Volume 8, Issue 4, 2018, 3395 - 3399 ISSN 2069-5837

Biointerface Research in Applied Chemistry

www.BiointerfaceResearch.com

Original Research Article **Open Access Journal**

Received:07.07.2018 / Revised: 03.08.2018 / Accepted:10.08.2018 / Published on-line: 15.08.2018

Effect of gamma radiations (^{60}Co) on seed germination and growth of turnip plant (*Brassica rapa* L.)

Shahana Malik[1], Ikramullah Khan[2,*], Muhammad Shuaib[3,], Kashif Ali[4]**

[1]Department of Weed Science, The University of Agriculture, Peshawar, Pakistan; e-mail: shaaninsr@yahoo.com
[2]Department of Botany, Abdul Wali Khan University Mardan, Pakistan; e-mail: ikramullah@awkum.edu.pk
[3]School of Ecology and Environmental Science, Yunnan University, NO.2 North Cuihu road, Kunming, Yunnan, 650091, PR. China; email: zeyadz44@yahoo.com
[4] Institute of Ecology and Geobotany, Yunnan University, No.2. North Cuihu Road, Kunming, Yunnan, PR. China; email: botanist_kashifali@yahoo.com

*corresponding author e-mail address: ***ikramullah@awkum.edu.pk* , *zeyadz44@yahoo.com***

ABSTRACT

Effect of various doses of gamma radiations i.e. 0.8, 1.0, 1.2, 1.4, 1.6 kGy on various characteristics of turnip (*Brassica rapa* L.) was studied. Seeds were radiated in the Nuclear Institute for Food and Agriculture (NIFA), Peshawar and set for germination in the Laboratory of Weed Science, The University of Agriculture, Peshawar for three weeks. Data were collected on germination percentage, radical length, number of roots, plumule length, the diameter of hypocotyls, time of germination, fresh weight, dry weight and percent moisture contents and were statistically analyzed. Due to radiation the differences in mean value doses were statistically highly significant for germination percentage, radical length and number of roots and significant for plumule length, percent moisture content, and diameter of hypocotyls. However, the time of germination, fresh weight, and dry weight was insignificantly affected. Thus, all doses showed the significant inhibitory effect on the germination and growth of turnip plant. This could potentially be applied to introduce a new variety of turnip that could tolerate water stress.

Keywords: *Brassica rapa L, Gamma radiations, Germination.*

1. INTRODUCTION

Brassica rapa L. (turnip) belongs to the Brassicaceae (Cruciferae) family. It's a biennial crop with a huge variety in shape and color. Turnips were introduced to China and cultivated before Christ based on the Chinese book of poetry "Shih Ching" [1]. Nowadays Chinese turnips are often replaced by other vegetables and its cultivation area is reduced. Its domestication was very old. It was an important crop in the Roman and Greek period. Its classification is based on morphological appearance, resulting of a division of the cultivated forms of *B. rapa* into three main groups: turnip, oil, and leafy types.

The intensive use of gamma rays and its techniques produced crop plant and the list of new improved varieties of it in this way in the last few years. This techniques have been used by different authors and used gamma rays of 200 Gy to get a good yield of groundnuts [2], with (250 Gy) mutant Jajai-25/A produced 57% higher paddy yield than its parent Jajai-77 rice variety [3], by using different doses of gamma radiations. Worked also has been done [4] on mung bean seeds to known about their textured appearance on *Hordeum Vulgare* (Barley) variety Nosrat [5] on dry seeds of the variety D-154 of *Corchorus capsularis* and C.G of *C. oliterius* (Rahman and Mia), in dry seeds of three broad bean varieties (Sinjar, Egyptian and French) to get quantitative variations and improvement in broad bean [6] and for the *in-vitro* mutagenesis with micropropagation in shoot tips of guava (*Psidium guajava* L.) with cultivar Safeda [7]. Mutation can also be induced through different techniques like Amplified fragment length polymorphism (AFLP) used in rice crop for obtaining new cultivars [8] and he also radiated tomato seeds with 60Co gamma rays to get 100% high yield with drought-resistant quality. Such as Korea and Japan and in the Northern regions of Aisa the flowering of sweet potato is artificially induced by grafting short day treatments [9].

