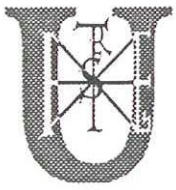

SZENT ISTVÁN UNIVERSITY

EFFECT OF PRE-SOWING SEED TREATMENTS FOR QUALITY OF CUCUMBER, PEPPER, TOMATO AND PEA SEED

PhD Dissertation

By

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1. Introduction

Early, uniform and adequate field stand is one of the key factors for obtaining early and profitable yield. Establishment of early, uniform and adequate field stands is, however, one of the major problem faced by the vegetable growers, especially during early season planting and under low temperatures and high moisture soil conditions, which are more favorable for soil pathogen growth than for seed germination and seedling emergence.

Seed is the starting point of most vegetable propagation, except those species that could be vegetativelly propagated. As seeds imbibe water for germination, they leak different substances including electrolytes, carbohydrates, proteins, amino acids enzymes and etc. These leakages not only weaken the seed performance, but also results in a conducive environment to soil pathogens by providing them substrate for their growth.

Sowing seeds under cool or wet soil conditions increase the probability of seed failure to germinate and to emerge, especially if low quality seed lot is used.

Ability of seed to perform well under adverse soil conditions is influenced by numerous factors including crop species, cultivar, seed quality (pre-harvest seed conditions on mother plant and post-harvest seed conditions), seed maturity, seed coat integrity, seed age, seed moisture content and pre-sowing seed treatment

Various pre-sowing seed treatments such as application of plant growth stimulators, fungicides and soaking have been found to be effective in improving seed performance under certain conditions.

Vegetable crops play an important role in human diet due to their valuable nutrient value. This study involved different varieties of four vegetable crops. These crops (cucumber, pea, pepper and tomato) were chosen because they are commonly used and are good source of water, minerals, proteins, vitamins and fibers.

1. 1. Cucumber (*Cucumis sativus* L.), belongs to Cucurbitaceae family, is a summer season crop grown manly for its immature fruits, which eaten fresh or pickled. For winter consumption, cucumbers are grown under cover, in which temperature and light are adequate.

1. 2. Pea (*Pisum sativum* L.), belongs to Leguminosae family, is a cool season crop grown for succulent or dry seeds.

1. 3. Pepper (*Capsicum annuum* L.) and **tomato** (*Lycopersicon lycopersicum* / L/ Karst.ex.Farw/Mill), belong to Solanaceae family, are summer season crops grown for their green or red and red fruits, respectively.

Aim of study

The objectives of this study were: 1) To improve the germination or seedling emergence with a simple and inexpensive procedure of seed soaking; 2) To determine the effectiveness of the treatments in improving seed performance; and 3) To observe variety response to pre-sowing seed treatments.

2. Materials and Methods

2. 1. Pepper

The seed samples of three different type of pepper varieties (*Capsicum annuum* L.) : hot long forcing variety **Csipke**, sweet open field variety **Fehérözön** and **Kalocsai-622** sweet spicy pepper were treated with fungicide Vitavax 200 (at rate of 1 ml Vitavax to 4 ml distilled water) or distilled water. After the filtration of Vitavax solution or water, seeds were immediately sown in polyethylene bags filled with Florasca soil-mix. Seedling emergence after 16 days and seedling survival, stem-leaf area, fresh and dry weight, nitrogen, phosphorus and potassium contents of 12 seedling (above soil surface) were assessed after 35 days.

2. 2. Cucumber and Tomato

Cucumber seeds of **Dolge Zelene** high germination seed sample, vigorous **Budai félhossú F_1** and medium plant growth **Nati F_1** varieties and **tomato** seeds varieties of **Delta** of low germination sample (57 %) and **k-Jubileum** of medium germination sample (77 %) were used

Seeds of cucumber **Dolge Zelen** variety and tomato varieties. **Delta** and **K-Jubileum** were soaked in Atonik at 0.0, 0.25, 0.5 and 1.0 ml of Atonik / L of deionized water for 8 or 24 h for cucumber and for 8 h for tomato. Seeds were then seeded between rolled towel papers and incubated for germination. Normal seed germination % and hypocotyl and radicle lengths of tomato seedlings were calculated. Seed germination % of cucumber Dolge Zelene after 96 ± 2 h and seedlings hypocotyl lengths ≥ 3 and ≥ 5 cm after 186 ± 2 h were calculated.

