GENETIC STUDIES OF THE COMBINED EFFECT OF GAMMA-RAYS AND CHEMICAL MUTAGENS ON BARLEY

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B. Sc. Agric. (Genetics), Ain Shams University, 1977

THESIS

Submitted in Partial Fulfilment of The Requirement for the Degree

OF

MASTER OF AGRICULTURAL SCIENCE

IN

GENETICS

Department of Genetics
Faculty of Agriculture
Ain Shams University

1987

APPROVAL SHEET

Title of thesis : Genetic Studies of the Combined Effect of Gamma-rays and Chemical Mutagens on Barley.

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Date : / / 1987

بسم الله الرحمن الرحيم

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation and gratitude to Prof. Dr. A. Z. EL-ABIDIN SALAM *Prof. of Genetics, Faculty of Agriculture, Ain Shams University, Dr.* R. A. EL-ADAWY *Associate Professor of Genetics, Faculty of Agriculture, Ain Shams University and Dr.* M. A. EL-GAYAR *Associate Professor, Desert Research Institute, for their guidance, suggesting the problem, continued interest, fruitful help, and constructive critism throughout the course of this work.*

Thanks are due to all the staff members of Dep. of Genetics, Faculty of Agriculture for providing facilities and helps. Specially Dr. EMAN M. FAHMY *for her sincere help in the work of electrophoresis.*

Acknowledgement is also extended to all members of the Department of Crops, Desert Research Institute, for providing facilities and helps.

I feel also obliged and grateful to my husband and my family for their continuous encouragement and for their kind help and patience.

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INTRODUCTION

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Barley (Hordeum Vulgare) is one of the most important cereal crops in the world. It is known to possess the ability to stand with drought and salinity besides its lower requirements of nitrogenous fertilizers. Therefore, it could be grown in soils under reclamation.

Since Muller's (1927) original paper on the induction of genetic changes through x-irradiation, mutation breeding takes place along with traditional breeding methods in many parts of the world.

During the last decade, the using of mutagenic chemicals has been strongly strengthened. The most important ones are ethyl methan sulfonate (EMS), diethyl sulfate (DES), dimethyl sulphate (DMS) and ethylene imine (EI). The mutagenic effeciency of these chemicals are comparable to the physical mutagens used, or even better (Conger and Carabia 1977; Sander and Muehlbauer 1977).

Nowadays, mutation breeding is predominatly used in higher plants not only to produce high yielding varieties but also to obtain a collection of new mutations for a gene bank. New genes can be obtained for conventional programs to be able to handle a gene bank in a most efficient way. (Hagberg *et al* 1983). Therefore, mutation breeding, at least may free the plant breeder from dependence on natural variability hardly makes a compelling case for adopting mutation breeding as general method for plant improvement.

At present, about 500 officially released varieties, derived from experimentally induced mutations are available. In many cases, the expenditure in time was considerably less than the time necessary for developing a variety by using conventional methods (Gottschalk and Wolff, 1983).

The main objective of the present investigation was to study the efficiency of different doses of gamma rays, dimethyl sulphate (DMS) and their combined treatments on variability and mutation processes in barley plants.

REVIEW OF LITERATURE

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It is well known in field crops that almost 500 experimentally mutants have been developed into officially released or approved varieties. The most remarkable results in this field were obtained in barley, if we do not consider the big group of ornamentals showing a specific behaviour which cannot be generalized. The first barley mutant variety, released in 1955 in the German Decmocratic Republic, was "Jutta", derived from an X-ray induced mutant. At least 57 barley mutant cultivars have been developed until 1977 (Gottschalk and Wolff 1983). They, also, mentioned that the number of realeased barley varieties were rapidly increased since 1967.

The utilization of radiation induced mutants for subsequent use of further irradiations proved to be a remarkable successful method for obtaining a large number of new mutants (Broertjes et al., 1980)

A survey on the mutagens used for developing 485 released or approved mutant varieties has been given by Gottschalk and Wolff 1983. They found that only 5.2% of the group have been obtained by chemical mutagens and 0.8% of the group have been obtained by the combination of physical and chemical mutagens. This does not mean, however, that the chemical mutagens are less important in mutation breeding than the physical one's.

Nowadays, chemical mutagens are widely utilized and it can be expected that on essentially higher portion of commercialized varieties will originate from chemical mutagenesis in future, at least in the sexually propagated crops. For example, the following barley mutants were induced by using alkylating agents; some of them used in crossbreeding and others were released as commercial varieties :

Short stemmed mutant with higher yield, (Gustafsson 1969,, Scholz, 1971; Yamaguchi et al.,1974, Sethi 1975, Konishi 1976 and Stephanov and Gorastev 1976).