The effects of gamma radiations on mutant sweet potato having high starch contents and high yields [10], irradiation effects on *Phaseolus vulgaris* L. cv, Blue Lake seeds revealed the amino acid composition and its variations [11]. Genetic diversity of 18 Iranian native turnips with a British cultivar i.e., Top Millan showed significant differences like highest storage in root weight and size, size and no. of leaves and flowers [12]. Significant effects on all parameters but not on germination percentage with the increase in dose irradiated over dry seeds of *Lepidium sativum* L. [13]. This study was conducted to see the genetic variability in cultivated turnip by radiation using various doses of gamma rays.

2. EXPERIMENTAL SECTION

Turnip seeds were collected from the Grain Storage of the New Developmental Farm, the University of Agriculture, Peshawar. Those seeds were taken to the Nuclear Institute for Food and Agriculture (NIFA), Peshawar to expose the seeds to different doses of Gamma i.e. 0.8,1.0, 1.2, 1.4 and 1.6 kGys. The effects of different doses of gamma radiations on different genetic parameters were observed. For this purpose, seeds were set for germination in the Laboratory of Weed Science, The University of Agriculture, Peshawar.

Under laboratory conditions, the following parameters were studied by placing 10 seeds in each Petri dish with five replications for each dose in a completely randomized design

(CRD). Those seeds were kept on filter paper with distilled water (5 ml/Petri dish) in sterilized Petri dishes which were kept at room temperature for three weeks. The seeds were kept moist until the termination of the experiment.

There were five radiation doses i.e. 0.8, 1.0, 1.2, 1.4 and 1.6 kGys and one control treatment, each treatment was replicated five times. The seeds were observed daily and whenever water required, the same amount of water was added.

After three weeks of data on the following parameters were recorded.

- Germination percentage
- Radical Length
- Number of roots
- Plumule Length
- Diameter of Hypocotyls
- Time of Germination
- Fresh Weight
- Dry weight
- Percent Moisture Content

Length of the stem and roots were measured on a calibrated scale in cm. The numbers of roots were obtained by counting the roots of each grain. The percentage of germination was calculated as by the multiplication with 100 of a total number of grains germinated and then further division occurs by the total number of grains planted. Time of germination was calculated by daily observation of each Petri dish, while the Diameter of hypocotyls was calculated by using a laboratory screw gage. Fresh weight of the specimen was measured with electric balance after the termination of experiment i.e. three weeks. Then the sample was oven dried and fresh weight data was calculated using the same balance. Finally, the difference between the fresh weight and dry weight was considered as moisture contents of the sample. Data on the above parameters were recorded and statistically analyzed through computer software Statistics 8.1 using the Analysis of Variance (ANOVA) techniques. Means were separated through Least Significant Different test (LSD).

3. RESULTS SECTION

Germination percentage. Least Significant Test (LSD) revealed that doses of different gamma irradiations showed significant effects on seed germination when means were compared with control treatment at $P \leq 0.05$. Lowest germination percentage was recorded in the 1.6 kGy treatment, which is significantly different from the control and 0.8, 1.0, and 1.2 kGy treatment ($P = 0.0001$). However, germination percentage in 1.4 was comparable with 1.6 kGy treatment (Figure1).

Radical length. From (LSD) concluded that doses of different gamma irradiations showed the highly significant effect on radical length as shown in (Figure 2). The lowest radical length was recorded in the 1.6 kGy i.e. 1.2520 treatment, which is significantly different from the control and 0.8, and 1.0 kGy treatments ($P = 0.0001$).

Plumule length. LSD test revealed that Plumule length increased under all the radiation doses applied but lowest Plumule length was recorded in the 1.6 kGy treatment, which is significantly different from the control and other treatments (Figure 3).