Cucumber seeds of **Budai félhossú F_1** and **Nati F_1** were either not soaked or soaked in aqueous solution of Atonik at 0.0, 0.25 ml/l. After removing of seed surface moisture, seeds were planted in small pots in glasshouse on February, and June 1997. Seedling emergence %, mean emergence time and hypocotyl seedlings lengths were calculated for February and June plantings. Plants photochemical efficiency for February planting was measured.

In another experiment, the two varieties were soaked in the same concentration of Atonik or in deionized water. Following removing surface moisture, seeds were seeded in plastic trays over folded towel paper and then incubated in 25°C and 20°C for one week and in 15°Cand 10°C for 30 days. Trays were checked daily. Germinated seeds were removedal. After 30 days, non-germinated seeds at 15°C and all seeds incubated at 10°C were transferred to 25°C. Germination % and mean germination time were calculated

2. 3. Pea

Pea seeds of round smooth seeded variety **Rajnai Törpe** and **Farida** wrinkle-seeded variety were soaked in deionized water at 5°C, 15°C, 15°C and 20°C for ½ h, 1 h, 4 h, 8 h, 24 h, 48 h and 72 hours. 50 seed weight was determined before and after soaking to calculate the amount of absorbed water after each predetermined period. Following removal of surface moisture, 50 seeds were seeded between rolled towel papers and then incubated at 20°C for 8 days. Percentages of normal germination, long and short seedling epicotyl, abnormal seedling and dead seeds were recorded. Seedling dry weight for Farida was recorded.

50 seeds of wrinkled seeded of **Lambado** wrinkle-seeded variety was soaked in deionized water at 20°C for 15, 30 min, 1 h, 4 h, 8 h, 24 h, 48 h and 72 h. Weight of these 50 seeds was determined before and after soaking. Water absorption was calculated. Electrical conductivity of water before and after each predetermined soaking time was also measured. Following removal of surface seed moisture, each 50 seed was sown in plastic trays filled with river sand. Trays were covered and incubated for 12 days at 20°C. Trays were inspected daily and percentages of seedling emergence, normal seedling emergence, epicotyl length, abnormal seedling, vigorous seedling (≥ 5 cm), mean emergence time, seedling dry weight and dead seeds were determined.

Minerals leaching in the steep water were determined at the end of each soaking period by Inductively Coupled Plasma (ICP) by soaking of known weight of 50 seed for previously predetermined periods at 20°C. The results were expressed as part per million (ppm). Water absorption and electrical conductivity were also determined.

3. Results

3. 1. Pepper

Although Vitavax seed treatment non-significantly improved seedling emergence % at 16 days after sowing, survival seedling %, normal seedling % and N and P contents of the seedling, P seedling content, it significantly improved seedling K content of Kalocsai-622 (sweet spicy pepper). The reduction in abnormal seedling %, seedling fresh weight, stem-leaf area, seedling dry weight was not significant.

While Vitavax significantly reduced Csipke (hot long forcing variety) seedling emergence % after 16 days and normal seedling %, it significantly improved seedling N and K contents after 35 days. The improvements of seedling survival and P seedling content were not significant. The reductions in normal seedling % and seedling fresh and dry weight were non-significant.

Seedling emergence %, seedling survival % and normal seedling % of Fehérözön (sweet open field variety) were significantly reduced by Vitavax seed treatment. Seedling N

content was significantly improved, but the reduction in seedling fresh and dry weight, stem-leaf area, P and K contents was not significant.

