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Mutation Breeding in Maize *(Zea mays* L.) by Using Different Doses of Gamma Irradiation

التربية الطفورية في الذرة الشامية باستخدام جرعات مختلفة من أشعة جاما

By

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B.Sc. in Agriculture Crop Production

Sudan University of Science and Technology 2010.

A Thesis Submitted in Partial Fulfillment for the Requirements of the Degree of the M.Sc. in Agriculture

(Agronomy, Plant Breeding)

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July, 2015

DEDCAICATION

To all whom I love

This work dedicated to my family
who supported me
and gave me efforts and time waiting for
nothing to by returned
To my mother Miriam, father Goma , and my
sister Noura.
To my future wife Abeer to be mother of my
children in sha Allah.

Acknowledgments

Parise and thanks to ALLAH who gave me his permission to finalized this work successfully. I would like to express my gratitude and appreciation to my advisor Dr. Atif Elsadig Edris for his guidance and continuous support throughout the process of the work. I am also grateful for Staff of kassala University, specially Dr. Badreldin Ahmed who help me for statistically ally analysis. I am indebted to Dr. Mohammedein Babaker for his interest, useful advice, constructive continuous encouragement.

I am also indebted to my coordinator Pro. Abdel Rahamn Ahmed in Agricultural Research Corporation, and to my colleagues Asim Mohamed Alsir, Abdalla el Hassan who where near me when I needed them.

I am also indebted to the staff member of Sudan University of Science and Technology, College Agricultural science department of Crop Science, specially, Prof. Yassin Dagsh, Dr. Ahmed Ali M, Sami. A. M. Hamid and Dr. Amani. Khartoum university Prof. Mahmoud fodual el Moula.

Also to my colleagues in streets four in ARC.

My family support which helped me to add this noble feather of excellence. And also for his patience in reviewing and editing this thesis.

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Abstract

This experiments of this Research were conducted to study effect of the gamma irradiation doses on four genotypes of maize (*Zea mays* L.) (Var-113, Hudiba-1, Hudiba-2 mug45). The maize genotypes were subjected to four doses (50, 100, 150 and 200GY) of gamma irradiation including control. One laboratory and two field experiments were conducted. The laboratory experiment was conducted to study the germination percentage, shoot, root and shoot to root ratios of the germinated seedling. The results of the laboratory experiments revealed that the growth of the four genotypes was decreased with increasing of gamma irradiation doses. The field experiments were conducted at two locations Shambat, College of Agricultural Research studies and Madeni, the experimental farm of Agricultural Research Corporation. During the summer season of 2014, the design of the experiment was a Randomized Complete Block Design (RCBD) with three replications. All the maize treated seeds with gamma irradiation were used in the field experiments. Different growth and yield characters were measured. The results revealed the failure of germination of all treated seed of the four genotypes except (zero and 50GY) doses. Significant results were obtained between the two doses (zero and 50GY), the genotypes and their interaction for most of the studied characters. This significance could be of a great value in any maize breeding program. The results of this study revealed that the availability of using gamma irradiation in any maize breeding program in the future.

الخلاصة

أجريت تجارب هذا البحث لدراسة آثر أشعة جاما علي أربعة أصناف من الذرة الشامية وهي VRA113، Hudiba-1، mug45 Hudiba-2 و عرضت هذه الطرز الوراثية للذرة إلى أربع جرعات مختلفة (50، 100، 150، GY200) من أشعة جاما بما في ذلك الشاهد. تم اجراء تجربه معمليه واحدة و اثنين من التجارب الحقلية. وأجريت التجربة المعملية لقياس نسبة الإنبات، وطول الجذر، طول الساق و نسبة طول الجذر إلي الساق في الشتلات النابتة. وأظهرت نتائج التجارب المعملية انخفاض في نمو الأصناف الأربع مع معدل زيادة جرعات أشعة جاما.التجارب الحقلية في كل من شمبات و كليه الدراسات الزراعيه جامعه السودان للعلوم والتكنلوجيا ومدني المزرعه التجريبيه خلال الموسم الصيفي للعام 2014، نفذت التجربة بتصميم القطاعات العشوائية الكامل بثلاثة مكررات. تم استخدام كل بذورالزرة الشاميه المعالجة بأشعة جاما في هذه التجارب الحقلية. وتم اخذ قياسات مختلفة من النمو و الإنتاجية. أظهرت النتائج فشل إنبات جميع البذور المعاملة من الأصناف الأربعة ماعدا الشاهد والجرعة GY50. وأظهرت نتيجة التحليل الإحصائي وجود فروقات معنوية بين الجرعات، الطرز الوراثية وتفاعلهما لمعظم الصفات التي درست في التجربة.هذه المعنوية ، يمكن إن تكون أهمية ذات قيمة كبيرة في أي برنامج لتربية الذرة الشامية. نتائج هذه الدراسة أظهرت إمكانية استخدام أشعة جاما في أي برنامج تربية للذرة الشامية مستقبلا.

CHAPTER ONE

INTRODUCTION

Maize *(Zea mays L.)* is considered as the third world most important cereal crop after wheat and rice (FAO, 2006), it is grown in various agro-Eco logical zones, the genus Zea belongs to the tribe Andropogneae, at sub family Panicoideae and family Poaceae. There are five species including the genus Zea. They have been examined largely and have a chromosome number (2n=20) (Nafziger, 2008).

Maize is versatile crop grown over a range of agro climatic zones, in fact the suitability of maize to diverse environments is unmatched by any other crop. It is grown from 58^0N to 40^0S, from below sea level to altitudes higher than 300 mm, and in areas with 250 mm to more than 500 mm of rainfall per year, its staple food for many people (Saad, 2009).

The worldwide production of maize was more than 960 million MT in 2013, in global production was grown at 3.4% from 967 million MT. Cultivated area 2.2% from 177 million hector, USA is the largest production at 37%, China 22%, Brazil7%, and other countries 17% (Singh, 2014).

The maize grain can be prepared for food in many different ways (fried, grilled, in a salad or soup). Processing maize can also produce a wide range of products, such as corn flour and cornmeal. Maize is also used in livestock feed (Poultry, Pigs, Cattle) in the form of grains feed milling or fodder. In addition is also used a raw material in a range of industries (Agric-Food, Textile, Pharmaceutical). To create biodegradable plastics, bio fuel, and even alcohol (Ngosamnick, 2012). In Sudan maize is the fourth cereal crop after Sorghum, Millet and wheat (Ahmed *et al* 2008). There has been an increasing interest in developing Maize cultivates. It is introduced in the diversification policy as a new food crop in the irrigated schemes. Local varieties are adapted to the unfavorable growing conditions. They constitute a good source of genes for breeding program (Ali *et al*, 2010). Maize is of recent introduction and occupies 36960 hectares with 70000 tones production and yielded 1894 Kg/hectare. Maize cultivated area are small as it is not stable food for most of the Sudanese, it is grown as a subsistent rain-fed crop around villages in Nuba mountains, southern Sudan and Blue Nile. It also grown under irrigation in central, eastern and northern States (Mohammed *et al*, 2008). Maize was not popular among the farmers in most parts of the countries. the production usually consumed local areas. Maize is among substitute crops to replace the wheat in agricultural schemes especially in the Gazira scheme, it can occupy an important position in the economy of the country due to the possibility of blending it with wheat for making bread (Mohammed *et al*, 2006).

Maize is a genetically highly studied plant species, consequently, the inheritance of several characteristics and its genome are well known and there are several alternatives for incorporating useful characteristics into adapted materials. The methodology depends on the heritability, gene action, number of genes involved, heterosis, and genotype x environment interactions (Nass *et al*, 2000)**.**

Artificial induction of mutations by ionizing radiation dates back to the beginning of the 20th century. It took about 30 years to prove that such changes caught be used in plant breeding initial attempts to induce mutations in plants mostly used X- rays, later at dawn of the (Atomic Age) for gamma and neutron radiation were employed as these types of ionizing radiation become readily available from newly established nuclear research centre's (Lagonda *et al*. 2009). Breeding for plant compositional traits to enhance nutritional quality or meet an industrial need are major plant breeding goals (wiley *et al* 2012). Plant breeding requires genetic variation for crop improvement. However, if desired variation is lacking, mutagenic agents, such as radiation and certain chemicals, can be used to induce mutations and generate genetic variations in the available or selected maize genotypes mutants may be selected (Novak *et al,* 1992), hence The objective of this study were

1-To study mutation induction of different doses on maize genotypes.

2-To determine the optimum dose of gamma radiation among the studies genotypes.

