بسم الله الرحمن الرحيم

Sudan University for Science and Technology

Faculty of Agricultural studies

Department of Agronomy

Gamma Rays Effect on Wheat (*Triticum aestivum* L.) Growth under Water Stress Condition.

Complementary research submitted in partial fulfillment of the requirements for the degree of B.Sc. in Agriculture

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Aug. 2016

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صدق الله العظيم

سورة يس الاية (33-36)

Dedication

This work is dedicated:

Jo my love Mother

Jo my love Father

Jo my brothers and sisters

Jo whom they changed with my life tones

Jo my love special friends

Thank to my friends and to all people whom love

Acknowledgement

MY great thanks firstly to Almighty Allah, who supporting me to finish this work successfully.

My special thanks to my doctor,Halaalmobasher andDr.Ahamed Ali my supervisors this valuable scientific guidance.

I would like to acknowledge with thanks all my family and all my friends at Sudan University of science and technology college of Agricultural studies at shambat

Finally thank my parents whom help me to complete this research.

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ABSTRACR

This study was conducted in the demonstration farm of Agricultural Studies College, Sudan University of Science and Technology- Shambat during the winter season of 2015-2016; with the aim of studying the effect of gamma rays on wheat growth under water stress condition. Nine wheat (*Triticumaestivum*L.) cultivars widely grown in Sudan namely:Khaleefa,Elnileen,Tagana,Emam,Argeen, Condor,Bohain,Nabtaand Debera were exposed to three doses of gamma rays (25, 45 and 65Gy). The irrigation intervals divided to three groups: group (A) watering every 10 days, group (B) watering every 15 days and group (C) watering every 21 days. Each group replicated three times and the irradiated cultivars separated randomly in each group.

Results showed significant differences among cultivars in plant high; Tagana cultivar achieved the highest value; followed by Bohain, Debaira, Condor, Argeen, Emam, Elnileen,KhaleefaNabta and respectively, No significant differences were obtained between cultivars in leaves number. The highest mean number of tillers was obtained in Tagana cultivar. The largest mean numbers of spikes were obtained in Bohain, Condor, Tagana and Argeen cultivars.The longest roots were obtained in Tagana cultivar and the shortest in Condor cultivar.

Results showed high significant differences among irrigation intervals in almost all growth parameters measured,results showed the preference of watering every 10 days. There were no significant differences between gamma rays doses tested in almost all growth parameters measured, the best results for plant high and tillers number were obtained at the control treatment, there were no significant differences in leaves number, spikes number and root length between gamma rays doses.

The interaction treatments results showed that 25 GY dose in interaction with watering every 10 days gave the highest values of plant high; followed by the interaction between gamma rays with watering every 15 days, the lowest values of

plant high obtained at the interactions between gamma rays doses and watering every 21 day.The highest tillers number was achieved in the control treatment watered every 10 days. The longest roots were obtained in 65 Gy dose treatment watered every 10 days.

الملخص العربي

تاثير أشعة جاما على نمو القمح تحت ظروف الاجهاد المائي

أجريت هذه الدراسة بمزرعة كلية الدراسات الزراعية- جامعة السودان للعلوم والتكنولوجيا –شمبات في الموسم الشتوي للعام(2015-2016) بهدف دراسة أثرأشعة جاما على نمو القمح تحت ظروف الإجهاد المائي. عرضت تسعة أصناف قمح مزروعة في السودان وهي: خليفة، النيلين، تقانة، إمام، أرقين، كندور، بوهين، نبتة و دبيرة. لثلاث جرعات من أشعة جاما (25، 45 و 65جراي)، و تم تقسيم معاملات التعطيش الي ثلاثة مجموعات: المجموعة (أ)تسقى كل 10 أيام، المجموعة (ب) تسقى كل 15 يوم، المجموعة(ج) تسقى كل 21 يوم. كررت كل مجموعة ثلاث مرات ووزعت الأصناف المشععة داخل كل مجموعة توزيعا عشوائيا.

أظهرت النتائج وجود فروقات معنوية بين الأصناف ؛ حيث حقق الصنف تقانة أعلى قيمة لطول النبات تتبعه الاصناف بوهين، دبيرة، كندور، أرقين، إمام، النيلين، خليفة ونبتة على التوالى، ولم توجد فروقات بين الاصناف في عدد الاوراق، كما حقق الصنف تقانة أكبر عدد من الخلف، أنتجت الاصناف بوهين، كندور، تقانة وأرقين على التوالي أكبر عدد من السنابل. أطول الجذور حصل عليه في الصنف تقانة وأقصرها في الصنف كندور.

أظهرت النتائج فروقات معنوية عالية بين معاملات الري لمعظم مقاييس النمو أفضلها الري كل عشرة أيام . حققت الأصناف غير المشععة (الشاهد) أفضل النتائج في طول النباتوعدد الخلف، ولم تظهر فروقات معنوية بين جرعات الإشعاع المستخدمة في عدد الأوراق، عدد السنابل وطول الجذور.

في تجربة التداخل بين العوامل أظهرت النتائج تفوق الجرعة 25 جراى بالتداخل مع الري كل 10 ايام في إنتاج أعلى طول للنبات، يليها التداخل بين جرعات الإشعاع الأخرى مع الري كل 15 يوم، أقل قيم لطول النبات تحصل عليه في التداخل بين جرعات الإشعاع والري كل 21 يوم. أعلي قيمة لعدد الخلف حصلنا عليه في الشاهد المروي كل 10 أيام، وأطول الجذورحصلنا عليه في الجرعة 65 جراي المروية كل 10 أيام.

CHAPTER ONE

1-INTERDUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world among the food crops; it's an annual plant and a member of the family poaceae originated in southwest Asia (Arnon, 1972). It is not only a main crop for more than one third of the earth population, but also the most abundant source of energy and nourishment for mankind (Elahmmadi *et al*., 1996). As well as an important staple food crop, dominant grain of world commerce, in addition it is one of the most important cereal and the most critical agricultural crop worldwide (Ezatollah *et al*., 2012).

