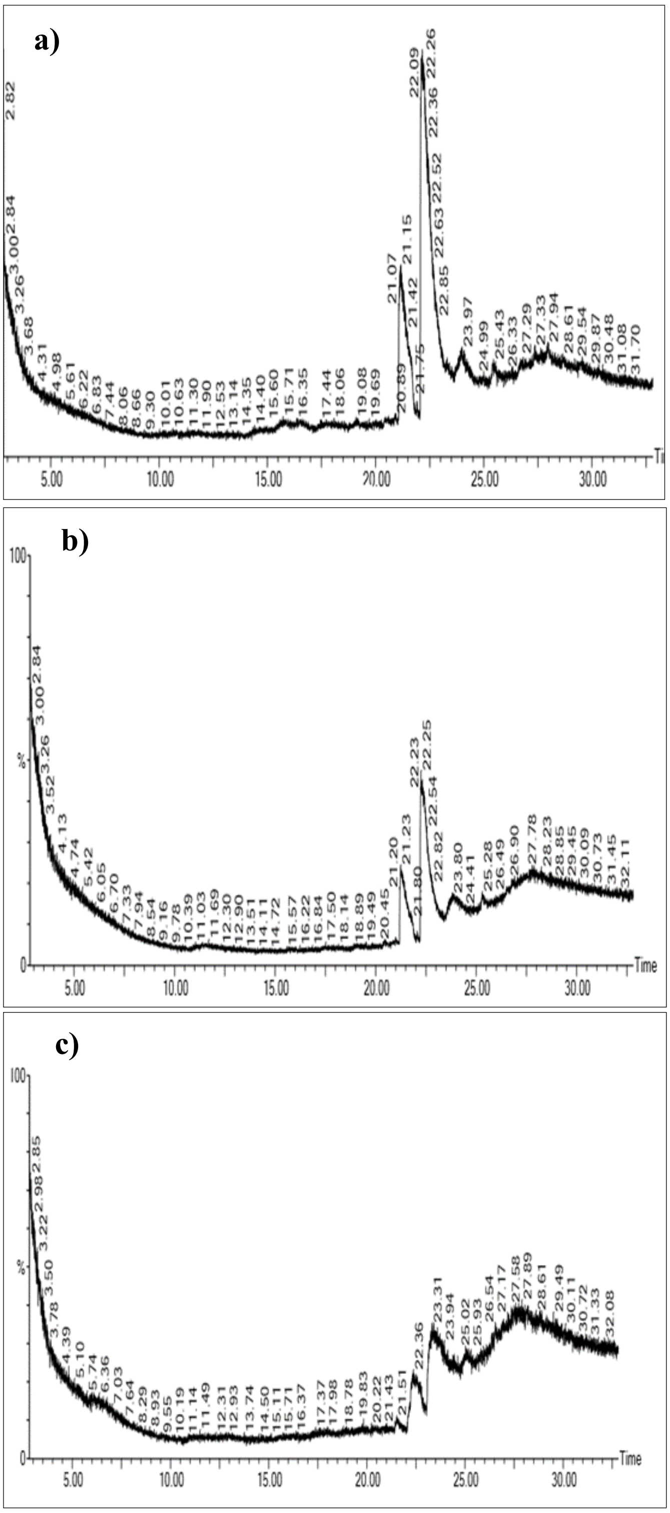
Changes in carbohydrate concentrations are particularly important since they are linked to physiological functions including photosynthesis, signal transduction and respiratory rate. The highest value of carbohydrates content was recorded at 400 Gy (35.67). The highest reduction value of carbohydrates content was recorded at 600Gy (30.79) when compared to control (32.31) (Fig. 4). Carbohydrate decrease was greater in the cultivar of peanut seeds. Carbohydrates were shown to be responsible for the heterogeneous population of free radicals in barley seed exposed to 0.75 Gy of gamma rays (49).

Lipids content

At various irradiation dosages, the effects of gamma irradiation on lipid content increased (Fig. 4). The quantitative of lipids was higher in 400 Gy (35.67), followed by 500 Gy (34.16), 100 Gy (33.65) and 600 Gy (30.79) compared to control. Where as in other doses like 200 Gy (33.65) and 300 Gy (29.78) were decline compared to control (32.31). Our findings are consistent with the rise in lipid levels seen in gamma irradiated almonds and coconut oil samples. However, there are only a few previous reports where no significant increase in lipids was observed after irradiation, which could be linked to the decomposition of primary oxidation products, such as carbonyl compounds, alcohols, and hydrocarbons, which could be linked to the decomposition of smaller stable fragments like carbonyl compounds, alcohols and hydrocarbons (50).

