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## ORIGINAL RESEARCH ARTICLE

# Seed dormancy as an obstacle in front of plant production

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## ABSTRACT

Dormancy is a state of lack of germination/sprouting in seed/tuber although required conditions (temperature, humidity, oxygen and light) are provided. Dormancy is based on hard seed coat dormancy or lack of supply and activity of enzymes (internal dormancy) necessary for germination/sprouting. Dormancy is an important factor limiting production in many field crops. Several physical and chemical pretreatments to production material (seed/tuber) are carried out for overcoming dormancy. Physical and physiological dormancy can be found together in some plants and this event makes it difficult to provide high frequency healthy seedling growth. Whereas, emerging of all production material (seed, tuber) sown/planted and forming healthy seedling are prerequisites of plant production.

***Keywords:*** Dormancy; Magnetic Field; Squirting Cucumber Fruit Juice; Gamma Radiation

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## 1. Introduction

Plantal production should be increased in order to meet the food demand of increasing world population. This can only be achieved by increasing yield since sowing areas cannot be enlarged. Furthermore, cultivated areas which cover 3% of the total world surface, are getting narrowed rapidly due to erosion, salinity, acidity, unplanned urbanization, intensive agriculture and extreme grazing. It is estimated that world population will be 11 billion in 2050[1]. With the effects of all these factors and increasing population, it is estimated that cultivated area per capita will be 0.15 hectare in 2050. On the other hand, food production is negatively affected by the changes of world climate caused by global warming. More than 30% of crop production are lost due to biotic (pests, diseases and weeds) and abiotic (drought, cold, heat and salinity) stress factors. Fighting against biotic stress factors which decrease crop production, is achieved by chemical methods. However, careless usage of chemicals such as fertilizers, pesticides and herbicides disturb ecological balance.

Seed as the initial material of plant production significantly affects the yield. Seeds germinate to grow and survive from seedlings at a favorable time and place. The prevention of germination in unfavorable circumstances is described as dormancy. Dormancy is where there is a lack of germination/sprouting in a seed/tuber even though the required conditions (temperature, humidity, oxygen and light) are provided[2]. Dormancy is a trait gained during evolution to survive in adverse conditions such as heat, cold, drought and salinity. Dormancy enables plant species to adapt to different geographical regions showing variations in precipitation and temperature. Dormancy has a significant role in the development of new species and the successful dispersal of existing species[3]. However, dormancy in seeds/tubers should be broken for a satisfactory plant production.

There are two types of seed dormancy in general: seed coat (physical) dormancy and internal dormancy. In seed coat dormancy, the seed coat prevents oxygen and/or water permeating into the seed. Physiological conditions causing internal dormancy arise from the presence of germination inhibitors inside the seed. The adverse effects of these inhibitors should be eliminated in order to start germination/sprouting by using substances such as abscisic acid (ABA), gibberellic acid (GA3) and potassium nitrate ($KNO_3$).

In plant production, dormancy in seed material should be eliminated in order to initiate rapid seed germination/tuber sproting, healthy and vigorous seedling growth. Although there are several methods to overcome dormancy, new methods have been reported including magnetic field strength, squirting cucumber fruit juice and gamma radiation.

## 2. New methods for breaking dormancy

### 2.1 Magnetic fields

All living creatures are exposed to magnetic fields throughout their lives. Exposing seeds to magnetic fields is one of the physical treatments to increase seed germination and plant developmentp[4–6]. It was reported that seed germination was improved by physiological changes in seeds, such as faster water assimilation and higher photosynthesis, under the effect of a magnetic field[7]. Many researchers have reported that exposing seeds to a magnetic field increased seed vigour and germination[5,6,8–11].

In studies conducted with lentil (*Lens culinaris* Medik.), grass pea (*Lathyrus sativus* L.) and potato (*Solanum tuberosum* L.), magnetic fields rapidly increased seed/tuber germination/sprouting and seedling growth by ending dormancy. Seeds/tubers from lentil (cv. 'Çiftçi'), grass pea (cv. 'Gürbüz') and potato (cv. 'Marabel') were sown in soil after keeping them in different magnetic field strengths (0-control, 75, 150 and 300 mT) for different period of times (0-control, 24, 48 and 72 hours), and then lentil and grass pea were incubated for 14 days at 24 ± 1 °C for a photoperiod of 16 hours of light/8 hours of darkness under white fluorescent light (27 μmol $m^{-2}\cdot s^{-1}$), while potatoes were grown in a greenhouse at 24 °C for 2 months.

In lentil, the lowest values were noted in the control treatment where no magnetic field was used. Lower results in germination and seedling growth percentages were the indicators of dormancy. On the other hand, the highest results in all characteristics (germination and seedling growth percentages, plant height and total chlorophyll content) were recorded from seeds treated with a magnetic field with a strength of 300 mT for 24 hours[12].

In grass pea, the lowest results were again recorded for the control treatment, while the highest values were obtained from seeds treated with a magnetic field strength of 300 mT for 72 hours. At the end of the study, the germination and seedling growth percentages, plant height, and plant fresh and dry weights were recorded as 0.00%, 75.00%, 21.66 cm, 0.556 g and 0.131 g, respectively, for the control treatment, while they were 100.00%, 100.00%, 28.50 cm, 0.798 g and 0.160 g, respectively from seeds treated with a magnetic field strength of 300 mT for 72 hours[12].

In the potato, sprouts emerged above ground 17 days after planting with tubers treated with a magnetic field strength of 300 mT for 72 hours. In the control treatment, sprouts emerged on day 39.50. There was 22.50 days difference observed between the treatment with a magnetic field and the control. In the control sample where no magnetic field was used, the lowest results in plant height and total chlorophyll content were found to be 25.56 cm and 1,127.46 μg chlorophyll/g of fresh tissue, respectively, at the end of the study. On the other hand, the highest values in plant height and total chlorophyll content were recorded as 90.78 cm and 2,105.74 μg of chlorophyll/g of fresh tissue, respectively, for the treatment with a magnetic field strength of 150 mT for 72 hours[12].