Wheat world production was 607 million tons in 2007, making it the third most-produced cereal after maize (784 million tons) and rice (651 million tons), in 2009 the production was 682 million tons making it the second most produced cereal after maize (817 million tons) and rice as close third with 679 million tons (FAO, 2007). Global wheat production must continue to increase 2% annually until 2020 to meet future demands of imposed population and prosperity growth (Ezatollah *et al*., 2012).

Wheat yield in the Sudan remained considerably low (Ageeb *et al*., 1996), its demand was limited prior to the 1960s, being mostly in northern Sudan and largely met by sustained domestic production in the traditional consumption area which shows the expansion of consumption from little over 220,000 tons in 1970-71 to over 800,000 tons in 1990-91. Although population growth is partially responsible for that increase; much of the increase quantitative restrictions and rationing of consumption have slowed growth in demand in the past (Hassan *et al*., 1994).

Shifting the crop south to be grown as a winter crop in the central clay plains of the Sudan has been faced by many production constraints. In most areas of the world, it is the principal food of man the properties of gluten in wheat are such that it produces bread stuffs generally. Wheat is grown in all temperate countries and in most of subtropical countries of the world, as well as at high elevation in some tropical countries. Wheat occupied about 75 percent of the acreage is fail sown. Varieties of wheat differ in their baking qualities, durum wheat for instance, is less satisfactory for bread but it is superior to other wheat for the preparation of alimentary postes like macaroni, spaghetti, and vermicelli (Bennett and Farnsworth, 1960).

Drought is one of the most common environmental limitations that cause significant reduction of growth, development and yield on present cultivated lands, together with major problem in the cultivation of crops n arid and semiarid areas (Ezatollah *et al*., 2012). The gap between local consumption and production could be narrowed by increasing productivity of wheat land unit area via development of new high yielding cultivars and of resistance to biotic and abiotic stresses including water deficit.

This study was conducted to study the effect of different gamma rays doses on growth parameters of nine wheat cultivars under water stress condition and increase drought tolerance through mutation

CHAPTER TWO

2-LITERATURE REVIEW

2.1. Origin and distribution

Wheat is grown on more land area worldwide than any other crop and is a close third to rice and corn in total world production. Wheat is well adapted to harsh environments and is mostly grown on wind swept areas that are too dry and too cold for the more tropically in dined rice and corn, which do best at intermediate temperature levels. Wheat is believed to have originated in southwestern Asia, some of the earliest remains of the crop have been found in Syrian, Jordan, and turkey. Primitive elatives of present day wheat have been discovered in some of the oldest excavation of the world in eastern irag, which date back 9.000 years. Wheat although useful as alive stock feed, wheat is used mainly as a human food. It is nutrition, concentrated, easily stored and transported, and easily processed in to various types of food. Wheat contains gluten protein which enables leavened drugh to rice by iformentution (www.agron.iastate.edu).

2.2. Wheat production in the world and Sudan

In 2007 world production of wheat was 607 million tons, making it the third most-produced cereal after maize (784 million tons) and rice (651 million tons), in 2009 world production was 682 million tons making it the second most produced cereal after maize (817 million tons) and with rice as close third (679 million tons) (FAO, 2007). Wheat demand was limited prior to the 1960s, being mostly in northern Sudan and largely met by sustained domestic production in that traditional consumption area, which shows the expansion of consumption from little over 220,000 tons in 1970-71 to over 800,000 tons 1990-91(Hassan *et al*., 1994).

Since it started in 1956, the breeding work on wheat accumulated a large amount of knowledge with respect to desirable characters to achieve high and stable yield. This knowledge focus on early maturity, resistance to shattering, lodging, rusts and tolerance to heat stress, moisture stress, grain yield, good baking quality and aphids. The main commercial cultivars widely cultured in Sudan wheat are:

Condor: early maturity, has a large number of tillers, resistant to rusts, sensitive to heat stress.

Debara: late maturity, suitable for growing in light temperate areas, resistant to rusts, tolerance to early season heat stress.

Elnileen: a new cultivars released in 1991 for sowing in Gezira blue and White nile areas. The cultivar tolerant to heat stress, early maturity, not recommended for sowing in new Halfa Scheme due to its susceptibility to rust.

Sasaraib: a new cultivar released in 1992 for sowing in New Halfa, heat tolerant, resistant to rust wide range adaptation and high yield (Alkhider, 1997).

2.3. Wheat botany

Wheat a member of the family poaceae, it can be divided in two parts normally root system and shoot system.

The Root system: wheat plant consists of two system of roots that is seminal or seedling roots and clonal roots, the first system of roots (seminal roots) are produced by the germination seedling in order to absorb nutrients for the young seedling, these are generally five in number and are also called primary root system, the second system of roots (clonal roots) vise from the basal nodes of the plants and from compact vegetation mass crown which is the principle organ of absorption as the young seedling progresses to maturity, it is the permanent root system and also known as secondary root system.

The Shoot system is collectively applies to the plant parts visible above the ground, the aerial portion of the plant these are stem leaves in florescence (Aberg, 1933-34).

The stem, the terminal four to seven internodes of the shoot elongate to flowering stem or culm, and internode is complete by the time of anthesis.Internodes increase in final length from the base of the culm to the uppermost internode, which carries the ear, or the peduncle. (Patrick, 1972a).

The Leaves, each leaf comprises the sheath, wrapping around the subtending leaf, and alumina (blade). At junction of the sheath and lamina, there is a membranous structure, the ligule, and a pair of small, hairy projection, the auricles, the auricles. The base of the leaves on the culm is thickened to from ahardknot or pulvinus (Sharman and Hitch, 1967).

The Spikes, each spikelet comprises an axis, the rachial, which bears two glumes and a number of florets. Within each spikelet, there are usually from two to four potentially fertile florets (Percival, 1921).

The Tillers, tillers which have the same basic structure as the main shoot, arise from the axils of the basal leaves. At anthesis; only some of tillers that have developed survive to produce an ear. Others die and may be difficult to find in the mature plant (Friend, 1965).

The Seeds, the seed grain or kernel of wheat is a dry indehiscent fruit. The dorsal side (with respect to the spikelet axis) is smoothly rounded, while the ventral side has the decay crease. The embryo or germ; is situated at the point of attachment of the spikelet axis, and the distal end has a brush of fine hairs (Kirby, 1993).