3. 2. TOMATO

Atonik seed treatment, regardless of its concentration, had no significant effects on seed germination %, normal seedling germination % and radicle and hypocotyl lengths of Delta as well as of K-Jubeleum varieties as compared to control. Atonik seed treatment had a trend to increase seed germination, normal seedlings and radicle length of Delta variety as well as normal seedlings and radicle length of K-jubileum variety. On the other hand, seed germination and hypocotyl length of K-jubileum tended to decrease by Atonik seed treatment.

3. 2. CUCUMBER

Dolge Zelene (high germination sample) cucumber variety

Soaking seeds in Atonik at 0.25 ml/L and 0.5 ml/L for 8 h or 24 h significantly increased the percentage of hypocotyl length ≥5 cm of Dolge Zelene variety compared to the control or to the highest concentration 1.0 ml/l. The difference between the effect of 0.25 ml/L and 0.5 ml/l was not significant at both 8 h and 24 h soaking period. Soaking seeds in Atonik at 0.25 ml/L for 24 h significantly reduced percentage of hypocotyl length (≥ 5 cm) as compared with soaking for 24 h at respective (0.25 ml/l) concentration.

Soaking at various Atonik concentrations for 8 h or 24 h had no significant effect on normal germination % as compared to control. Soaking in deionized water or in Atonik at 0.25 for 24 h significantly reduced the normal germination % as compared to soaking for 8 h in deionized water and Atonik at 0.25 ml/L.

Early germination % (96 ± 2 hours) and total germination % was not affected by seed treatment for both soaking periods (8 h and 24 h).

Budai félhossú F_1 vigorous plant growth and medium plant growth Nati F_1 Cucumber varieties

Atonik seed treatment did not affect seedling emergence %, mean emergence time and hypocotyl length of both the varieties on February sowing time as compared to control. While in June sowing, seedling emergence of both varieties and mean emergence time for Budai félhossú F_1 were not affected by Atonik seed treatment, however, mean emergence time of Nati F_1 was significantly reduced. The increase in hypocotyl length was significantly more in Budai félhossú F_1 seedling than Nati F_1.

In the early sowing time of February, Nati F_1 proved to be significantly superior than Budai félhossú in seedling emergence %,(93.17-48.67 %), mean germination time (6.79-8.39 days) and hypocotyl length (11.84-8.28 cm).

Atonik seed treatment showed a trend to reduce seedling emergence %, and to increase mean emergence time and hypocotyl length of Budai félhossú F_1.

Atonik tended to reduce mean emergence time but increase the hypocotyl length of Nati F_1.

Atonik seed treatment showed a tendency to improve photochemical efficiency of both the varieties.

In later sowing time (June), Budai félhossú F_1 proved to be highly superior to Nati F_1 in mean emergence time and hypocotyl length but seedling emergence % of both the varieties was comparable.

Atonik treatment showed a tendency to reduce seedling emergence % (98-95.5 %) and increase mean emergence time (3.27-3.49 days) and hypocotyl length (5.56-6.26 cm) of Budai félhossú F_1. On the contrary, Atonik seed treatment tended to increase seedling emergence % (98-100 %) and to reduce mean emergence time (5.51-5.07 days) and hypocotyl length (4.65-4.14 cm) of Nati F_1.

Incubation temperature

At 10°C, no germination was observed in both the varieties and seed treatments. When these seeds were transferred to 25°C, they germinated faster than those incubated at 20°C or 25°C, indicating that incubation at 10°C for 30 days did not damage seed ability to germinate under suitable temperature.

At 15°C, Atonik seed treatment reduced germination % of Budai félhossú F_1 from 67 to 53.50 % but increased it with Nati F_1 from 9.50 % to 28.50 %. Although Atonik seed treatment increased mean germination time for Budai félhossú F_1, Atonik decreased it with Nati F_1. However, neither the increase nor the decrease in means germination time was statistically significant.

