Sudan University of Science and Technology

College of Graduate Studies

Effect of X-rays and Gamma Rays on Tomato Seeds Growth

تأثير الأشعــة السينية وأشعــة جــاما عــلى نمــو بذور الطمــاطم

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إستهلال

بسم الله الرحمن الرحيم

قال تعالى:

﴿ قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ إِنَّمَا يَتَذَكَّرُ

أُولُوا الْأَلْبَابِ ﴾

صدق الله العظيم

سورة الزمر الآية (9)

Dedication

To the spirit of my pure father

To my dear mother

To my brothers and sisters

To all my teachers

To all my friends

I dedicate you this research

Acknowledgements

Firstly, thanks to Allah for reconciling me Thanks to my family, Sudan University of science and technology family and my teachers and especially the supervisor of this research; Dr. Ahmed Elhassan Elfaki.

Abstract

This thesis deals with the effect of irradiation on growth of tomato seeds. Tomato seeds were irradiated using x-ray radiation and Gamma ray radiation for different period of time. To grow those samples were supplied by magnetized water and tap water. Which reveals that the sample irradiated using x-ray radiation for three minutes and irrigating with tap and magnetized water was grown in 20 and 8 days respectively. The sample which irradiated for six minutes reveals the result of growth in 9 and 10 days respectively.

In case of Gamma radiation the samples was exposure for 15 and 30 minutes. For the samples which exposure for 15 minutes and irrigating with tap water and magnetized water it was grown in 7 days for magnetized water and not yet grown for tap water.

While the tomato seeds which exposure to Gamma rays radiation with tap and magnetized water was found that they were grown in 10 days for both samples. In conclusion, the samples which exposure for short period of time to irradiation and magnetized water was grown fast.

المستخلص

تناولت هذه الدراسة تأثير الإشعاع على نمو بذور الطماطم. وتم تعريضها للأشعة السينية وأشعة جاما لأوقات زمنية مختلفة، من أجل نمو عينات بذور الطماطم تمت إضافة ماء ممغنط وآخر طبيعي، ووضح أن العينات التي استخدمت الأشعة السينية لثلاث دقائق وتم ريها بماء طبيعي واخرى ممغنطة نبتت في فترة زمنية قدرها (20 و 8) أيام على التوالي. أظهرت نتائج العينات التي عرضت للأشعة السينية لمدة ستة دقائق أن بذور الطماطم نبتت في فترة زمنية قدرها (9 و 10) أيام على التوالي.

وفي حالة تعرض عينات بذور الطماطم لاشعة جاما لفترة زمنية قدرها (15 و 30) دقيقة وتم ريها بماء عادي وآخر ممغنط.

أظهرت النتائج العينات التى عرضت لفترة قدرها خمسة عشر دقيقة تم ريها بماء ممغنط نبتت في فترة سبعة ايام، والاخرى التي تم ريها بالماء الطبيعي لم تنبت.

أما في ما يتعلق ببذور الطماطم التي عرضت لاشعة جاما لفترة ثلاثين دقيقة وتم ريها بماء ممغنط وآخر طبيعي وجد أنها نبتت في فترة عشرة ايام لكلتا العينتين، والعينات التي تعرضت لفترة قصيرة من الزمن للأشعة وتم ريها بماء ممغنط نبتت سريعاً.

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CHAPTER ONE

Introduction

1.1 Introduction:

X-ray photons are created by the interaction of energetic electrons with matter at the atomic level. Photons (x-ray and gamma) end their lives by transferring their energy to electrons contained in matter. X-ray interactions are important in diagnostic examinations for many reasons. For example, the selective interaction of x-ray photons with the structure of the human body produces the image; the interaction of photons with the receptor converts an x-ray or gamma image into one that can be viewed or recorded. This chapter considers the basic interactions between x-ray and gamma photons and matter.

All particulate and electromagnetic radiations can interact with the atoms of an absorber during their passage through it, producing ionization and excitation of the absorber atoms. These radiations are called *ionizing radiations*. Because particulate radiations have mass and electromagnetic radiations do not, the latter travel through matter longer distance before losing all energy than the former of the same energy. Electromagnetic radiations are therefore called *penetrating* radiations and particulate radiations non-penetrating radiations. The mechanisms of interaction with matter, however, differ for the two types of radiation, and therefore they are discussed separately.

1.2 Research problem:

Growing tomatoes at home is very easy; because it does not require much maintenance or large areas, but its germination stages, which are water absorption, the stage of digesting nutrients from the soil, and converting them into simple substances that are easy for the seeds to benefit from, require a period ranging from forty to seventy-five days.

1.3 objective of research:

The objectives of this research were to:

1- Studying the effect of irradiation of tomato seed by x-ray.
2- Study the effect of irradiation of tomato seeds with a gamma ray.
3- A comparison between the study of the effect of irradiation of tomato seeds by x-ray device and gamma ray device.
4- Study the effect of irrigating of tomato seeds by tap water.
5- Study the effect of irrigating of tomato seeds by magnetized water.
6- Studying the effect of irrigating of tomato seeds irradiated by x-ray.
7- Study the effect of irrigating of tomato seeds irradiated by gamma ray.
8- A comparison between the studies of irrigating of tomato seeds irradiated by x-ray and gamma ray.

1.4 Literature review

Osama AlabdAllah, Mohammed Nabil Elayobi, their study was to study of different doses in gamma rays in the growth and yield of garlic (the local pyroud variety in Syria). The lobes were irradiated with 4 doses of gamma rays (1, 2.5, 5, 10, Gray). The experiment was carried out by designing randomized whole sectors. The results showed a decrease in the number of plants surviving after 60 days of planting with an increase in the gamma ray dose, as the percentage of dead plants at the two doses was (2.5, 5 Gray)(50%, 54%)respectively with the possibility of obtaining the largest possible number of viable mutations. Therefore, they can be considered as close as possible to the rate of dead plants. While the 10 Gray dose negatively affected the length of time required in all lobes and led to the death of all plants after 60 days of planting, and it can be considered a dead dose. It was also found that the response of the garlic variety to the effect of the low dose of gamma rays 1 Gray was higher compared to the other applied doses due to its positive stimulating effect on the vegetative characteristics and this was reflected positively in its productivity indicators, as the productivity of its plants from dry bulbs reached 4.5 kg / m^2 It was significantly superior to plants treated with doses of 2.5, 5Gray

Delia Marcu, Grigore Damian, their study was effects of gamma radiation are investigated by studying plant germination, growth and development, and biochemical characteristics of maize. Maize dry seeds are exposed to a gamma source at doses ranging from 0.1 to 1 kGy. Our results show that the germination potential, expressed through the final germination percentage and the germination index, as well as the physiological parameters of maize seedlings (root and shoot lengths) decreased by increasing the irradiation dose. Moreover, plants derived from seeds exposed at higher doses (≤0.5 kGy) did not survive more than 10 days. Biochemical differences based on photosynthetic pigment content revealed an inversely proportional relationship to doses of exposure. Furthermore, the concentration of chlorophyll higher than chlorophyll *b* in both irradiated and non-irradiated seedlings. Electron spin resonance spectroscopy used to evaluate the amount of free radicals induced by gamma ray treatment demonstrates that the relative concentration of radiation-induced free radicals depends linearly on the absorbed doses.