2.4. Crop adaptation

Wheat (*Tritium aestivum* L.) is adapted wide range of climatic conditions, from temperate to tropical zones. The great wheat regions of the world, however are found in the temperate zones, between latitudes 30-60º n and 25-40ºs (Leonard and Martin, 1963), where the average rainfall varies between 300 more than 1000 mm (Brown and Cambell, 1966). The crop doses not succeed in very warm and humid regions because of the too short spell of cool temperatures conducive to flowering and also for its susceptibility to diseases (Wilsie, 1962). Wheat is grown in the cool winter season by irrigation in the avid subtropics for example in the Sudan. The temperature range for crop survival and from minimum of 3-4ºc, an optimum of 25ºc and maximum daily temperature around 35ºc or more during maturity. The best soil is deep, will-drained as sandy loams, loams and clay (Arnon, 1972). The crop classified as medium salt tolerant, pH rang of 7.0 to 8.5.

2.5. Cultural practices and environmental requirements of wheat

2.5.1. Land preparation

The land usually prepared by tillage operations. The basic purpose of tillage is to provide a favorable soil environment for the germination and growth of the crop. Tillage usually affects four soil physical properties aeration, moisture-holding capacity, temperature and mechanical impedance-primary tillage is usually done to break the soil compaction, while secondary tillage is for obtaining a fine seedbed. Other benefits is to of tillage include weed control and turning under crop residues pest control or for easier cultivation.

The best time for the first tillage is during the rainy season when the soil is adequately wet and easy to manipulate. The second tillage could be done before seeding so as to obtain a fine seedbed (Mohammed *et al*., 1994.). Ageeb, 1999 concluded that; poor crop establishment of wheat is major cause of low yield on the heavy clay soils of the Sudan.

2.5.2. Sowing date

The length of the growing season for wheat in the Sudan is critical (90-100) in determining its yield (Ageeb, 1994). Therefore; optimization of sowing date of the crop. A large number of studies in Sudan showed that the optimum range of sowing date was 15 november-16 december at New halfa research (east), 1 november-9december at Gezira research station center (Ibrahim, 1995) .

2.5.3. Seed rate

Akasha, 1966-78 found no significant between seed rates ranging from 48 to190 kg/ha, Ageeb, 1974-76 tried seed rates between 11.9 and 190.4 kg/ha, but he found no significant difference between them and he attributed this to the compensatory effects of components of yield (mainly the survival of productive tillers. Ali, 1979-82 carried out an experiment on seed rate and found 15% increase when seed rate was increased from 41 to 95 kg/ha.

High seed rates hastened maturity, which is considered on advantage in short growing season as most grain filling takes place in relatively cool weather.

2.5.4. Sowing methods

Sowing on flat or ridges gave similar results but where leveling was poor, ridging gave better distribution of irrigation water. Ali, 1979-82 found that sowing by a seed drill significantly out yielded the broadcasting method by 19%.

2.5.5. Watering

Many investigators have shown that with a given quantity of water supply it is advisable to apply light and frequent irrigations compared to heavier irrigation at longer intervals in dry environments (Dastanen, 1974; Androus, 1976). ElRyah, 1970-75 in Wad medani found that 21-days interval was the best, but not significantly different from 7-days and 14 days intervals, whereas 21-days interval was the poorest.

(Ahmed, 1992.) from Al- Hudeiba Research Station, showed that very little depressive effect on grain yield when irrigation was skipped before heading, while grain yield was considerably reduced when irrigation was skipped during heading and early grain filling stage.

2.5.6. Weed control

The important weed Bracharia Ocimum basillcum, Rhyncosia memnonia dinebra retroflex, wild sorghum (Sorghum suddenness and Cynodn dactyl on the other weeds were predominant in certain areas, but had localized distribution the critical period of weed control in the crop was between two and six weeks from sowing .presowing irrigation proved to be very effective with tillage operations in northern Sudan. A post-emergence application of the grain yield of wheat by up to 61% (Mohammed, 1995).

2.6. Diseases

There are many wheat diseases, mainly caused by fungi, bacteria and viruses (Slafer and Satorre, 1999). Plant breeding to develop new disease-resistant varieties, and sound crop management practices is important for preventing disease. Fungicides used to prevent the significant crop losses from fungal disease; it can be a significant variable cost in wheat production. A wide range of organisms infects wheat, in which the most important are viruses and fungi. Seed-borne diseases: these include seed-borne scab, seed-borne *Stagonospora* (previously known as Septoria), *common bunt* (stinking smut), and *loose smut*. These are managed with fungicides.

Leaf and head blight diseases: powdery mildew, leaf rust, *Septoria tritici* leaf blotch, *Stagonospora* (Septoria) nodorum leaf and glume blotch, and *Fusarium* head scab (Gautam and Dill-Mackey, 2012).

Crown and root rot diseases: two of the more important of these are take-all and *Cephalosporium stripe*. Both of these diseases are soil borne.

Viral Diseases: Wheat spindle streak mosaic (Yellow mosaic) and barley yellow dwarf are the two most common viral diseases. Control can be achieved by using resistant varieties.

2.7. Pests

Wheat is used as a food plant by the larvae of some Lepidoptera (butterfly and moth) species including the flame, Rustic Shoulder-knot, Setaceous Hebrew Character and Turnip Moth, Early in the season ,birds and rodents can also cause significant damage to a crop by digging up and eating newly planted seeds or young plants. They can also damage the crop late in the season by eating the grain from the mature spike. Recent post-harvest losses in cereals amount to billions of dollars per year in the USA alone, and damage to wheat by various borers, beetles and weevils is no exception (Lavoisier, 2001). Rodents can also cause major losses during storage in major grain growing regions. Tracking insect infestations in stored grain is critical for food safety as well as for the marketing value of the crop.

2.8. Wheat harvesting

Wheat is harvested in the large projects using combine harvesters losses of seed can occur before harvesting due to wind, birds, rats and rain or by the movement of people in the fields.

During mechanical harvester losses of seed can occur due to header losses of the combine harvester that in include, dropped heads, shattered seeds and missed heads, which happen as the combine header passes over the wheat plants. At Gezira Scheme, field surveys showed that an increasing trend was observed in percent total grin losses with the delay of harvest. In the 1993-94 seasons, mean total harvesting losses amounted to about 13% (Dawelbeit and Abdelwahab, 1994).

