ABSTRACT

Noura Mohammed Taha Mohammed Ali: Effect of Some Mutagenic Agents on Garlic Production. Unpublished M.Sc. Thesis, Department of Horticulture, Faculty of Agriculture, Ain Shams University, 2009.

In spite of garlic is one of the oldest crops under Egyptian cultivation, but productivity is very settled from a long time. This settlement is due to sexual sterility of garlic, hence it does not set seeds. Thus, induced mutation and clonal selection proved as an effective way for improving garlic crop. So, the aim of this work was to study the mutagenesis effect of gamma irradiation (at doses 2.5, 5 and 10 Gy), EMS (at concentrations 15 and 20 mM) and sodium azide (at concentrations 0.1, 0.2 and 0.3 g/l) on two garlic cultivars, Balady and Seds 40. The results indicated that in M1 generation the values of most studied traits were decreased at the high doses and high concentrations of gamma-rays and S.A. compared with control plants. In M2-generation, most of the studied characters showed higher rates when lower concentrations and lower doses were used, therefore, selection in this generation could be carried out.

Keywords:

Garlic, gamma rays, EMS, sodium azide, mutagenic, mutation

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviations	Full name
M1	First mutant generation
M2	Second mutant generation
M3	Third mutant generation
M1 plants	Plants of M1 generation
M2 plants	Plants of M2 generation
M3 plants	Plants of M3 generation
EMS	Ehylemethane sulphonate
SA	Sodium azide
MMS	Methylemethane sulphonate
DES	Diethyle sulphate
NEU	N-ethyle-N-nitrosourea
Cv (s)	Cultivar (s)
mM	Millimoler
Gy	Gray
Kr	Kilo rad

ACKNOWLEDGEMENT

Praise worthy and gratitude to **Allah**, for helping me and willing this work.

Great appreciation and deep gratitude are extended to **Prof. Dr. Ibrahim Ibrahim El-Oksh** Professor of vegetable crops, Horticulture Dept., Faculty of Agriculture, Ain Shams Univ. for his kind supervision, continuous guidance and encouragement and great support through the achievement of this work.

Great thanks also are extended to **Prof**. **Dr. Mohamed Hashem El-Deep** Professor of vegetable crops, Horticulture Dept., Faculty of Agriculture, Ain Shams Univ. for his encouragement, kind supervision and advice in presenting this thesis.

Sincere thanks and deepest gratitude are also extended to **Dr. Salah El-Deen Mahmoud El-Miniawy** Associate Professor of vegetable crops, Fac. of Agric., Ain Shams University for his encouragement, helpful discussion, keen supervision and help as well as offering the facilities needed to make this work possible.

Special thanks are due to **Prof. Dr. Mohamed Emam Ragab** Professor of vegetable crops, Department of Horticulture, Faculty of Agriculture, Ain shams University for his unlimited help, guidance in this work.

I am particularly grateful to **my husband Yasser El Gabery and my family** for their helps and continuous encouragement during my study period.

1. INTRODUCTION

Garlic (*Allium sativum* L.) is the second most widely cultivated *Allium*- after onion. Area planted with garlic in Egypt during 2007 season was 24853 feddans with an average of 9.43 tones /feddan. It has been recognized world-wide as a valuable spice for foods and a popular remedy for various aliments and physiological disorders. Garlic cultivars often vary in some characteristics including bulb weight, bulb diameter, clove number per bulb and storage-life. Garlic is a vegetatively propagated crop that doses not set seed under standard growing conditions **(Volk *et al.*, 2004)** and new genotypes have not been obtained through hybridization of spontaneous. Induced mutagensis with gamma rays, ethyl methane sulphonate (EMS) and sodium azide (SA) may help to overcome these genetic barriers.

Mutation breeding is tried to increase variability. Gamma irradiation, EMS and SA have been used successfully in several crop species for the induction of variability in quantitative and qualitative traits **(Costantin *et al.*, 1976).** There are few studies on using mutagensis in inducing mutation in garlic.

