A Study on Change of Physiology of Okra Plant exposed by Gamma and Alpha Radiation

Win Khaing[1] , Kyaw Wai Oo[2]

Abstract

Okra (*Abelmoschus esculentus* L.) is an annual important vegetable of the tropical and subtropical areas. This kind of vegetable is suitable in planting in Myanmar. Almost all parts of okra plant are consumed, like fresh okra fruits are used as vegetable, roots and stem are used for clearing the cane juice and leaves and stems are used for making fiber and ropes. So, okra seeds are irradiated by gamma and alpha sources for one days and two days. After irradiation the seeds are germinated in plant incubator. And then they are transplanted in the field. In this paper, physical changes of okra plants are presented.

1. Materials and Equipments

1. Seeds of target plant: Okra seed which should be dry, clean, disease-free and of uniform size.
2. Gamma radiation source: Caesium Cs (137), Sodium Na(22)
   Alpha radiation source: Am (241)
3. Vacuum Chambers
4. Pots
5. Plastic trays (any plastic tray for holding water to a depth of 5 cm)

Fig.1.1 Vacuum Chambers

Fig.1.2 Gamma Sources

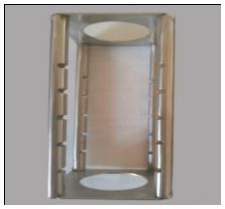


Fig.1.3 Stand For Sample Holder

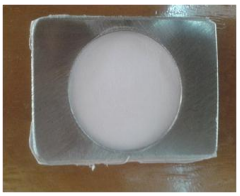


Fig.1.4 Sample Holder

Fig.1.5 Alpha Source Holder

Fig.1.6 Sealed Alpha Source

2. Method

This involves preirradiation handling, irradiation, postirradiation handling of the seeds, data collection and analyses.

(1) Preirradiation handling of seeds: Make 2 batches each of 20 of the sorted seeds. These correspond to two replications of the untreated seeds and each of the 2 doses each batch inside an air and water permeable seed envelope and label the envelopes accordingly.

[1] Associate Professor, Dr, Department of Physics, Monywa University.
[2] Lecturer , Department of Physics , Loikaw University.

(2) Place the packed seeds in a vacuum leave at room temperature for 1-2 days. Expose the seeds to gamma irradiation in the source, taking care to observe all safety.
(3) Store seeds at room temperature for a maximum of 4 weeks. Beyond this period, storage should be in dry conditions, with a minimum of oxygen (in airtight vials or bags, in the dark and at low temperature (25◦C). These conditions minimize metabolic activity and prevent additional lesions to the genome.
(4) Sow seeds exposed to the same dosage simultaneously with the batches arranged in a manner to permit easy visual comparison of the different treatments.

3. Biology of Okra Plant

Okra (*Abelmoschus esculentus* L.) is an annual, often cross pollinated important vegetable of the tropical and subtropical areas. It was originated in India but now grown in many parts of world including the Middle East, Africa, Brazil, Turkey and southern states of [2].

The okra flowers are 4-8 cm diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal and flower lasts only one day. The flower structure combines hermaphrodism and self compatibility. A flower bud appears in the axil of each leaf above 6^{th} to 8^{th} leaf depending upon the cultivar. The crown of the stem at this time bears 3-4 underdeveloped flowers but later on during the period of profuse flowering of the plant there may be as many as 10 undeveloped flowers on a single crown. As the stem elongates, the lower most flower buds open into flowers. There may be a period of 2, 3 or more days between the time of development of each flower but never does more than one flower appear on a single stem. The buds measuring 2.82 x 1.55 cm open into flowers. A flower bud takes about 22-26 days from initiation to full bloom.The flowers are large around 2 inches in diameter, with five white to yellow petals with a red or purple spot at the base of each petal and flower will last only for a day. Each blossom develops a small green pod. The flowers are almost always bisexual and actinomorphic.

Figure (3.1) Okra flower bud and immature seed pod

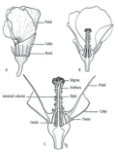


Figure (3.2) Okra flower. A Side view; B longitudinal section; C longitudinal section of stamina column

The erect sexual parts consist of a five to nine part style, each part with a capitate stigma, surrounded by the staminal tube bearing numerous filaments (Purewal and Randhawa 1947, Purseglove 1968). The petals wilt in the afternoon and usually fall the following day.

4. Results and Discussions

4.1 Results and Discussions

The genetic improvement of the following traits has been identified for increased productivity in terms of time and area of cultivation. Breeder's objectives are as follows:

i. To breed early maturing and late senescing varieties.
ii. To evolve high yielding varieties capable of an increased marketable yield of dark green, tender, long, smooth pods. High yield of seed would be an added advantage.
iii. To develop varities resistant to virus diseases such as okra mosaic virus, YVMV and leafcurl; fungal diseases such as vascular wilt, Cercospora blight, powdery mildew,

fruit rot and damping off, Insect, pests such as shoot and fruit borer, leafhopper, apdhids, whitefly etc.

