

**PHYSIOLOGICAL EFFECTS OF
GAMMA-RADIATION ON SEED GERMINATION**

THESIS

Submitted in Partial Fulfilment for the Degree

of

MASTER OF SCIENCE (M. Sc.)

in

Botany (Plant Physiology)



19802

581.134
S.S.

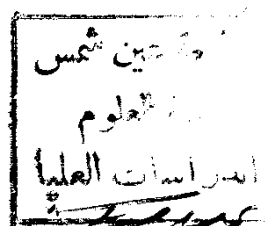
By

SOMIA SALAH EL-DIEN EL-AKKAD

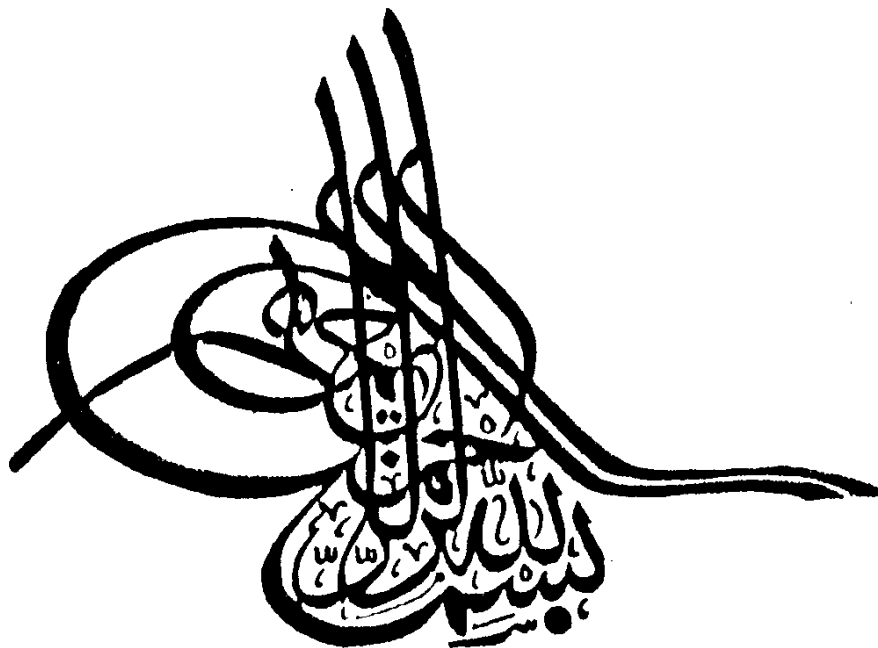
(B. Sc.)



Ain Shams University
Faculty of Science
Botany Department



1985





TO
MY PARENTS

and

MY HUSBAND

This thesis has not been previously
submitted for any degree at this or
at any other University.

Somia Salah-EL-Dien El-Akkad.

ACKNOWLEDGMENT

I wish to express my deepest gratitude to Dr. Hassan Anwar Foda, Professor of Plant Physiology and Head of Botany Department and Dr. Azza S.El-Shafey Lecturer of plant Physiology. Faculty of Science, Ain Shams University for suggesting the point of research, supervision, constructive criticism, continuous discussion and help throughout this work.

Sincere thanks and gratitude to Dr. Raifa A. Hassanein, Assistant Professor of plant physiology., Ain Shams University, for her valuable help and encouragement.

I wish also to express my thanks to all the staff members and my fellow research students of Botany Department.

C O N T E N T S

	Page
INTRODUCTION.....	1
MATERIALS AND METHODS.....	30
A- MATERIALS.....	30
B- METHODS.....	30
1- Estimation of carbohydrates.....	30
a) Estimation of direct reducing value.....	31
b) Estimation of reducing value after sucrose hydrolysis.....	33
c) Estimation of polysaccharides.....	33
2- Estimation of nitrogenous constituents.....	34
a) Estimation of total soluble-nitrogen.....	34
b) Estimation of amino-nitrogen.....	35
c) Estimation of total-nitrogen.....	37
3- Estimation of oil content.....	37
4- Estimation of nucleic acids contents.....	38
5- Extraction and assay of certain enzymes.....	41
a) Catalase enzyme.....	41
b) Peroxidase enzyme.....	42
c) Lipase enzyme.....	42
d) IAA-Oxidase enzyme.....	43

	Page
6- Extraction , Separation and Bioassay of Growth Regulating Substances.....	44
Bioassay of auxins and growth inhibitors.....	47
Bioassay of gibberellins and gibberellin-like substances.....	48
Biassay of cytokinin substances.....	50
EXPERIMENTAL RESULTS.....	
EXPERIMENT I.....	53
Physiological effects of seed-irradiation with different doses of gamma rays on <u>Phaseolus vulgaris</u> seedlings.....	53
1- Effect of gamma-irradiation on the germination percentage of <u>Phaseolus vulgaris</u> seeds.....	54
2- Effect of gamma-irradiation of <u>Phaseolus vulgaris</u> seeds on seedling growth.....	55
3- Effect of seed-irradiation with gamma rays on the carbohydrate content of dry ungerminated and germinated <u>Phaseolus vulgaris</u> seeds.....	60
4- Effect of seed-irradiation with gamma rays on the nitrogen content of dry ungerminated and germina- ted <u>Phaseolus vulgaris</u> seeds.....	62

	page
5- Effect of seed-irradiation with gamma rays on the oil content of dry ungerminated and germinated <u>Phaseolus vulgaris</u> seeds.....	64
6- Effect of seed irradiation with gamma rays on the nucleic acid content of dry ungerminated and germinated <u>Phaseolus vulgaris</u> seeds.....	64
7- Effect of seed-irradiation with gamma rays on the activity of certain enzymes of <u>Phaseolus vulgaris</u> seedlings.....	67
A- Changes of peroxidase activity.....	67
B- Changes of catalase activity.....	67
C- Changes of lipase activity.....	67
D- Changes of IAA-oxidase activity.....	70
8- Effect of gamma-irradiation on auxins, growth inhibitors, gibberellins and cytokinins of <u>Phaseolus vulgaris</u> seedlings.....	70
1- Changes in auxins and growth inhibitors.....	70
2- Changes in gibberellins and gibberellin-like substances.....	73
3- Changes in cytokinin substances.....	76

