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The Effects of Gamma Ray Irradiation and PEG on Germination of two Varieties of Rapeseed

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ABSTRACT

In order to develop nuclear energy uses in improvement of plants to dry condition and to investigate the effect of Gamma ray (800, 1000, 1200 gry and control) and PEG (-3, -6, -9 bar and control) on germination of two varieties of rapeseed (Sarigol and RGS003), an experiment was conducted in CRD design in factorial way at laboratory condition with 3 replication in 2011. The results obtained from analysis of data variance indicated that the effect of drought stress on germination percentage is significant ($p<0.001$). The results pertained to trait mean comparison for germination percentage on stress levels indicated that drought level with -3 bar osmotic pressure and 86.35 mean has the highest percent of germination and drought level -9 bar with 56.52 mean has the lowest one. The results of mean comparison in stress condition indicated that Gamma ray with 1000 gry dosage in all drought levels yields the highest mean which shows the beneficent effect of this dosage on resistance against drought stress. The results revealed that through application of drought stress and Gamma ray, Coefficient of Velocity of Germination on Sarigol in 1000 gry and -9 bar pressure and RGS003 in 800 gry and -9 bar pressure was in the maximum. Also Sarigol in all levels of Gamma ray in -9 bar had the most germination velocity in comparison with other drought levels. Finally it was identified that use of Gamma ray has a positive effect on resistance against the stress and 800 and 1000 gry was the best usable dosage.

Key words: Gamma ray, PEG, drought stress, rapeseed, germination.

INTRODUCTION

The oil seeds, after grains, are considered as the second world food supply. The published statistical analyses indicate that rapeseed, is the 5th source of world vegetable oil with more than 59 million ton production [1]. At the present time, the annual consumption of cooking oil in Iran has been estimated more than 16 kilograms. Considering the country population, more than 1 million ton oil is needed which more than 90% is provided through importation. With respect to the mentioned issues, the necessity of long-term and integrated planning with the goal of achieving self-sufficiency in cooking oil will be undeniable. So the rapeseed, due to highly favored quality, has been the focus of attention as the most important oil vegetable to be cultivated in climatic condition of the country [2].

The information related to the each dominant and recessive traits of living creatures in the genetic material of those creatures have been carefully recorded and are transferred from one generation to the another one. The genetic information are usually transferred intact, the genetic material (DNA) sometimes is changed under influence of natural or artificial factors. Some of the changes cause phenotypic variation in order to better conformity with environment and existence of different new species. But most of these changes are harmful and lead to death of living creature [3].

The nuclear energy is a kind of energy which is produced through nuclear decay, nuclear fission, and nuclear fusion and can be described by $\Delta E = \Delta m.C^2$ equation. The result is thermal energy or different electromagnetic waves which have different functions in modern human being's life such as medicine, farming, veterinary medicine, agriculture, electrical energy production, industry, and unfortunately in military. Gamma ray, in the case of penetration into genetic material of the cell, breaks the intermolecular bonds and inter-nucleotide bonds or even changes the structure and connection of atoms forming the material in DNA. The seeds can withstand against heat and saltiness through Gamma irradiation and genetic and morphological changes. In Iran, at the present time the irradiation is carried out onto crops like wheat and rapeseed in Khuzestan, Golestan, and Yazd provinces under supervision of international agency of atomic energy [4]. The selected dosage is referred to the dosage that causes 30%-50% of growth reduction in seedlings using ionizing rays like x-ray or Gamma ray in the laboratory condition which reaches to 10-30% in chemical mutagenic agents [5]. The most research activities of mutation in the world are conducted in cooperation with Food and Agricultural Organization of United Nations and International Atomic Energy Agency (FAO/IAEA) [6].

Any change in environmental condition which makes the plant to have performance lower than normal and optimal condition is called stress. The stress, as the most important limiting factor, plays a main role in decreasing the crops production all over the world [7]. Drought as a stress influences different aspects of plant growth and causes reduction and delay of germination, reduction of shoots growth, and reduction of dry matter production. The reduction of osmotic potential and water potential, swelling removing, and stomas closure as well as growth reduction are symptoms of water stress. If the water stress severity is high, it will lead to photosynthesis reduction, physiological process disruption, growth stop, and finally death [8].