Gas Chromatography –Mass Spectroscopy (GC-MS) analysis of lipids content of the seed

Based on the quantitative amount of lipids contents 200, 400 and 600 Gy were selected for the GC-MS investigations; along with control samples. The treatment and control samples of lipids were used to analysed GC-MS (Fig. 5 and Table 1). Here, in 200 Gy doses shows minimum number of chemical compound like Pentadecanoic acid, 14-Methyl, Methyl Ester, 7-Hexadecanoic acid, Methyl Ester, (Z)-, 2-Methyl 1-6-Methylene-Octa-1,7-Dien-3-OL. Whereas in control such as Pentadecanoic acid, 14-Methyl, Methyl Ester, Hexadecanoic acid, Methyl Ester, 7-Hexadecanoic acid were recorded (Fig. 5 and Table 1).



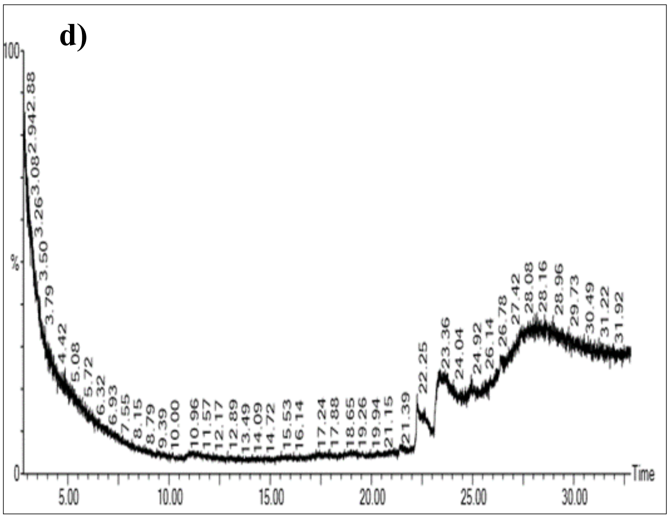


Fig. 5. Effect of gamma irradiation on Gas Chromatography–Mass Spectroscopy **a**) Control, **b**) 200 Gy, **c**) 400 Gy, **d**) 600 Gy.

At 400 Gy doses shows appearance of the new chemical compounds including 2-(1, 2 Dihydroxyethyl) 9-(Beta-D Ribofuranosyl) Hypoxanthine, 1-Hexyl-2-Nitrocyclohexane, Dodecyl Acrylate, 1- Hexadecyne, Dodecanal, 7-Hexadecanoic acid, methyl Ester, (Z)-, Z-8-Methyl-9-Tetradecenoic acid, Dodecanal, 3-Decyn-2-OL, 19,19-Dimethyl-Elcosa-8,11-DienoicAcid, 7,11-Hexadeca dienal, 4-Pentylbicyclohexyl-4-Carboxamide, 4,4- Dimethyl -OCT-5-Enal as compared to control (Fig. 5 and Table 1) The optimum doses of gamma irradiation 400 Gy presented in high amount of chemical compounds compared to control and other doses, because compounds lipid contents are not altered by gamma irradiation.

Higher radiation doses (600 Gy) shows 2-Piperidinone, N-(4- Bromo- N-Butyl)-, Oleic Acid, 2,6-Lutidine 3,5-Dichloro-4-Dodecylthio-, 2,7-Octadiene-1,6-Diol, 2,6-Dimethyl-, (Z)-, Ethylamine, 2-(Adamantan-1-Yl)-1

Table 1. GC-MS analysis of chemical composition of groundnut (*Arachis hypogaea* L.) selected gamma irradiation doses and control on M_1 generation seed

Control			200 Gy			400 Gy			600 Gy		
Retention Time (RT)	**Compound name**	**Formula**	**Retention Time (RT)**	**Compound name**	**Formula**	**Retention Time (RT)**	**Compound name**	**Formula**	**Retention Time (RT)**	**Compound name**	**Formula**
21.171	Pentadecanoic acid, 14-Methyl, Methyl Ester	$C_{17}H_{34}O_2$	21.231	Pentadecanoic acid, 14-Methyl, Methyl Ester	$C_{17}H_{34}O_2$	22.501	2-(1,2 Dihydroxyethyl)-9-(Beta-D Ribofuranosyl) Hypoxanthine	$C_{12}H_{16}O_7N_4$	22.246	2-Piperidinone, N-(4-Bromo- N-Butyl)-	$C_9H_{16}ONBr$
21.391	Hexadecanoic acid, Methyl Ester	$C_{17}H_{34}O_2$	22.247	7- Hexadecanoic acid, Methyl Ester, (Z)-	$C_{17}H_{32}O_2$	23.251	1-Hexyl-2-Nitrocyclohexane	$C_{12}H_{23}O_2N$	22.371	Oleic Acid	$C_{18}H_{34}O_2$
22.151	7- Hexadecanoic acid, Methyl Ester, (Z)-	$C_{17}H_{32}O_2$	23.862	2-Methyl-6-Methylene-Octa-1,7-Dien-3-OL	$C_{10}H_{16}O$	23.311	Dodecyl Acrylate	$C_{15}H_{28}O_2$	27.418	2,6-Lutidine 3,5-Dichloro-4-Dodecylthio-	$C_{19}H_{31}NCl_2S$
						23.417	1- Hexadecyne	$C_{16}H_{30}$	27.738	2,7-Octadiene-1,6-Diol, 2,6-Dimethyl-, (Z)-	$C_{10}H_{18}O_2$
						23.592	Dodecanal	$C_{12}H_{24}O$	27.894	Ethylamine, 2-(Adamantan-1-Yl)-1-Methyl-	$C_{13}H_{23}N$
						22.247	7- Hexadecanoic acid, Methyl Ester, (Z)-	$C_{17}H_{32}O_2$	27.984	1-Adamantanemethylamine,Alpha-Methyl-	$C_{12}H_{21}N$
						23.722	Z-8-Methyl-9-Tetradecenoic acid	$C_{15}H_{28}O_2$	28.309	1-Octadecyne	$C_{18}H_{34}$
						23.937	Dodecanal	$C_{12}H_{24}O$	28.394	1,E-11,Z-13-Octadecatriene	$C_{18}H_{32}$
						26.553	3-Decyn-2-OL	$C_{10}H_{18}O$	28.544	4'-Pentylbicyclohexyl-4-Carboxamide	$C_{18}H_{33}ON$
						26.958	19,19-Dimethyl-Elcosa-8,11-Dienoic Acid	$C_{22}H_{40}O_2$	28.659	2-Methyl-6-Methylene-Octa-1,7-Dien-3-OL	$C_{10}H_{16}O$
						28.178	Dodecanal	$C_{12}H_{24}O$			
						28.218	7,11-Hexadecadienal	$C_{16}H_{28}O$			
						28.829	4-Pentylbicyclohexyl-4-Carboxamide	$C_{18}H_{33}ON$			
						29.214	4,4- Dimethyl-OCT-5-Enal	$C_{10}H_{18}O$			