CHAPTER TWO
LITRETURE REVIEW

2.1 Historical background

Maize (*Zea mays L.)* is one of the most important economic crops, best studied and most tractable genetic system among monocotyledons (Drinic *et al*, 2004). It is one of the most important cereal crops and occupies prominent position in global agriculture after wheat and rice. Maize is a C4 plant, physiologically more efficient, it has high grain yield and great adaptation over a wide range of environmental conditions. Globally, 67% of maize is used for livestock feed, 25% for human consumption and the rest for industrial purposes. Morphologically maize exhibits greater diversity of phenotypes than any other grain crop, and is extensively grown in temperate, subtropical and tropical regions of the world. (Rajesh *et al,* 2013).

In Sudan, although maize is of less importance as a staple human food than sorghum, wheat and millet. However, the crop plays a great role in food security for the people in Blue Nile and South Kordofan States. The crop is grown in the two states by traditional farmers in small-holdings under rain-fed. Nowadays, different companies and individuals started to grow the crop at a large scale under irrigation or under rainfall in different parts of Sudan. However, the total cultivated area of maize in the Sudan is increased from 17 thousand hectares in 1971 to 37 thousand hectares in 2010. Recently, there has been an increasing interest in maize Production in the Sudan (Abuali *et al,* 2014).

2.2 Genetic variability

The existence of variability is essential for resistance to biotic and abiotic factors and also for wider adaptability in genotypes. Genetic variability among individuals in population offers effective selection. The magnitude of genetic variability present in population is of paramount importance for the success of any plant breeding program. Knowledge of heritability and genetic advance of characters indicates scope for improvement of traits through selection (Rajesh *et al,* 2013).

Information on the genetic diversity is useful for description of existing heterotic groups and identification of new heterotic groups; selection of parental strains is of a great importance in the prediction of hybrid performance especially in economic crops such as maize in which hybrids are commercially important. The various steps involved in hybrid breeding programs such as making several crosses, screening the combinations for superior performance and heterosis are very costly, laborious, and time consuming. Hence if heterosis can be predicted before making the crosses, then the number of crosses to be performed and the progeny to be screened can be considerably reduced (Drinic *et al*, 2004).

Idris *et al*, (2011), reported that the low productivity of maize is due to low yield of local open–pollinated cultivars used in Sudan. However, work on maize improvement in Sudan is limited and only three cultivars have been released. And the genetic improvements in traits of economic importance, along with maintaining sufficient amount of variability are always the desired objectives in maize breeding programs.

Conventional plant breeding has been the method used to develop new varieties of crops for hundreds of years. However, conventional plant breeding can no longer sustain the global demand with the increasing population due to the decline in natural and agricultural resources such as land, water and the apparent plateau of the yield curve of the staple crops. Thus, new crop improvement technologies should be developed and utilized. Breeders inspect their fields and travel long distances in search of individual plants that exhibit desirable traits. A few of these traits occasionally arise spontaneously through a process called mutation (ISAAA, 2014). It is very important to widen the genetic base for maize breeding by the application of various methods. One particular way to increase genetic variability is treatment with various mutagens (Pepo, *et al.*2014).

2.3 Mutation breeding

In the late 1920s, researchers discovered that they could greatly increase the number of the variations or mutations by exposing plants to X-rays and mutation-inducing chemicals. “Mutation breeding” accelerated after World War II, when the techniques of the nuclear age became widely available. Plants were exposed to gamma rays, protons, neutrons, alpha particles and beta particles to see if these would induce useful mutations. Chemicals such as sodium azide and ethyl methanesulphonate, were also used to cause mutations. Mutation breeding efforts continue around the world today. In the 73 years ago of mutation breeding (1939-2013), a total of 3,218 varieties obtained through mutation breeding have been registered in the IAEA database. Staple crops such as rice has registered 824 varieties, barley (312), wheat (274), maize (96), common bean (57), tomato (20), potato (16), sugarcane (13), soybean (2), as well as other important crops that were improved to possess agronomical-desirable characteristics (ISAAA, 2014).

2.4 Induction mutation

In nature, sudden, rare discrete change in the genetic material which results in a permanent change in expression of the genes take place spontaneously may be due to an interaction of combined effect of radioactivity, extremely high nutrition. Or occurring spontaneously with fixed frequencies. These sudden heritable changes in plants are called mutation and may be classified as spontaneous or induced (MINT, 1998).

2.5 Types of mutation

In terms of origin, mutations may be spontaneous (natural) or induced (artificial, with the aid of agents). Mutations may also be classified according to the type of structural change produced as

2.5.1 Poloidy variation

Involving changes in chromosome number (grain or loss in complete sets of chromosomes or parts of a set)

2.5.2 Chromosome structure variation

Involving changes in chromosome structure (e.g. duplications of segments, translocation of segments).

2.5.3 Gene mutation changes in nucleotide constitution of DNA (by deletion or substitution) (Wiley *et al*, 2012).

2.6 Mutagenesis

Mutagens as the name implies, (mutation-change; genesis – to give rise to or generate change) as an agent of mutation can increase its frequency and rate. There are different types of mutagens completely unrelated in structure and mechanism of action. The type of chemical mutagens that it can change the genetic material of incorporated cells and the ionizing mutagens those of lesser energy radiations are mutagens that are quite efficient for producing changes in genetic material (MINT, 1998).

2.7 Radiation Mutagenesis

It has been suggested that ionizing radiation acts by ionizing nitrogenous bases in the DNA chains in particular during the DNA synthesis in the production of mutations. If ionization of the base occurs during DNA synthesis. There are available a number of radiation types and radiation sources to mutation breeders (Riganakos, 2010).

2.8 Radiation types and the sources

There are several types of ionizing radiations. But three types commonly used in commercial radiation to process products such as foods and medical and pharmaceutical devices. Gamma rays, X-rays and accelerated electrons (Riganakos, 2010).

2.8.1.1 GAMMA RAYS

Gamma rays have generally a shorter wavelength and hence possess more energy per photon than X-rays. Gamma radiation in usually obtained from radioisotopes in contrast to X-rays. A gamma radiation facility can be used essentially in the same manner as an X-ray machine for acute or semi-acute exposures. The most distinct advantage of gamma radiation source for prolonged treatments is that it can be placed in a greenhouse or field so that plants can be exposed as they develop over long periods of time. Cesium -^{137} Cs and ^{60}CO are the main sources of gamma rays used in mutation breeding. Are stored in lead containers when not in use and operated by remote control mechanisms to irradiate plant material (Riganakos, 2010).

2.8.1.2 X-Rays

X-Rays are a form of electromagnetic radiation with a wide range of short wavelength. They are caused by atomic transitions, and they are usually less energetic than gamma rays. They have the same properties and effects on materials, whereas their origin is the main difference between them. X-rays with varying energies are generated by machines. They use the same technology that produces electron beams, but they have more flexibility in food processing applications because of their greater penetrating power. The X-ray generation efficiency is a quite low. Like gamma rays, X-rays can pass through thick foods and require heavy shielding for safety (Riganakos, 2010).

2.8.1.3 Electron Beam Sources

The e-beam is stream of high energy electrons, propelled out of an electron gun. This electron gun apparatus is a larger version of a standard elevation tube. The e-beam generator can by on or off simply by pushing a button. A treatment of food with ionizing electrons is often more easily accepted because there are no radioactive substances in the process. The electrons can penetrate food only to a depth of 3cm, or slightly more than one inch, the food treated mute be no thicker than this for it to be treated all the way through. This is the advantages of electron radiation compared with gamma rays produced by radionuclides (Riganakos , 2010).

2.8.2 Chemical Mutagens

The number of chemical mutagens is numerous and continuously increasing but for mutation induct in cultivated plants only a few are readily very useful, most of them belong to the special class of alkyl ting agents such as, ethyl methane sulhonate (EMS), diethyl sulfate (dES), ethyleimine (EI), ethyl nitroso urethane (ENU), ethyl nitroso urea (ENH), and methyl nitroso urea (MNH). A number of workers also found Azides as effective mutagens (MINT, 1998).

2.8.2.1 Base Analogues and Related Compounds

True base analogues are closely related to DNA bases, Adenine, Guanine, Cytosine or Thymidine and can be incorporated into DNA without affecting its replication. But analogue differs from the normal base in certain substitutes hence its electronic structure is modified and it can be expected that occasional pairing errors will occur at the time of DNA replication after the analogue has been incorporated. The most frequently used analogues are 5-bromo-uracil (BU) and 5-bromo-deoxyuridine (BUDR), which are analogues of thymine. Apart from true analogues, it has been found that N-methylated oxypurines have a chromosome effect. The most efficient compounds are 8-ethoxy caffeine (EOC) and 1,3,7,9 tetramethyluric acid (TMU), but their mode of action is still unknown. Maleic hydrazide (MH), an isomer of uracil, induces chromosome breaks in cell and aberrations are localized in heterochromatic regions near the centromere of the chromosomes (MINT, 1998).