MATERIALS AND METHODS

In this research, two varieties of rapeseed namely Sarigol and RGS003 were selected for the experiment. Both varieties are spring hybrids of rapeseed. The reason for this selection is symmetry between spring planting and drought seasons of crop year which was in relation with the goal of study.

At first, the seeds were irradiated by Gamma ray due to easiness of irradiation and more effect. The dosage was identified according to predetermined range for rapeseed [5] and 3 dosages 800, 1000, 1200 gry were chosen. The seeds of both varieties were divided into 3 parts and were placed in paper package. One package of each variety was kept as control. The packages, considering the specifications written on each box, were delivered to Atomic Energy Organization for Gamma irradiation. After Gamma irradiation whose dosage is calculated regarding time and distance from irradiation source, the seeds were transferred to the laboratory for cultivation and examination. Using vanthoff and Michel formula [9], the required amount of PEG for providing solutions with -3, -6, and -9 pressure was computed and was prepared through solving the solid material in distilled water and increasing to 1000 cc in order to irrigate the cultivation environment.

Equation 1:

$$\psi_s = -(1.18\times10^{-2})C - (1.8\times10^{-4})C^2 + (2.67\times10^{-4})CT + (8.39\times10^{-7})C^2T$$

In this formula, **C** is the required PEG gram /water kg and **T** stands for the environment temperature (usually 25 ċ). Osmotic pressure is mega Pascal (each mega Pascal equals to 10 bars).

The packages including the seeds irradiated with 3 dosages and control seeds which each one has been divided into 4 parts for application of PEG treatment formed 16 packages for every variety. The seeds inside each package were randomly re-divided into 3 sections. These 3 sections were indicator of three repetitions for each treatment. The above division has been planned and performed according to CRD design in factorial way with 3 treatments and 3 repetitions.

96 pottery dishes were washed with 96 degree ethanol alcohol to be prepared for planting the seeds. The same number of circular filter papers were provided and washed with 96 degree ethanol alcohol. Some 70% ethanol alcohol was prepared through diluting 96 degree alcohol in order to wash the seeds. The seeds firstly were soaked into alcohol for 7 seconds and were washed with distilled water. Afterwards 20 seeds were randomly selected and were placed in pottery dish on the dried filter paper.

After above-mentioned stages, the irrigation of cultivation environment with distilled water for environments including control seeds and with dosage-based PEG for pre-divided environments were started. Pottery dishes were transferred to incubator machine with 27 ċ temperatures.

With respect to germinated seeds till 8th day, the germination percentage of each pottery dish was computed [10] and recorded.

Equation 2:
Germination Percentage = the number of germinated seeds till ith day/all seeds ×100

Using below formula and considering the number of germinated seeds during 3rd to 8th day, the Coefficient of Velocity of Germination (CVG) was computed and recorded for every pottery dish [11].

Equation 3:

$$CVG = \frac{1}{\frac{\sum N.D}{N}} \times 100$$

In this formula, N = the number of germinated seeds and D = the germination day.

RESULTS AND DISCUSSION

The results obtained from data variance analysis (table 1) indicated that the drought stress resulting from PEG treatment on germination percentage was only significant with ($p<0.001$.

Table 1: the variance analysis of data related to measured traits of rapeseed

S.O.V.	df	MS	
		Germination percent	CVG
Varieties	1	12.78	0
Gamma ray	3	123.6	0.01
Varieties × Gamma ray	3	56.08	0
PEG	3	4583.26 **	0.01
Varieties × PEG	3	193.91	0.04
Gamma ray	9	47.5	0.02
Varieties × Gamma ray× PEG	9	150.77	0.02
Error	64	81.26	0.01
C.V.		11.73%	7.86%

**significant if p 5% ** Significant if p 1%*

The comparison of data mean indicated that PEG has reducing effect on germination percentage so that control and -3 bar dosages have the most quantity and -9 bar dosage has the lowest quantity. Regarding the role of water in seed germination, it can be claimed that the seeds cannot germinate or start to germinate with difficulty because of no water penetration into seeds of rapeseed varieties due to negative osmotic pressure (figure 1).

