

THE EFFECT OF GAMMA IRRADIATION ON THE GERMINATION AND GROWTH OF TURDA STAR MAIZE HYBRID DRY SAMPLES

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ABSTRACT

In order to study the effects of gamma rays on germination indices i.e. germination index (GI), total germination (GT) and the germination energy (GE), of maize hybrid, Turda Star current experiment was conducted. Dry seeds of Turda Star maize hybrid were irradiated with 2, 5, 15, 30 and 50 Gy, using a ⁶⁰Co-gamma radiation source.

Results showed that gamma irradiation affected all the above mentioned parameters except germination percentage. Total germination and germination energy was significantly affected at higher doses of gamma rays. However, increasing doses of gamma rays did not have significant effects on seed germination percentage. The other growth parameters showed declining tendency with increasing doses of gamma irradiation.

Keywords: gamma ray, maize hybrid, seed germination

INTRODUCTION

Nuclear techniques, in contrast to conventional breeding techniques, are widely applied in agriculture for improving genetical diversity. Unlike conventional breeding procedures which involve, the production of new genetic combinations from already existing parental genes, nuclear technology causes exclusively new gene combinations with high mutation frequency. Basic tool of nuclear technology for crop improvement is the use of ionizing radiation which causes induced mutations in plants. These mutations might be beneficial and have higher economical values.

Gamma rays generally influence plant growth and development by inducing cytological, genetical, biochemical, physiological and morphogenetic changes in cells and tissues (Gunckel & Sparrow, 1961). There are some reports which showed that the higher exposures of gamma rays were usually inhibitory (Bora, 1961; Radhadevi & Nayar, 1996; Kumari & Singh, 1996), whereas lower exposures were sometimes stimulatory (Torne & Desai 1965; Taylor, 1968; Sparrow, 1966; Mujeeb & Greij, 1976; Mathew & Gaur, 1975; Raghava & Raghava, 1989; Thapa, 1999). (Majeed et al., 2010)

Gamma rays are the most energetic form of electromagnetic radiation, possesses the energy level from 10 keV to several hundred kiloelectron volts, and they are considered as the most penetrating in comparison to other radiation such as alpha and beta rays (Kovacs & Keresztes, 2002). Gamma rays belong to ionizing radiation and interact on atoms or molecules to produce free radicals in cells. These radicals can damage or modify important components of plant cells and have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants depending on the irradiation level. These effects include changes in the plant cellular structure and metabolism e.g., dilation of thylakoid membranes, alteration in photosynthesis, modulation of the antioxidative system and accumulation of phenolic compounds (Kim *et al.*, 2004, Wi *et al.*, 2005). (Ikram et al., 2010)

The objectives of the present investigation were to (i) treat the seeds of Turda Star maize hybrid with gamma rays (⁶⁰Cobalt) and (ii) evaluate the seed germination and various growth parameters of this hybrid maize.

The vegetal material, represented by maize, was chosen due to its agricultural and economic contribution. Maize has been a model species for researchers since it became the first plant to have a genetic map, published in 1935. (Bennetsen, Hake,). The hybrid used in this study has been registered in 2005 at the Agricultural research and development station Turda, Romania.

MATERIALS AND METHODS

Dry seeds of *Turda Star maize hybrid* were treated with different doses of gamma rays irradiated with different doses of gamma rays (2, 5, 15, 30 and 50 Gy), using a ⁶⁰Co gamma radiation source emitting at 5,72 Gy/h rate at Babes-Bolyai University, Physics Faculty, from Cluj-Napoca, Romania.

The Turda Star maize hybrid seeds were obtained from Agricultural research and development station Turda, Romania. Samples of 40 dry seeds were packed in polyethylene bags, labeled and identified with its respective irradiation doses. The germination was performed in laboratory conditions. Seeds were placed

trays containing humidified filter paper, at 21⁰C room temperature. Growth parameters, both on the control and irradiated seedlings, were recorded daily for 7 days.