2.9. The use of mutation in wheat improvement

Drought limits plant growth on a large proportion of the world's agricultural land. The effects of drought on yield of crops depend on their severity and the stage of plant growth during which they occur. Seed germination is the first stage of growth that is sensitive to water deficit. Under semiarid regions, low moisture is often a limiting factor during germination (Rauf *et al.,* 2007).. To start a proper wheat breeding program for improving drought tolerance, the source populations should possess a great amount of genetic variability amenable for efficient selection. Unfortunately, selections from new released high-yielding wheat cultivars would rarely isolate a new genotype. Inducing new genetic variability in wheat populations could be achieved *via* mutation breeding procedures, using physical or chemical mutagen agents (Jain 2010). Physical mutagens are efficient tools for increasing genetic variability. The most important physical mutagens include X-rays, gamma-rays and fast neutrons.

Searching for higher yielding drought tolerance wheat varieties, one of the Kenyan high yielding variety pasa was irradiated with Gama rays dose at (150 -200 –and 250 Gy) in 1991 so as to induce variability and select for drought tolerance. Six mutants (km 10 –km 14 –km 15 –km18 –km 20-and km 21) were selected at M4 for their drought tolerance screening the six mutants and 2 checks. Duma and pasa were tested for their performance trial. The study was carried out as a national dryland wheat performance trial in 4 sites in Kenya and selection done for two seasons, data on plant height yield and heat the weight were taken , the results showed that mutant line km 21 and km 14 performance significantly ($p<0.05$) better than the other elite ling in yield performance .

CHAPTER THREE

3-MATERIALS AND METHODS

The field experiments were conducted during the winter season of 2015-2016 in the demonstration farm of the agricultural studies college - Sudan University of Science and Technology, shambat. The longitude and latitude of the experiment site are 15.32˚N-32.32˚E.

3.1. Plant material

Seeds of nine cultivars were brought from Wheat Research Center - Agricultural Research Corporation – Wad medani; namely: Khaleefa, Elnileen, Emam, Nabta, Tagana, Condor, Debara, Argeen, and Bohain.

3.2. Radiation with Gama rays

Seeds of the nine cultivars were exposed to three doses (25, 45, 65 Gy) of Gamma rays.

3.3. Cultural practices

3.3.1. Culture pots and soil preparation

The experiments were executed in plastic pots (height 25.5 cm**,** diagonal 30 cm)**,** several holes were made in bottom of the pots for draining, and the pots were filled equally with clay and sand with a ratio of 2:1 respectively.

3.3.2. Sowing

Seeds were sown in the 15th November, 2015 in (5cm) depth, seeds rate was 12 seeds/pot.

3.3.3. Irrigation and fertilization

All pots were irrigated every 10 days before head appearance, 30 gram of organic fertilizer were applied for each pot before anthesis.

3.4. Experiment design

The experiment was divided to three groups; group (A): watering every 10 days, the irradiated wheat cultivars (with different levels of gamma rays 0.0, 25Gy, 45Gy, 65Gy) were randomly separated within the group and watered 13 times during the season.

Group (B): watering every 15 days, the irradiated wheat cultivars (with different levels of gamma rays 0.0, 25Gy, 45Gy, 65Gy) were randomly separated within the group and watered 9 times during the season.

Group (C): watering every 21 days, the irradiated wheat cultivars (with different levels of gamma rays 0.0, 25Gy, 45Gy, 65Gy) were randomly separated within the group and watered 6 times during the season.

Each group replicated three times. The different irrigation intervals started after heads appearance.

3.4.1. Effects of cultivar type on some growth parameters under water and radiation stresses condition.

This treatment compares the performance of nine wheat cultivars under different irrigation intervals and different gamma rays doses.

3.4.2. Effects of irrigation intervals on some growth parameters of nine irradiated wheat cultivars.

This treatment compares three irrigation intervals for nine irradiated wheat cultivars

3.4.3. Effects of gamma rays on some growth parameters for nine wheat cultivars under water stress condition.

This treatment compares the different gamma rays for nine wheat cultivars under water stress condition.

3.4.4. Interaction effects of irrigation intervals and irradiation doses on some growth parameters.

The interaction between irrigation intervals and gamma rays doses were tested in this treatment.

3.5. Harvesting and data collection

Data were recorded after three month of sowing date (from15 plants/pot), the growth parameters recorded were: plant height (cm), leaves number, tillers number, spikes number and root length (cm).

3.6. Data analysis

Statistix 8. program was uses for data analysis. Analysis of variance conducted using ANOVA table, means were separated using LSD test at 0.05 probability level.

CHAPTER FOUR

4-RESULTS

4.1. Effects of cultivar type on some growth parameters under water and radiation stresses condition.

The results presented in (Table 1.) showed significant differences among wheat cultivars in different growth parameters. For plant height; Tagana cultivar achieved the highest value (31.66^{a}), followed by Bohain, Debaira, Condor, Argeen, Emam, Elnileen and Khaleefa respectively, the least value for plant height (23.83^{d}) was obtained in Nabta cultivar. No significant differences were obtained between cultivars in leaves number. The highest mean number (0.94^{a}) of tillers was obtained in Tagana cultivar. Bohain, Condor, Tagana and Argeen cultivars achieved the largest mean value of spikes number respectively. The longest roots (14.49^{a}) were obtained in Tagana cultivar and the shortest roots (7.26^{e}) obtained in Condor cultivar. Tagana cultivar outstand other cultivars in most growth parameters.

Table 1. Effects of cultivar type on some growth parameters under water and radiation stresses condition.