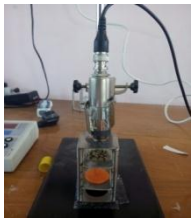
Mutation involves preirradiation handling, irradiation, postirradiation handling of the seeds, data collection and analyses. Before irradiation, the paddy seed samples are choice and measured the seed weight with digital balance. The size of okra seeds are measured with vernier clipper as shown in Fig. 4.1. Two batches of okra seeds are selected from the 24 cm pods and 15cm okra pods as shown in Fig.4.2. And then, they are irradiated in the vacuum chambers at room temperature for 1-2 days. Exposed seeds by gamma irradiation is stored at room temperature for a maximum of 4 weeks. Beyond this period, storage should be in dry conditions, with a minimum of oxygen (in airtight vials or bags, in the dark and at low temperature (25 ◦C). These conditions minimize metabolic activity and prevent additional lesions to the genome. Gamma irradiation was conducted by using Cs (137) and Na (22) gamma sources for 1 day, two days at University Research Centre, University of Monywa. Activity of Cs source is 1μ Curie and half- life 30.07 years and Na 22 is 1μ Curie and half- life is 2.6 years. The activity of Am 241 is 333 kBq and half-life is 432.2 years. The sample preparation for gamma irradiation is shown in Fig. 4.3.(a) and (b). The experimental setup of gamma radiation is as shown in Fig. 4.4. In this case, the distance between source and sample is 1cm apart. It is optimum position for gamma radiation absorption. 19 okra seeds are placed in the target area as shown in Fig.4.3 (a). Moreover, the sample seeds are also irradiated with ^{241}Am alpha source. The sample preparation of alpha irradiation is shown in Fig. 4.5. (a) and (b) and experimental setup is also shown in Fig. 4.6. Four okra seeds are placed in the target area as shown in Fig.4.5.(a). And then, the okra seeds are placed into the vacuum chambers and irradiated for one day and two days. After irradiation process, the okra seeds are cultured in plastic trays including untreated seeds called control. The germination of okra seeds collected from 24 cm okra pod and 14cm okra pod are shown in Fig.4.7 and fig.4.8, respectively. In this case, all of the seeds irradiated by ^{137} Cs source are grown up in the two trays.

Figure (4.1) Measurement of okra seeds with vernier

Figure (4.2) Measurement of okra fruit before irradiation

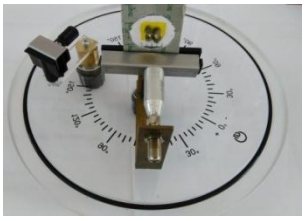
(a) (b)

Figure (4.3) Sample Preparation for Gamma Radiation



(a)

Figure (4.4) Experimental Setup of Gamma Radiation Detection with G.M Counter



(b)

Figure (4.5) Sample Preparation for Alpha Radiation

Figure (4.6) Experimental Setup of Alpha Radiation Detection

Figure (4.7) Germination of okra seeds collected from 24 cm pod

Figure (4.8) Germination of okra seeds collected from 14cm pod

Comparison of seeds germination of okra plants in the tray (1) are shown in Fig.4.9. (a) to Fig.4.9 (g) and Fig.4.10.(a) to (g) in the tray two after three days. In these figures, radicle of control and gamma radiated seeds are more longer than the radicle of seed radiated by alpha radiation. Comparison of growth of okra plant after one month are also shown in Fig. 4.11.(a) to Fig.4.11.(d). In this figure, leave lets of irradiated plant is more leaves than control plant. The length of the control plant is minimum and irradiated plant is greater than in length.

(a)

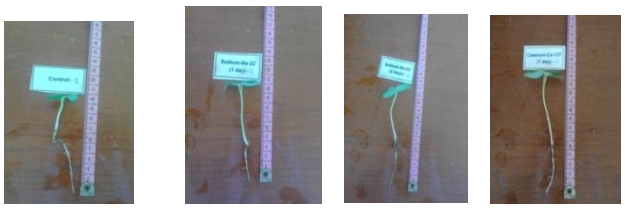
(b)

(c)

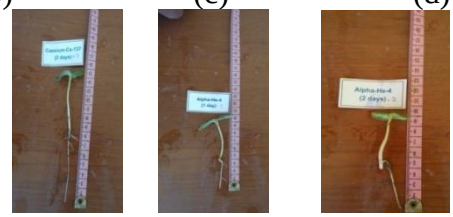
(d)

(e) (f) (g)

Figure (4.9) Comparison of stem shoots, main roots and tap roots of okra in the tray one after three days



(a) (b) (c) (d)



(e) (f) (g)

Figure (4.10) Comparison of stem shoots, main roots and tap roots of okra in the tray two after three days.