In the present study, seeds of Moluccella leaves were divided into two parts, one part were soaked for 12 hours in water before treatments, while the other were used as a dried. Seeds were exposed to gamma rays at doses (0, 2.5, 5, 7.5, 10, 12.5,15, 17.5 and 20 Kr) to examine their effects on germination and survival percentage, growth traits and morphological variation. The highest germination percentage was obtained by2.5 and 5 Kr of dry seeds and 2.5 Kr of wet seeds in both seasons. Low doses of wet seeds and all doses of dry seeds except 20 Kr had the same plant survival percentage 100% in both seasons. Low dose of wet seeds increased plant height, while higher doses decreased it. Higher gamma radiation doses of wet seeds increased number of branches and dry weight of vegetative growth. The doses of 7.5, 17.5 and 20 Kr of dry seeds and 5Kr of wet seeds were hastened flowering date. Low dose (2.5 Kr) of dry and wet seeds increased number of flowers per branches. Wet treatments caused a simulative effect in most characters. The high doses 12.5 to17.5Kr of wet seeds caused some morphological variations.

1.5 Thesis Layout:

This thesis consists of four chapters, chapter one introduction, chapter two basic concepts of radiation, chapter three consist methodology, materials, and method, chapter four results, discussion, finally references.

CHEAPER TWO

Basic Concept of Radiation

2.1 Introduction:

Radiation is energy in the form of waves or streams of particles. There are many kinds of radiation all around us. When people hear the word radiation, they often think of atomic energy, nuclear power and radioactivity, but radiation has many other forms. Sound and visible light are familiar forms of radiation; other types include ultraviolet radiation (that produces a suntan), infrared radiation (a form of heat energy), and radio and television signals.

All life has evolved in an environment filled with radiation. The forces at work in radiation are revealed upon examining the structure of atoms. Atoms are a million times thinner than a single strand of human hair, and are composed of even smaller particles – some of which are electrically charged [1].

2.2 Atoms: Where all matter begins

Atoms form the basic building blocks of all matter. In other words, all matter in the world begins with atoms – they are elements like oxygen, hydrogen, and carbon. An atom consists of a nucleus – made up of protons and neutrons that are kept together by nuclear forces and electrons that are in orbit around the nucleus. The nucleus carries a positive charge; protons are positively charged, and neutrons do not carry a charge. The electrons, which carry a negative charge, move around the nucleus in clouds (or shells). The negative electrons are attracted to the positive [1].

2.3 Types of Radiation

Radiation is energy in the form of electromagnetic waves or stream of particles.

There are two forms of radiation –ionizing and non-ionizing.

2.3.1 Non-ionizing radiation

Non-ionizing radiation has less energy than ionizing radiation; it does not possess enough energy to produce ions (to remove electrons from atom). Examples of non-ionizing radiation are visible light, infrared, radio waves, microwaves, and sunlight.

These are defined as Extremely Low-frequency (ELF) waves and are not considered to pose a health risk.

2.3.2 Ionizing radiation

Ionizing radiation is capable of knocking electrons out of their orbits around atoms, upsetting the electron/proton balance and giving the atom a positive charge. Electrically charged molecules and atoms are called ions. Ionizing radiation includes the radiation that comes from both natural and man-made radioactive materials.

There are several types of ionizing radiation:

(a)Alpha radiation (α):

Alpha radiation consists of alpha particles that are made up of two protons and two neutrons each and that carry a double positive charge. Due to their relatively large mass and charge, they have an extremely limited ability to penetrate matter. Alpha radiation can be stopped by a piece of paper or the dead outer layer of the skin.

Consequently, alpha radiation from nuclear substances outside the body does not present a radiation hazard. However, when alpha-radiation-emitting nuclear substances are taken into the body (for example, by breathing them in or by ingesting them), the energy of the alpha radiation is completely absorbed into bodily tissues.

For this reason, alpha radiation is only an internal hazard. An example of a nuclear substance that undergoes alpha decay is radon-222, which decays to polonium-218.

(b) Beta radiation (β):

Beta radiation consists of charged particles that are ejected from an atom's nucleus and that are physically identical to electrons. Beta particles generally have a negative charge, are very small and can penetrate more deeply than alpha particles. However, most beta radiation can be stopped by small amounts of shielding, such as sheets of plastic, glass or metal. When the source of radiation is outside the body, beta radiation with sufficient energy can penetrate the body's dead outer layer of skin and deposit its energy within active skin cells. However, beta radiation is very limited in its ability to penetrate to deeper tissues and organs in the body. Beta-radiation-emitting nuclear substances can also be hazardous if taken into the body. An example of a nuclear substance that undergoes beta emission is tritium (hydrogen-3), which decays to helium-3.

(c)Neutrons:

Neutrons are neutral particles and uncharged particles. They are one the particles that make up an atomic nucleus. Because they have no charge, they are very penetrating.

(d)Protons

Protons are positively particles found in every atomic nucleus .Their mass are close to that of a neutron. Protons are the chief constituent of primary cosmic rays.

(e)Heavy ions

Heavy ions, larger than alpha particles, are the nuclei of any atoms that have been stripped of their electrons. They move at the great speeds and have large amounts of energy. They are common in auter space, and may also be produced by special types of accelerators.

(f)Electrons

Electrons are small negatively charged particles also found in all normal atoms. They are about 1800 times smaller than neutrons .Electrons are often given off when radioactive materials break down ,in which case they are called Beta rays.

(g) Photon radiation (gamma [γ] and x-ray):

Photon radiation is electromagnetic radiation. There are two types of photon radiation of interest for the purpose of this document: gamma (γ) and X-ray. Gamma radiation consists of photons that originate from within the nucleus, and x-ray radiation consists of photons that originate from outside the nucleus, and are typically lower in energy than gamma radiation. Photon radiation can penetrate very deeply and sometimes can only be reduced in intensity by materials that are quite dense, such as lead or steel. In general, photon radiation can travel much greater distances than alpha or beta radiation, and it can penetrate bodily tissues and organs when the radiation source is outside the body. Photon radiation can also be hazardous if photon-emitting nuclear substances are taken into the body. An example of a nuclear substance that undergoes photon emission is cobalt-60, which decays to nickel-60 [1].

