

The effect of various pre-treatments on soybean seed performance

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ABSTRACT

The effect of pre-treatment with poly-ethylene glycol (PEG) and hydrogen peroxide on germination performance of soybean seed of low quality was investigated. The interaction of these pre-treatments with a sodium molybdate treatment was also investigated. There was a significant interaction between molybdenum concentration and pre-treatment solution. After pre-treatment with PEG seed appeared less susceptible to Mo-induced damage whereas the same trend was not visible with hydrogen peroxide pre-treatment. PEG pre-treatment increased the total germination percentage of the low quality seed whereas hydrogen peroxide decreased it. Germination rate was only influenced significantly by hydrogen peroxide treatment and high Mo levels. Further research is needed to clarify the interactions.

KEY WORDS

Molybdenum treatment, osmoconditioning, seed quality, soybean.

INTRODUCTION

Soybean seed treatment with molybdenum (Mo) generally increased soybean production in low pH soils in Kwa-Zulu Natal Province in South Africa (1). However, in certain instances soybean production was decreased after seed treatment with molybdenum. It was thought that low seed quality played a role. Low quality seed may result in lower yields due to a lower establishment percentage as well as a lower and more erratic rate of establishment (2). Osmoconditioning involving imbibition of low quality seed in a solution with a low osmotic potential appears to facilitate membrane repair in the seed and also slows the rate of imbibition (2, 3). This results in a higher percentage and a less erratic germination of seeds. In this experiment, the effect of osmoconditioning and molybdenum treatment on the germination percentage, germination rate and early seedling growth of low quality seeds of the soybean cultivar Dumela was investigated.

MATERIALS AND METHODS

Soybean seed (cv. Dumela) were subjected to pre-treatments involving two chemical substances *viz.* poly-ethylene glycol (PEG 6000) and hydrogen peroxide. Four levels of PEG (0, 179, 224 and 262 g l^{-1}) were used. This corresponds to osmotic potentials of 0, -0.4, -0.6 and -0.8 bar. Four concentrations of hydrogen peroxide (0, 1.5, 3 and 10%) were used. Distilled water was used in all cases. Seeds (300) were imbibed in 200 ml of the various solutions at 25 °C for 24 hours. The PEG treatments were aerated for the duration of the pretreatment. After 24 hours the seed was rinsed thoroughly in distilled water and subjected to a treatment of four sodium molybdate concentrations *viz.* 0, 1, 4 and 8 mg Mo kg^{-1} seed. Ten seeds per pot were then planted in plastic plant pots (20cm diameter) containing ca. 3 kg of acid-washed sand. *Rhizobium* bacteria were sprinkled onto the surface of the pots and washed in. The plants were fertigated with a Mo-free balanced nutrient mixture with a low (15% of normal) N content. De-ionised water was used for the nutrient mixture. The experimental layout was an 8X4 factorial with three replications. Seedling emergence was monitored daily for 12 days and thereafter every second day for a further 12 days after which no further seedlings established. The percentage establishment and rate of establishment were calculated. Seedlings were harvested four weeks after the planting date, dried in an oven at 45 °C for 48 hours and the dry mass of the aboveground material was determined. The MEANS command of the SAS statistical package was used to test for significant differences between means. The establishment percentage data was logit transformed before analysis.

RESULTS AND DISCUSSION

Significant ($P=0.0131$) interaction occurred between pre-treatment solutions and molybdenum concentration (Figure 1). Pre-treatments with PEG appeared to increase the establishment percentage of soybean seeds whereas pre-treatments with hydrogen peroxide at the higher concentrations tended to decrease establishment percentage. The highest level of molybdenum treatment only responded to the PEG pre-treatments at the higher levels, indicating that too much molybdenum enter the low quality seed due to weak membranes. If some membrane repair takes place during pre-treatment with PEG less damage is done to the seed. The high establishment percentage of the third molybdenum treatment at PEG 0 pre-treatment cannot be explained. Establishment percentages were consistently high in all three replicates. The same trends were observed when total dry mass per pot was considered, because at such an early age no density-dependent variation in growth took place and the total dry mass was correlated with plant numbers in pots. Regarding rate of establishment, no significant interactions occurred. There were, however, significant differences at the 5% level between levels of the main factors. PEG pre-treatments had no significant effect on the rate of establishment but the higher concentrations of hydrogen peroxide significantly decreased rate of establishment. The higher rates of molybdenum also had a significant negative effect on rate of establishment. Hydrogen peroxide treatment is usually applied to seeds with impermeable seed coats. The hydrogen peroxide then damages the membranes of the seed rendering them more permeable. In this case the damage done to the already weakened membranes of the seed is evident.

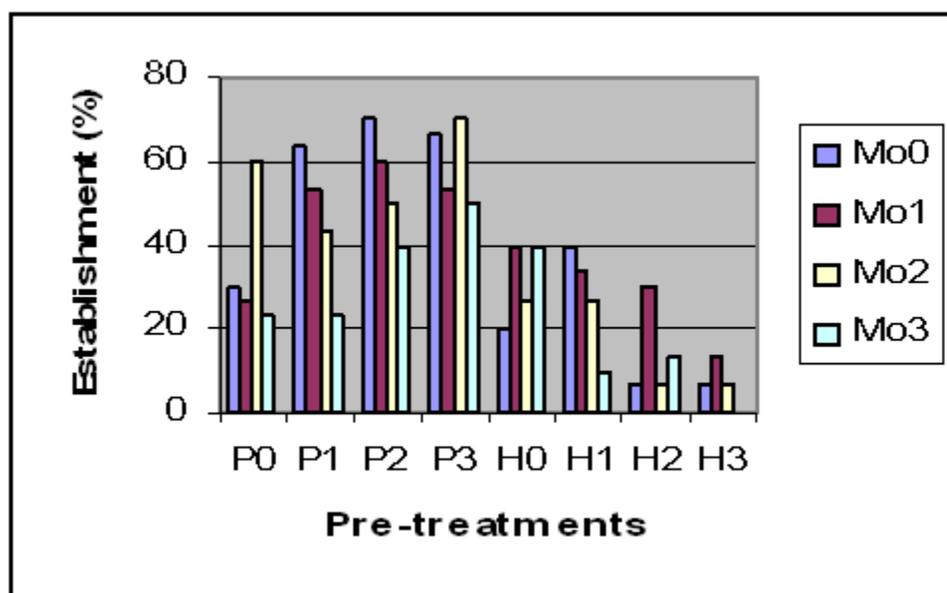


Figure 1. The interaction between different pre-treatments and molybdenum treatment of soybean seedlings established (P0, P1, P2 and P3 = PEG at 0, 179, 224 and 262 g l^{-1} ; H0, H1, H2 and H3 = Hydrogen peroxide at concentrations of 0, 1.5, 3 and 10% and Mo0, Mo1, Mo2 and Mo3 = Molybdenum treatments at 0, 1, 4 and 8 mg Mo kg^{-1} seed respectively).

CONCLUSIONS

There appears to be a relationship between seed membrane quality and damage caused by molybdenum. These results warrant further research on the interaction between osmoconditioning, seed quality and response to Mo of soybean.

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