2.8.2.2 Antibiotics

Antibiotics such as azaserine, mitomycin Cstreptonigrin and actinomycin have been found to have chromosome breaking properties, but their usefulness are limited.

2.8.2.3 Alklating Agnes

This is the most important group of mutagenic chemicals for mutation induction in cultivated plants. They have one or more reactive alkyl groups which can be transferred to other molecules. They react with DNA by alkylating the phosphate groups as well as the purine and pyrimidine bases. One should be extremely careful in using them because most are potential carcinogens, such as EI, EMS, and MNH, and should be used in small units.

2.8.2.4 AZIDE

Azide is an effective mutagen under certain treatment conditions. It is possible to obtain high mutation frequencies with azide. Most mutations are gene mutations with some minor frequencies of chromosome aberrations. It is relatively safe, non-persistent and inexpensive but are also potential carcinogens (MINT, 1998).

2.9 Factors affecting the success of mutagenesis

Mutations are random events, even when scientists induce them. The plant breeder using the technique can increase the success rate by observing the following:

2.9.1 Clear objective

A program established to select one specific trait is more focused and easier to conduct with a higher chance of success than a program designed to select more than one trait.

2.9.2 Efficient screening method

Mutation breeding programs examine large segregating populations to increase the chance of finding the typically rare desirable mutational events. An efficient method of screening should be developed for a mutation breeding program.

2.9.3 Proper choice of mutation and method of treatment

Mutagens, as previously discussed, vary in various properties including source, ease of use, penetration of tissue, and safety. Some are suitable for soft tissues, whereas others are suited to hard tissue.

2.9.4 Dose and rate

The breeder should decide on the appropriate and effective dose rate (dose and duration of application). The proper dose rate is determined by experimentation for each species and genotype. Plant materials differ in sensitivity to mutagenic treatment. It is difficult to find the precise dose (intensity), but careful experimentation can identify an optimum dose rate.

2.10 Example of successful application in mutation breeding

More than 2700 officially released mutation varieties form 170 plant species and more than 60 countries. Over 1000 of them major staple crop, over 60 countries, resulting in the annual treatment of 500,000 metric tons of foods in over 180 gamma radiation facilities. According to the FAO/IAEA database, more than half of the mutant varieties were developed in Asia; China 638, India 272, and Japan 233 are the largest number of mutant varieties in the world (kharkwal, 2009).

The most important characteristics improved in rice as an example are high yield potential wide adaptability, high resistance to rice blast, and tolerance to cold. High quality, and early maturity mutant varieties. In china released two rice varieties were (zhefu 802 .No. 2), early maturity about (105-108) days. In Japan More than 200 varieties were generated through gamma irradiation, and chemical mutagenesis. About 61% of them developed mutation induction by Gamma-ray irradiation. In 2005, two direct-use cultivars and 97 indirect-use cultivars made up for approximately 12.4% of the total cultivated+ area in Japan.

In 2004 listed a total of 309 mutant cultivars of crops, belonging to 56 plant species that were released in India by the end of the 20^{th} century.

An updated list of 343 mutant cultivars released in India. The largest number of mutant cultivars have been produced in ornamentals (119) followed closely by legumes (85) and cereals (74) (Lagoda. 2009).

Almost 89% of mutant varieties developed by using of physical mutagens and about 60% of them were created by applying gamma ray mutants at barley caused to product high yield, resistant to mildew, strong stem, high protein and skinless seeds (Sarduie *et al*, 2010).

2.11 Effect of gamma irradiation on yield components in maize

Yadav *et al*, (2014), reported that study in maize, this study was performed to determine the effect of gamma irradiation on maize genotype (HQPM-1). Thirteen doses of gamma irradiation viz, 0.00 (control), 0.0025, 0.005, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4 0.5, 0.75, 1.0 and 2.0kGy(kilo gaga rays). The physiological parameters of seeds and plants viz., germination (%), plant height and photosynthetic rate were determined. Physiological parameters such as plant height, and photosynthetic rate at days at 50% silking (DAS), increased significantly in lower doses of gamma irradiation. Grain yield attributes and yield per hectare were also determined. Data attained revealed that the plant biomass, grain per plant and yield per hectare increased significantly in lower doses of gamma irradiation (0.0025- 0.2 kGY) and reduced on and beyond the 0.3kGy dose.

Saad, (2009). Reported in maize was investigated in to maize genotypes (Mug-45 and VAR113), then treated with different gamma rays (00, 50, 100, 150, and 200 GY). Results showed that, effects of gamma radiation in all measured traits increased gamma irradiation doses. The highest dose (200 GY) resulted in significant decrease in germination%, emergence%, growth parameters, ear parameters, and grain yield for Mugtama-45. But in Var-113 the same trend was observed, except for germination%, it was not significant decreased. And the root to shoot ratio was significantly increased in Var-113, and Mugtama-45. The grain yield for the two varieties revealed highly significant positive correlation with effective ear length, ear diameter, 100 kernel weights, weight of kernel/ear, dry ear weight, plant height, and number of plant at harvest, with a coefficient, value of correlation ranged from 36to78%.

AJAYI, (1989) was reported that studied the effects of gamma irradiation on maize, using different doses were (0.0, 100, 200, 300, 400, and 500GY), While no mortality was recorded for maize seeds exposed to a dose of 500Gy. Seedling and plants that resulted from seeds exposed to 200Gy and 300Gy differed in morphological characteristics from those that resulted from the unexposed seeds and they matured earlier. Generally, rate of seedling growth decreased with increasing dose in all plants.

Marcu *et al*, (2013) The 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. He results shows 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.

According to a research conducted by Nepali, (2013) Ionizing radiation like gamma rays can induce some positive effects at lower doses on the crops physiological indices like CGR(Crop Growth Rate), LAI(Leaf Area Indices), NAR(Nete Assimilation Rate). And refer dry matter weight, time and ground area, leaf area respectively. The highest LAI and CGR obtained in 25 GY gamma irradiation with average 4.81 and 25.6, respectively LAI, CGR and NAR decreased with increasing gamma irradiation. The best combination in order to obtain the highest LAI and CGR was 50 GY gamma irradiation and Zagros cultivar The highest NAR was obtained in Alamot cultivar and 50 GY, gamma irradiation.

CHAPER THREE

MATIRIALS AND METHODS

3.1 Plant material and irradiations treatment

The plant material used in this study consisted of four OPVS (open pollinated varieties) local maize (Zea mays L) open pollinated varieties. These varieties were var-113, Hudiba -1, Hudiba-2 and Mug45.

3.2 The laboratory experiments

The seeds of these varieties were subjected to four doses of gamma irradiation rays (0.00, 50, 100, 150 and 200GY) at the laboratory of the Sudan Atomic Energy Center, Khartoum Sudan by using ^{60}CO irradiation. These experiments were conducted at the laboratory of Agricultural Research Corporation (ARC), Wad Madeni, Sudan. A sample of 50 seeds from any treated varieties were sown in pots filled with sandy soil, these pots were irrigated and then the flowing parameters were measured.

3.2.1 The germination %

This parameter was measured after 3 days from emergence of the seeds at each pots by counting the number of emergent seeds.

3.2.2 The shoots length

This parameter was measured after 15 days from the sowing date, the shoot length in mean of the emerged seedlings at any pots. Was measured from the surface of the land to the node of last fully expended leaf.

3.2.3 The Root to shoot Ratio

This parameter was counted after 15 days from sowing date. The root shoot ratio was calculated by dividing the root length over shoot for the emergent counted pot seedlings plant at any pots.

3.3 The field experiments

3.3.1 The experimental locations

Two experiments were conducted in season 2014 at two locations, the first location was at Gezira Research Station, Wad Madeni, (latitude 14-24^{0}N longitude 33-29^0 E and 407 m above sea level).The soil type of this location is central clay plains soil, characterized by its heavy cracking clays. It's also described as high calcareous alkaline soil with PH of 8.3 and low organic matter content (0.02%). The second is site, the demonstration farm, (College of Agricultural Studies, Sudan University of Science and Technology- (Shambat). (15-40^{0}N longitude 32-33^{0}E, and 280m above sea level). The climate of this location is described as tropical semi arid, maximum temperature is above 40^C in the summer is around 20^C in the winter season. The relative humidity ranges between (14-27%), during dry season, and 31-51% in wet season.

3.3.2 The layout of the field experiment

The experiments were laid out in a randomized complete block design (RCBD) with three replicate. The land was prepared by using disc plow, disc harrow and then ridged. Sowing date at the tow location was the first week of July in Gezira and the third week of July at Shambat location.