## 2.2 Squirting cucumber fruit juice

Squirting cucumber (*Ecballium elaterium* (L.) A. Rich.) is an important medicin**al plant**[13]**. It** contains different compounds such as α-elaterin (cucurbitacin E), β-elaterin (cucurbitacin B), elatericine A[14] and elatericine B (cucurbitacin I) in different plant organs[15]. It also contains sterols, phenolic compounds, vitamins, flavonoids, alkaloids, resin, starch, amino acids and fatty acids[15]. It was also reported that squirting cucumber fruit juice stimulated rapid germination and seedling growth in rapeseed[16].

In a study conducted for ending dormancy in 'Marabel' potato tubers using squirting cucumber mature fruit juice, tubers at 40 to 60 g in weight were rinsed for 6 hours at 180 rpm in bottles containing water with different concentrations of mature squirting cucumber fruit juice (0-control, 200, 400, 800 and 1,600 µl/L). Then, tubers were planted in pots. Mature squirting cucumber fruits were collected from their natural growing areas around Ankara. Fruit juice was extracted and then filtered in order to remove the bigger parts. The fruit juice was subject to sterile filtration and kept in the refrigerator at -20 °C. Results clearly showed that squirting cucumber fruit juice had a significant role in ending dormancy in potato tubers. The best result was recorded at a concentration of 800 µl/L of fruit juice at 16.25 days. That meant that the sprouts of tubers treated with 800 µl/L of fruit juice emerged above the ground 16.25 days after planting. In contrast, in the control treatment where no fruit juice was used, sprouts emerged above ground later than the other treatments. From the results of the study, it can be concluded that squirting cucumber fruit juice stimulated sprout development by ending dormancy in potato tubers[12].

## 2.3 Gamma radiation

Gamma rays have an ionizing radiation effect on plant growth and development by inducing cytological, biochemical, physiological and morphological changes in cells and tissues by producing free radicals in cells[17–19]. Higher doses of gamma radiation have been reported to be inhibitory[20,21], whereas lower doses are stimulatory. Low doses of gamma rays have been reported to increase seed germination and plant growth, cell proliferation, germination, cell growth, enzyme activity, stress resistance and crop yields[22,23]. Stimulation of plant growth at low gamma radiation doses is known as hormesis[24]. The hormesis phenomenon is described as a stimulating effect on any factor in the growth of an organism[25].

In the study conducted by Beyaz *et al.*[26], the effects of gamma radiation on ending dormancy in seeds of *Lathyrus chrysanthus* Boiss. under *in vitro* conditions was examined. In the study, *Lathyrus chrysanthus* Boiss. seeds of an ecotype "Diyarbakir" were firstly irradiated with different doses (0-control, 50, 100, 150, 200 and 250 Gy) of $^{60}$Co γ rays at 0.8 kGy·h$^{-1}$ at the Sarayköy Nuclear Research and Training Center of the Turkish Atomic Energy Authority at Sarayköy, Ankara. Seeds were surface-sterilized with a 3.75% NaOCl solution at 35 °Ctemperature for 15 minutes—as reported by Telci *et al.*[27]. The seeds were then placed between filter papers in Petri dishes each containing 6 ml of distilled water. The petri dishes were incubated for 7 days at 15 ± 1 °Cin the dark for seed germination. The pre-germinated seeds were then transferred to Magenta vessels (12 × 12 cm) containing a basal medium of Murashige and Skoog's (MS) mineral salts and vitamins, 3% sucrose and 0.7% agar 14 days after the study initiation. Then, all cultures were transferred to a growth chamber for incubation at 25 ± 1 °Cunder cool white fluorescent light (27 µmol m$^{-2}$·s$^{-1}$) with a 16 hour light/8 hour dark photoperiod. The seed germination percentage was determined at the end of the 7th day, while seedling growth percentage, seedling height and root length were recorded 14 days after culture initiation[28].

The stimulatory effect of low gamma doses was observed in the study at a radiation dose of 150 Gy. The best results in seed germination percentage at the end of the 7th day and in seedling growth percentage, seedling height and root length at the end of the 14th day were observed at a dose of 150 Gy of gamma radiation. In doses over 150 Gy, the inhibitory effect of gamma radiation was seen. Seed germination percentage was 62.4% at a gamma radiation dose of 150 Gy, while it was 14.3% for a gamma radiation dose of 250 Gy. The highest seedling growth percentage, seedling height and root length were again recorded for a 150 Gy gamma radiation dose at 75.7%, 1.2 cm and 2.9 cm, respectively. The root length obtained from seeds irradiated with 150 Gy of gamma radiation was significantly increased by 63.2% from 1.8 cm in the control treatment (0 Gy) to 2.9 cm, which has been confirmed by Melki and Marouani[29].

## 3. Conclusion

Dormancy is a state of lack of germination/sprouting in seeds/tubers even though the required conditions (temperature, humidity, oxygen and light) have been provided, and is based on hard seed coat impermeability or a lack of supply and activity of the enzymes necessary for germination. Dormancy is an important factor limiting production in many field crops. Several physical and chemical pretreatments are applied to organic material (seeds/tubers) for overcoming dormancy. Physical and internal dormancy can be found together in some plant species and this makes it difficult to provide high frequency healthy seedling growth, whereas, germination/sprouting of seeds/tubers sown and the formation of healthy seedlings is a prerequisite for plant production.

## Conflict of interest

The author declared no conflict of interest.

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