The first aim of this investigation was to study the efficiency of mutagenesis especially ethyl methane sulphonate (EMS), SA, gamma-rays and their combinations in the process of mutation in two cultivars of garlic, namely Balady and Seds-40, as well as to induce genetic variability for selecting mutants with desirable characters.

2. REVIEW OF LITERATURE

A few of review are available concerning the effect of irradiation on growth and yield of garlic, therefore literature concerning other crops will be reviewed.

2.1. Effect of irradiation on M1 – plants:

Gamma radiation is one of the most effective factors in improving plant production. Generally, low doses stimulate plant growth, while high doses have harmful effects **(El-Sherbeny *et al*., 1997; Youssef and Mousa, 1998)**. The stimulative effect of low doses of gamma rays irradiation on growth may be due to the increase of cell length or cell number and size, shifting in metabolites which promoted the stimulating effect of photohormones on biosynthesis of nucleic acids **(Pitirmovae, 1979).**

2.1.1. Effect of irradiation on emergence and vegetative growth:

Constantin *et al*. (1976) exposed seeds of soybean to 0, 15, 20, 25, 30, 35 and 40 Kr of gamma-rays. They found that seeding survival was unaffected by the gamma doses less than 70 K rad but decreased with an increase in dose of mutagens. Plant height was reduced by approximately 35% of control at 40 Kr.

Badr *et al.* (1978) exposed dry seed of two varieties of tomato to gamma radiation doses at 0,250,500, 1000, 2000 and 4000 r. They found that the doses 500 and 1000 r increased significantly the height of plants, compared with the control. However, the varieties did not respond similarly to the different radiation doses, indicating the presence of interaction effects between doses and varieties.

Shalaby *et al.* (1983 a) exposed cloves of Egyptian garlic cultivar Balady to 250, 500, 1000, 2000, 4000, 16000 and 32000 rad of gamma rays. They found that the highest values of clove germination were recorded by 250 and 500 rad. Higher doses of gamma ray (2000 and or more) had an inhibitory effect on clove germination. The higher doses of gamma radiation had decreasing effects on number of leaves and plant height.

Coppola (1986) irradiated tubers of Jerusalem artichoke cv. Violet de Rennes with 3 Kr of gamma rays .It was found that some plants showed abnormal leaf shapes and sizes and a few had white – skinned tubers instead of red. Plants developed from these white tubers had unbranched stems that were thinner than those of controls.

Oommen and Gopimony (1986) treated seeds of the *vigna unguiculata* with 6 doses of γ rays i.e. 5, 10, 15, 20, 25, 30 Kr. They found that, there were reductions in M1 plant survival, plant growth and fertility. Chlorophyll mutation frequency was increased with increasing mutagenic treatment. They also found that the most efficient (mutation frequency/damage) dose, estimated on the basis of lethality or sterility, was 10 k rad, while on an injury basis it was 30 k rad.

Hammad *et al.* (1988) exposed the grains of barley to 0, 2,4,8,16,32 and 64 Kr of gamma- rays from a Co^{60} source. They found that irradiated barley grains with 2-8 K rad increased germination percentage, germination rate index, plant height, number of tillers and leaves as well as dry weight of plant.

Abd El – Halem *et al.* (1989) irradiated the grains of wheat with 0,2,4,8,16,32,64 Kr of gamma rays from a Co^{60}source. They found that, irradiating grains with the range of 2-8 K rad caused an increase in germination percentage, germination rate index, coefficient of germination ratio and growth characters, i.e., plant length, number of tillers and leaves per plant as well as dry weight of plant, but the higher doses up to 64 K rad depressed all characters.

Abo-Hegazy (1980) exposed the seeds of bean to 0.5, 1, 2, 2.5, 3, 4.5 and 10 Kr of gamma – radiation. The average plant height was increased by the intermediate doses. Whereas the high doses caused some stunting effect. The intermediate doses tended to increase the average number of branches for plant. High doses of radiation showed some stimulating effects on leaf area, compared with the lower or intermediate doses.