	Page
EXPERIMENT II.....	79
Physiological effects of seed-irradiation with different doses of gamma rays on <u>Arachis hypogea</u> seedlings.	79
1- Effect of gamma-irradiation on the germination percentage of <u>Arachis hypogea</u> seeds.....	80
2- Effect of gamma-irradiation of <u>Arachis hypogea</u> seeds on seedling growth.....	81
3- Effect of seed-irradiation with gamma rays on the carbohydrate content of ungerminated and germinated <u>Arachis hypogea</u> seeds.....	86
4- Effect of seed-irradiation with gamma rays on the nitrogen content of ungerminated and germinated <u>Arachis hypogea</u> seeds.....	88
5- Effect of seed-irradiation with gamma rays on the oil content of ungerminated and germinated <u>Arachis hypogea</u> seeds.....	90
6- Effect of seed-irradiation with gamma rays on the nucleic acid content of ungerminated and germinated <u>Arachis hypogea</u> seeds.....	90
7- Effect of seed-irradiation with gamma rays on the activity of certain enzymes of <u>Arachis hypogea</u> seedlings.....	93

	Page
A- Changes of peroxidase activity.....	93
B- Changes of catalase activity.....	93
C- Changes of lipase activity.....	96
D- Changes of IAA-oxidase activity.....	96
8- Effect of gamma-irradiation on auxins, growth inhibitors, gibberellins and cytokinins of <u>Arachis</u> <u>hypogea</u> seedlings.....	96
1- Changes in auxin and growth inhibitors.....	96
2- Changes in gibberellins and gibberellin-like substances.....	99
3- Changes in cytokinin substances.....	101
EXPERIMENT III.....	104
Effects of seed-irradiation with certain doses of gamma rays on growth, flowering and fruiting of <u>Phaseolus vulgaris</u> and <u>Arachis hypogea</u> plants grown under field conditions.....	104
Time course experiment.....	104
Results.....	106
DISCUSSION.....	130
SUMMARY.....	152
REFERENCES.....	155
ARABIC SUMMARY.	

INTRODUCTION AND AIM OF WORK

INTRODUCTION

The application of radiation in different biological fields is now of prime importance. In spite of the intensive work with the different types of radiation in different purposes, it is somewhat surprising to find that so much uncertainty yet exists concerning their exact behaviour inside the living organisms. However, some of the immediate physiological changes which occur in living matter when radiation energy is absorbed are now well understood, but the complex sequence of events concerning these changes with the ultimate alternations in the cellular behaviour to which they give rise, is still largely unknown.

Radiation had attracted the attention of most, if not all, the scientists including physiologists, ecologists, cytologists, pathologists and those who are concerned with the field of plant breeding. In this respect, one may mention the striking application of radiation in the purpose of improving the food quality and its storageability. Numerous review articles are available on the changes produced in irradiated foods (Roushdy et al ., 1973; Elsayed, 1973 and Mahmoud, 1973). Radiation technique had proved to be very useful in the technological processing and nutritive

value of foods. Publications of Vakil et al. (1973) established the wholesomeness of irradiated foods on short and long-term feeding tests with experimental animals. Low-irradiation dose had been reported not to alter the nutritive value of foods. However, Ananthaswamy et al. (1971) reported that some changes occurred in the physico-chemical properties of macro-compounds like starch and proteins of foods may be expected to improve food quality.

In the following, the most important and striking effects of gamma and other ionizing radiations on the physiological state of plants will be reviewed.

Gamma radiation effects on seed germination

The sharp reduction in the percentage of seed germination is the most obvious effects of gamma radiation at the higher dosage levels. Singh (1974) observed that germination percentage of safflower seeds was gradually reduced as the doses of radiation increased. Exposures of the order of 40, 45 and 50 KR resulted in complete mortality. Consistent results were obtained by Van Huystee (1967) with pea nut seeds exposed to 250 and 500 KR of X-rays which showed 30 and 50 % reduction in germination respectively and 759 KR had completely inhibited their

germination. Also, Rokba & Aly (1982) showed that exposing seeds of some citrus varieties to acute doses of gamma rays had reduced the germination percentage by 7.9 % to 69.7 %. Moreover, irradiation treatments with the higher doses had delayed the seed germination from 4 to 7 days. El-Shafey (1978) found that higher doses of gamma rays (10000, 25000 and 50000 r.) markedly decreased the percentage of germination of the treated Vicia faba seeds.

However, the relatively adequate doses of gamma rays were reported to increase the percentage of germination and accelerate this process. In this respect, one may refer to the work of Woodstock & Justice (1967) and Banacher et al. (1971) who found that radiation doses (0.66 to 11 K rad) had a stimulating effect on germination of carrot seeds. Similarly, Shamsi et al. (1978) recorded that doses of 0.5 KR and 0.75 KR stimulated germination in three cultivars of broad bean. Badr and Abdel-Maksoud (1981) reported that low gamma radiation doses (1-5 KR) increased germination percentage of Portulaca grandiflora. Also, Lebedinete (1971) observed that under the effect of low doses of radiation (1000-3500 R) peanut seed germination was stimulated. Application of 3 and 5 K rad of gamma rays to Sorghum grains had increased the percentage of their germination (Sharon & Muralidharan, 1978).