(a) Control 1

(b) Okra plant Irradiated by ^{22}Na

(c) Okra plant Irradiated by ^{137}Cs

(d) Okra plant irradiated by ^{241} Am

Figure (4.11) Comparison of growth of okra plant after one month

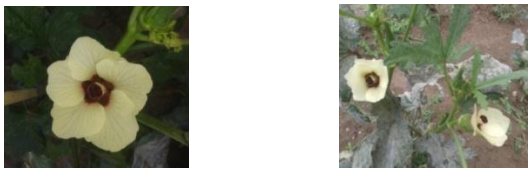
The flowers are borne vertically only on the orthotropic axis every two or three days. The flower is axillary and solitary, borne on a peduncle 2.0 – 2.5 cm long. The flowers are large around 2 inches in diameter, with five white to yellow petals with a red or purple spot at the base of each petal and flower will last only for a day. Each blossom develops a small green pod. In the flower stage, irradiated okra plants bloom five or four petals are appeared, alternatively as shown in Fig.4.12(a) to(d). Moreover, stigmas of okra flowers are investigated as shown in Fig.4.13. In this case, one of the stigma is branched as shown in Fig.4.14 . The stem length of the okra plant irradiated by ^{137} Cs gamma source in pot 1 is the tallest compare with the other samples and the okra plant irradiated ^{137} Cs in pot 1 is the shortest among the

other plants. In this case the okra plant in pot 2 is irradiated for two days . Simillary, other plants induced by two days are also short. Comparison of okra plants irradiated by sources in pot 1 are as shown in fig.4.14. (a) to Fig.4.14(i).The okra plant irradiated by ^{241} Am source is the tallest and shortest in okra plant irradiated by ^{137} Cs source as shown in Fig.4.15 and Fig. 4.16, respectively. Measurement of reproductive phase of okra plants are investigated again and okra plant irradiated by radioactive sources are mature and long in comparing with the control plants. The absorption coefficient of the gamma irradiation of ^{22}Na source and ^{137} Cs source are shown in Table 4.1 and Table 4.2, respectively.

4.2 Conclusion

Control plants are short and late in germination stage and vegetative stage. The pods of control plants are not mature and small in comparing with irradiated plants. The okra plants irradiated by radioactive sources are early mature for one month than control plant. Finally, it can be concluded that the structure and flower of plants changed from its original characters okra plant. Generally, okra flower presents five petals on one leave as shown in Fig.3.2. but there are four petals and two buds on single leave in irradiated okra plants as shown in Fig. 4.17. It can also be seen in Fig.4. 14, Fig.4.15 and Fig.4.16.

(a) (b)



(c) (d)

Figure (4.12) Flowers of okra plant induced by radiation

Figure (4.13) Comparison of stigmas of okra plants

(a) Control in pot 1

(b) Control in pot 2 (c) Control in pot 2



(d) Okra plant (^{22}Na) (e) Okra plant (^{241}Am) (f) Okra plant (^{137}Cs)



(g) Okra Plant (^{22}Na) (h) Okra Plant (^{137}Cs) (i) Okra plant (^{241}Am)

Figure (4.14) Comparison of the okra plants in pot-1

Figure (4.15) Okra plant induced by ^{137}Cs in pot-2

Figure (4.16) Okra plant induced by ^{241}Am in pot-2

Fig.4.17 . Flower and buds of okra plant induced by radiation

Table.4.1. The absorption coefficient of 22Na gamma source

Source	**Distance** / Absorption coefficient	**1 (cm)** (cm^{-1})	**2 (cm)** (cm^{-1})	**3 (cm)** (cm^{-1})	**4 (cm)** (cm^{-1})	**5 (cm)** (cm^{-1})
^{22}Na	14cm	2.819	5.0961	4.992	4.941	4.91
	24cm	2.448	4.426	4.4	4.29	4.26

Table.4.2. The absorption coefficient of 137 Cs gamma source

Source	**Distance** / Absorption coefficient	**1 (cm)** (cm^{-1})	**2 (cm)** (cm^{-1})	**3 (cm)** (cm^{-1})	**4 (cm)** (cm^{-1})	**5 (cm)** (cm^{-1})
^{137}Cs	14cm	6.135	6.2596	5.702	0.1389	6.2079
	24cm	5.53	5.436	4.952	0.1206	5.391

Acknowledgements

I am grateful to Dr Thein Win , Rector of University of Mandalay, Dr Kay Thi Thin and Dr Myit Zu Win , Dr Mi Mi Gyi , Pro-rectors of University of Mandalay . For their encouragement to conduct this research. Thanks are also due to Dr Lae Lae Win , Professor Head of Physics Department, University of Mandalay for her excellent advice and guidance throughout this research.

References

[1] Adams, C.F. (1975). Nutritive value of American foods in common units, U.S. Department of Agriculture, Agric Handbook, 425, pp 29.

[2] Bisht. I.S and Bhat. K.V (2006). Genetic Resources, Chromosome Engineering and Crop Improvement Okra (*Abelmoschus sp.*). Chapter 5, pp 149-185.

[3] Hamon, S. and Hamon, P. 1992. Future prospects of genetic integrity of two cultivated species of okra (*A.esculentus* and *A. caillei*) cultivated in West Africa. Euphytica, 58: 101-111.

[4] Plant Mutation Reports Vol.1, No.1 May, 2006. International Atomic Energy Agency (IAEA).

[5] United Nations of Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1982 Report to the General Assembly.

[6] Technical Report Series No.119, 289 pp. International Atomic Energy Agency, Vienna, Australia.