Seed quality as a basis for successful soybean production in the South-eastern Europe

Svetlana Balesevic-Tubic*, Zlatica Miladinov±, Jegor Miladinovic, Vuk Djordjevic, Vojin Djukic, Marjana Vasiljevic, Marina Ceran

Department of Soybean, Institute of Field and Vegetable Crops, 21000 Novi Sad, Serbia.

∗ Presenter
± Corresponding author: zlatica.miladinov[at]ifvcns.ns.ac.rs

1 Introduction

One of the most challenging decisions in agricultural production is variety selection. This decision should be based on agro-ecological conditions in the production area and type of production, yield, protein content, etc. However, low-quality seed of the best variety can have low yield, whereas high-quality seed of the variety with less performance, at the end, can have higher yield. This confirms that the seed quality is significantly important, because it determines the success of the harvest. Seed of plant species is a complex biological system depends on various external factors, which cannot be predicted and planned in advance. Production technology applies various methods of seed quality improvement in order to enhance seed germination, and other seed properties. Seed quality improvement can reduce the effect of seed aging, as well as the effects of various stress factors. The IFVCNS therefore applies various methods for improving the quality of soybean seed.

2 Materials and Methods

Pulsating electromagnetic waves - The seed was exposed to pulsed electromagnetic field (PEMF) using the impulse generator and strip. Low frequency (16, 24, 30 and 72 Hz) PEMF in the duration of 0, 30, 60 and 90 minutes were used. Immediately after exposure of the seed to PEMF, sowing was carried out at optimum time. After sprouting, seedlings were counted to determine the percentage of germinated seeds.

Priming of seed - To determine the impact of seed priming on germination in the presence of NaCl, seeds were immersed into different solutions: potassium nitrate - KNO3 (1 %), ascorbic acid ASA - (100m g l-1) and potassium chloride - KCl (1 %). After 6 h (Miladinov et al., 2015) seeds were washed out with a jet of distilled water and dried at 25 °C up to moisture content of 10-11%. Salinity was imposed by addition of NaCl to the distilled water which was added during germination, in the following concentrations: 0 (control), 50, 100, 200 mMNaCl. Also, at optimum temperature -25° C and low temperature -10° C. Seed germination results were read daily and seed germination was defined by protrusion of the radical by at least 2 mm. Germination was recorded after 8 days.

Aging of seed and vigor - The seeds were placed in metal dishes, on metal sieve into water bath at 42 °C, and relative humidity of 100%. Testing was performed after three and five days, in four replications. Natural aging: Seed was stored in two ways. 1) seed was kept in cool chamber (controlled conditions) at 4 °C and relative humidity of 80 to 85%, 2) seed was kept under conventional storage conditions (uncontrolled conditions). Testing was performed after six and 12 months of storage.

The seed was kept in two ways:
1) in a cool chamber (controlled conditions) at 4°C and relative humidity 80-85%
2) under conventional storage conditions (uncontrolled conditions).

Testing was performed after storage for 6 and 12 months.

Hiltner test: 4 × 50 seeds were placed onto moistened sand, and a 3 cm layer of cracked brick (previously sterilized and moistened) was placed upon them. Incubation period under optimal condition lasted for 10 days.

Cold test: 4 × 50 seeds were placed onto moistened soil (up to 40% of field capacity) at 5-8°C for seven days, and afterwards placed in a germination chamber at 25°C for four days.

3 Results

Pulsating electromagnetic waves - The effect of pulsating electromagnetic waves on seed quality depends on the frequency and duration of exposure. Finding the proper combination is necessary to achieve a positive effect. In our research, the application of pulsating electromagnetic waves has increased seed germination in field conditions up to 8%. Such significant increase is a good basis for introducing this cultivation technique, primarily in organic production where the application of seed treatment is very restrictive according to Law of Organic Agriculture.

Priming of seed - Our research has shown that, as the level of salinity increases, the effect of seed priming as a pre-setting measure is increased. On average, when saturated with 50 mMNaCl, germination of primed seed increased by 6%, while saturated in 200 mMNaCl, the increase in germination of primed seed was 9%. Also, reduction of seed germination is a common occurrence at lower temperatures due to disruption of cell structure, reduction of enzymes activity, as well as reduction of respiration and transporting electrons processes. Results of our investigation pointed out that seed priming reduced the negative effect of low temperature on seed germination. At the temperature of 10°C, germination increased by 13% compared to the results obtained under optimum soybean germination temperature.