Incubation at higher temperatures (20 °Cor 25°C) increased of both varieties at both seed treatments compared to that at 15°C. The differences in germination % between incubation at 20 °C and 25°C were not significant with Atonik or with control

Mean germination time of both the varieties was significantly decreased as incubation temperature increased from 15 °C to 20°C or 25°C at both the seed treatments. Increasing the incubation temperature from 20 °C to 25°C decreased mean germination time of both varieties and seed treatments. The differences in mean germination time between 20 °C and 25°C at both seed treatments were not significant with Budai félhossú F_1 while the differences with Nati F_1 were significant at both the seed treatments.

3. 3. Pea

Rajnai Törpe (smooth-seeded variety type) and Farida (wrinkle-seeded variety type) seed performance

The effects of soaking periods of on seed performance of Rajna Törpe and Farida pea seeds were found to be influenced by soaking temperature and pea variety.

At 5°C soaking temperature, significant results of long seedling epicotyl (epicotyl length ≥ 5 cm) % 76.5 % and 81 % was obtained by soaking for 48 h and 24 h for Rajna Törpe and Farida, respectively as compared to their respective controls. The normal germination % of both the varieties was lesser than that of control, but these differences were not significant.

At 10°C, the highest % of long seedling epicotyl (epicotyl length ≥ 5 cm) 76.50 % was established by soaking for 24 h and 30 min or 24 h for Rajnai Törpe and Farida, respectively as compared to the control of each cultivar. The normal germination % of Rajnai Törpe was comparable to its control but for Farida, it was significantly lesser than the control.

At 15°C, soaking for 48 h and 72 h yielded 78.50 % and 83.50 % long seedling epicotyl (length ≥ 5 cm) for Rajnai Törpe and Farida, respectively as compared to the their controls. The normal germination % of both the varieties was significantly not different form their respective controls.

At 20°C, maximum percentage of long epicotyl (length ≥ 5 cm) 81 % and 82.50 % were obtained by soaking seeds for 24 h and 8 h for Rajnai Törpe and Farida, respectively as compared to their respective controls. The normal germination % in soaked seeds of both the varieties was significantly not different than their respective controls.

Seed water absorption of Farida, increased by increasing soaking period up to 72 h, except at 10°C. Maximum water uptake was established by 48 h. The change in water absorption % from 48 h to 72 h soaking was not significant, but at 5°C soaking temperature, the change was significant. The rate of water uptake was decreased by increasing soaking period.

Increasing soaking temperature from 5°C to 15°C or 20°C increased water absorption %, but water uptake % was decreased as temperature increased from 5°C to 10°C. Similarly, increasing soaking temperature from 10°C to 15°C or to 20°C and from 15°C to 20°C increased water absorption %.

Lambado (wrinkle-seeded variety type)

Seed water uptake was increased by increasing time of imbibition up to 72 h. The difference between imbibition for 15 min and 30 min was not significant but the water absorption % from 30 min and more up to 72 h was highly significant. The rate of water uptake was decreased by increasing time of soaking.

Electrical conductivity readings indicated that there were no differences in electrical conductivity after 15 min and 30 min soaking. Increasing soaking period from 15 min to 1 h or more, resulted in significant increasing of electrical conductivity up to 24 h, however, further increase in soaking time had no significant effect.

Seedling emergence % and mean germination time were not affected by the various soaking periods as compared to their respective controls.

Normal seedling % was not affected by soaking periods up to 48 h but after that it was significantly decreased as compared to control.

Maximum seedling length of 86.7 mm, significantly higher than the control, was established by soaking for 24 h. All soaking periods produced comparable seedling length with respect to control (no significant differences), except soaking for 15 min, which yielded seedling length significantly lesser than control.

Vigorous seedling % (epicotyl length $\geq$ 5 cm) was not affected by soaking periods up to 48 h compared to the control but soaking for 72 h produced the significantly lower percentage of vigorous seedling as compared to control. Maximum vigorous seedling of 94.5 % was observed at 30 min soaking.