2.4 Sources of radiation

2.4.1 Natural sources:

Throughout the history of life on earth, organisms continuously have been exposed to cosmic rays, radionuclides produced by cosmic ray interactions in the atmosphere, and radiation from naturally occurring substances which are ubiquitously distributed in all living and nonliving components of the environment. It is clear that contemporary life have adjusted or are doing so to all features and limitations of the environment, including the natural radiation background which are

a) Cosmic rays:

Radiation of extraterrestrial origin, which rain continuously upon the earth, is termed "cosmic rays". The fact that this highly penetrating radiation was impinging upon the earth from space, rather than emanating from the earth, was deduced from balloon experiments in which ionization measurements were made at various altitudes from sea level to 9,000 m. It was found that the ionizing radiation rate decreased for some 700 m and from that point increased quite rapidly with elevation. The initial decrease could be explained by a decreased intensity of terrestrial gamma rays, while the increasing component was due to cosmic rays. The likely origin of cosmic rays is the almost infinite number of stars in the Universe. Evidence for this is the increased cosmic ray intensity observed on earth following solar flares. However, it is clear that the sun is not normally a major contributor to the total cosmic flux since diurnal variations are very small. Cosmic ray intensity increases sharply with elevation until a maximum is reached at an altitude of about 20 km. From 20 km to the limit of the atmosphere (up to 50 km), the intensity decreases.

b) Terrestrial radiation:

Radionuclides, which appeared on the Earth at the time of formation of the Earth, are termed "primordial". Of the many radionuclides that must have been formed with the Earth, only a few have half-lives sufficiently long to explain their current existence.

c) Radon:

The most important of all sources of natural radiation is tasteless, odorless, invisible gas about eight times heavier than air, called radon. It has two main isotopes Radon-222, one of the radionuclides in the sequence formed by the decay of U-238, and Radon-220, produced during the decay series of Th-232.

Bedrock, soil, plants, animals, and decomposer compartment all release radon to the atmosphere. Radon is the decay product of radium and is produced in any material containing radium. Since radon is one of the inert gases, it can escape from surfaces, which are in contact with the atmosphere. The amount of radon, which emanates from a given mass of rock, depends upon the quantity of radium present and upon the amount of surface area presented by the mass. The more finely broken a given mass of rock, the more radon it can release. The concentration of radon in the air adjacent to radium-bearing material also depends upon the rate of fresh air movement into the space in question. In basements, caves, and mine shafts that have poor air circulation, the radon concentrations can build up to very significant levels. Efficient ventilation in mines is often necessary to maintain radon concentrations below those, which would be hazardous for workers.

2.4.2 Man – Made Sources:

Over the last few decades man has "artificially" produced several hundred radionuclides. And he has learned to use the power of the atom for a wide variety of purposes, from medicine to weapons, from the production of energy to the detection of fires, from illuminating watches to prospecting for minerals. Individual effects from man-made sources of radiation vary greatly. Most people receive a relatively small amount of artificial radiation, but a few get many thousand times the amount they receive from natural sources. This variability is generally greater for man-made sources than for natural ones. Most man-made sources can be controlled more readily than most natural ones. Though exposure to external radiation due to fallout from past nuclear explosions, for example, is almost as inescapable and uncontrollable as that due to cosmic rays from beyond the atmosphere or to radiation from out of the earth itself.

a) Medical sources

In industrial and medical applications, typically only single radionuclide is involved, thus simplifying identification of leakage pathways from encapsulation, from radioactive tracer tests and for disposal process. The use of radioisotopes in medicine is widespread and may potentially have significant radiological impact. These applications can be classified as

(1) Diagnostic uses.

(2) Therapy.

(3) Analytical procedures

(4) Pacemakers and similar portable sources.

The major potential environmental impact arises from the use of radioactive tracers in nuclear medicine, a field that has grown enormously in recent years.

Nuclear medicine exposures can be classified as

(1) Exposure of the patient.

(2) Exposure of hospital personnel.

(3) Exposure during transport of radioactive pharmaceuticals.

(4) Exposure during manufacture.

(5) Exposure from radioactive waste.

b) In Industrial sources:

Radioisotopes are much more widely used in industry than is generally recognized and represent a significant component in the man-made radiation environment. The principal applications include industrial radiography, radiation gauging, smoke detectors and self-luminous materials. Because most of these applications entail the utilization of encapsulated sources, radiation exposures would be expected to occur mainly externally during shipment, transfer, maintenance, and disposal.

In the past decade, radiation exposures in research and industrial applications were roughly half those due to medical occupational exposure; hence, their contribution to the direct population dose is substantial [4].

c) Nuclear Explosions:

For the last 50 years, everyone has been exposed due to radiation from fall-out from nuclear weapons. Almost all is the result of atmospheric nuclear explosions carried out to test nuclear weapon. This testing reached two peaks: first between 1954 and 1958 and second, greater, in 1961 and 1962.

d) Nuclear Power:

The production of nuclear power is much the most controversial of all the man-made sources of radiation, yet it makes a very small contribution to human exposure. In normal operation, most nuclear facilities emit very little radiation to the environment. By the end of 2006 there were 437 nuclear power reactors in operation in 30countries, worldwide. These power stations are just part of the nuclear fuel cycle.

This starts with the mining and milling of uranium ore and proceeds to the making of nuclear fuel. After use in power stations the irradiated fuel is sometimes "reprocessed" to recover uranium and plutonium. Eventually the cycle will end with the disposal of nuclear wastes. At each stage in this cycle radioactive materials can be released [1].

2.4.3. Radiation Exposure from Background Radiation

Naturally occurring background radiation is the main source of exposure for most people. Levels typically range from about 1.5 to 3.5 Millis everts. Ionizing radiation is also generated in a range of medical, commercial and industrial activities. The most familiar and, in national terms, the largest of these sources of exposure is medical X-rays. Natural radiation contributes about 85% of the annual dose to the population and medical procedures most of the remaining 14%. Natural and artificial radiations are not different in kind or effect. There are many sources of harmful, high energy radiation. Industrial radiographers are mainly concerned with exposure from x-ray generators and radioactive isotopes, but let’s start by considering sources of radiation in general. It is important to understand that eighty percent of human exposure comes from natural sources such as outer space, rocks and soil, radon gas, and the human body.

The remaining twenty percent comes from man-made radiation sources, such as those used in medical and dental diagnostic pro, One source of natural radiation is cosmic radiation. The earth and all living things on it are constantly being bombarded by radiation from space. The sun and stars emits EM radiation of all wavelengths. Charged particles from the sun and stars interact with the earth's atmosphere and magnetic field to produce a shower of radiation, typically beta and gamma radiation. The dose from cosmic radiation varies in different parts of the world due to differences in elevation and the effects of the earth's magnetic field. Radioactive material is also found throughout nature. It occurs naturally in soil, water, plants and animals. The major isotopes of concern for terrestrial radiation are uranium and the decay products of uranium, such as thorium, radium, and radon. Low levels of uranium, thorium, and their decay products are found everywhere. Some of these materials are ingested with food and water, while others, such as radon, are inhaled. The dose from terrestrial sources varies in different parts of the world. Locations with higher concentrations of uranium and thorium in their soil have higher dose levels. All people also have radioactive isotopes, such as potassium-40 and carbon-14, inside their bodies [1].