Early flowering mutants, (Gustafsson 1966, Scholz 1971, Yamashita et al.,1972, Yamagnchi et al.,1974 Stephanov and Gorastev 1976 and Ukai and Yamashita 1980).

Disease resistant mutant, (Schwarzbach 1967; Hanis 1974, Fuchs et al.,1974, Einfeld et al.,1976, Robbelen *et al.*, 1977, Abdel-Hafez and Robbelen 1979, 1981).

Protein and lysine mutants, (Doll 1972, 1980; Balaravi *et al.*,1976; and Koie and Doll 1979).

For the diversity of the work reported in this thesis, the literature dealing with the induced variability in some quantitative characters as well as chlorophyll and morphological mutants and protein mutants which induced by physical and chemical mutagens and its combinations are reviewed as separately

a) Variability induced in quantitative characters :-

Many quantitative characters of cereal crops such as wheat and barley are controlled by polygenic systems. These characters can altered be easily positively or negatively under the influence of mutant genes.

By using physical and chemical mutagens, many investigators obtained marked variability for plant height (Borojevic, 1965, 1966; Tavcar, 1965; Borojevic and Borojevic, 1969; Vasudevan *et al*, 1969; Gill *et al.*, 1974; Ibrahim and Sharaan, 1974; Galal *et al*, 1975 and Larik, 1975), number of tillers per plant (Goud, 1967, 1968 and Kumar, 1977); Culm diameter (Larik, 1975), Spike Length (Vasudevan et al, 1969; Ibrahim and Sharaan, 1974; Galal et al, 1975 and Kumar,1977). number of spikelets per spike (Goud, 1967, 1968,Gill et al 1974; Galal et al, 1975 and Kumar, 1977), number of grain per spike (Mehta, 1972; Ibrahim and Sharaan, 1974 and Galal et al, 1975); grain weight (Goud, 1967, 1968; Galal et al.1975; Larik, 1975 and Kumar, 1977) and grain yield (Vasudevan et al, 1969 and Morsi et al 1977). The mean values of these traits have been shifted considerably in the desired direction.

On the other hand, Khadr (1970) found that the gamma irradiation or ethyl methan-sulphonate (EMS) increased the variability of seed width, length, and weight of wheat plants, but had no effect on the mean values. Also, Mishra and Das (1974) induced considerable variability for plant height, spike length, number of spikes per plant, number of grains per spike, grain weight and grain yield of barley plants in M_3 and M_4 generations by gamma-rays. Their results showed that the means shifted in either direction in M_3 and in the negative direction in M_4 generation. The same authers (1976) reported that the means of genetic variances for plant height, tiller number, spike length, grain number and grain yield of barley in M_3 and M_4 generations were generally reduced at the highest gamma-ray dose (40 kr.).

Shah et al (1968) noticed that the deleterious effect of irradiation was found in the first generation and was absent in the second generation. But, Syed et al (1968) found that gamma-rays have harmfull effect on final yield of wheat in both M_1 and M_2 generations, although, most of irradiation effect was restricted to the M_1.

The effect of gamma-rays on yield and yield components were more pronounced at the higher dose rates. Grain yield and its components were decreased by the increasing gamma-ray dose (Mohamed et al., 1964 and Shah et al., 1968). The dose of 10 and 20 kr. of gamma-rays increased the dry weight, plant height and number of tiller per plant (Sharabash et al, 1972). Doses higher than 20 kr. in wheat (Sharabash et al, 1972) and higher than 35 kr. in barley (Nikdov, 1981) had the greatest depressing effects on stem length and growth.

Thakare et al (1974) found that the two hour treatment with 0.3% DES caused a reduction in seedling height.

The combined treatment of gamma-rays and alkylating agents were studied by many investigators (Nilan *et al*, 1962 and Mohan Rao 1972) who noticed that DES in combination with gamma-rays caused significant interaction leading to synergistic effect on barley seedling height.

Habetinek (1973) reported that the maximum variability in 1000-grain weight and number of grains per spike occurred after the combined treatment of irradiation (10 kr.) and EMS (0.2%). He , also, found that treatment with a single mutagen had more effect on spike length. Orav (1973) studied the ear length, stem thickness and number of fruiting stems of spring barley after seeds treated with various gamma-ray doses and EI. He reported that the strong effect of the gamma-rays masked the effects of EI in the M_2, but in the M_3 the influence of the gamma-rays was weakened, and the changes cause by EI become more apparent.

b) Chlorophyll mutations :

Chlorophyll mutants, are a chlorophyll deficient which happen as a result of disturbance in pigment synthesis or plastid's function in leaves. In most cases,chlorophyll mutations lead to death or lethality