The considered parameters for the collected data are: germination index (GI), total germination (G_T) and the germination energy (GE) calculated as follows:

$$GI = N_1/1 + N_2/2 + N_3/3 + \dots + N_n/n$$

where N₁, N₂, N₃, N_n: number of seeds which germinated in day 1, 2, 3, ..., n (Dezfuli et al., 2008)

$$G_T = \frac{N_T \times 100}{N}$$

with N_T: proportion of germinated seeds in each treatment for the final measurements; N: number of seeds used in bioassay (Anjum es Bajwa., 2005)

$$S = (N_1 \times 1) + (N_2 - N_1)1/2 + (N_3 - N_2)1/3 + \dots + (N_n - N_{n-1})1/n$$

where N₁, N₂, N_n, N_{n-1}: proportion of germinated seeds observed at 1, 2, 3, ..., n-1, n days (Swaminathan et al., 1992)

All experiments were repeated three times (40 seeds replication). Collected data (both irradiated and non-irradiated) was subjected to One-way ANOVA test, using GraphPadPrism software.

RESULTS AND DISCUSSION

This investigation was carried out to study the relation between different doses of gamma radiation, seed germination and development of maize hybrid Turda Star.

The calculated germination index shows that the numbers of germinated seed/day in the irradiated samples is enhanced with 20% for 2 Gy, 18% for 5 Gy, 25% for 15 Gy, 6% for 30 Gy and 28% for 50 Gy comparing with the control (Fig.1). The statistical analysis of the germination index revealed that the differences between the control and the irradiated samples are not significant

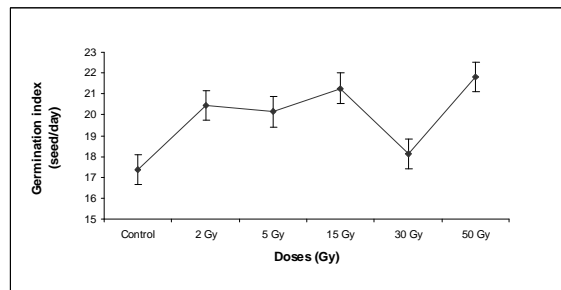


Figure 1. Germination index (seed/day)

The total germination percentage was increased at doses of 2 Gy with 5%, 5 Gy with 2.5%, at 15 Gy with 13% and at 50 Gy with 5%, while at 30 Gy the percentage of germination was decreased with 6%. Semnificative differences were observed between control and 15 Gy sample, 2 Gy and 30 Gy samples and 15 Gy and 30 Gy samples. (Figure 2)

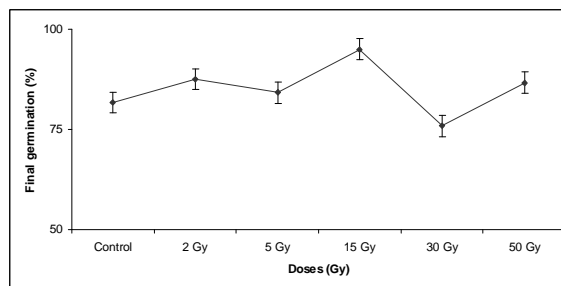


Figure 2. Total percent (%)

Germination energy is used as a measure of the speed germination. This parameter shows a linear increase up to 15 Gy, at 30 Gy it shows a sudden decrease and then is increasing up to 50 Gy. The differences between 30 Gy and 15 Gy, respectively 50 Gy, are statistical semnificative.

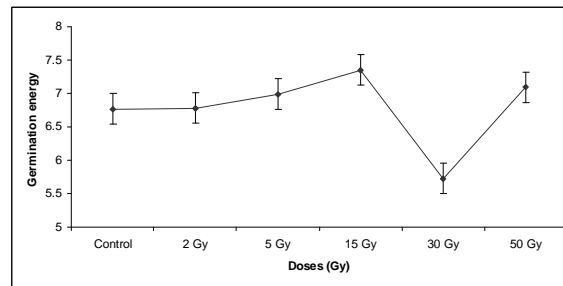


Figure 3. Germination energy

The growth parameters analyzed in this study reveals that seed irradiation prior sowing can affect the growth and development of the seedlings.

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