Abd El–Maksoud (1992a) exposed dry seeds of *Solanum pseudo capsicum* to different doses of gamma – rays (0, 5, 10, 15, 20 and 25 Kr). It was found that the dose of 5 Kr significantly increased the plant height, while the doses from 15 to 25 Kr caused a significant reduction in plant height compared with the control plants, and no significant differences were detected among the doses from 0 to 15 Kr on number of branches at the end of both seasons.

Mokable *et al.* (1992) exposed seeds of broad bean cvs. Rebaya and Romy to different doses of gamma – rays (0, 1, 2 and 4 Kr). They found that the high doses of gamma radiation caused the tallest plants of cv. Rebaya in all stages, while in cv. Romy the lower dose was superior in the first and last stages. Also, the three doses of gamma radiation tended to increase branching in the two varieties in the last stages.

Al-Safadi and Simon (1996) exposed dry seeds, germinated seeds and tissue culture of carrot to gamma radiation. Irradiation accelerated germination of carrot seed in M1 generation at the 1ow doses (0.5 and 1 K rad), whereas higher doses delayed germination. Plant size and root weight were 20 to 35% greater than control plants. They found that higher doses reduced M1 plant size by > 50% in germinating seed and tissue culture treatments but were less for the dry seed treatment.

Alvarez (1996) irradiated garlic cloves of cv. Morado Arequipeno to 1, 3, 6, 9, 12 and 15 Gy doses of gamma rays, at 90 days after harvest in order to artificially induce phenotypic variations. The results showed that the different doses induced different phenotypic variations in the M1 population.

Sharma and Pandey (1996) found that low gamma irradiation doses up to 8 kr in potatoes gave useful mutations and led to selection of clones with better tuber characters, also, irradiation beyond 8 Kr adversely affected number and size of whole tubers and slowed down sprouting during storage at room temperature.

Talavere and Cervantes (1999) irradiated small (<8 m) and large (>8m) size of cloves of 5 garlic varieties with 4,8,12, 16 and 20 Gy. Plant height was evaluated 25 days after planting. They found that the radiosensitivity varied significantly between cloves of different size.

Abd El–Rahman (2000) treated the seeds of *Citrullus colocynthis* with 0.5, 10, 15 and 20 Kr of gamma rays. It was found that the low doses of gamma rays (5 and 10Kr) promote stem length, number of leaves and branches. However high doses (15 and 20 Kr) reduced plant fresh and dry weight.

Bader *et al.* (2000) treated dry seeds of *Tagetes erecta* L. with different doses of gamma rays (0, 5, 10 and 15 Kr). They found that the doses of gamma rays more than 5 Kr gave the lowest germination percentages in both seasons. Also, there were no significant differences among the different treatments of gamma rays in M1 and M2-generations of both seasons on the plant height. All doses of gamma rays delayed the flowering date in all generations for both seasons.

Pellegrini *et al.* (2000) exposed bulb of garlic cv. Colorado to 2,5,10,30,60,90,150 Gy from a Co^{60} gamma rays .They found that high doses caused the complete inhibition of sprouting and mitosis (due to nuclear aberrations) while the relatively low dose showed no effects on bulbs. The doses of 10 Gy applied in post – dormancy were the exception because they reduced sprouting more than 50% on sown bulbs.

Selvaraj *et al.* (2000) exposed cloves of garlic varieties Mettupalayam and Ooty-1 to two doses of gamma rays (2.5 and 5 Gy). They found that increasing doses of gamma rays increased the rate of lethality, injury and clove sterility of treated populations, mutation for plant ,leaf and shoot morphology were more frequent than bulb characters in both varieties .Also, non- viable mutants were dose dependant and this increased with higher doses.

Taner *et al.* (2006) exposed cloves of garlic to 0,5,10,15,20,25 and 30 Gy doses of Cs 137. They found that the germination rate and shoot