PERFORMANCE OF SOYBEAN SEEDS TREATED WITH SALICYLIC ACID DOSES

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ABSTRACT

Seed treatment with salicylic acid is a promising alternative in the seed technology area because it can induce resistance against biotic and abiotic stress; however its effect is not fully elucidated. The objective of the present study was to evaluate the performance of soybean seeds treated with doses of salicylic acid as a seed treatment. The seed cultivar used was CD 201 and the experimental design was completely randomized with four repetitions. The treatments consisted of five concentrations of salicylic acid (SA): 0, 25, 50, 75 and 100 mg L^{-1} SA, and the spray volume was 500 mL of solution per 100 kg of seeds. The physiological quality by the first germination count, accelerated aging, cold test and longitude of the root of the seedlings. It appears that seed treatment with SA did not interfere significantly in the first count of germination in cold test and root length, but responded in positively quadratic way for germination and the length of the shoot, taking its points of maximum concentrations of 44.1 and 78.8 mg L^{-1} SA. It was concluded that treatment of soybean cultivar CD 201, depending on the dose, can stimulate the germination and growth of the tops of the plants.

KEYWORDS: *Glycine max*, plant regulator, growth regulator, germination, vigor.

DESEMPENHO DE SEMENTES DE SOJA TRATADAS COM DOSES DE ÁCIDO SALICÍLICO

RESUMO

O tratamento de sementes com ácido salicílico (AS) é uma alternativa promissora, visto o mesmo ser um importante indutor de resistência contra estresses abióticos, porém seu efeito não está completamente elucidado na área de tecnologia de sementes. Objetivou-se no presente trabalho avaliar o desempenho de sementes de soja tratadas com dose de ácido salicílico. A cultivar de soja utilizada foi a CD 201 e o delineamento experimental utilizado foi o inteiramente casualizado, com quatro repetições. Os tratamentos constaram de cinco doses de ácido salicílico (AS), sendo 0, 25, 50, 75 e 100 mg de AS L^{-1} e o volume de calda foi de 500 mL de solução por 100 kg de sementes. Verifica-se que o tratamento das sementes com AS não interferiu significativamente na primeira contagem da germinação, no teste de frio e no comprimento de raiz, mas respondeu de maneira quadrática positiva para a

germinação e para o comprimento de parte aérea, tendo seus pontos de máxima nas concentrações de 44,1 e 78,8 mg de AS L^{-1}. Concluiu-se que o tratamento de sementes de soja da cultivar CD 201 com AS, estimula a germinação e o crescimento da parte aérea das plântulas, no entanto, reduz o desempenho das sementes em campo e diminui sua capacidade de armazenamento pelo teste de envelhecimento acelerado.
PALAVRAS-CHAVE: *Glycine max*, fitorregulador, regulador de crescimento, germinação, vigor.

INTRODUCTION

Soybean is a great expression of culture in Brazil, and the 2013/2014 crop, the estimated production is about 85.4 million tons in an area of 29.7 million hectares (CONAB, 2014). Soy is among the most economically important crops in Brazil, so it is justified to search for low-cost technologies that will improve seed performance in the field, especially in abiotic stress tolerance, especially water stress and salinity.

Salicylic acid is a phenolic compound involved in the regulation of many processes in the growth and development of plants, including stomata movement, seed germination, ions absorption and the induction of disease resistance. The compound can also interfere with the biosynthesis and action of ethylene on plants (RASKIN, 1992). It represents the first plant-derived phenolic compound shown to induce systemic acquired resistance (ARAUJO et al, 2005). This compound is found naturally in leaves, inflorescences of plants and thermogenic plants attacked by pathogens (CASTRO & VIEIRA, 2001).

The exogenous application or stimulating the endogenous synthesis of organic acids, such as salicylic acid can act as an inducer of tolerance protein to various stresses, and may increase and regulate the activity of detoxification enzyme as well as peroxidases and superoxide dismutase, particularly involved in the degradation of oxygenated active radicals (CARVALHO et al., 2007). Acts stimulating the cell wall lignification, directing the pentose phosphate pathways and chiquimato for producing phenolic compounds (lignin) in the treated seeds, which allows vigor manifestation (PACHECO et al, 2007). GUO et al. (2009) found that pretreatment of rice seeds with salicylic acid inhibited the activity of catalase and increased levels of hydrogen peroxide, increasing resistance in plants treated with cadmium, thus alleviating oxidative stress and increasing tolerance of these plants to cadmium.