2.5 Radiation law and activity:

The nature of radioactive decay is determined by the fundamental fact that the probability per unit time that a radioactive nucleus will undergo decay is equal to some positive constant, λ, called the decay constant. The value of this constant depends on the type of decay and on certain properties of the nucleus undergoing decay (the parent nucleus) as well as the nucleus which remains after the decay has taken place (the daughter nucleus). From this fundamental relation it follows that of a sample containing N radioactive nuclei at time t, the number decaying per unit time is $N \lambda$ and the number dN which decay in time dt is $N \lambda\, dt$. Since the nuclei which decay in time dt represent a decrease in the number of parent nuclei present in the sample, one writes the change in N as:

$$\mathbf{dN = -N\,\lambda\,dt.} \qquad \text{………….. (2.1)}$$

Integrating this expression from t = 0 to some later time t yields the radioactive decay law:

$$\mathbf{N = N_o e^{-\lambda t}} \qquad \text{………….. (2.2)}$$

N ≡ number of parent nuclei at time t

N_o≡ number of parent nuclei present at t = 0

where N_o is the number of parent nuclei present at t = 0. The activity, or number of disintegrations per second, is given by

$$\mathbf{A = -dN/dt = \lambda\, N_o\, e^{-\lambda t} = A_o\, e^{-\lambda t}} \qquad \text{………….. (2.3)}$$

A ≡ number of disintegration/sec

$\mathbf{A_o}$ ≡ the initial activity

where A_o is the initial activity. The unit of activity is the Becquerel, defined as 1disintegration/sec. Also used is the Curie (Ci), where:

1 Ci =3.7 x 10^{10} Becquerels.

The decay rate of a radioactive isotope is normally characterized by its half-life, $t_{1/2}$, which is defined as the time required for one-half of a given number of nuclei to decay. Equivalently, $t_{1/2}$ is the time interval during which the activity of a radioactive sample decreases by a factor of two.

$$\mathbf{N/N_o = \tfrac{1}{2} = e^{-\lambda t1/2}} \qquad \text{………….. (2.4)}$$

or $\mathbf{t_{1/2} = \ln 2/\,\lambda = 0.693/\,\lambda}$

2.6 X-ray device:

An x-ray generator generally contains an x-ray tube to produce the X-rays. Possibly, radioisotopes can also be used to generate x-rays. An x-ray tube is a simple vacuum tube that contains a cathode, which directs a stream of electrons into a vacuum, and an anode, which collects the electrons and is made of tungsten to evacuate the heat generated by the collision. When the electrons collide with the target, about 1% of the resulting energy is emitted as x-rays, with the remaining 99% released as heat. Due to the high energy of the electrons that reach relativistic speeds the target is usually made of tungsten even if other material can be used particularly in XRF applications.

An x-ray generator also needs to contain a cooling system to cool the anode; many X-ray generators use water or oil recirculating systems. The discovery of X-rays came from experimenting with Crookes tubes, an early experimental electrical discharge tube invented by English physicist Crookes around 1869-1875. In 1895, Wilhelm Rontgen discovered X-rays emanating from Crookes tubes and the many uses for X-rays were immediately apparent. One of the first X-ray photographs was made of the hand of Röntgen's wife. The image displayed both her wedding ring and bones. On January 18, 1896 an X-ray machine was formally displayed by Henry. A fully functioning unit was introduced to the public at the 1904 World's Fair by Dally. In the 1940s and 1950s, x-ray machines were used in stores to help sell footwear. These were known as Shoe-fitting fluoroscopes. However, as the harmful effects of ray radiation were properly considered, they finally fell out of use. Shoe-fitting use of the device was first banned by the state of Pennsylvania in 1957. (They were more a clever marketing tool to attract customers, rather than a fitting aid.) Together with Robert J. Van de Graaff, John G. Trump developed one of the first million-volt x-ray generators [1].

2.7 Applications

x-ray machines are used in health care for visualizing bone structures, during surgeries (especially orthopedic) to assist surgeons in reattaching broken bones with screws or structural plates, assisting cardiologists in locating blocked arteries and guiding stent placements or performing angioplasties and for other dense tissues such as tumors. Non-medicinal applications include security and material analysis [2].

2.8 Gamma ray device

Gamma radiation is somewhat similar to x-rays in that both pass through living materials easily. Also referred to as "photons" they travel at the speed of light. Gamma rays have sufficient energy to ionize matter and therefore can damage living cells. The damage produced in the cell or tissue is proportional to the number of ionizing paths produced in the absorbing material.

Isotopes of elements that are emitters are radionuclides important in fission products from nuclear testing, nuclear power plant disasters or waste. The injurious affect of gamma rays depends on (1) their number (2) their energy and (3) their distance from the source of radiation. Radiation intensity decreases exponentially with increasing distance. Radiation damage on vascular plant species was demonstrated by Wood well (1962) who subjected a mature pine oak forest at Brookhaven National Laboratory to gamma radiation from a cesium 137 source.

Gamma rays are external emitters that penetrate biological materials easily and produce their insidious effects without being taken internally. Alpha and beta particles are internal emitters; their damage to organisms is greatest when taken internally. Odum (1971) summarizes this concept best, "the alpha beta gamma series is one of increasing penetration but decreasing concentration of ionization and local damage." Alpha and beta radiation, unlike gamma radiation, are corpuscular in nature. While alpha particles travel but a few centimeters, and can be stopped by a layer of dead skin, they are dangerous because they produce a large amount of local ionization which can cause mutations disrupting cell processes. Beta particles are high speed electrons. While much smaller than alpha particles, they are able to travel up to a couple of centimeters in living tissue, giving up their energy over a large path. Beta particles, like alpha particles can damage tissue, and like alpha particles, can cause mutations that affect the functioning of cells [2].

2.8.1 The history of gamma radiation as applied

Familiar with the discovery of x-radiation by Roentgen in 1895 and the isolation of radium by the Curies in 1898 (Good speed and Uber 1939). Researchers soon learned that both x-rays and radioactive substances such as radium produced similar effects on biological materials. Koernicke (1905) noted that cell division was delayed on x-ray and radium treated cells. Both Koernicke (l905) and Gager (1907) described “striking chromosomal disruptions” after cells were dosed with x-rays or exposed to radium, treatment (Gager 1907, 1908). For additional historical work on radiation and plant cytogenetic the reader is directed to a review article by Good speed and Uber (1939).

Smith (1958) compiled a paper on the use of radiation in the production of useful mutations based on papers presented in three symposia in the United States from August 1956 to January 1957. A more recent review article on ionizing radiation damage to plants was prepared by Klein and Klein (1971).

There are numerous studies applying gamma radiation to biological systems. Several investigations involving botanicals follow. Nuttall et al (1961) found that yellow sweet Spanish onions exposed to 4000 or 8000 rad prevented sprouting in 97% of their experimental group suggesting that irradiation might be a viable method of prolonging storage life for onions. This study, while intriguing, has not been generally accepted by a public concerned with the problems of radiation. A second article by Heeney and Rutherford (1964) examined the effects of gamma radiation on the storage life of fresh strawberries. A dose of 330,000 rad prevented fungal development of the redcoat strawberry variety stored at 40 degrees F for 26 days. The fugal free period was sharply reduced at lower radiation doses and/or at higher temperatures. Pritchard et al (1962) studied the effect of gamma radiation on the utilization of wheat straw by rumen microorganisms. They concluded that, "high levels of gamma radiation were needed to release nutrients trapped in wheat straw needed by microbes. However, the levels of gamma irradiation necessary for nutrient release were well above what was practical for commercial purposes."