Seedling dry weight (shoot + root) was not influenced by soaking periods up to 8 h. At soaking periods of 24 h and more, seedling dry weight was significantly lesser than the control. Seedling dry weight being maximum 0.0361 g at 1 h soaking followed by 0.0360 g and 0.0359 g at soaking for 30 min and 4 h, respectively. These values were, however, not significantly higher than that of the control 0.0346 g.

Mineral leaching results showed that there was measurable amounts of potassium, sodium, calcium and magnesium, while others were either in a trivial amount or absent. The pattern of these four minerals leakage was different through out the various soaking periods.

Potassium ions (K^+) leakage was increased throughout the soaking periods, getting maximum 36.0925 ppm by 24 h soaking. Potassium ions accounted for about 75 % of total electrolyte leakage (K^++Na^++Ca^{2+}+Mg^{2+}) during the 24 h followed by sodium 15.4 %, calcium 6.9 % and magnesium 2.9 % .

After 24 h soaking there was a significant correlation between electrical conductivity and potassium (r^2 = 0.8333). The correlation between potassium and calcium was non-significant (r^2 = 0.6112). The correlation between potassium and sodium was also not significant (r^2 = 0.7199), while the correlation between potassium and magnesium was significant (r^2 = 0.8113).

Sodium ions (Na^+) leakage was almost steady during the first 24 h soaking. Maximum amount of sodium (9.24 ppm) was established after 48 h then decreased to 8.7703 ppm at 72-h. Sodium leaching amount ranked the second level. Sodium had significant correlation only with potassium at 72 h.

Calcium ions (Ca^{2+}) reached maximum level of 3.8 ppm after 72 h. No significant correlation was established between calcium and other minerals at soaking of 24, 48 and 72 h, except with magnesium (Mg^{2+}) after 72 h ($r^2 = 0.8655$).

Magnesium ions (Mg^{2+}) reached maximum amount (1.627 ppm) after soaking for 72 hours.

Electrical conductivity (EC) after 24 h was significantly correlated with potassium, and magnesium and highly significant with sodium having the vlaues of $r^2 = 0.8333$, 0.8113 and 0.9217, respectively. After 48 h, EC was correlated highly significantly only with sodium ($r^2 = 0.9559$) while after 72 h, it was highly significantly correlated with magnesium ($r^2 = 1.0$) and just significant with calcium ($r^2 = 0.8680$).

New scientific results

- Seeds of Kalocsai-622 (sweet spicy pepper variety, treated by Vitavax seed 16 days after sowing showed tendency to increase seedling emergence %, ratio of the normal seedling, seedling survival % and N seedling content significantly improved seedling K content of normal seedling %,.

- Seeds of tomato treated by Atonik at 0.25ml/l had a trend to increase seed germination %, normal seedling % and radicle length of *Delta* and *K-Jubileum* varieties.

- -High germination cucumber seed sample treated by Atonik , dose 0.25 ml/l soaked during 8 h significantly increased the percentage of the ratio of vigorous seedlings. This seed treatment showed a trend to improve efficiency of photosynthesis of both varieties.

- At 10°C incubation temperature, no germination was observed for both the varieties at the two seed treatments. When these seeds were transferred to 25°C, they germinated faster than those incubated at 20 or 25°C. Incubation at 10°C during 30 days was not damaging seed ability if germination was under suitable temperature.

- Study of the effect of the soaking time and period gave a results that at 5°C soaking temperature, high significant percentages of long seedling, vigorous epicotyl.

- Potassium ions (K^+) leakage was increased throughout the soaking period and was maximum by 24 h. Potassium ions accounted for the highest percentage of total electrolyte leakage (K^++Na^++Ca^{2+}+Mg^{2+}) followed by sodium, calcium and magnesium.

- Electrical conductivity (EC) after 24 h showed significant correlation with potassium, sodium and magnesium.

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