It can act regulating the flavonoid formation pathway, considered by some authors as a phytohormone involved in plant defense reactions, inducing systemic acquired response (CURTIS et al., 2004; HABIBI, 2012). Besides initiating such responses, it is also involved in the activation of genes related to responses to stress for drought, cold, heat, salinity and UV radiation (PENG & JIANG, 2006). The induction of flowering in herbaceous species (HAYAT et al., 2010), stimulation of root development, as well as regulation of various physiological processes and, regulating the functions of chlorophyll, carotenoids, photosynthesis, stomatal conductance and transpiration (LIU et al., 2011), increasing the number of grains per spike and agronomic yield in wheat (LOPEZ-DELGADO et al., 1996), are important routes of action of salicylic acid. The effect of exogenous salicylic acid applied in tomato roots infected with the fungus *Fusarium oxysporum f.* was evaluated by MANDAL et al. (2009) who found positive effects.

Among the products and/or compound that has been used as a seed treatment, salicylic acid is a natural compound that plays an important role in certain

physiological processes and defense responses in plants (SHI & ZHU, 2008), may also influence seed germination, cell growth, opening of stomata, expression of genes associated with senescence and fruit production (KLESSIG et al., 2009). Seed treatment with salicylic acid is a promising alternative, since the regulating action of growth and inducing resistance is not fully elucidate in the seed area. Furthermore, the salicylic acid action is still unclear as seed treatment on physiological quality of them.

In this context, the aim of the present study was to evaluate the performance of soybean seeds treated with concentrations of salicylic acid solutions.

MATERIAL AND METHODS

The study was developed in the Didactic Laboratory of Seed Analysis at the Agronomy College Eliseu Maciel, at the Federal University of Pelotas.

The soybean cultivar used was CD 201 and the treatments consisted of five salicylic acid (SA) concentrations, being zero, 25, 50, 75 and 100 mg L^{-1} of SA, and the spray volume of 500 mL per 100 kg of seeds. For the seed treatment we used plastic bags, in which was added a solution of SA, spreading it to a height of 10 cm on the surface of the bag. Then added the seeds and shaking for three minutes and further dried at ambient temperature for 24 hours.

In the laboratory, the seeds were subjected to the following tests: **Germination (G):** performed with four replicates of 50 seeds for each treatment. Sowing was on paper substrate, previously soaked in distilled water at amount of 2.5 times the mass of dry paper, the rolls were kept in germinator at a constant temperature of 25 ℃. The evaluations were performe d after eight days, according to the Seed Analysis Rules (BRAZIL, 2009) and the results expressed as percentage of normal seedlings. **First count of germination (FCG):** was evaluated five days after sowing at the occasion of germination test. **Accelerated aging (AA):** was conducted in “gerbox” boxes, covered with wire mesh. The amount of 40 mL of distilled water was added to the bottom of each box. The seeds of each treatment were distributed in a single layer on the wire mesh. Then the boxes containing the seeds were covered and placed in the BOD incubator at 41 ℃, w here they remained for 48 hours. After this period, the seeds were subjected to germination tests and evaluated on the fifth day. **Length of shoot and root:** The evaluation of the length of shoot and root was performed with four replicates of 20 seeds for each treatment. Substrate paper roll type *germitest* was used; in which the seeds were distributed in two longitudinal straight lines and staggered in the upper third of the paper. After the confection, the rolls were wrapped in plastic bags and placed in a germination chamber set at a constant temperature of 25 ºC. On the fifth day after sowing, the length of shoots and roots of normal seedlings were measured, each seedling measured separately and then calculated the average length of shoot and root. **Cold test (CT):** It was conducted with four replicates of 50 seeds for each experimental unit, and the rolls of paper placed in plastic bags, which were sealed and kept at controlled temperature of 10 ºC during seven days. After this period, they were transferred to a germinator and maintained under the same conditions of the germination test, then evaluated after five days (CÍCERO & VIEIRA, 1994). **Seedling emergence (SE):** was performed in a greenhouse, as proposed by POPINIGIS (1985), using washed sand medium-type as substrate where were sowed four replications of 50 seeds, making up only a count at 21 days after date of sowing and

expressing the results as percentage of emerged seedlings.

The data were then analyzed for normality and homoscedasticity and subsequently submitted to analysis of variance ($p \leq 0.05$) and in case of significance were carried out the polynomial regression.