Baumhover et al (1955) investigated the use of gamma irradiation on male sterilization on the control of screw-worm flies in the southern United States while Bushland (l960).

Cutcomp (l967) and Lawson (1967) discussed this practice as a general way of controlling certain insect pests. Gambino and Lindberg (1964) examined the response of the pocket [2].

2.9 Radiation interaction with matter

rent types of radiation interact with matter in widely different ways. A large, massive, charged alpha particle cannot penetrate a piece of paper and even has a limited range in dry air. A neutrino, at the other extreme, has a low probability of interacting with any matter, even if it passed through the diameter of the earth.

Radiation can be classified into two general groups, charged and uncharged; therefore, it may be expected that interactions with matter fall into two general types. Charged particles directly ionize the media through which they pass, while uncharged particles and photons can cause ionization only indirectly or by secondary radiation.

A moving charged particle has an electrical field surrounding it, which interacts with the atomic structure of the medium through which it is passing. This interaction decelerates the particle and accelerates electrons in the atoms of the medium. The accelerated electrons may acquire enough energy to escape from the parent atom, this process is called ionization. Uncharged moving particles have no electrical field, so they can only lose energy and cause ionization by such means as collisions or scattering. A photon can lose energy by the photoelectric effect, Compton Effect, or pair production. Because ionizing radiation creates ions in pairs, the intensity of ionization or the specific ionization is defined as the number of ion-pairs formed per centimeter of travel in a given material. The amount of ionization produced by a charged particle per unit path length, which is a measure of its ionizing power, is roughly proportional to the particle's mass and the square of its charge as illustrated in the equation below

$$\mathbf{I=mz^2/KE} \qquad \text{………….. (2.5)}$$

Where: I is the ionizing power, m is the mass of the particle, z is the number of unit charges it carries and K.E. is its kinetic energy, Since m for an alpha particle is about 7300 times as large as m for a beta particle, and z is twice as great, an alpha will produce much more ionization per unit path length than a beta particle of the same energy. This phenomenon occurs because the larger alpha particle moves slower for a given energy and thus acts on a given electron for a longer time [4].

2.9.1 Alpha radiation

Alpha radiation is normally produced from the radioactive decay of heavy nuclides and from certain nuclear reactions. The alpha particle consists of 2 neutrons and 2 protons, so it is essentially the same as the nucleus of a helium atom. Because it has no electrons, the alpha particle has a charge of +2. This positive charge causes the alpha particle to strip electrons from the orbits of the target atoms. As the alpha particle passes through material, it removes electrons from the orbits of atoms it passes near. Energy is required to remove electrons and the energy of the alpha particle is reduced by each reaction. Eventually the particle will expend its kinetic energy, gain 2 electrons in orbit, and become a helium atom.

Because of its strong positive charge and large mass, the alpha particle deposits a large amount of energy in a short distance of travel. This rapid, large deposition of energy limits the penetration of alpha particles. The most energetic alpha particles are stopped by a few centimeters of air or a sheet of paper.

2.9.2 Beta-Minus Radiation

A beta-minus particle is an electron that has been ejected at a high velocity from an unstable nucleus. An electron has a small mass and an electrical charge of -1. Beta particles cause ionization by displacing electrons from atom orbits. The ionization occurs from collisions with orbiting electrons. Each collision removes kinetic energy from the beta particle, causing it to slow down. Eventually the beta particle will be slowed enough to allow it to be captured as an orbiting electron in an atom. Although more penetrating than the alpha, the beta is relatively easy to stop and has a low power of penetration. Even the most energetic beta radiation can be stopped by a few millimeters of metal.

2.9.3 Positron Radiation

Positively charged electrons are called positrons. Except for the positive charge, they are identical to beta-minus particles and interact with matter in a similar manner. Positrons are very short-lived, however, and quickly are annihilated by interaction with a negatively charged electron, producing two gammas with a combined energy (calculated below) equal to the rest mass of the positive and negative electrons.

2electrons [0.000549 amu /electron][931.5 MeV/amu]= 1.02 MeV

2.9.4 Bremsstrahlung

Small charged particles such as electrons or positrons may be deflected by nuclei as they pass through matter, which may be due to the positive charge of the atomic nuclei. This type of interaction generates x-radiation known as bremsstrahlung, which in German means “braking radiation.”

2.9.5 Neutrons Radiation

Neutrons have no electrical charge. They have nearly the same mass as a proton (a hydrogen atom nucleus). A neutron has hundreds of times more mass than an electron, but 1/4 the mass of an alpha particle. The source of neutrons is primarily nuclear reactions, such as fission, but they may also be produced from the decay of radioactive nuclides. Because of its lack of charge, the neutron is difficult to stop and has a high penetrating power. Neutrons are attenuated (reduced in energy and numbers) by three major interactions, elastic scatter, inelastic scatter, and absorption. In elastic scatter, a neutron collides with a nucleus and bounces off. This reaction transmits some of the kinetic energy of the neutron to the nucleus of the atom, resulting in the neutron being slowed, and the atom receives some kinetic energy (motion). As the mass of the nucleus approaches the mass of the neutron, this reaction becomes more effective in slowing the neutron. Hydrogenous material attenuates neutrons most effectively. In the inelastic scatter reaction, the same neutron/nucleus collision occurs as in elastic scatter. However, in this reaction, the nucleus receives some internal energy as well as kinetic energy. This slows the neutron, but leaves the nucleus in an excited state. When the nucleus decays to its original energy level, it normally emits a gamma ray. In the absorption reaction, the neutron is actually absorbed into the nucleus of an atom. The neutron is captured, but the atom is left in an excited state. If the nucleus emits one or more gamma rays to reach a stable level, the process is called radiative capture. This reaction occurs at most neutron energy levels, but is more probable at lower energy levels [4].

2.10 Tomato Seeds

Tomato seed develops in a mucilaginous gel which has germination inhibitors. During the process of seed extraction and fermentation this gel is broken down. After the seeds are washed and dried, the seeds are normally tan or light brown in color with a pubescent covering (fuzz). Tomatoes are unique among the Solanaceae in that they are the only seed that is pubescent. The number of seeds per fruit typically ranges from about 150 to 300 or more seeds per fruit.

Tomato seed germinates in the range of 50 to 95^{o}F (10^{o}C to 35^{o}C). The optimum range is 60 to 85^{o}F (16^{o}C to 29^{o}C), and optimum germination occurs at 85^{o}F (29^{o}C). The Federal standard for germination is 75% [3].

