The influence of seed treatments on germination and initial growth of maize seedlings

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Abstract

Seed coating with protective substances, as fungicide and insecticides is very important practice in maize seed production. Some fungicides and insecticides could stimulate or reduce germination and initial growth of seedlings. The aim of this study was to investigate different seed treatments of fungicide (fludixonil + metalxil-M) and insecticides (tiametoxam and imidacloprid) on germination and initial growth of six maize inbred lines. Applied pesticides generally elevated the germination percentage, while fresh matter of root and shoot varied, depending on the genotype. Furthermore, all applied treatments induced increase in dry matter in root and shoot, what can be related to a decrease in hydrolysis, parallel to increase in biosynthesis, in general. The observed seed coating treatments induced increase in maize inbreds germination, as well as it stimulated fresh and dry matter accumulation via increasing of biosynthesis. Adequate pesticide combination depends on genotype.

Key words: maize, germination, seedlings, growth, insecticide, fungicide

Introduction

Contemporary seed production is inconceivable without seed coating with protective substances, as fungicides and insecticides. They provide seed storage during some period without negative influence of present microorganisms (Protić et al., 2004; Mrđa et al., 2009). On the other hand, some fungicides and insecticides could act as suppressors or stimulators of germination (Lomović et al., 2000; Stevanović et al., 2009). In seedlings, observed effect could prolong during some time, inducing poorer growth, with less fresh and dry matter accumulation in root and shoot (Singh et al., 1982; Kunkur et al., 2007; Moore and Kroger, 2010). Toxic or stimulant effects of seed coating fungicides and insecticides could be expressed by cytological aberrations (Singh et al., 1979), higher production of plant hormones (Singh et al., 1982), what could have as consequence unequal distribution of seed matter into root and shoot (Dragičević et al., 2008).

The aim of this study was to investigate different seed treatments with fungicide and insecticides on germination and initial growth of maize inbred lines.

Material and methods

The seeds of six maize inbred lines (PL A 680 - L1, PL 173/4 - L2, PL 357/3 - L3, PL 217 - L4, PL 17/5 - L5 and 255/75 - L6), were treated with fungicide fludixonil + metalxil-M (preparation Maxim XL035-FS) in dose of 1 ml kg⁻¹ seeds. Applied insecticides were: tiametoxam (preparation Cruiser 350 FS) in dose 9 ml kg⁻¹ seeds, and imidacloprid (preparation Gaucho 600 FS) in dose of 7 ml kg⁻¹ seeds, as follows:

Control - without treatments (Ø);
Treatment with fludixonil + metalxil-M (M);
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Treatment with fludixonil + metalxil-M and tiametoxam (M+C);
Treatment with fludixonil + metalxil-M and imidacloprid (M+G);

The germination capacity was determined by ISTA Rules, in four replications of 100 uniform seeds (ISTA, 2007), after 7 days. The seeds were weighed before germination. Filter paper towels were used as the germination medium. The following conditions were maintained in the germination cabinet: a temperature of 25 °C, with an 8 h light regime of 1250 lux (simulation of daylight) and a relative humidity of 97%.

The uniformly grown seedlings were separated into four replications of 25 plants and then fractioned into root, shoot and the rest -seed. The roots and the shoots were weighed for fresh matter determination (FM, g) and dried in the ventilation drier at 60 °C to the constant mass for dry matter determination (DM,%).

Based on obtained measurements sum of hydrolysis and biosynthesis were calculated:

$$\Sigma Hy = SeedM - DM\text{seed rest}$$
$$\Sigma Bs = DM\text{root} + DM\text{shoot}$$

Where $\Sigma Hy$ is sum of hydrolysis (g); $\Sigma Bs$ is sum of biosynthesis (g); $SeedM$ is seed weight (g); $DM\text{seed rest}$ is dry weight of rest -seed (g); $DM\text{root}$ is dry weight of root (g); $DM\text{shoot}$ is dry weight of shoot (g);

The data of fresh matter, dry matter, hydrolysis and biosynthesis were expressed with standard deviation.