A number of roots. From LSD the lesser number of roots were recorded in the 1.6 kGy treatment, which is significantly different from the control and 0.8, 1.0, and 1.2 kGy treatment ($P = 0.0001$). However, a number of roots in 1.4 were comparable with 1.6 kGy treatment (Figure 4).

Fresh weight. Fresh weight increased under all the radiation doses applied, revealed through LSD test but the minimum fresh wt. was recorded in the 1.6 kGy treatment and compared with 1.0 and 1.4kGy (Fig.5) which is significantly different from the control and other treatments ($P = 0.0001$).

Dry weight. Least Significant Test (LSD) revealed that no significant difference was recorded in different treatment and was statistically at par with the control treatment (Fig 6). The highest dry weight was recorded in control (1.33 mg) and all other treatments were similar except 1.6 kGy which is slightly different when doses of different gamma irradiations applied (Figure.6).

Diameter of hypocotyls. LSD Test depicts that the maximum diameter of hypocotyl showed by control and minimum by 1.6 kGy when doses of different gamma irradiations applied (Figure7).

Percent moisture contents. Different gamma irradiations effects on seeds showed by LSD test which revealed that the highest percentage moisture contents found in 0.8 kGy and lowest in 1.6 (Figure 8).

Time of germination. Time of germination increased under all the radiation doses when applied revealed by LSD test and but when means were compared with control treatment at $P \leq 0.05$, a significant difference was observed (Figure 9). Minimum time of germination was recorded in the 1.4 and 1.6 kGy treatments, which is significantly different from the control and 0.8, and 1.0 kGy treatment ($P = 0.0001$) (Figure 9).

Discussion. The germination percentage decreased after gamma irradiation, but the decrease was related to the increase of dosage. A high increase was observed at 0.0 and 0.8 KGy and lowest at 1.6 KGy for usually all parameters, which shows some stimulatory effect of hormones. This result is in agreement with the result of [14,15,16]. The radical length was increased with application of all doses applied. A high increase was observed at 0.8 KGy and lowest at a higher dose of 1.6 KGy, in general, lower doses were stimulatory and higher doses were inhibitory in action. Similar results were also obtained by [17,18]. The effect of plumule length was highly significant with the application of all doses applied. This result is compatible with the result of [19], and [20, 21]. The number of roots was highly significant with the application of all doses applied. A high increase was calculated at 0.8 KGy and lowest at 1.6 KGy. This result is in contrast with the result of [18, 22]. The time of germination was decreased with the application of all doses [18,22,23]. The fresh and dry weight was increased with application of all doses. A high increase was observed at 0.0 KGy and lowest at 1.6 KGy. All the doses have similar effects on the average fresh and dry weight/replicates. The effect of gamma rays on percent moisture content and on the diameter of hypocotyls were also significant in the response of all radiation doses which is similar to the result of [18,23]. The effect of gamma rays on the diameter of hypocotyl was significant in the response of all radiation doses apply. A high increase was observed at 0.8 KGy which is contrasting with [18] values and lowest at 1.6 KGy which is in similarity with the result of [18]. From the parameters examined and it is seen that 150 Gy inhibited seedling growth significantly [24]. The success of vitro studies based firstly on the viability of seedling from which explain were excised [24, 25].

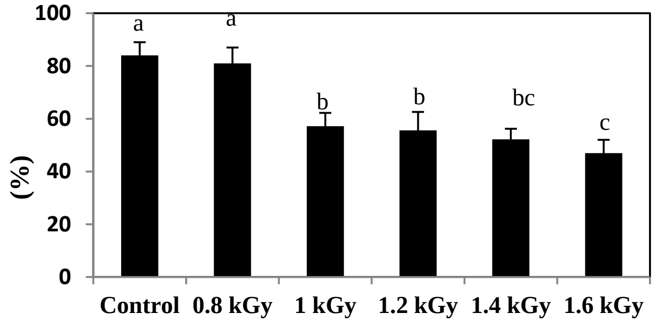

Figure 1. Gamma irradiation effects on germination percentage.