2.10.1 Isolation Distances

The subject of isolation distances in tomatoes has either been ignored in most seed production guides, or the information is incorrect. The issue is also controversial. There are a variety of reasons for the controversy, mostly stemming from a lack of understanding of what factors are important for determining isolation distances. For an in-depth discussion of this topic, see the companion manual devoted to the topic of isolation distances. The most important point for the seed grower to remember is that isolation distances should be understood within the context of the environment in which the crops are grown. The manual on isolation distances helps the grower understand that context. In addition, the basic principles of pollination ecology are explained, along with practices that can be used to modify isolation distances according to your growing conditions. It also contains a chart of recommended minimum isolation distances, and factors to consider when making modifications to the recommendations. One key to understanding isolation distances in tomatoes is knowing that the tomato originated in South America, largely in the area of Ecuador and Peru where it was (and is) a plant pollinated by wild solitary bees. During the domestication of the wild tomato, it gradually moved out of its original geographic range, and out of the range of native pollinators. For this reason, the tomato came under increasing selection pressure to become self-pollinated. So, although tomatoes have been domesticated to a great degree, and are now mostly self-pollinated, they retain some of their ancestral capacity for cross-pollination, depending on the species and variety. Traditionally, most seed saving guides indicate that tomatoes are self-pollinated. This is essentially true for modern varieties, but under certain conditions for certain varieties, considerable cross-pollination of tomatoes can take place. Even a small amount of crosspollination over a number of years can lead to the loss of one or more characteristics unique to a variety. Therefore it is essential that varieties be isolated from each other in order to obtain pure seed. There are many factors that affect the amount of cross-pollination. These include: (1) variety characteristics such as flower structure; (2) environmental variables such as wind movement, light intensity, day length, and carbon-nitrogen ratio; (3) types of pollinating bees present and their behavior on the blossoms; (4) isolation distance; (5) presence of barrier plants; (6) planting patterns such as row or block planting; (7) number of varieties; (8) number of plants of each variety; and (9) regional or bioclimatic factors. Day length can effect the length of the style, as can heat and low humidity. Long day length, periods of high temperature and low humidity cause the style to elongate which in turn favors cross-pollination. Generally speaking, most modern varieties (introduced after 1950) can be isolated from each other by a relatively short distance. This is because most modern tomato varieties have a blossom structure in which the length of style does not exceed the length of the anther cone. This arrangement of flower structure favors self fertilization. Older tomato varieties, potato-leaf varieties, and large fruited, beefsteak-type tomatoes (including varieties with double blossoms) tend to have an “exerted style,” meaning that the style protrudes beyond the anther cone, typically by a millimeter or more. This arrangement of reproductive parts favors cross-fertilization by pollinating wild bees. Some garden tomatoes have retained some of the characteristics of their wild ancestors. These characteristics may be found in many cherry tomatoes and currant tomatoes. These types have a blossom structure such that the style protrudes considerably beyond the anther cone [3].

CHAPTER THREE

Methodology

3.1 Introduction

The aim of this chapter is to present the materials and apparatus and method used in this work (sample preparation and setup).

3.2 Materials and Apparatus

Tomato seed samples were collected and prepared to irradiate them with X-ray and gamma ray devices.

Figure 3.1: Tomato Seeds

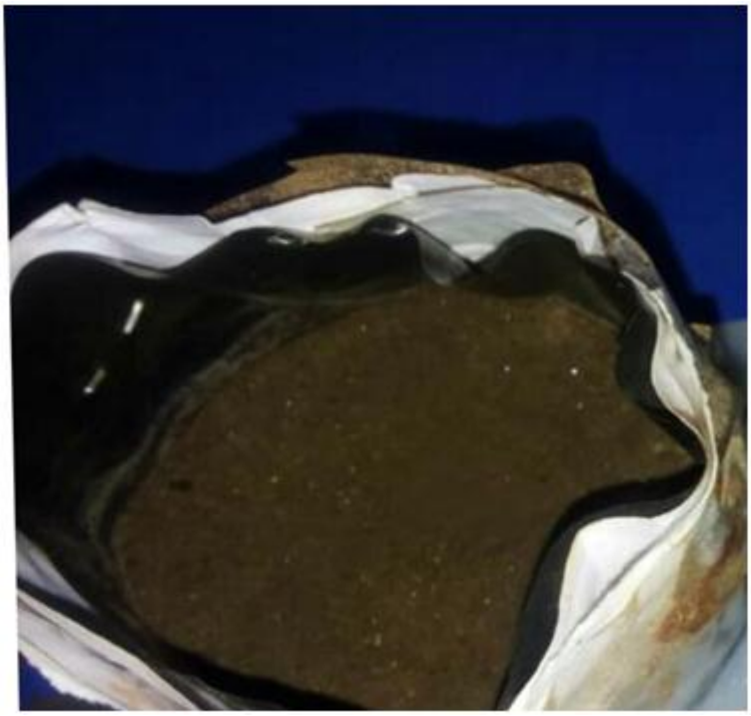

Figure 3.2: Non irradiated tomato seed sample watered by tap water.

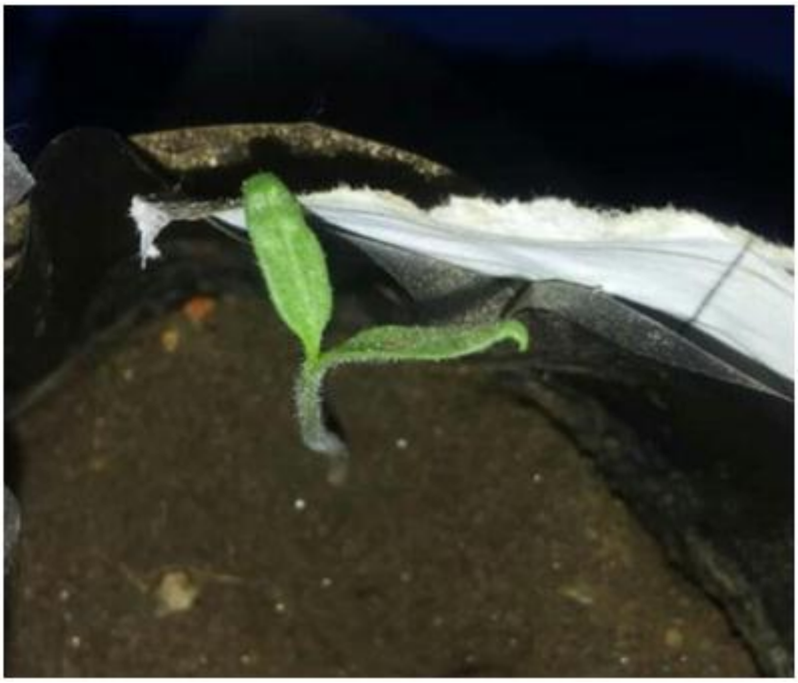

Figure 3.3: Non irradiated tomato seed sample watered by magnetized water.