Aging of seed and vigor - Extreme conditions such as 40 °C and 100% of relative air humidity caused some biochemical changes in seed as well as reduction in seed germination. After three days of accelerated aging, obtained seed germination was on the level of six-month naturally aged seed germination, both under controlled and conventional storage condition. Seed germination after five days of accelerated aging was the same as the germination of seed stored for 12 months under conventional storage conditions. The highest difference in vigour of soybean aged seed and control was found after application of cold test. Tested soybean genotypes had initial seed germination 89.7%. The obtained results showed that soybean was significantly more sensitive to the duration of storage. The obtained results showed that soybean was significantly more sensitive to the duration of storage, as well as to storage conditions. Decrease in germination of soybean genotypes after six months of storage (soybean 81.0%), and under conventional conditions (soybean 76.8%).

4 Discussion and Conclusions

Pulsating electromagnetic waves - Besides physical and chemical methods, pulsating electromagnetic radiation is also applied in seed treatment. The effect of these methods is based on changing the course of some physiological and biochemical processes in the seed, which leads to an increase of vigor and improved growth and development in the stage of plant emergence.

Priming of seed - Seed priming is a common procedure in seed processing technology. It affects the metabolic activity of seed before the emergence of seedling root, and generally improves germination and seedling performances. Beneficial effects of this practice are primarily obtained under unfavourable environmental conditions, such as high salinity and low temperature. Increased salt concentration in soil solution can lead to a number of changes in plant metabolism as well as nutritional disorders. Although it affects all stages of plant growth, seed germination and initial growth are the most sensitive in most plant species.

Aging of seed and vigor - Better understanding of seed aging processes enables improvement of seed storage conditions, which is important not only for seed production, but also for the storage of high-value seed for breeding purpose and gene banks. Seed aging, both artificial and natural, stimulated various biochemical processes during seed storage. In our research, the aging of seeds, both artificially and naturally, caused the occurrence of various biochemical processes. The results showed that the degree of damage and the ability of the seed to resist the negative effects of aging depended on the length of the aging period, the way of seed keeping, and of the seeds characteristics of examined varieties. Cold test provides data on seed viability even in very adverse germination conditions, which gives better insight into seed behaviour during field emergence. Hiltner test imposes a physical stress on the seed, predicting seed emergence capacity under conditions of soil crust formation. Seed vigour declines first as seed deteriorates, followed by loss of germination and viability. The highest difference in vigour of soybean aged seed and control was found when cold test was applied. Cold test is the most reliable test for assessing aged seed viability and seed reaction under field emergence conditions.

Soybean seed is the subject of various experiments at the IFVCNS. This is because seed production is the base of successful plant production. The seed is the primary factor of high yield food production and supply, the basis for gene preservation for future breeding. Our main conclusion is: "The seed is starting point of everything – food and feed".

References

Balešević-Tubić S, Malenčić Đ, Tatić M, Miladinović J. (2005). Influence of aging process on biochemical changes in sunflower seed. Helia 28(42): 107-114.

Balešević-Tubić S, Tatić M, Đorđević V, Nikolić Z, Subić J, Dukić V. (2011). Changes in soybean seeds as affected by accelerated and natural aging. Rom Biotechnol Lett 16(6): 6740-6747.

Đukić V, Miladinov Z, Dozet G, Cvijanović M., Tatić M., Miladinović J., Balešević-Tubić S. (2017). Pulsed electromagnetic field-a cultivation practice used to increase soybean seed germination and yield. Zemdirbyste-Agriculture 104 (4): 345–352.

ISTA (International seed testing association) (2008). International rules for seed testing. ISTA, Zurich. https://www.seedtest.org/en/home.html

Miladinov Z, Balešević-Tubić S, Đorđević V, Đukić V, Ilić A, Čobanović L. (2015). Optimal time of soybean seed priming and primer effect under salt stress conditions. Journal of Agricultural Sciences 60 (2): 109–117.