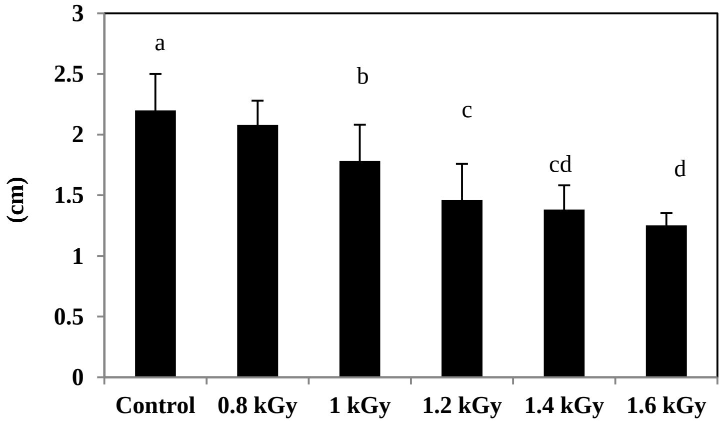

Figure 2. Gamma irradiation effects on radical length.

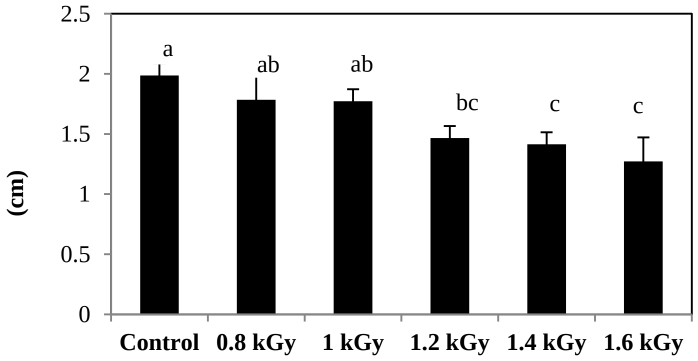

Figure 3. Gamma irradiation effects on Plumule length.

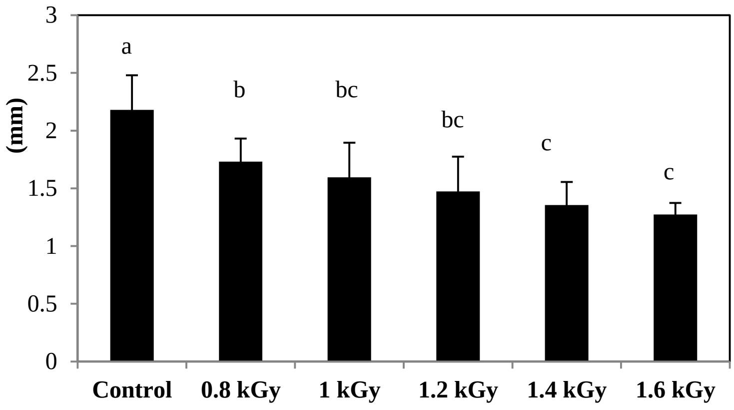

Figure 4. Gamma irradiation effects on a number of roots.

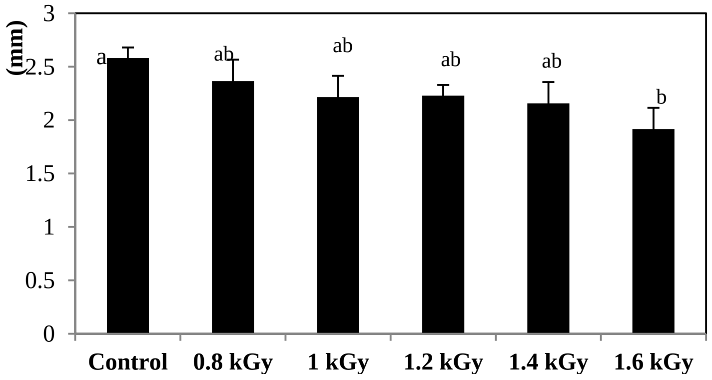

Figure 5. Gamma irradiation effects on fresh weight.