The land was divided to plot, size was maintained two ridges 5 meter long and 0.8 meter between ridges in Madeni and 0.7 meter in Shambat location. The seeds were sown in 25 cm between holes. Seeds at the sowing 2/hill, then thinning to one plant /hill. All field practices were applied in the field as the recommended by (ARC), Agricultural Research Corporation.(harvest)

All treated varieties with the different irradiation doses were sown in the experimental field of the two locations. The data were collected on the four varieties treated with two doses (zero and 50GY) due to failure of the germination of the other doses. Data were recorded flowing growth and yield characters.

3.3.3 Growth and yield parameters in the field

Plants at Harvested (PH)

Total number of the plant harvested per plot and then converted to hectare.

Days of 50% flowering

Days of 50% tassaling (DT), were taken as the number of days from sowing to the time when 50% of plants within a plot had shed pollens. And days of 50% silking (DS) number of days from sowing to the time when 50% of the plants within a plot had exerted silks about 1-2 cm long from the ear tip.

Plant height cm (PH)

Measured in centimeter as an average height of random sample of the plant in the harvest area. It was measured from the soil surface up to the top of the plant.

Ear height cm (EH)

Measured in centimeter as an average height of random sample of five plants in the harvest area. It was measured from the soil surface to the node bearing the upper most ears.

Fresh ear weight husked (g) (FEWH)

Fresh ear weight determined in grams as an average of fresh ear husked selected at random from each plot.

Number of husked leaves/ear (NHL/E)

Husked leaves number taken as mean number of husk leave random sample of five ears from each plot.

Fresh ear weight de husked g (FEWD)

Fresh ear weight de husked was determined in grams as an average of ear de husked selected random sample of five ear from each plot.

Dry ear weight g (DEW)

This parameter was determined as an average of random sample of five dry ears per plot.

Total ear length cm (TEL)

Ear length was measured in centimeter as an average of random sample of five ear s from the base to the tip of the ear.

Effective ear length cm (EEL)

Effective ear length was measured in centimeters as an average of random sample of ears, for the effective length where kernels were on the produced on the ear.

Number of rows per ear (NRE)

Number kernel per ear was determined as number of kernel rows an each ear counted from ears samples taken from the harvest area number of kernels per row.

Number of kernels per row (NKR)

Number of kernels per row was determined as number of kernels counted row on the ear an average counts from three kernel rows taken at random from each ear , were used counts were made on ear sample taken from harvested area .

Ear diameter cm (ED)

Ear diameter was measured in centimes using venire caliper from de husked ears measurements were taken on deferent positions on the ear (the top, middle and bottom) and the average was then taken Measurements were taken from sample in the harvested area .

100 kernels weight g (k w)

The average weight of 100 kernels was taken at random from the bulk of kernels from a random samples of ears harvested in each plot by grams.

Grain yield kg /h (GY)

After ear dried and threshed the dry weight of grains from all the harvested ears per plot. The grain yield was obtained by converted the yield of the actual harvested to kg/h.

3.4 STATCAL ANALYSIS:-

Analysis of the variance was carried out on data collected used Statistical analysis system (SAS) computer package to detected differences among the treatments and the means compared by Duncan's Multiple Range Test (DMRT). At both level 0.05 and 0.01, and correlation between to location.

CHAPTER FOUR

RESULTS AND DISCUTIONS

4.1 The effect of gamma irradiation for laboratory tests

4.1.1 Germination (%)

The result of the laboratory test for the germination percentage revealed that the growth of the genotypes was decreased with the increasing of the gamma rays doses. The genotype Hudiba-1 obtained the highest percentage (81.4%)for the control, whereas the genotypes Mug45 and Hudiba-1 obtained the lowest percentage (6.6and 6.4 %) respectively, for the dose 200GY. As presented in fig-1.

These results were similar with the findings of Yadav, (2014) and AJAYI (1989), who reported the germination % for the different maize genotypes was deceased with the increasing of gamma doses.

4.1.2 Effects of gamma irradiation on the length of shoot, root and shoot root ratio

The results of gamma irradiation on the lengths of shoot, root and shoot root ratios of the tested genotypes are shown in figures 2, 3, 4 and 5. This results shown that shoot and root lengths of the seedlings of the four genotypes were decreased with the increasing of gamma irradiation doses.

For Hudiba-2, the highest shoot and root ratios were (26.4 and 15.0cm) respectively. 50GY, these lengths were relatively higher than the control (26.2 and 13.0cm) but the lowest lengths were obtained by irradiation doses 150GY, (10.3 and 7.8ncm) (Fig-2).

For the Hudiba-1 the highest shoot and root ratios were (23.3 and 14.5cm) respectively. They were obtained by dose 50GY, and the lowest lengths were obtained by the dose 150GY, (3.9 and 5.3 cm) compared with control (24.9 and

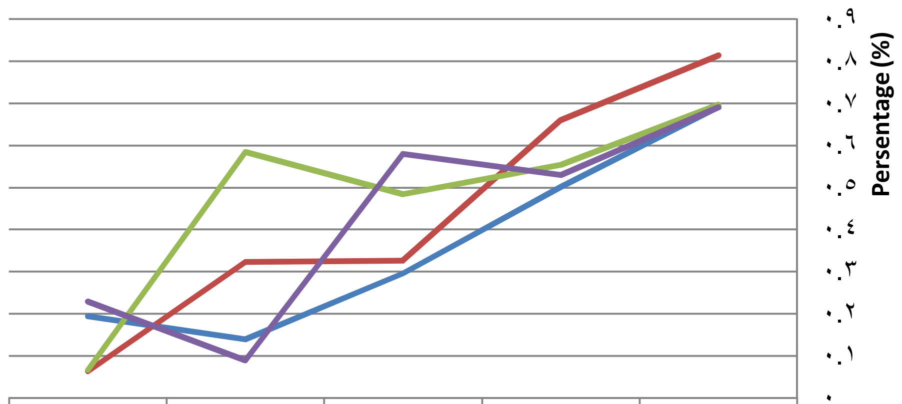
16.3cm) (Fig-3). The irradiation dose 200GY did not survive further investigations in both genotypes (Hudiba-1 and Hudiab-2) respectively.

For the genotype Mug 45 the highest shoot and root ratios (25.6 and 14.8cm) were obtained by the dose 50GY, and the control (25.6 and 11.5 cm) respectively , and the lowest lengths were (15.8 and 7.7cm) were obtained by the dose (100GY) as the presented in (Fig -4).

For the genotype VAR 113, the highest shoot and root ratios were (21.5 and 13.5 cm) obtained by the irradiation dose (50GY) these lengths were relatively lower than the control (24.4 and 19.1 cm) respectively, and the lowest lengths were (7.9 and 5.2 cm) obtained by the irradiation dose (100GY) (Fig-5). The doses 150 and 200GY appears dominated lethality in Mug45 and Var-113), showed in (Fig-4 and Fig-5).

These results in agreement with Emrani *at el* (2013) who studied the effect of the different doses of irradiation in two maize cultivars, their results showed that the root and shoot of both cultivars were decreased with the increasing irradiation of the doses up to 400 and 600 GY.

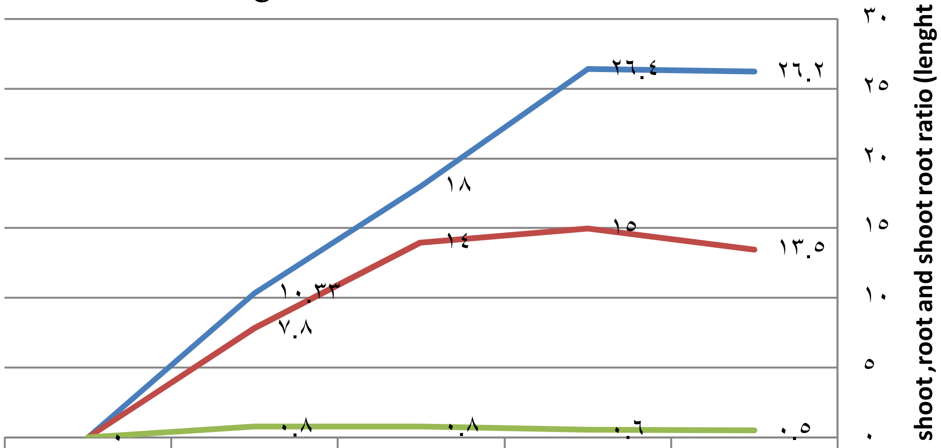
Figure-1Germenation % for the seedlings of the four genotypes of maize treatedwith different doses of gamma rays.