RESULTS AND DISCUSSION

It was found that the treatment of soybean seeds with salicylic acid (SA) was not significant in the first count of germination in cold test and seedling root length, and significant for the variables germination, shoot length of seedling, accelerated aging and field emergence.

Regarding to the germination of soybean, it is observed that increasing the concentration of salicylic acid through seed treatment, had resulted in a quadratic positive response for incidence of normal seedlings germinated (Figure 1). The point of maximum efficiency was obtained at a concentration of 44.1 mg L^{-1} of SA, whereas concentrations greater than this had caused reduction in germination. We can infer that high concentrations of SA have caused phytotoxicity to seed. In a research conducted by SILVEIRA et al. (2000) it was demonstrated that salicylic acid applied in rice seeds, cultivar EMBRAPA 7 TAIM, had resulted in an inhibitory effect on germination and the first count of germination, being more drastic at concentrations of 18 and 36 mg L^{-1}. Similar results were also found by CARVALHO et al. (2007) for the SA concentration of 0.045 mg L^{-1} had influenced positively on germination percentage and rate of germination of calendula seeds, under favorable conditions and under the effect of drought stress and heat to 35 º C. However, according to ZANET (2011) the use of salicylic acid in *Brachiaria humidicola* seeds did not improve on germination.

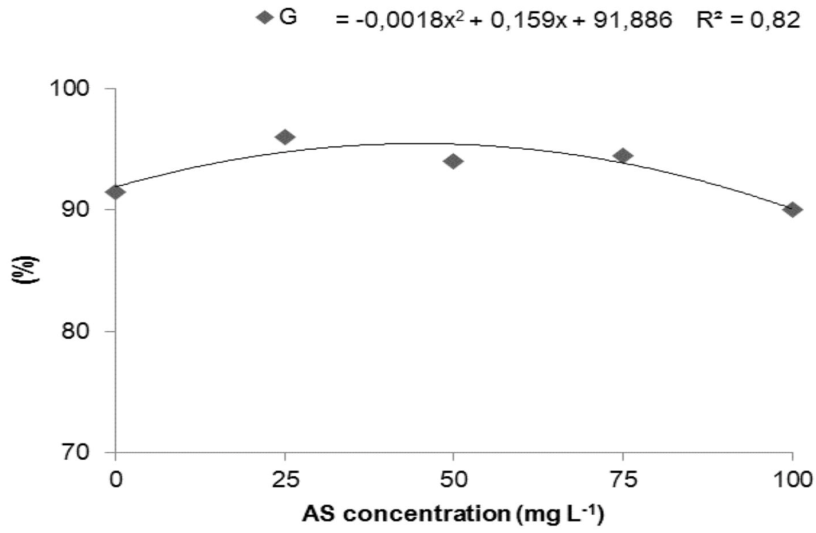

FIGURE 1. Germination (G) of soybean seeds treated with doses of salicylic acid (SA) by seed treatment.

In relation to shoot length of soybean seedlings, it had an increase on the grew with increasing concentration of SA, until the concentration of 79 mg L^{-1}, where the seedlings showed an increment of 1.86 cm in relation to zero concentration (Figure 2). From this concentration, the increase of SA in the solution had caused

reduction in shoot length. Contrasting these results with those obtained in a similar study where rice seeds treated with SA, a considerable reduction in the shoot length was observed when the concentration of SA was between 18 and 36 mg L^{-1}, and insignificant when in the concentrations of zero; 0.18 and 1.8 mg L^{-1} (SILVEIRA et al. 2000). In soybean seeds treated with doses of 0, 20, 50 and 100 mg L^{-1} SA, there were not found significant difference for this variable (MAIA et al., 2000) also for maize seeds treated with the concentrations of 0, 54, 162 and 324 mg L^{-1}, and watermelon seeds at doses of 0, 3, 6 and 45 mg L^{-1}.

Concerning the root length of soybean seedlings was not identified significant difference between treatments of concentration of 0 to 100 mg L^{-1}. These results differ from those observed by MAIA et al. (2000), where concentrations of 20, 50, and 100 mg L^{-1} caused an increment in the root length of soybean seeds. The use of salicylic acid in watermelon seeds of cv. Crimson Sweet showed no difference in root length (SILVA et al., 2014).