Wheat cultivars	Plant height (cm)	No. leaves	No. Tillers	No. Spikes	Root length (cm)
Khaleefa	26.32^{cd}	3.37^{a}	0.31^{c}	0.95^{de}	14.38^{ab}
Elnileen	27.00^{bc}	3.31^{a}	0.68^{b}	0.98^{cde}	10.96^{cd}
Tagana	31.66^{a}	3.74^{a}	0.94^{a}	1.11^{bc}	14.49^{a}
Emam	27.23^{bc}	3.46^{a}	0.65^{b}	0.86^{e}	13.67^{abc}
Argeen	29.11^{abc}	3.62^{a}	0.60^{b}	1.02^{cd}	11.09^{bcd}
Condor	29.13^{abc}	3.66^{a}	0.61^{b}	1.19^{ab}	7.26^{e}
Bohain	29.43^{ab}	3.56^{a}	0.68^{ab}	1.28^{a}	8.80^{de}
Nabta	23.83^{d}	3.37^{a}	0.47^{bc}	0.89^{de}	13.90^{abc}
Debaira	29.37^{ab}	3.48^{a}	0.66^{b}	0.97^{cde}	10.29^{de}

Means with the same letter(s) in the same column are not significantly different at 0.05 probability level.

4.2. The effect of irrigation intervals on some growth parameters for nine irradiated wheat cultivars

The results in (Table 2.) showed the preference of watering every 10 days. There were high significant differences between irrigation intervals in almost all growth parameters measured. The water deficiency negatively affected the plant high, tillers number, spikes number and root length. But there were no significant differences between treatments in leaves number.

Table 2. Effects of irrigation intervals on some growth parameters of nine irradiated wheat cultivars.

Irrigation intervals	Plant height (cm)	No. Leaves	No. Tillers	No. Spikes	Root length (cm)
10 days	38.86[a]	3.90[a]	1.10[a]	1.28[a]	14.75[a]
15 days	28.64[b]	3.71[a]	0.57[b]	1.05[b]	11.42[b]
21 days	16.86[c]	2.92[b]	0.20[c]	0.76[c]	8.79[c]

Means with same letter(s) in the same column are not significantly different at 0.05 probability level.

4.3. Effects of gamma rays on some growth parameters for nine wheat cultivars under water stress condition

The effects of different gamma irradiation doses on some growth parameters were presented in (Table 3.). The best results for plant high (29.09[a]) and tillers number (0.83[a]) were obtained in the control treatment compared the other treatments with significant differences. There were no significant differences in leaves number, spikes number and root length between treatments. Different gamma radiation doses did not affect the wheat growth positively comparing with control.

Table 3. Effects of gamma rays on some growth parameters for nine wheat cultivars under water stress condition

Gamma rays doses (Gy)	Plant height (cm)	No. Leaves	No. Tillers	No. Spikes	Root length (cm)
0.0	29.09[a]	3.60[a]	0.83[a]	1.04[a]	11.46[a]
25	28.30[ab]	3.50[a]	0.57[b]	1.08[a]	11.40[a]
45	28.20[ab]	3.50[a]	0.58[b]	1.02[a]	11.82[a]
65	26.85[b]	3.37[a]	0.51[b]	0.98[a]	11.93[a]

Means with the same letter(s) in the same column are not significantly different at 0.05 probability level.

4.4. Interaction effects of irrigation intervals and irradiation doses on some growth parameters of wheat.

The interaction effects between irrigation intervals and gamma rays were presented in (Table 4.). The highest values of plant high were obtained at the interaction between different gamma rays doses with watering every 10 days; the best gamma rays dose was 25 GY (Figure 2.), followed by the interaction between gamma rays with watering every 15 days, the lowest values of plant high obtained at the interactions between gamma rays doses and watering every 21 day. There were no significant differences between the interactions of watering every 10 and 15 days for leaves number, but there were significant differences between them and irrigating every 21 days. The largest number of spikes obtained at the interaction of 25 Gy gamma rays with watering every 10 days (Figure 2.); the lowest values were achieved in watering every 21 days (Figure 1. 2. 3. 4.), the highest value of tillers number was achieved in the control treatment watered every 10 days. The longest roots were obtained in 65 Gy gamma rays dose treatment watered every 10 days.

Table 4. Interaction effects of irrigation intervals and irradiation doses on some growth parameters of wheat**.**

Irrigation intervals (days)	Gamma rays dose (Gy)	Plant height (cm)	No. Leaves	No. Spikes	No. Tillers	Root length (cm)
10	0.0	39.75^{ab}	4.05^{a}	1.19^{bc}	1.30^{a}	12.90^{abcd}
10	25	40.19^{a}	3.87^{a}	1.49^{a}	1.20^{ab}	13.80^{abc}
10	45	38.83^{ab}	3.90^{a}	1.30^{ab}	1.03^{b}	15.90^{ab}
10	65	36.69^{b}	3.73^{a}	1.28^{b}	0.90^{b}	16.43^{a}
15	0.0	30.70^{c}	3.83^{a}	1.14^{bcd}	0.96^{b}	12.18^{bcde}
15	25	28.02^{c}	3.70^{a}	1.016^{cd}	0.38^{cd}	11.31^{cdef}
15	45	28.50^{c}	3.63^{a}	1.008^{d}	0.58^{c}	11.17^{cdef}
15	65	27.40^{c}	3.68^{a}	1.022^{cd}	0.39^{cd}	11.09^{cdef}
21	0.0	16.89^{d}	2.99^{b}	0.78^{e}	0.16^{d}	9.27^{def}
21	25	16.82^{d}	3.044^{b}	0.80^{e}	0.23^{d}	$9.15d^{ef}$
21	45	17.26^{d}	2.90^{b}	0.71^{e}	0.18^{d}	8.39^{ef}
21	65	16.48^{d}	2.70^{b}	0.71^{e}	0.28^{cd}	8.34^{f}

Means with the same letter(s) in the same column are not significantly different at 0.05 probability level.