	٢٠٠	١٥٠	١٠٠	٥٠	٠
H٢	٠.١٩٤	٠.١٤	٠.٢٩٦	٠.٥	٠.٦٩
H١	٠.٠٦٤	٠.٣٢٤	٠.٣٢٦	٠.٦٦	٠.٨١٤
MUG	٠.٠٦٦	٠.٥٨٤	٠.٤٨٤	٠.٥٥٤	٠.٦٩٦
VAR	٠.٢٣	٠.٠٩	٠.٥٨	٠.٥٣	٠.٦٩

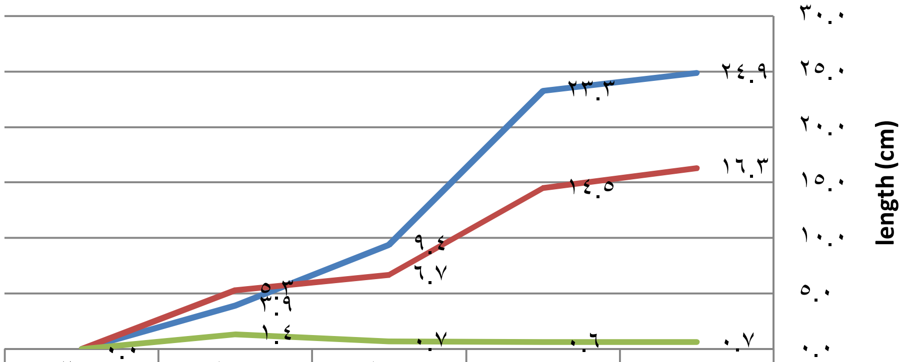
H2= Hudiba-2, H1= Hudiba-1, MUG= Mugtama-45 and VAR=Var-113 Respectively.

Figure-2 Determent the shoot and root ratios for the seedlings of the maize genotype Hudiba-2 treated with the differnt doses of gamma irradiation.



	٢٠٠	١٥٠	١٠٠	٥٠	٠
shoot	٠	١٠.٣٣	١٨	٢٦.٤	٢٦.٢
root	٠	٧.٨	١٤	١٥	١٣.٥
ratio	٠	٠.٨	٠.٨	٠.٦	٠.٥

Figure-3 The shoot and root ratios for the seedlings of the maize genotype Hudiba-1 treated with different doses of gamma irradiation.



	٢٠٠	١٥٠	١٠٠	٥٠	٠
shoot	٠.٠	٣.٩	٩.٤	٢٣.٣	٢٤.٩
root	٠.٠	٥.٣	٦.٧	١٤.٥	١٦.٣
ratio	٠.٠	١.٤	٠.٧	٠.٦	٠.٧

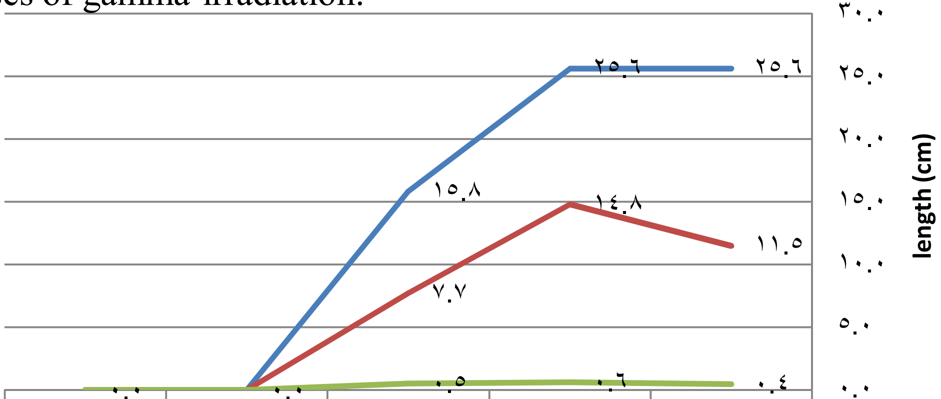
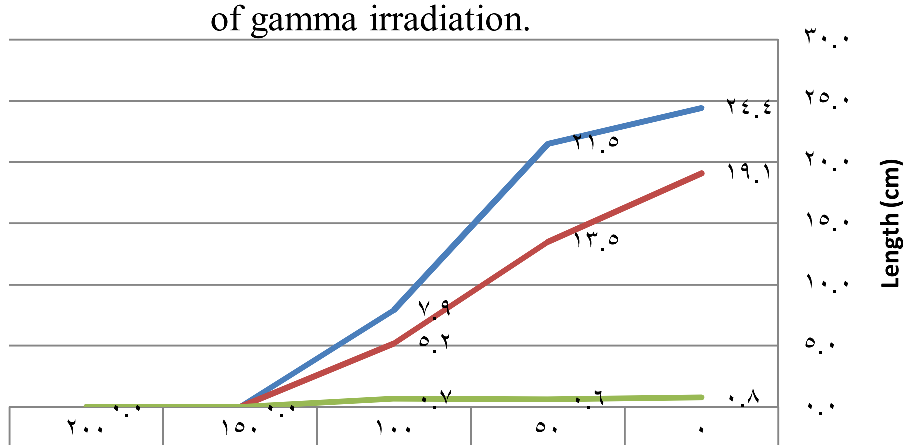


Figure-4 Determent of shoot and root ratios for the seedlings of the genotype Mug45 treated with different doses of gamma irradiation.

	٢٠٠	١٥٠	١٠٠	٥٠	٠
shoot	٠.٠	٠.٠	١٥.٨	٢٥.٦	٢٥.٦
root	٠.٠	٠.٠	٧.٧	١٤.٨	١١.٥
ratio	٠.٠	٠.٠	٠.٥	٠.٦	٠.٤

Figure-5 Determenet on shoot and root ratios for seedling maize genotype Var-113treated with with different doses of gamma irradiation.



	٢٠٠	١٥٠	١٠٠	٥٠	٠
shoot	٠.٠	٠.٠	٧.٩	٢١.٥	٢٤.٤
root	٠.٠	٠.٠	٥.٢	١٣.٥	١٩.١
ratio	٠.٠	٠.٠	٠.٧	٠.٦	٠.٨

4.2 The effect of gamma irradiation of the field experiments

4.2.1 Shambat location

The statistical analysis of variance for Shambat location revealed that there were significant difference between the two doses of irradiation (control and 50GY dose). for the days to silking, significant at ($p<0.01$). For the days to tassaling, ear height, leaf area, number of rows and 100 kernel weight, revealed significant at ($p>0.05$). And non significant differences for the other characters. (Table 1.a).

The results also showed that there were no significant differences for the genotypes for all studied traits except number of husks, it revealed a significant differences a level at ($p<0.05$) as presented in table (1.b).

On the other hand the interactions between the two doses and the genotypes of maize, the results showed that there was significant at ($p<0.01$) for 100 kernel weight, significant at ($p<0.05$) for number of leafs, leaf area and effective ear length, and non- significant difference for the other traits (Table 1.c).

For number of leafs character, the highest value was (12), obtained by variety Mug45 in the 50GY dose, and the lowest value was (10) obtained by Var-113, in the 50GY dose respectively.

For Leaf area, the highest value (286.2 mm), obtained by the Hudiba-2 in the control, and the lowest value was (165.6mm), obtained by Hudia-1, in the 50GY dose. For the effective ear length, the highest value was (9.3cm), obtained by Hudia-2 in the control, and the lowest were value was (6.1m), obtained by Mug45 in the control.

And for the 100 kernel weight, the highest value was (20.1g), obtained by Hudia-1, in the 50GY dose, and the lowest value was (15.3g), obtained by Var-113, in the control.

These results were in agreement with Saad (2009), who reported that ear weight husked, ear weight dehusked, dry ear weight, weight of kernel/ear characters were decreased with the increasing of gamma irradiation doses.

Breeding programs in maize and other economical crops aim to exploit the existing variability and to enhance genetic variability (Allawad, 2000). Selection of the suitable mutagenic treatment is another way for existing variability than can be used in any successful breeding program (Sakin and Sencar, 2002). Mutation breeding by using gamma rays or other physical and chemical mutagens has been studied in many crops. e.g. FAO (2010), in differnat crops Mudibn *et al* (2012) and Hanafiah *et al* (2010), in soybean, Human and Sihono (2010) in sorghum and Sakin and Sencar (2002), in wheat.

Similar findings of this study existing variability in maize by using gamma irradiation were reported by Yang *et al* (2011) and Rafinddin *et al* (2013). This variability could be of great value in many maize breeding program.

4.2.2 Madeni location

The statistical analysis of variance in Madeni location showed that there were a significant differences at ($p<0.01$) between the two doses of irradiation (control and 50GY dose) for the days to 50% tassaling and silking, ear height, number of leafs, number of node and number of rows, significant at ($p<0.05$) for the plant height. as presented in (Table 2.a). but the grain yield was decreased in the dose 50GY which compared with the mean of the control (962.9-1003), and the mean (983.8) respectively. Reduction of the grain yield due to sterility of the pollen grain and the kernel set (dominant of lethality doses (Nepali, 2013).