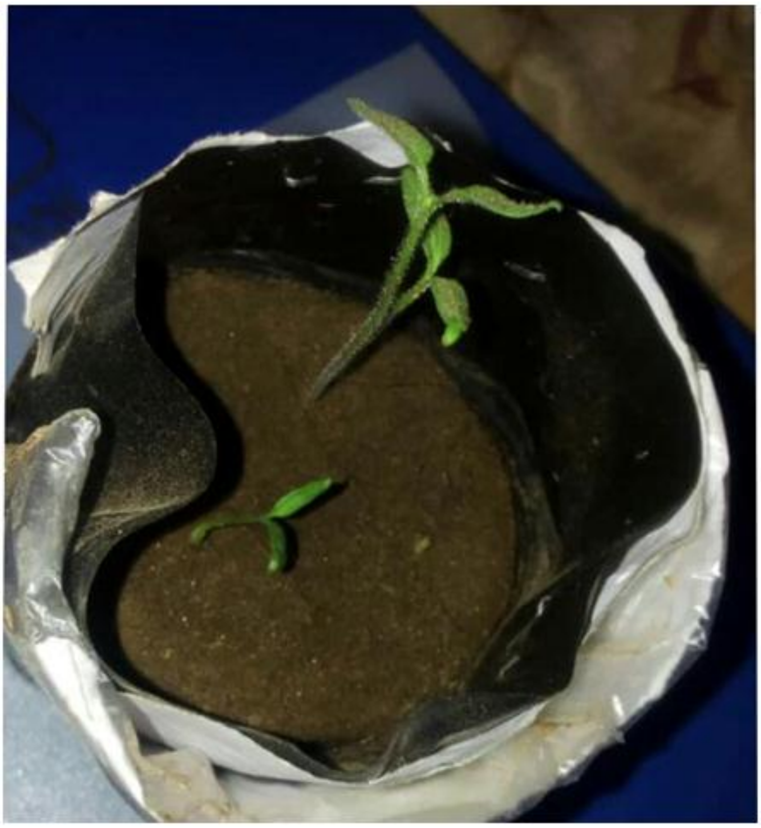

Figure 3.4: Tomato Seed sample irradiated by x-ray device for 3 minutes and watered by magnetized water.

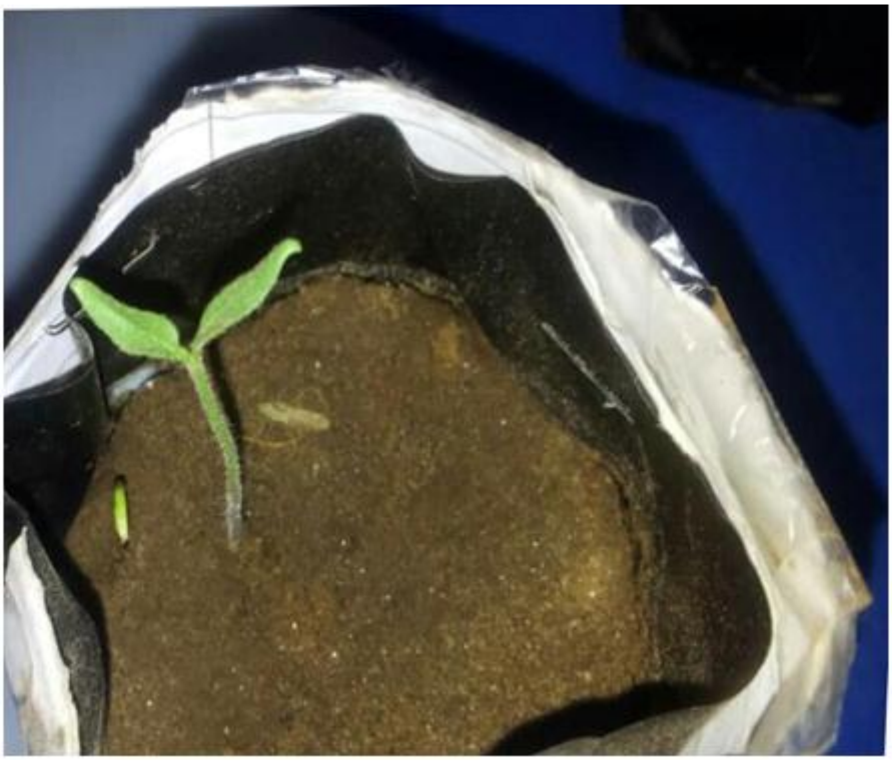

Figure 3.5: Tomato Seed sample irradiated by x-ray device for 6 minutes and watered by magnetized water.

Figure 3.6: Tomato Seed sample irradiated by x-ray device for 3 minutes and watered by tap water.

Figure 3.7: Tomato Seed sample irradiated by x-ray device for 6 minutes and watered by tap water.

Figure 3.8: Tomato Seed sample irradiated by gamma ray device for 15 minutes and watered by magnetized water.

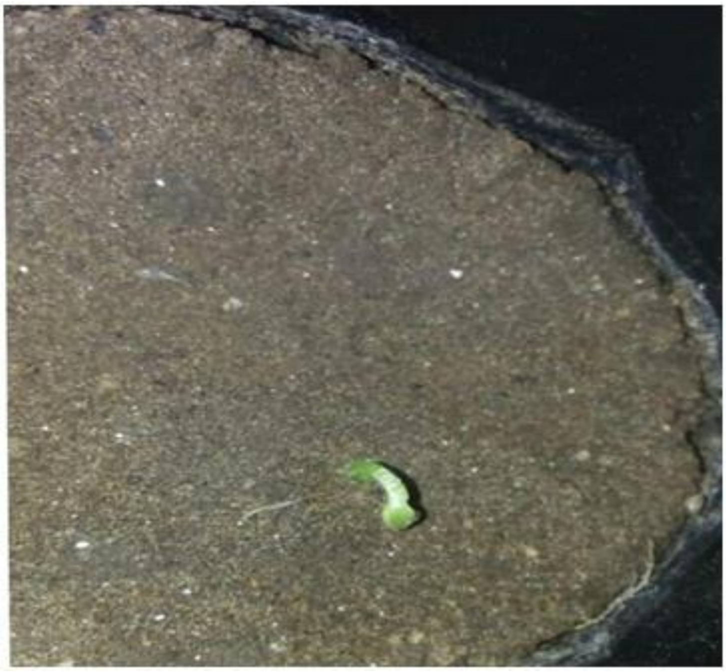

Figure 3.9: Tomato Seed sample irradiated by gamma ray device for 30 minutes and watered by magnetized water.

Figure 3.10: Tomato Seed sample irradiated by gamma ray device for 15 minutes and watered by tap water.

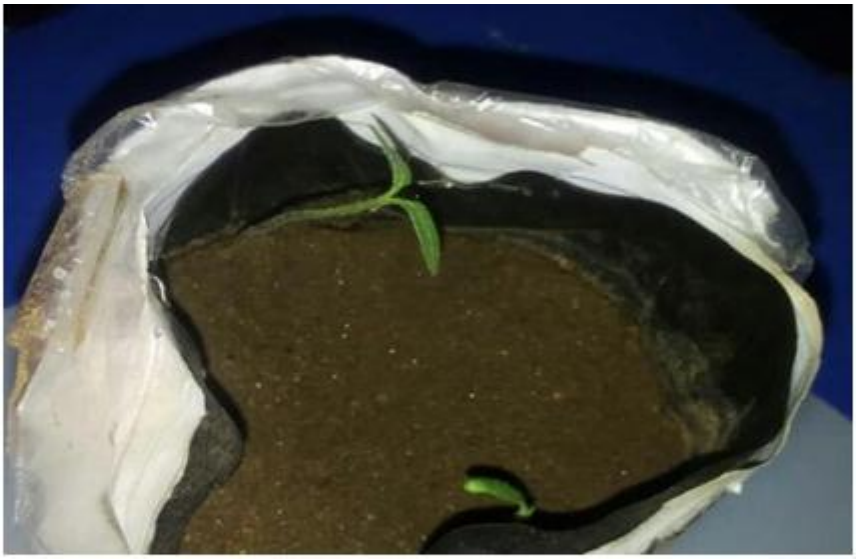

Figure 3.11: Tomato Seed sample irradiated by gamma ray device for 30 minutes and watered by tap water.