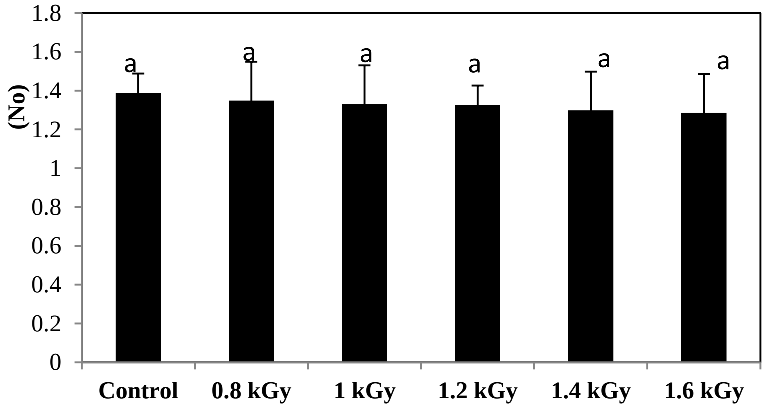

Figure 6. Gamma irradiation effects on dry weight.

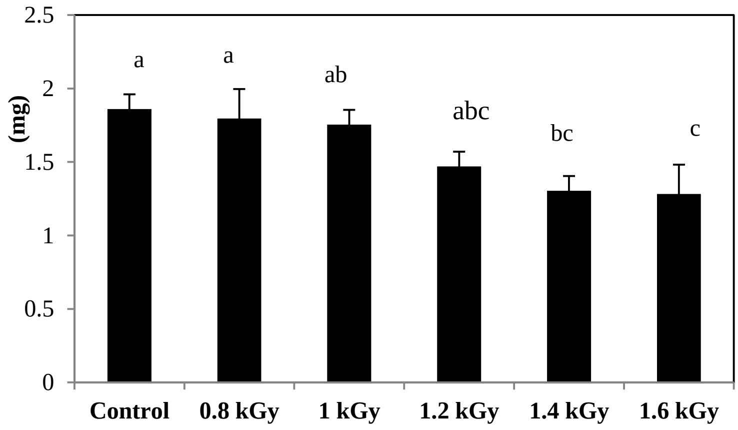

Figure 7. Gamma irradiation effects on diameter of hypocotyls.

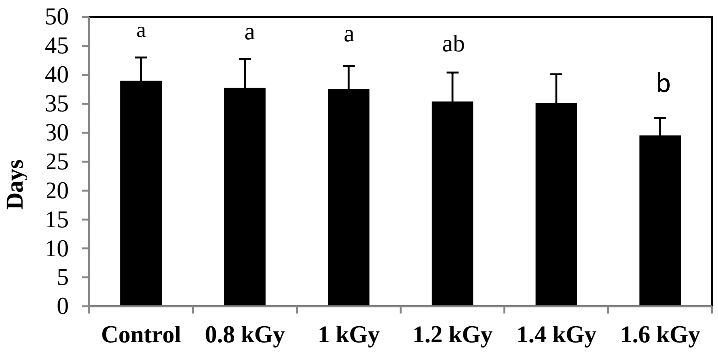

Figure 8. Gamma irradiation effects on Percent Moisture Contents.