The results also appears that there were non-significant different between the four genotypes for all characters except days to 50% tassaling and silking and number of leaf, it was significant at ($p<0.05$). (Table 2.b).

For the interaction between the two doses of irradiation and the genotypes the results revealed that there were significant at ($p<0.05$) for the ear height, number of cob and the number of rows /ear, wearers non significant different for the other characters. (Table 2.c). For ear height, the highest value (66.6cm), was obtained by Hudiba-1, in 50GY dose. and the lowest value (43cm) obtained by the Hudiba-1, in the control. For number of cob the highest value (21) was obtained by the variety Hudiba-1, in the 50GY dose and the lowest value (14) was obtained by the variety Hudiba-2, in the control. For number of rows/ ear, the highest value (15) were obtained by the (Hudiba-1 and Hudiba-2), similar number in the control.

These results similar to Saad, (2009), who reported that, number of rows/kernel, 100 kernel weight, number of rows/ear decreased with the higher doses 200 GY. Also were in accordance with Yang, *et al* (2011) and Rafinddin , *et al* (2013).

Table (1.a) The means effects of gamma irradiation on doses (0.0 and 50GY) on maize genotypes traits performance at Shambat farm season 2014 .

parameter	Control	Dose50 GY	Means	C.V %	F-value
Plant at harvest	34896a	35625a	35625	23.1	0.05ns
Days of tassaling	49b	53a	51	7.6	5.8*
Days of silking	51b	56a	53.5	6.4	9.3**
Plant height (cm)	100.6a	92.4a	96.5	16.1	1.6ns
Ear height (cm)	30a	25.7b	28.3	16.7	7.1*
Number of leaf	11a	11a	11	7	4.2ns
Stem diameter (cm)	1.27a	1.25a	1.2	23.1	0.04ns
Number of Node	11a	11a	11	7.3	4.1ns
Leaf area (mm)	232.a	192.7b	212.9	20	5.1*
Number of cob	13a	11a	13	23.6	1.7ns
Dry weight (g)	151.1a	226a	238.9	22.8	1.2ns
Husked weight (g)	42.5a	38.6a	40.6	27.7	0.7ns
Dehusked weight (g)	34.9a	34.7a	34.8	28.9	0.01ns
Number of husked	6a	7a	6.5	14.5	4.05ns
Ear length (cm)	9.7a	9.1a	9.4	16.6	0.86ns
Effective ear length (cm)	8.4a	8.1a	8.2	18.8	0.12ns
Ear diameter (cm)	2.7a	2.8a	2.7	22.4	0.4ns
Number of rows/ear	11a	10a	10.5	12.7	4.2ns
Number of rows	16a	13b	14	28.8	3.9*
100 kernel weight (g)	15.6a	17.4a	16.5	13	3.9*
Grain yield (k/ha)	1540a	1423.2a	1481.5	37	0.27ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant.

Table(1.b) The means of effects gamma irradiation for studied genotypes on the growth performance traits in Shambat season 2014.

parameter	VAR	HU1	HU2	MUG	Means	C.V%	F-value
Plant at harvest	34375a	34375a	a31250	a42500	35625	23.1	2.25 ns
Days of tassaling	51.1 a	49.8a	51.8a	a51.1	51	7.6	0.28 ns
Days of silking	54a	52.1a	54.5a	53.3a	53.5	6.4	0.51 ns
Plant height (cm)	93.8a	a94.7	100.2a	a97.3	96.5	16.1	1.63 ns
Ear height (cm)	29a	28.3a	27a	28.8a	28.3	16.7	0.21 ns
Number of leaf	11a	a11.1	11a	11a	11.2	7	1.5 ns
Stem diameter (cm)	1.28a	a1.21	1.21a	1.28a	1.2	23.1	0.07ns
Number of Node	10.8a	a11.1	10.8a	10.8a	10.9	7.3	0.26
Leaf area	209.8a	199.9a	232.3a	207.8a	212.9	20	0.64ns
Number of cob	12a	14a	12.5a	11.6a	12.5	23.6	0.73
Dry weight (g)	220a	230a	235a	270a	238.9	22.8	0.96ns
Husked weight (g)	43.4a	35.2a	43.4a	40.3a	40.6	27.7	0.7ns
Dehusked weight (g)	31.8a	a31.1	39.3a	37a	34.8	28.9	0.95ns
Number of husked	6.3b	5.6a	6.3ab	7.3a	6.2	14.5	4*
Ear length (cm)	9.3a	9.9a	9.5a	8.7a	9.4	16.6	0.61
Effective ear length cm	8.5a	8.6a	8.4a	7.4a	8.2	18.8	0.72ns
Ear diameter (cm)	2.6a	2.5a	3a	2.7a	2.7	22.4	1.11ns
Number of rows/ear	11a	11a	10.6a	10.6a	10.8	12.7	0.12ns
Number of rows	14.6a	15a	14.6a	a13.1	14.3	28.8	0.23ns
100 grain weight (g)	15.9a	16a	17a	16.4a	16.5	13	1.11ns
Grain yield (k/ha)	1125.6a	a1551.9	1537.6a	1711.3	1481.5	37	1.24ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant.
Var = Var-113, HU1= Hudiba-1, HU2= Hudiba-2 and MUG= Mugtama-45 Respectively

Table (1.c) The means effects of gamma irradiation on genotypes and doses combined on maize genotypes season 2014 in Shambat, location.

Genotypes	Var-113		Hudiba-1		Hudiba-2		Mug 45			
Dose	0.00	50	0.00	50	0.00	50	0.00	50	CV%	F.V
Plant at harvest	33333	35416	37083	28750	28333	34166	40833	44166	23.1	0.88ns
Days of tassaling	47.6	54.6	50.6	49	49	54.6	49	53.3	7.6	1.4 ns
Days of silking	50.6	57.3	52.3	52	51.3	57.6	51	55.6	6.4	1.3ns
Plant height (cm)	98.7	88.9	94.3	94.7	108.7	91.7	100.2	94.5	16.1	0.32ns
Ear height (cm)	32.9	25	29.7	26.9	30.7	23.3	30.1	27.5	16.7	0.24ns
Number of leaf	12	10	11.6	10.6	11.3	10.6	11.3	12.3	7	3.7*
Stem diameter (cm)	1.3	1.2	1.2	1.2	1.4	1.1	1.1	1.4	23.1	1.4ns
Number of Node	11.6	10	11.6	10.6	11	10.6	10.6	11	7.3	1.7ns
Leaf area (mm)	226.5	193	234.2	165.6	286.2	178.5	181.9	233.7	20	3.8*
Number of cob	12.3	11.6	14	14	13.6	11.3	13.3	10	23.6	0.4ns
Dry weight (g)	240	200	233.3	226.6	264	206.6	267.3	273.3	22.8	1.4ns
Husked weight (g)	46.8	40.1	37.5	33	47.6	39.2	38.2	42.3	27.7	0.37ns
Dehusked weight (g)	29.6	34	36.2	26	39.3	39.4	34.5	39.6	28.9	0.7ns
Number of husked	5.3	6.3	5.6	5.6	5.6	7	7	7.6	14.5	0.5ns
Ear length (cm)	9.2	9.4	10.6	9.3	11	8.1	8	9.5	16.6	2.2ns
Effective ear length (cm)	8.5	8.5	9.3	8	9.7	7.2	6.1	8.8	18.8	2.9*
Ear diameter (mm)	2.8	2.5	2.3	2.8	2.9	3.1	2.7	2.7	22.4	0.9ns
Number of rows/ear	11.3	10.6	11.6	10.3	12.3	9	10.3	11	12.7	2.1ns
Number of rows	14.6	14.6	18	12	18	11.3	13.3	13	28.8	1.11ns
100 kernel weight (g)	15.3	16.1	11.9	20.1	18.6	17.1	16.5	16.3	13	6.1**
Grain yield (k/ha)	1324	926.6	1397	1706	1671.6	1403.5	1766.2	1656.2	37	0.47ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant.

4.2.3 Shambat and Madeni locations (combined)

The results of the combine analysis of variance for the two location (Shambat and Madeni) showed that there was significant at ($p<0.01$) between the two doses of irradiation (control and the dose 50GY) for the days of 50% tassaling, number of leaf, number of node and number of rows, and significant at ($p<0.001$) for the days to 50% silking, also significant at ($p<0.05$) for the pant height, leaf area, number of rows/ear and 100 grain weight. (Table 3.a).

The results also revealed that there were non-significant different between the four genotypes in all characters. (Table 3.b).