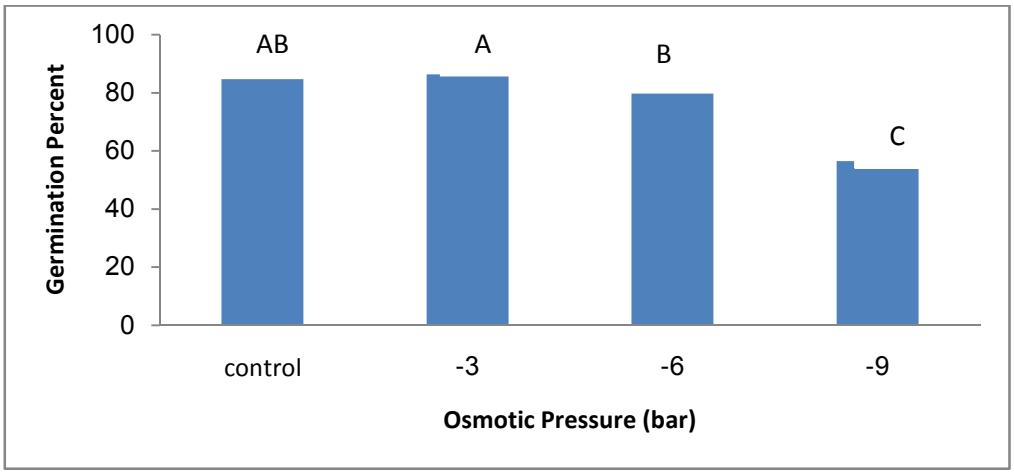

Figure 1: the effect of PEG treatment on germination percentage in both varieties namely Sarigol and RGS003

The results pertaining to figures 2 and 3 displaying the varieties mean in stress and no stress conditions indicated that applying drought stress and Gamma ray makes 800 and 1000 gry dosages in all drought levels to yield the highest mean and the lowest changes which suggests the useful effect of this dosage on resistance against drought stress. Without control, CVG on Sarigol in 1000 gry and -9 bar pressure and RGS003 in 800 gry and -9 bar pressure was in the maximum. Also Sarigol had the highest germination rate at all levels.