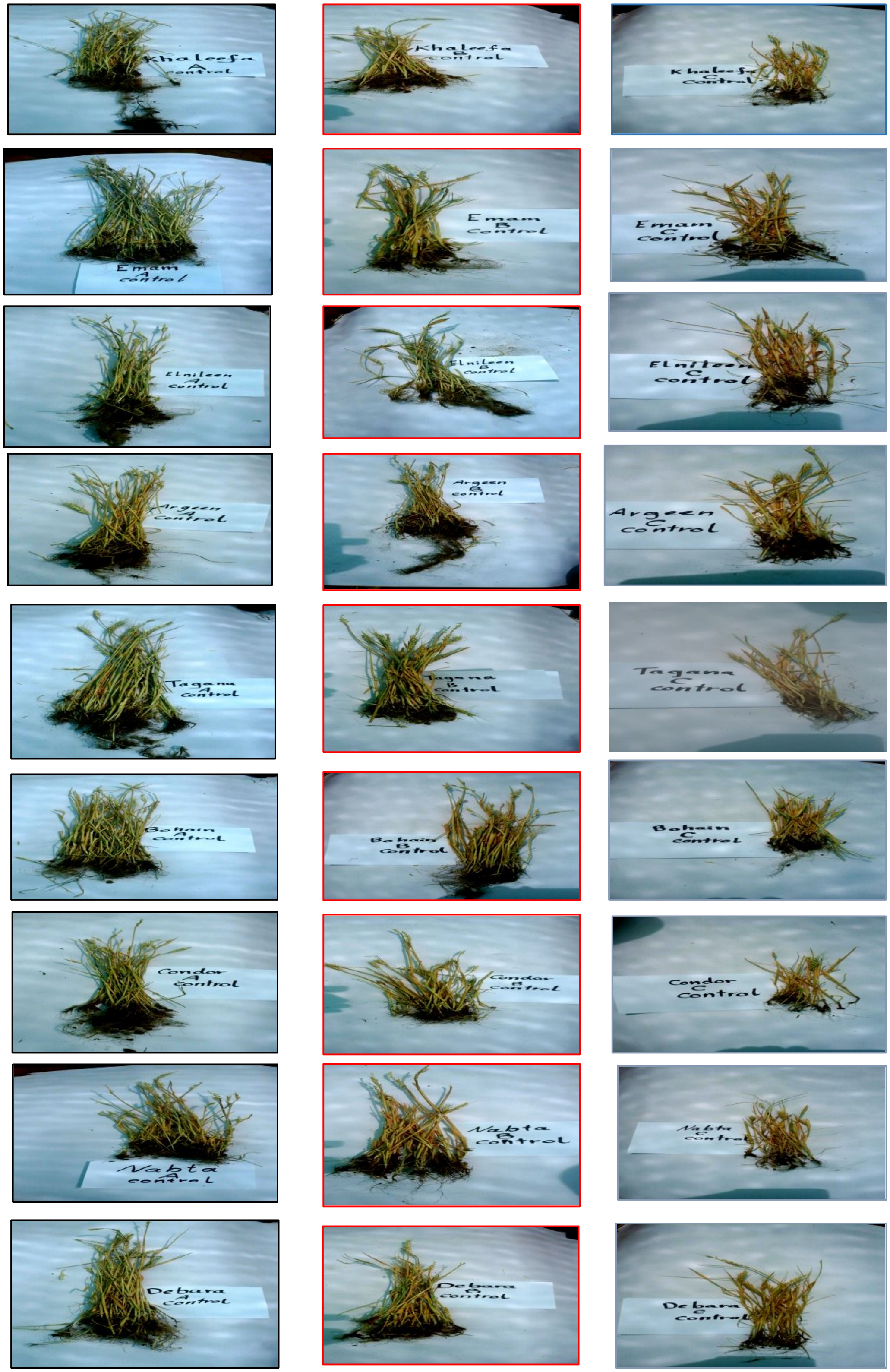

Figure 1. The performance of nine wheat cultivars (control) under different irrigation intervals
A) Watering every 10 days (left column).
B) Watering every 15 days (middle column).
C) Watering every 21 days (right column).