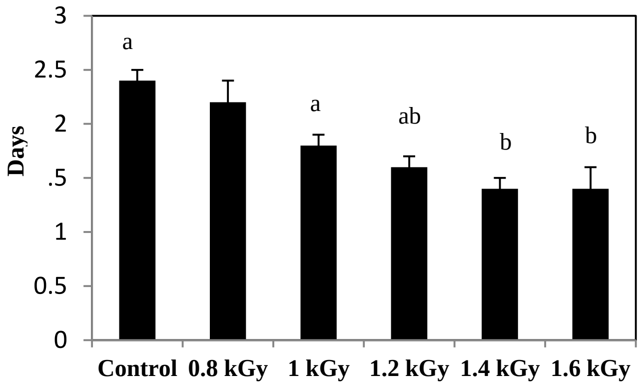

Figure 9. Gamma irradiation effects on time of germination.

4. CONCLUSIONS

On the basis of above work, concluded that the effects of all the doses of Gamma Irradiations applied were highly effective against all parameters studied where the growth parameter is shown a significant decrease in growth, which could possibly be used to introduce a new short statured variety with less water requirement.

5. REFERENCES

[1] Keng H., Economic plants of ancient north China as mentioned Shih Ching (Book of Poetry), *Econ Bot*, 28, 391-410, **1974.**

[2] Azad M.A.K., Hamid M.A., Yasmine F., Binachinabadam-4: A High Yielding Mutant Variety of Groundnut with Medium Pod Size Pl, *Mutation Rep*, 2,2, 212-218, **2010.**

[3] Bughio H.R., Asad M.A., Odhano I.A., Arain M.A., Bughio M.S., Genetic Improvement of an Indigenous Aromatic Variety 'Jajai 77' through Mutagenesis, *Pl. Mutation Reports*, 2, 2, 125-132, **2010**.

[4] Nasab S.S., Sirchi G.R.S., Sirchi M.H.T., Assessment of dissimilar gamma irradiations on barley (*Hordeum vulgare* spp.) *J.of Pl. Br. and Crop Sci*, 2,4, 059-063, **2010**.

[5] Chen Y., Lee1 L.S., Hill H., Henry R., Banos C., Rough Texture of Mungbean(*Vigna radiate* L.) First True Leaves Induced by Gamma Irradiation, *Pl. Mutation Reports*, 2, 1, 190-200, **2008**.

[6] Amir K., Hussain S., Shuaib M., Hussain F., Urooj Z., Khan W.M., Zeb U., Ali K., Zeb M.A., Hussain, F., Effect of gamma irradiation on OKRA (*Abelmoschus esculentus* L.). *Acta Ecologica Sinica*, **2018.**

[7] Zamir R., Khattak G.S.S., Mohammad T., Shah S.A., Khan A. J., Ali N., In-Vitro mutagenesis in guava (*Psidium guajava* L.), *Pak. J. Bot*, 35, 5, 825-828, **2003**.

[8] González M.C., Mukandama J.P., Ali M.M., Trujillo D., Ferradaz1 I., Fuentes J.L., Altane S., Fernandez A., Peteira B., Selection and Characterization of Tomato Mutants Tolerant to Low Water Supply, *Pl. Mutation Rep*, 2, 1, 35-45, **2008**.

[9] Ahn Y.S., Min K.S., Jeong B.C., Chung M.N., Lee J.S., Oh Y.H., KukY.I., Cross-Compatibility and Incompatibility of Korean Sweet potato Varieties, *Korean J. Br. Sci*, 34,3, 236-243.**2002**.

[10] Shin J.M., Kim B.K., Seo S.S., Jeon S.B., Kim J.S., Jun B.I., Kang S.Y., Lee J.S., Chung M.N., Kim S.H., Mutation breeding of sweet potato by gamma-ray radiation, *Afri. J. of Agric. Res*, 6, 6, 1447-145, **2011**.

[11] Marsh J. T., Tryfona T., Powers S. J., Stephens E., Dupree P., Shewry P.R., Lovegrove A., Determination of the N-glycosylation patterns of seed proteins: Applications to determine the authenticity and substantial equivalence of genetically modified (GM) crops. *Journal of agricultural and food chemistry*, 59,16, 8779-8788,**2011**.