For the results of the interaction between the two locations showed non-significant different except ear height, it was significant at ($p<0.01$) (Table 3.c). The highest value (46.7 cm), was obtained by the variety Hudiba-1, in 50GY dose, and the lowest (37.4) was obtained by VAR113, in the control.

4.3 Correlation of grain yield with other traits

In the two locations correlation analysis was showed the grain yield highly significant negative correlated with plant stand, plant height, ear height, stem diameter, leaf area, number of cob, dry weight, dehusked weight, husked weight, ear length, effective ear length, number of rows/ear and number of kernel/ear respectively as presented in (table 4).

This results des agreement with (Saad, 2009) how reported the grain yield positive correlated with effective ear length, number of rows/ear, number 0f kernel/ear, ear length number of hused.

Adams (1967) reported that the negative associations between different characters might be due to the competition of two developing characters of plant limited resources like nutrients and water supply. However, the negative correlation between yield and days to flowering could be of a value in obtains maize genotypes characterized with high grain yield and late flowering and maturity.

Table(2.a) The means effects of gamma irradiation doses (0.0 and 50 GY) on maize traits performance in Medeni season 2014.

parameter	Control	Dose 50GY	Means	C.V%	F-value
Plant at harvest	51354a	47386a	49456.5	12.4	2.4ns
Date of tassaling	45.9b	48.2a	47	2.4	37**
Date of silking	48.8b	51.5a	50.1	2.8	31**
Plant height (cm)	159a	145.4b	152.5	7.4	8.2*
Ear height (cm)	48.2b	59.1a	53.4	13.9	12.3**
Number of leaf	12.5a	11.6b	12.1	5.5	11.5**
Stem diameter (cm)	1.8a	1.8a	1.8	8.4	0.5 ns
Number of Node	12.4a	12.6b	12	4.8	10.1**
Leaf area (mm)	461.6a	444.6a	453.5	11.2	0.6 ns
Number of cob	17.4a	19a	18.1	11.6	3.1ns
Dry weight (g)	648.3a	600.9a	625.6	20.4	0.7 ns
Husked weight (g)	116.8a	124.7a	120.6	14	1.2 ns
Dehusked weight (g)	100.5a	100.2a	100	16.6	0.04 ns
Number of husked	6.9a	7a	6.9	12.6	0.05 ns
Ear length (cm)	16.3a	16.1a	16.2	7.1	.016 ns
Effective ear length (cm)	14.2a	14.3a	14.2	12.4	0.01 ns
Ear diameter (cm)	3.4a	3.4a	3.4	7.2	0.1 ns
Number of rows/ear	14.2a	13.8a	14	7	1 ns
Number of rows	32.5a	29b	30.8	8.6	9.8**
100 kernel weight (g)	19.4a	21.7a	20.5	13.4	3.9ns
Grain yield (k/ha)	1003a	962.9a	983.8	17.2	0.3 ns

Where, * and ** significant at 5% and 1% level of significance respectively.
ns = non significant , and the mean with same letter showed non- significant.

Table (2.b).The means effects of gamma irradiation of four genotypes of maize on growth traits performance in Medeni season 2014.

parameter	Var-113	HU1	HU2	MUG	Means	C.V%	F-value
Plant at Harvest	47292a	50208a	52083a	48000a	49456	12.4	0.7 ns
Date of tassaling	46.5b	48.3a	47.1ab	46b	47	2.4	4.3*
Date silking	49.5b	51.8a	50b	49b	50.1	2.8	1.4*
Plant height (cm)	144.6a	155.1a	157.8a	152.5a	152.5	7.4	1.4 ns
Ear height (cm)	51.6a	55.9a	54.5a	51.4a	53.4	13.9	0.5 ns
Number of leaf	11.5b	12.3ab	12.6a	12ab	12.1	5.5	3.3*
Stem diameter (cm)	1.9a	1.8a	1.7a	1.9a	1.8	8.4	1.2 ns
Number of Node	11.8a	12a	12.1a	12.2a	12	4.8	0.4 ns
Leaf area (mm)	446.6a	466.5a	440.7a	461.6a	453.5	11.2	0.3 ns
Number of cob	19a	19.5a	16.6a	17.4a	18.1	11.6	2.3 ns
Dry weight (g)	656.6a	683.3a	578.3a	576a	625.6	20.4	1 ns
Husked weight (g)	114.9a	114a	119.3a	136.9a	120.6	14	2.ns
Dehusked weight (g)	92a	100.2a	100.4a	110.6a	120.6	16.6	1.2 ns
Number of husked	7a	6.8a	7.1a	6.8a	100	12.6	0.2 ns
Ear length (cm)	16.2a	15.7a	16.1a	17a	6.9	7.1	1.1 ns
Effective ear length (cm)	14.6a	13.8a	14.2a	14.5a	16.2	12.4	0.2 ns
Ear diameter (cm)	3.3a	3.4a	3.4a	3.5a	14.2	7.2	0.3 ns
Number of rows/ear	13.5a	14.3a	14.5a	13.8a	3.4	7	1.3 ns
Number of rows	30.8a	31.3a	29.5a	31.8a	14	8.6	0.7 ns
100 kernel weight (g)	21a	19.6a	19.9a	21.6a	30.8	13.4	0.6 ns
Grain yield (k/ha)	952.5a	969a	1110.a	983.8a	20.5	17.2	0.3 ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant
Var = Var-113, HU1= Hudiba-1, HU2= Hudiba-2 and MUG= Mugtama-45 Respectively

Table (2.c) the effects of gamma irradiation on genotypes and doses combined

Genotypes	VAR113		Hudiba-1		Hudiba-2		Mug 45			
Dose	0	50	0	50	0	50	0	50	C.V%	F.V
Plant at Harvest	46666	47916	53750	46666	55000	49166	50000	45000	12.4	0.6ns
Date of tassaling	45	48	47	49	46	48	45	47	2.4	0.01ns
Date silking	48	51	50	53	48	51	48	50	2.8	0.01ns
Plant height (cm)	148	140.6	167.6	139.3	160.1	150.1	159.8	154.7	7.4	1.8ns
Ear height (cm)	43	60.3	45.1	66.6	55	54.1	49.8	53.7	13.9	2.8*
Number of leaf	11.6	11.3	12.6	12	13.3	12	12.6	11	5.5	1.2ns
Stem diameter (mm)	1.9	1.8	1.9	1.8	1.7	1.7	1.8	1.9	8.4	0.4ns
Number of Node	12.3	11.3	12	12	12.6	11.6	12.6	11.5	4.8	1.1ns
Leaf area (mm)	468.7	424.5	497.8	435.1	442.9	438.4	437.1	498.3	11.2	1.5ns
Number of cob	19.6	18.3	18	21	14	19	17.6	17	11.6	2.5*
Dry weight (g)	720	593.3	743.3	623.3	546.6	610	583.3	565	20.4	0.8ns
Husked weight (g)	115.4	114.4	96.8	131.3	118.8	119.7	136.4	137.8	14	1.6ns
Dehusked weight (g)	98.2	86.2	85.8	114.6	99.8	98.8	122.2	113.6	16.6	1.8ns
Number of husked	6	7.3	6.6	7	7.3	7	7	6.5	12.6	0.5ns
Ear length (cm)	16	16.4	15.5	15.8	16.2	15.9	17.4	16.3	7.1	0.4ns
Effective ear length (cm)	14.5	14.7	13.6	14	14.3	14.1	14.4	14.7	12.4	0.04ns
Ear diameter (mm)	3.4	3.3	3.3	3.5	3.4	3.4	3.6	3.4	7.2	0.78ns
Number of rows/ear	13.3	13.6	15.3	13.3	15	14	13.3	14.5	7	2.8*
Number of rows	33.6	28	31	31.6	30.6	28.3	34.6	27.5	8.6	2.2ns
100 grain weight (g)	19.5	22.5	19.2	20.1	18.3	21.5	20.6	23.2	13.4	0.34ns
Grain yield/hectare	983	922	917	1021	929.6	918.6	1182	1003	17.2	0.5ns

on maize genotypes season 2014 in Madeni, location.