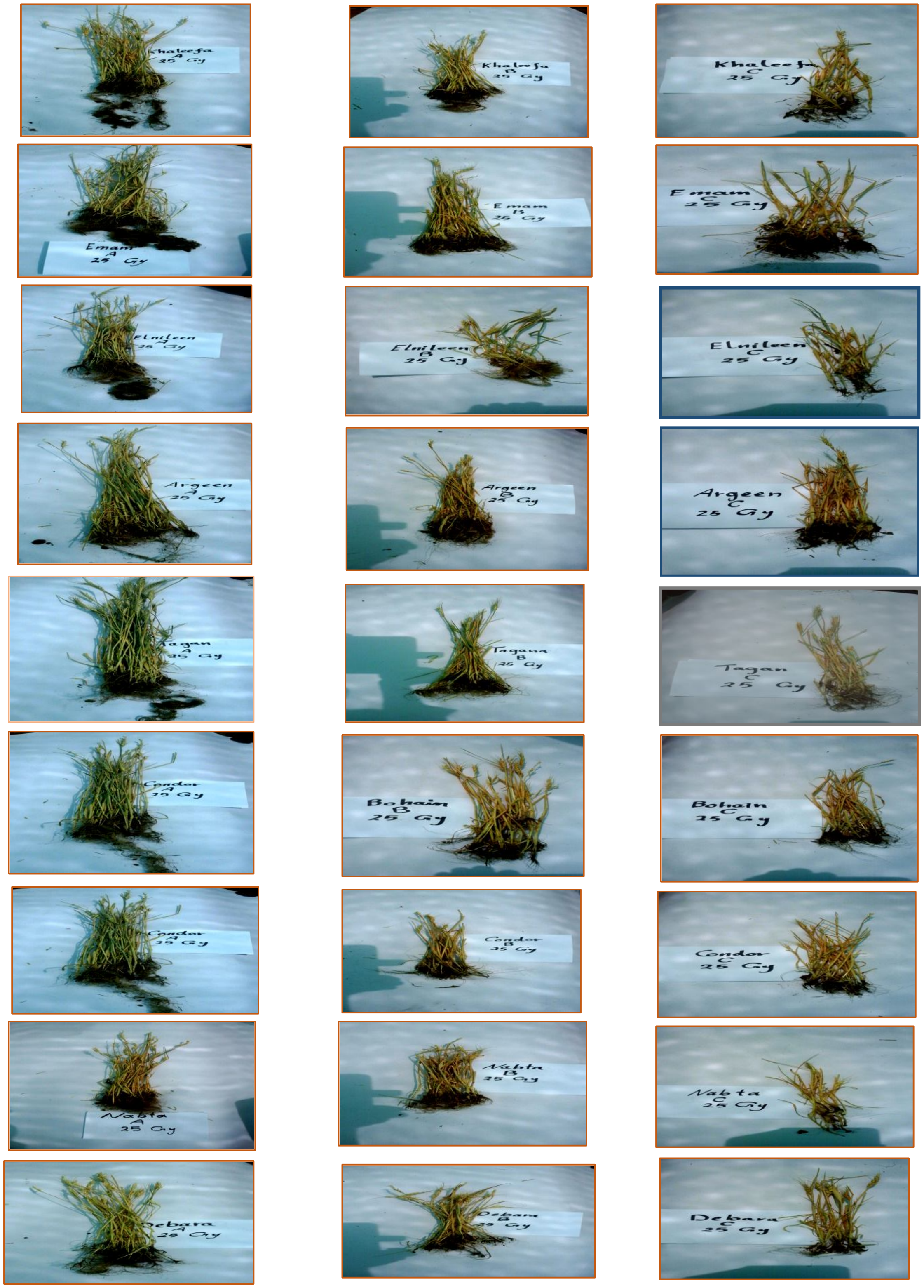

Figure 2. The performance of nine wheat cultivars (irradiated with 25 GY) under different irrigation intervals

A) Watering every 10 days (left column).

B) Watering every 15 days (middle column)

C) Watering every 21 days (right column).

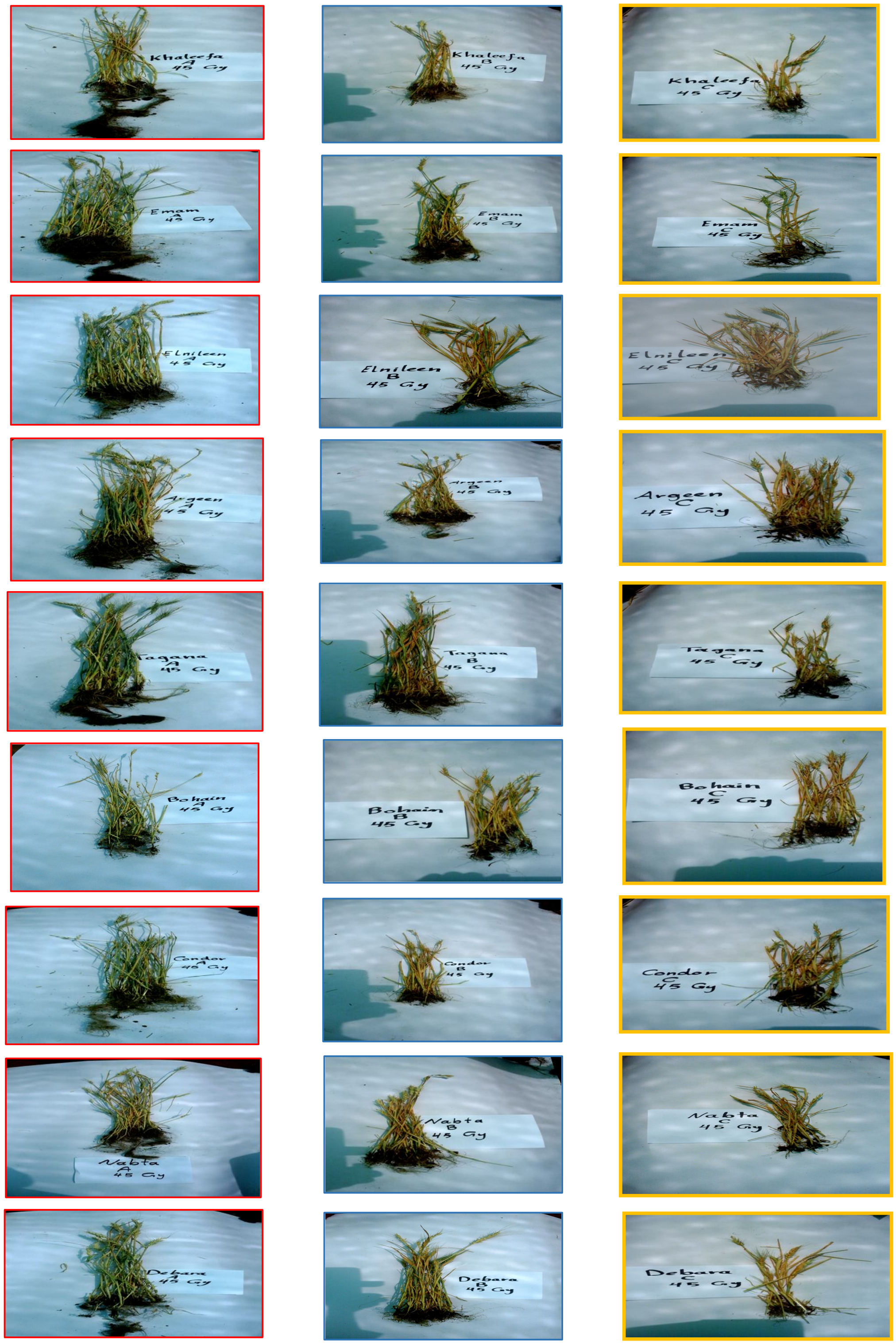

Figure 3. The performance of nine wheat cultivars (irradiated with 45 GY) under different irrigation intervals
A) Watering every 10 days (left column).
B) Watering every 15 days (middle column).
C) Watering every 21 days (right column).