-Methyl-, 1-Adamantanemethylamine, Alpha-Methyl-, 1-Octadecyne, 1,E-11,Z-13-Octadecatriene, 4’-Pentylbicyclohexyl-4-Carboxamide, 2-Methyl-6-Methylene-Octa-1,7-Dien-3-OL, 1-Hyptyn-4-OL (Fig. 5 and Table 1). When compared to control. Pentadecanoic acid, 14-Methyl, Methyl Ester, Hexadecanoic acid, Methyl Ester, 7-Hexadecanoic acid were also present. GC-MS analysis shows new chemical compounds induced by gamma irradiation was observed at 400 and 600 Gy doses. It may be enhance the quality of the lipids contents and promote the new desire traits it will developed for further generations.

The GC-MS analysis is used to analyse fatty acids and esters in the sample. The sample has a substantial quantity of unsaturated fats, which are beneficial for absorption and digestion and the oil content contains unsaturated fats (51). The chemical composition of the materials may also be determined via GC-MS analysis (52, 53). At irradiation dosages, 3 chemicals were found. Previous report stated except for 6, 9-heptadecadiene irradiated at 50 Gy, the relative quantities of 1, 7, 10-hexadecatriene, 6,9 -heptadecadiene and 8- increased when the radiation dosage was raised. The sesame seeds of these three compounds may thus be employed as identifiers to identify the spent apricot kernel, which was consistent with prior oil studies and increased with radiation exposures (0.5 to 10 Gy and 0.5 to 4 Gy) (54). Infrared spectroscopy was used to identify components in pea seed. The mass spectra and GC retention data of the individual components were compared, and additional identifications were obtained by comparing the mass spectra with those of the data system libraries and those referenced in the literature (55). In the case of stearic acid, the effect of radiation at all radiation doses, the quantities of and 1-hexadecen were higher for 400 Gy. In comparison to palmitic acid, the hydrocarbon content was low. These results are comparable to those obtained with dry green bean control seeds (56).

Importance of this study

Protein, amino acid, carbohydrate, lipid are the major components so we add done. This morphology, quantitative traits, biochemical contents of seed in M_1 generation of groundnut, is to find out the variations and optimum dose for plant growth among the applied doses.

Conclusion

The effects of gamma irradiation on morphological and various quantitative characters of *Arachis hypogaea* L. was observed in this study. Seed germination on the 7th day and the % of plant survival was analysed on the 30th day. From the present investigation, it may concluded that morphological and quantitative parameters were decreased in M_1 generation with increasing doses of gamma rays. These alterations may be due to the application of gamma ray treatment, Leads to chromosome alterations in the seeds. Meanwhile the biochemical characteristics such as protein were increased with increasing doses, amino acid at 500 Gy, carbohydrate and lipids are increased at 400 Gy as compared to control. This exhibited a significant effect on yield in further generations. The lipid concentration were found to be increased in 400 Gy in GC-MS analysis, more research could be done on specific components in feature. Thus, the gamma irradiation were could be used to develop the novel kinds with attractive traits for agronomic and crop improvement.

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Authors contributions

GA conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing original draft, writing review and editing. AD conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing original draft, writing review and editing. LS helped in the experimental setup and data collection.

Compliance with ethical standards

Conflict of interest: There are no conflicts of interest reported by the authors.

Ethical issues: None.

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