[12] Mojarad M.A., Hassandokht M.R., AboosiV., Tabatabayi S.A., Study of genetic diversity of Iranian indigenous turnip accessions (*Brassica rapa* L.) by morphological traits, *Pl. Ecophy*, 2, 109-114, **2010**.

[13] Majeed A., Muhammad Z., Gamma Irradiation Effects on Some Growth Parameters of *Lepidiumsativum*L, *World. J. of Fungal and Pl. Bio*, 1, 1, 08-11, **2010**

[14] Khan W.M., Shah S.Z., Shah L., Khan M.S., Muhammad Z., Ahmad I., Anwar M., Ali S., Effect of Gamma Radiation on Some Morphological and Biochemical Characteristics of *Brassica napus* L.(variety Bulbul 98). *Pure and Applied Biology*, 4,2, 236, **2015**.

[15] Sandhu B.S., Dhaliwal N.S., Grain yield and economics of mungbean (*Vigna radiata* L.) as influenced by different varieties and previous crops. *Food Legumes*, 31,1, 49-52, **2018**.

[16]] Hassan S., Javed M.A., Studies on radio sensitivities of six varieties of Kabuli type chickpea (*Cicer arietinum* L), *Sarhad J. Agri*, 7,5, 613-620, **1991**.

[17] Khan W.M., Shah S.Z., Khan M.S., Islam Z., Ali S., Irshad M., Zahid M., Effect of gamma radiations on some morphological and biochemical characteristics of *Brassica napus* L.(variety Altex). *International Journal of Biosciences*, 4,10, 36-41, **2014**.

[18] Hussain F., Mutation breeding in sunflower (*Helianthus annus* L.)., *M.sc thesis. Deptt of Bot*. ICP, **2007**.

[19] Ahmed S., Khan W.M., Khan M.S., Akhtar N., Umar N., Ali S., Shah S.S., Impact of gamma radiations on wheat (*Triticum aestivum* L.) varieties (Batoor and Janbaz). *Pure and Applied Biology (PAB)*, 6,1, 218-225, **2017**.

[20] Araújo S.D.S., Paparella S., Dondi D., Bentivoglio A., Carbonera D., Balestrazzi A., Physical methods for seed invigoration: advantages and challenges in seed technology. *Frontiers in plant science*, 7, 646, **2016**.

[21] Bhat R., Impact of ultraviolet radiation treatments on the quality of freshly prepared tomato (*Solanum lycopersicum*) juice. *Food chemistry*, 213, 635-640, **2016**.

[22] Shah S.A., Muhammad I., Hassan S., Jabbar A., Studies on the radiosensitivity of bread wheat and RBE values of different radiation type.modern Trends, *Pl. Sci. Res. Pak*, 219-227, **1987**.

[23] Hussain S., Khan W.M., Khan M.S., Akhtar N., Umar N., Ali S., Ahmed S., Shah S.S., Mutagenic effect of sodium azide (NaN3) on M2 generation of *Brassica napus* L. (variety Dunkled). *Pure and Applied Biology*, 6,1, 226-236, **2017.**

[24] Beyaz R., Kahramanogullari C.T., Yildiz C., Darcin E.S., Yildiz M., The effect of gamma radiation on seed germination and seedling growth of *Lathyrus chrysanthus* Boiss. under in vitro conditions. *Journal of Environmental Radioactivity*, 162-163, **2016**.

[25] Ulukapi K., Ozmen S.F., Study of the effect of irradiation (60Co) on M1 plants of common bean (*Phaseolus vulgaris* L.) cultivars and determined of proper doses for mutation breeding. *Journal of Radiation Research and Applied Sciences*, 11, 157e161, **2018**.

6. Acknowledgments

The authors gratefully acknowledge the support received from the Department of Weed Science, The AUP Peshawar, Pakistan. This research work received no specific grant from any donor agency in the public, commercial, or not-for-profit sectors, and these organizations have had no involvement in the analysis and interpretation of data, in the writing of the draft, and in the decision to submit the article for publication.