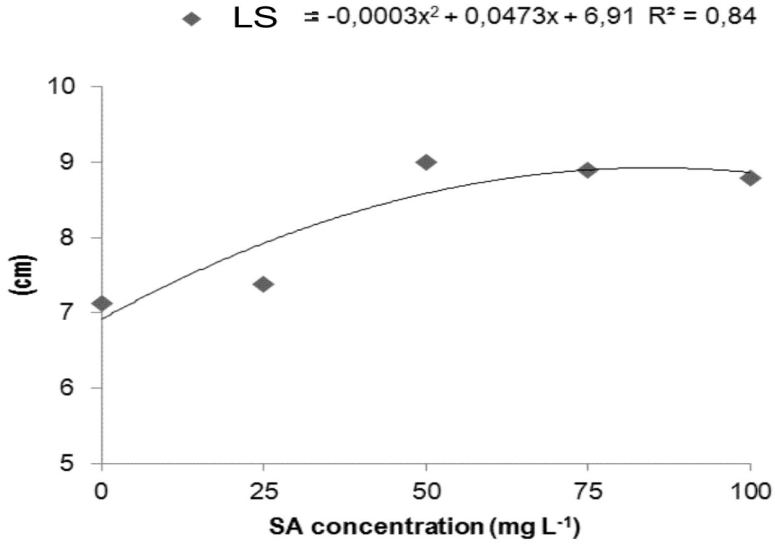

FIGURE 2. Length of shoot (LS) of seedlings originated from soybean seeds treated with doses of salicylic acid (SA) as seed treatment.

Regarding the accelerated aging, the increased concentration of SA caused a reduction in soybean seed vigor, it is more pronounced for the higher concentration (Figure 3 A). This variable has showed a quadratic behavior and the point of maximum efficiency was at a concentration of 19.5 mg L^{-1} SA, with 14 percentage points below the zero concentration. Indicating that the concentrations of SA used, did not promote the induction of resistance to stress caused by the test in soybean seeds, in the contrary, providing a reduction in seed vigor. According to RADWAN et al. (2010) salicylic acid plays an important role in the induction of resistance in situations of stress.

The same result could not be checked for seedling emergence in field (Figure 3 B), where the increases of the concentration of SA in the seeds resulted in a decrease in the percentage of emerged seedlings, and the behavior of polynomial regression for this variable was quadratic negative with point of minimum efficiency in the concentration of 85.3 mg L^{-1} SA, whose emergence was reduced by 21 percentage points.

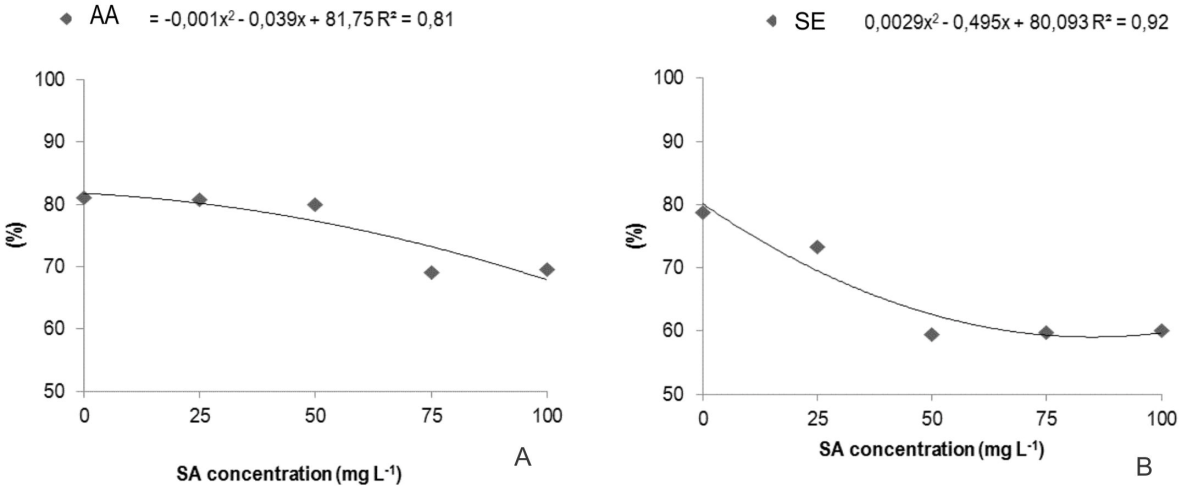

FIGURE 3. Accelerated aging (A) and seedling emergence in sand (B) of soybean seeds treated with doses of salicylic acid (SA)

CONCLUSION

The soybean treatment, cultivar CD 201, with salicylic acid depending on the dose, can stimulate the germination and growth of seedling shoot, and can reduce seedling emergence in field as well as the vigor evaluated by accelerated aging test.

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