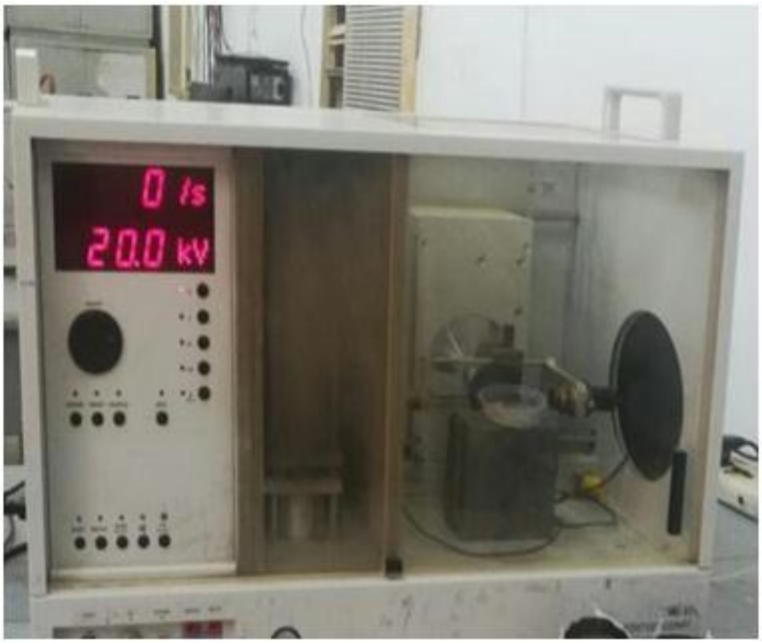

Figure 3.12: X-ray device.

Figure 3.13: Gamma ray device.

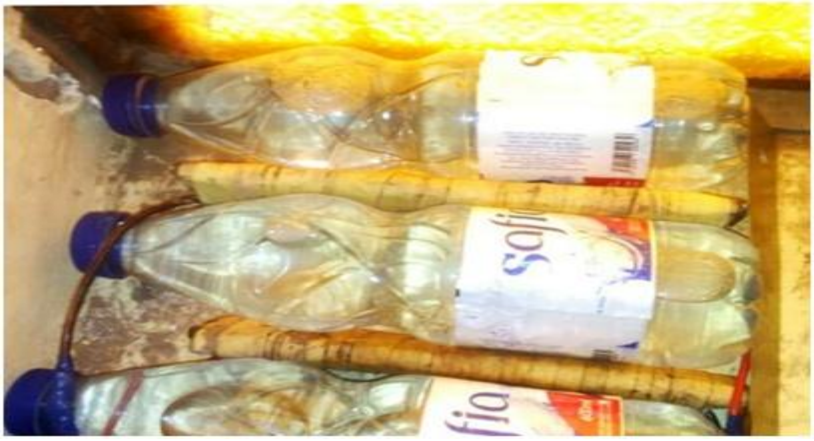

Figure 3.14: Electromagnetic Field Generator.

3.3 Method

Two types of radiation devices were used, which are the x-ray machine and the gamma ray machine.

Tomato seed samples were irradiated by an X-ray machine for 3 and 6 minutes at a voltage of 20KV and a current of 1mA.Also samples of tomato seeds were irradiated by a gamma ray device (Co^{60}) with an exposure time of 15 minutes and the other sample with an exposure time of 30 minutes, and the distance between the source and the samples was 2 cm.

A sample was taken from tomato seeds that were not irradiated, and they were cultivated and watered by magnetized water once and again by tap water.

The samples that were exposed to x-rays for 3 minutes were divided into two parts and were cultivated, one of which was watered by magnetized water and the other with tap water, also the samples that were irradiated with x-rays for 6 minutes were divided into two parts and were cultivated, one of which was watered by magnetized water and the other by tap water.

Likewise, samples that were irradiated with gamma rays with Exposure time of 15 minutes and 30 minutes were divided into two parts, cultivated and irrigated by magnetized water and the other by tap water.

CHAPTER FOUR

Discussion, Conclusion, Recommendations

4.1 Introduction

This Chapter obtains the results of this research, discussion, conclusion and recommendations.

4.2Result

Type of Sample	Growth Time/day	Flower Length/Cm
Non irradiated tomato seed sample watered by tap water	-	-
Non irradiated tomato seed sample watered by magnetized water	10	**2.6**
Tomato Seed sample irradiated by x-ray device for 3 minutes and watered by magnetized water.	8	4.2
Tomato Seed sample irradiated by x-ray device for 6 minutes and watered by magnetized water	9	3.5
Tomato Seed sample irradiated by x-ray device for 3 minutes and watered by tap water	20	2.3
Tomato Seed sample irradiated by x-ray device for 6 minutes and watered by tap water	10	2.9
Tomato Seed sample irradiated by gamma ray device for 15 minutes and watered by magnetized water	7	5.4
Tomato Seed sample irradiated by gamma ray device for 30 minutes and watered by magnetized water	10	0.6
Tomato Seed sample irradiated by gamma ray device for 15 minutes and watered by tap water	-	-
Tomato Seed sample irradiated by gamma ray water for 30 minutes and watered by tap water	10	3.0

4.3 Discussion

It was found that the samples that was irradiated by x-rays in 3 minutes and was irrigated by magnetized water, it grew in 8 days, and which was irrigated by tap water, it grew in 20 days.

As for the samples that were irradiated by x-rays with an exposure time of 6 minutes, which were irrigated by magnetized water, they grew in 9 days, and those that were irrigated by tap water grew in 10 days.

Also, it was found that the samples that were irradiated by gamma rays with a time of exposure of 15 minutes and were irrigated by magnetized water grew in 7 days, which were irrigated by tap water not yet grown.

As for the samples that were irradiated by gamma rays with an exposure time of 30 minutes, which were irrigated by magnetized water, they grew in 10 days, and also those that were irrigated with tap water grew in 10 days.

4.4 Conclusion

X-rays are ionizing radiations and can cause mutation. Therefore in the early days x-rays were used in mutation breeding and x-rays do induce mutations in seeds if high dose of hard x-rays are used.

The energy of gamma rays is greater than the energy of x-rays because the energy of nuclear binding is greater than the energy of atomic binding, That is, the basic difference between them relates to their origins, where gamma rays are produced from changes in the nucleus, while x-rays are emitted when there is a change in the orbit of the atomic electrons, and gamma rays are not affected by electric and magnetic fields.

4.4 Recommendations

The further studies in this research problem could be done using another devices; like laser devices, such as He Ne laser, ND-YAG laser, diode laser. Also could be done using X-ray and Gamma but with fixed exposure time and change the amount to that dose the samples are exposed to.

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