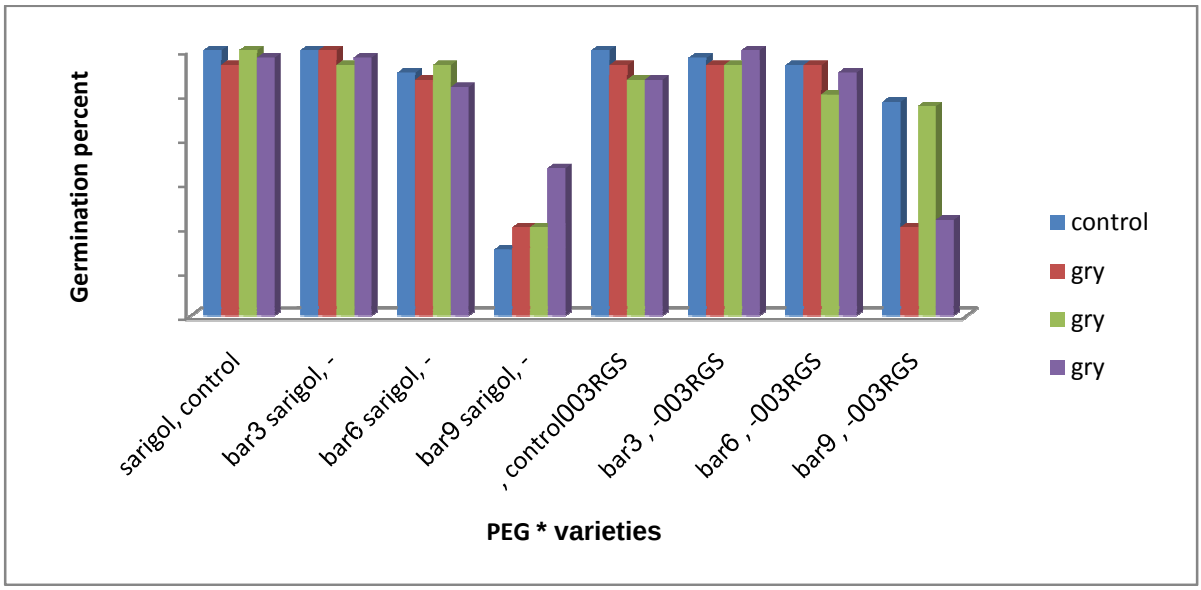

Figure 2: (Y_p) and (Y_s) changes rate in fixed dosages of PEG onto rapeseed varieties in Gamma Ray treatment

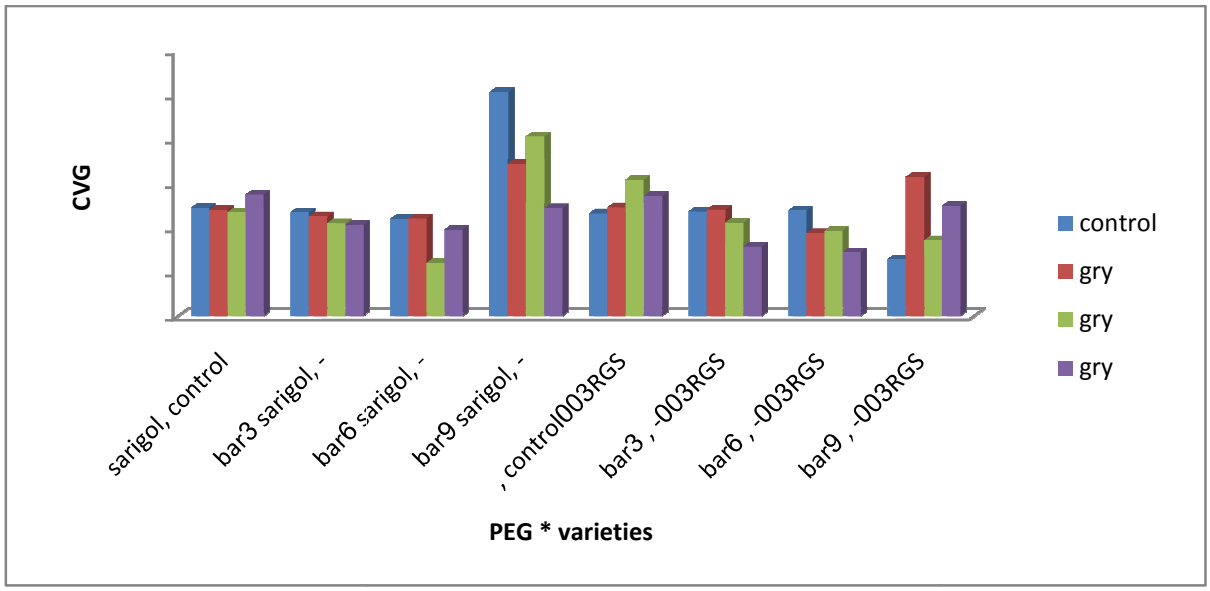

Figure 3: (Y_p) and (Y_s) changes rate in fixed dosages of PEG onto rapeseed varieties in Gamma Ray treatment

CONCLUSION

Finally it was identified that Gamma ray has a positive effect on resistance against stress using (Y_p) and (Y_s) and because of having the highest mean for both varieties, 800 and 1000 gry was the best usable dosage. Observing the changes in the figures, it can be inferred that Gamma ray and artificial drought are beneficent for making positive changes and improving rapeseed. Of course the increase in Gamma ray dosage can have a negative effect on measured indices of the plant. But in the controlled dosages, it is possible to investigate the stability of changed traits with help of out of the lab cultivation and select the strong and withstanding plants.

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