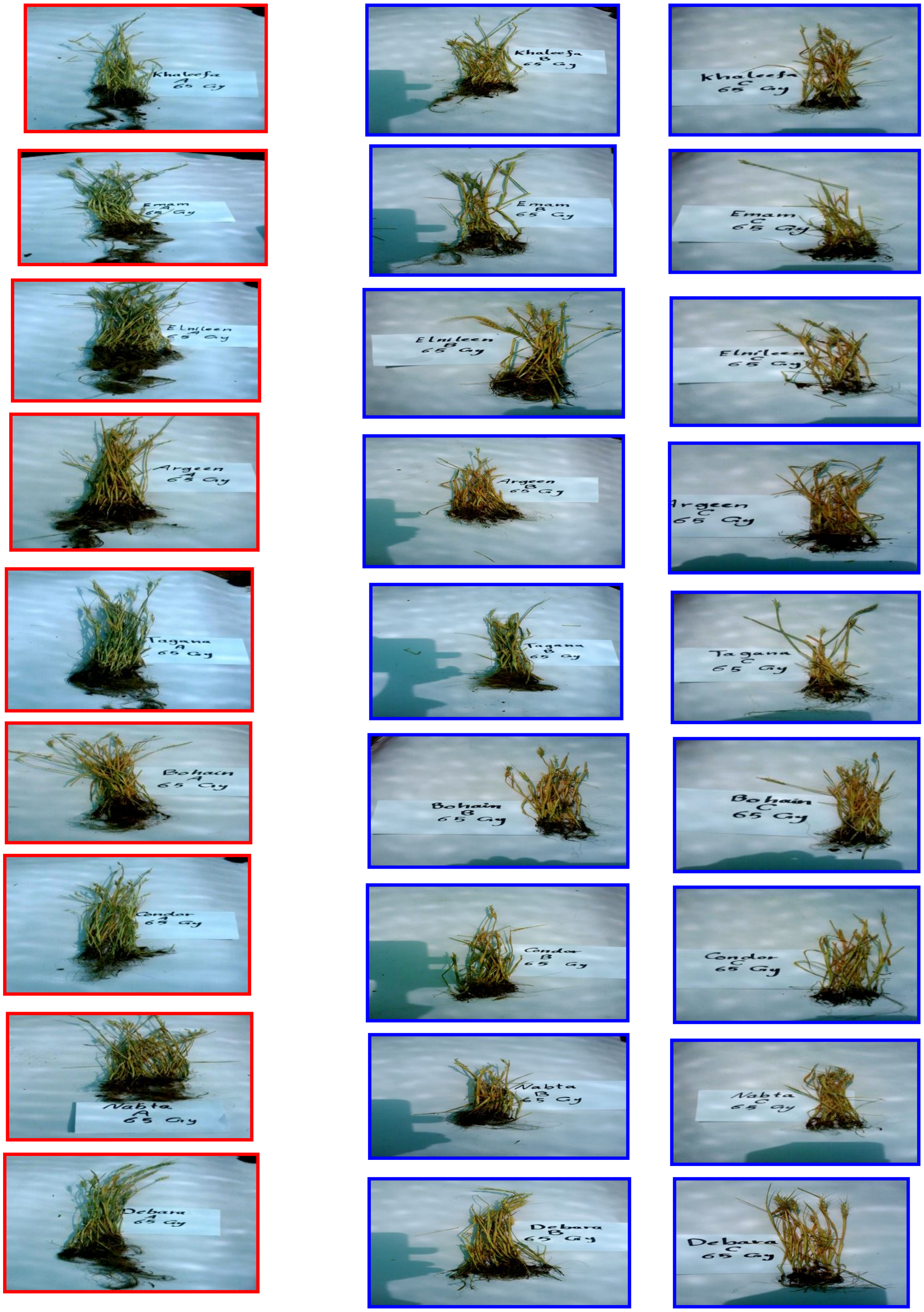

Figure 4. The performance of nine wheat cultivars (irradiated with 65 GY) under different irrigation intervals

A) Watering every 10 days (left column).

B) Watering every 15 days (middle column).

C) Watering every 21 days (right column).

CHAPTER FIVE

5-DISCUSSION

Our results agreed with the finding of (Pan *et al.*, 2002); he reported that the stress factors especially drought, negatively affect plant growth and development and causes a sharp decrease of plants productivity. In addition Le Thiec and Manninen, 2003 reported that the most common symptom of water stress injury is the inhibition of growth, which is reflected in a reduction in the dry matter yield. Water deficit inhibits photosynthesis as it causes chlorophyll content alterations, harms the photosynthetic apparatus (Costa *et al*., 1997).

Drought stress causes great losses in wheat yield and its components (Bruckner and Frohberg, 1987), (Clarke *et al.*, 1992). Using wheat cultivars that tolerate drought stress could solve this problem. Blum, 1983 stated that the ideal genotype for moisture stress conditions must combine a reasonably high yield potential with specific plant characters, which could buffer yield against severe moisture stress.

Al-Naggar *et al.*, 2013 indicated that 350 gray (Gy) was the best gamma ray dose to irradiate the studied wheat genotypes for inducing useful mutants he reported that the highest estimates of genetic parameters were exhibited by the M2 populations derived from Sids-4 and Maryout-5.

Gamma rays have been proved economical and effective as compared to other ionizing radiations because of its easy availability and the power of penetration. This penetration power of gamma rays helps in its wider application for the improvement of various plant species (Moussa, 2006). Sjodin, 1962 reported that the material and energy necessary for initial growth are already available in the seed, and so the young embryo has no need to form new substances, but only to activate those already stored in the cotyledons. Low doses of γ-radiation may increase the enzymatic activation and awakening of the young embryo, which results in stimulating the rate of cell division and affects not only germination, but also vegetative growth and flowering. Exposing the dry seeds to low γ-irradiation doses resulted in the increasing yield of some plants such as sunflower (Abo-Hegazi *et al.*, 1988) and *Ammi visnage* (El-Shafie, 1993).

Conclusion

In this study low doses of gamma rays were tested to study its effects on wheat growth under water stress and to induce useful mutation affect wheat drought tolerance positively. Results showed significant differences among cultivars in plant high; Tagana cultivar achieved almost the highest values of growth parameters among other cultivars. Results showed the preference of watering every 10 days; there were high significant differences between irrigation intervals in almost all growth parameters measured. The water deficiency negatively affected the plant high, tillers number, spikes number and root length.

There were no significant differences between gamma rays doses tested in almost all growth parameters measured. The best results for plant high and tillers number were obtained at the control treatment; there were no significant differences in leaves number, spikes number and root length between gamma rays doses tested.

The interaction treatments results showed that 25 GY dose in interaction with watering every 10 days gave the highest value of plant high; followed by the interaction between gamma rays with watering every 15 days, the lowest values of plant high obtained at the interactions between gamma rays doses and watering every 21 day. The largest number of spikes obtained at the interaction of 25 Gy dose with watering every 10 days and the highest tillers number was achieved in the control treatment watered every 10 days. The longest roots were obtained in 65 Gy dose treatment watered every 10 days.

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