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant

Table(3.a) The means effects of the gamma irradiation doses of combined between Shambat and Medani locations on Maize growth traits performance season, 2014.

parameter	control	Dose 50GY	Means	C.V %	F-value
Plant at harvest	43125a	41458a	42291.6	16.7	0.6 ns
Date of tassaling	47.5b	50.7a	49.1	6.6	11.7**
Date of silking	50b	53.7a	51.9	5.7	18.7***
Plant height (cm)	129.8a	119.7b	124.7	10.7	6.7*
Ear height (cm)	39.9a	42.3a	41.1	16.1	1.6 ns
Number of leaf	12a	11.3a	11.6	8.1	8.3**
Stem diameter (cm)	1.6a	1.5a	1.5	14.9	0.2 ns
Number of Node	11.8a	11.1b	11.4	6.5	10.5**
Leaf area (mm)	346.9a	316.6b	332.8	13.8	4.5*
Number of cob	15.3a	15.2a	15.2	19.6	0.04 ns
Dry weight (g)	449.7a	414.2a	431.9	23.7	1.4 ns
Husked weigh (g)	79.7a	80.4a	80	19.5	0.03 ns
Dehusked weight (g)	68.2a	67.5a	67.8	22.6	0.03 ns
Number of husked	6.4a	6.8a	6.6	13.1	2.7 ns
Ear length (cm)	13a	12.6a	12.8	10.5	1.1 ns
Effective ear length (cm)	11.3a	11.2a	11.2	14	0.02 ns
Ear diameter (cm)	3a	3.1a	3	11.4	0.08 ns
Number of rows/ear	12.8a	12b	12.4	9.7	5.6*
Number of rows	24.2a	20.8b	22.5	15.3	11.6**
100 kernel weight (g)	17.5b	19.3a	18.4	13.5	6.1*
Grain yield (k/ha)	1271.5a	1181.6a	1226.5	33.5	0.5 ns

Where, * and ** significant at 5% and 1% level of significance respectively .
ns = non significant , and the mean with same letter showed non-significant

Table(3.b) The means effects of the gamma irradiation combined between Shambat and Madeni locations Maize growth performance season 2014.

parameter	Var	HU1	HU2	MUG4	Means	C.V%	F-value
Plant at Harvest	40833a	41563a	41667a	45104a	42291	16.7	0.8ns
Date of tassaling	48.8a	49a	49.5a	49a	49.1	6.6	0.08ns
Date of silking	51.7a	52a	52.2a	51.7a	51.9	5.7	0.08ns
Plant height (cm)	119.2a	124.1a	127.7a	128.1a	124.7	10.7	1.13ns
Ear height (cm)	40.3a	42.1a	40.8a	41.4a	41.1	16.1	0.17ns
Number of leaf	11.2a	11.7a	11.8a	11.9a	11.6	8.1	1.2ns
Stem diameter (cm)	1.5a	1.5a	1.5a	1.6a	1.5	14.9	0.4ns
Number of Node	11.3a	11.5a	11.5a	11.5	11.4	6.5	0.2ns
Leaf area (mm)	328.2a	333.6a	336.5a	333.2a	332.8	13.8	0.07ns
Number of cob	15.5a	16.7a	14.5a	14.3a	15.2	19.6	1.6ns
Dry weight (g)	438.3a	4566a	406.8a	426.3a	431.9	23.7	0.5ns
Husked weight (g)	79.2a	74.6a	81.1a	84.1a	80	19.5	0.9ns
Dehusked weight(g)	62a	65.7a	69.8a	73.8a	67.8	22.6	1.3ns
Number of husked	6.4a	6.2a	6.7a	7a	6.6	13.1	2.17ns
Ear length (cm)	12.8a	12.8a	12.8a	12.7a	12.8	10.5	0.01ns
Effective length (cm)	11.5a	11.2a	11.3a	10.9a	11.2	14	0.3ns
Ear diameter (cm)	3a	2.9a	3.2a	3a	3	11.4	0.9ns
Number of rows/ear	12.2a	12.6a	12.5a	12.1a	12.4	9.7	0.5ns
Number of rows	22.7a	23.1a	22a	22.1a	22.5	15.3	0.26ns
100 grain weight (g)	18.4a	17.8a	18.9a	18.5a	18.4	13.5	0.4ns
Grain yield (k/ha)	1039.1a	1260.5a	1230.9a	1376a	1226.5	33.5	1.4ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant.
Var = Var-113, HU1= Hudiba-1, HU2= Hudiba-2 and MUG= Mugtama-45 Respectively

Table (3.c) the means effects of the gamma irradiation combined between Shambat and Medani locations Maize growth performance season 20014.

LOCATION	Shambat and Medani									
Genotypes	Var-113		Hudiba-1		Hudiba-2		Mug 45		C.V%	F.V
Dose	0	50	0	50	0	50	0	50		
Plant at Harvest	39999	41666	45416	37083	41666	41666	45416	44791	16.7	1.4ns
Date of tassaling	46.3	51.3	48.9	49.1	47.5	51.1	47.1	50.9	6.6	0.8ns
Date silking	49.3	54.1	51.4	52.5	49.8	54.6	49.6	53.8	5.7	1.0ns
Plant height (cm)	123.6	114.7	131.1	117	134.4	120.9	130	126.1	10.7	0.5ns
Ear height (cm)	37.5	42.6	37.4	46.7	42.5	38.6	41.5	41.3	16.1	3**
Number of leave	11.8	10.6	11.2	12.1	11.3	12.3	11.3	11.9	8.1	1.3ns
Stem diameter (cm)	1.6	1.5	1.5	1.5	1.5	1.4	1.5	1.7	14.9	0.8ns
Number of Node	11.9	10.6	11.8	11.3	11.8	11.6	11.6	11.3	6.5	0.8ns
Leave aria (mm)	347.6	308.7	365.9	300.3	364.4	308.4	309.5	356.9	13.8	1.7ns
Number of cob	15.9	14.9	16	17.5	13.5	15.5	15.4	13.1	19.6	0.9ns
Dry weight (g)	480	396.6	488.3	434.9	405.3	408.3	425.3	426.6	23.7	0.8ns
Husked weight(g)	81.1	77.2	63.1	82.1	83.2	79.4	87.3	82.8	19.5	1.15ns
Dehusked weight(g)	63.9	60.1	61	70.3	69.5	70.2	85.1	69.3	22.6	1.2ns
Number of husked	5.9	6.8	6.1	6.3	6.4	7	7	7	13.1	1.2ns
Ear length 9cm)	12.6	12.9	13	12.5	13.6	12	12.7	12.7	10.5	1.5ns
Effective ear length	11.2	11.6	11.4	11	12	10.6	10.2	11.6	14	1.09ns
Ear diameter(cm)	3.1	2.9	2.8	3.1	3.1	3.2	3.1	3	11.4	0.9ns
Number of rows/ear	12.3	12.1	13.4	11.8	13.6	11.5	11.8	12.5	9.7	1.6ns
Number of rows	24.1	21.3	24.5	21.8	24.3	19.8	23.9	20.3	15.3	1.05ns
100 grain weight(g)	17.6	19.3	15.5	20.1	18.4	19.3	18.5	18.5	13.5	1.7ns
Grain yield (k/ha)	1223.3	921.8	1209	1318	1295.1	1292.9	1332.4	828.1	33.5	0.6ns

Where, * and ** significant at 5% and 1% level of significance respectively
ns = non significant , and the mean with same letter showed non-significant.

Table (4)Simple linear Correlation Coefficient of grain yield with other traits in two locations (Combine for Madeni and Shambat of four maize genotypes in season 2014.

Traits parameters	Grain yield
Plant at Harvest	-0.36*
Date of tassaling	-0.02ns
Date silking	-0.013ns
Plant height	-0.413**
Ear height	-0.424**
Number of leave	-0.074ns
Stem diameter	-0.332*
Number of Node	-0.225ns
Leave aria	-0.531**
Number of cob	-0.283*
Dry weight	-0.393**
Husked weight	-0.409**
Dehusked weight	-0.362*
Number of husked	-0.117ns
ear length	-0.478**
Effective length	-0.501**
Ear diameter	-0.1ns
Number of rows/ear	-0.35*
Number of rows	-0.428**
100 grain weight	-0.124ns
Grain yield/hectare	-

Where, * and ** significant at 5% and 1% level of significance Respectively.

ns = non significant , and the mean with same letter showed non-significant

CHAPTER SIX

CONCLUSIONS

Based on the results obtained from this study, it could be conducted that:

1-The gamma rays has negative effect on the germinations of the seedlings of maize genotypes.

2-The increasing of the gamma irradiation decreased the growth of the germination. The genotypes treated with the high doses (150-200GY) were germinate but they failed to survive after 10 days of their germination. In addition the dose 100GY failed in the two locations.

3-The genotype (Mug45 and VAR113), more radiosensitive than (Hudiba-1 and Hudiba-2).

4-Significant findings were obtained between two doses (control and 50GY) used in the field experiments. Between the four genotypes and their interaction for most of the studied characters. This variability existed by using gamma irradiation could be of a great value in any maize breeding program aim at exist variability among maize genotypes.

5-The results of this study could be used as indicator for using gamma irradiation for obtaining variability between maize genotypes, therefore another doses could be used in the future in any maize breeding program.

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