Results and discussion

The germination percentage was in general elevated by influence of applied pesticides (Figure 1). Only for L4 possible toxicity was noticed, by lowering the germination percentage, similar to results of Singh et al. (1979) and Lomović et al. (2000). Treatment with fludixonil + metalxil-M induced increased germination on average 4%, evidencing positive impact of fungicide against possible fungus activity (Protić et al., 2004). Meanwhile, fludixonil + metalxil-M and imidacloprid show better results for L1, L3 and L5, increasing germination percentage up to 9%, which was opposite to the results of Mrđa et al. (2009), attained on sunflower.

The applied treatments induced variations in root and shoot FM, dependently on genotype. In general, application of insecticide and fungicide increased root and shoot FM (Figure 1), except for L1, where pesticide application decreased FM, similar to results of Singh et al. (1979) and Moore and Kroger (2010), which discussed phytotoxicity of some insecticides to crops. The best results in the increase of FM were obtained on root level, with application of fludixonil + metalxil-M and tiametoxam (L6 up to 54% increase in comparison to control) and on shoot level, with application of fludixonil + metalxil-M and imidacloprid (L6 up to 37% increase in comparison to control).

Furthermore, all applied treatments induced increase of root and shoot DM, in comparison to control (Figure 2), evidencing a better utilization of seed matter (Dragičević et al., 2008). The application of fludixonil + metalxil-M increased root DM of L1, L2 and L3, up to 1.21%, while combination of fludixonil + metalxil-M and tiametoxam was more effective for L5 and L6, increasing root DM up to 2.01%. At shoot level fludixonil + metalxil-M and imidacloprid induced DM increase for L1, L3, L4 and L5, up to 0.92%. Obtained results are in agreement with results of Siddiqui and Zaman (2004), and Kunkur et al. (2007), where positive impact of fungicides and insecticides seed treatments on DM accumulation was observed.

The differences in growth of seedlings of examined inbreds, influenced by applied pesticides could be better understood on hydrolysis and biosynthesis level (Figure 3). Namely, relatively poor growth, expressed through low shoot and root FM of L2 (Figure 1), with no remarkable influence of applied pesticide treatments could be connected to a highest hydrolysis level among all inbreds (Figure 3) and lowest biosynthesis. High hydrolysis and low biosynthesis levels are evidence of high deprivations of dry matter, giving poor growth potential to a specified seedling (Dragičević et al., 2008). In general, pesticide treatments induced decrease in hydrolysis, parallel to increase in biosynthesis. It is important to underline that for L4, as inbred with highest average biosynthesis, the applied seed treatments increased biosynthesis (Figure 3), but mainly on the root level (highest root DM, Figure 2), similar to results achieved by Kunkur et al. (2007) on cotton. On the other hand, highest impact of applied treatments was observed for L5, where biosynthesis was elevated 34.4% in fludixonil + metalxil-M and imidacloprid treatment, and in L6 it was 52.5% higher in treatment with fludixonil + metalxil-M and tiametoxam, indicating stimulation, irrespective to the way of their action (Singh et al., 1979, Singh et al., 1982, Siddiqui and Zaman, 2004).
Figure 1. Germination percentage of maize inbred lines (L1-L6), influenced by fludixonil + metalxil-M (M), fludixonil + metalxil-M and tiametoxam (M+C), fludixonil + metalxil-M and imidacloprid (M+G) and control (Ø); Values are mean ± SD.

Figure 2. Fresh matter of maize inbred lines (L1-L6), influenced by fludixonil + metalxil-M (M), fludixonil + metalxil-M and tiametoxam (M+C), fludixonil + metalxil-M and imidacloprid (M+G) and control (Ø); Values are mean ± SD.

Figure 3. Dry matter of maize inbred lines (L1-L6), influenced by fludixonil + metalxil-M (M), fludixonil + metalxil-M and tiametoxam (M+C), fludixonil + metalxil-M and imidacloprid (M+G) and control (Ø); Values are mean ± SD.

Figure 4. Sum of hydrolysis (ΣHy) and biosynthesis (ΣBs) of maize inbred lines (L1-L6), influenced by fludixonil + metalxil-M (M), fludixonil + metalxil-M and tiametoxam (M+C), fludixonil + metalxil-M and imidacloprid (M+G) and control (Ø); Values are mean ± SD.
Conclusion

Based on the obtained data it can be concluded that the applied pesticide treatments induced increase in germination of maize inbreds, as well as stimulate fresh matter and dry matter accumulation, through lowering the hydrolysis level and increasing the biosynthesis. Adequate pesticide combination depends on the genotype.

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References


