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RESEARCH ARTICLE

FUNGICIDE SEED TREATMENT ON THE PHYSIOLOGICAL AND SANITARY QUALITY IN MAIZE CULTIVATION

*Maria Johana González Vera, Andréa BiccaNoguez Martins, Fernanda da Motta Xavier, Geri Eduardo Meneghello, Catalina SoledadGaona Duarte, Viviana Maria Palacios Acuña, Pamela Peña Almeida, YesminaLezcano Aquino and Diego Torres Arza

Agronomist, National University of Asunción, Faculty of Agricultural Science, San Lorenzo, Paraguay

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ABSTRACT

At post-harvestperiod, quality of corn sedes may be influenced by several important factors such as: presence of harmful microorganisms, chemical treatments, host speciesgeno type and storage conditions. Seed treatment with fungicides is a recommended practice to protect the seeds from pathogens, therefore, seed treatment is advisable in most cases. Seeds were treated with different fungicides in order to evaluate the treatment effect on the physiological and sanitary quality of the crop. The incidence, severity and index of damage were determined, as well as plant height, dry weight and root length. The experimental design was a randomized complete block with three replications, in a factorial scheme 4x2 + 1; factor A: fungicides (carbendazim + thiram; carboxyn + thiram; methyl thiophanate + thiram and tebuconazole); factor B: dose (minimum and maximum); and 1: control. The data were subjected to analysis of variance and for the comparison of means, Tukey's test was used at 5% error probability. The results showed that there were no significant differences for the variables that determined the sanitary quality of seeds when treated with the fungicides compared with the control, due to the low presence of pathogens in the same and in the soil, as well as there were no significant differences in the variables that determine the physiological quality. It is concluded that due to the low presence of pathogens, it was not possible to determine the effectiveness of the fungicides and, once treated, the maize seeds were not affected by the same with regard to the physiological quality.

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INTRODUCTION

Maize (*Zea mays* L.), belonging to the family Poaceae, is one of the most widely grown agricultural plants in the world, of great importance for Brazil, where it is produced in several regions (Agrianual, 2009). Its cultivation extends to several countries, and Brazil appears in the third place, with 13.7 million hectares planted, representing 8.6% of the world total (FAOSTAT, 2011). The crop remains highly profitable and with multiple applications both for direct food and for the food industry, as well as for grain production (Sulewska *et al.,* 2014). The evaluation of the physiological potential of seeds is the main component of a quality control program, as it provides information to identify and solve problems during the production process and to estimate seed yield in the field (Martins *et al.,* 2014). Therefore, the use of seeds with high physiological potential is an important aspect that must be considered to increase yield and, therefore, seed quality control tends to be increasingly efficient, comprising tests to quickly evaluate this aspect, allowing the precise differentiation of seed lots (Fessel *et al.,* 2010). According to Marcos Filho (2005), the quality of a seed is determined basically by its physiological aspects, which include information on the viability and vigor of a seed lot, in addition to its yield potential, i.e., the set of skills to perform tasks and produce results. A good quality seed must have excellent sanitary, physiological, genetic and physical characteristics. The sanitary quality is determined by means of the evaluation of the incidence of pathogens, while the physiological quality is determined through germination and vigor parameters. Maize seeds are subject to the attack of numerous fungi associated with them; those that cause seed rot, seedling death and fall are considered highly destructive pathogens. They are responsible for poor germination, low vigor, reduction in plant density and decreased seed quality for planting. This is why chemical treatment, whose action inhibits pathogens in the seeds, is one of the measures aimed at reducing the recurrence of diseases transmitted by seeds. The objective of the research was to evaluate the seed treatment effect on the physiological and

Corresponding author: Maria Johana González Vera,
Agronomist, National University of Asunción, Faculty of Agricultural Science, San Lorenzo, Paraguay.

sanitary quality of the maize crop treated with different fungicides.

MATERIALS AND METHODS

Sowing was done in an experimental field (25° 19'35" S, 57°31'13" W) and the evaluations of the variables were performed in the Laboratory of Seed Quality Analysis (25.33°51'59" S, 57.51º33'01" W), both of the Faculty of Agrarian Sciences of the National University of Asunción. The experimental period comprised the months of November and December 2015. The experimental site had 332.5 m^2 separated into three blocks, each block containing nine experimental units of four rows; in each row, 25 seeds were planted. The experiment consisted in the use of several fungicides for treatment of seeds against fungi, at minimum and maximum doses, using a randomized complete block design, in a factorial scheme 4x2 + 1, where factor A corresponds to the fungicides and factor B corresponds to the minimum and maximum doses, in addition to the control, thus constituting 9 treatments and 3 replications representing each block.

The treatments to which the seeds were subjected were:

- Thiram + carbendazim in minimum and maximum doses;
- Carboxin + thiram in minimum and maximum doses;
- Methyl thiophanate + thiram in minimum and maximum doses;
- Tebuconazole in minimum and maximum doses;
- Control.

Prior to the sowing, a germination test was carried out, yielding a germination of 98%, in addition to sanitary tests, blotter test and PDA, being observed in these tests the presence of *Fusarium* sp. Once the seeds were treated with the corresponding field treatment, it was evaluated the emergence at 10 days after sowing, taking into account the two central rows; every 7 and 14 days of collection of seedlings with symptoms of damage by pathogens, these were evaluated to determine the causative pathogen. At 30 days after sowing, 15 plants were collected per treatment for physiological evaluations, the experiment had a period of one month because these fungicides have a maximum action period of 30 days.

RESULTS AND DISCUSSION

Table 1 shows the results of the percentage of emergence of maize seeds in the different treatments. The analysis of the data obtained shows that there was no significant statistical difference for this variable. The average value of the experiment was 79%, with a C.V. of 10.68%. These results reflect a low incidence of the fungus *Fusarium* sp. due to a low presence of inoculum in the seeds, verified in the PDA and blotter tests carried out before sowing. Lasca et al. (2005) obtained a low average emergence, with a statistically significant increase in relation to the control in treatments with captan and carbendazim + thiram, indicating that the conditions were adverse and that both seed and soil fungi would have affected the emergence. These results do not agree with Pinto (1998), who worked with sorghum seeds and observed significant differences between treated and untreated seeds in humid and cold soils, concluding that soil-dwelling fungi promoted a significant reduction in seed emergence when the edaphoclimatic conditions were favorable.

Table 1. Percentage of emergence of maize seeds treated with fungicides in minimum and maximum doses. San Lorenzo, 2016

Treatments	Emergence (%)
T9: Control	85,33 A(*)
T7: Tebuconazole Min. D.	84,00 A
T1: Carbendazin +Thiram Min. D.	82,67 A
T3: Carboxin+Thiram Min. D.	82,00 A
T2: Carbendazin +Thiram Max. D.	82,00 A
T4: Carboxin+ thiram Max. D.	78,67 A
T6: Metiltiofanato + thiramMax.D.	76,67 A
T8: Tebuconazole Max. D.	76,00 A
T5: Metiltiofanato +Thiram Min. D.	68,67 A
Means	79,00
C.V (%)	10,68

(*)Means followed by different letters in the vertical differ from each other by the test of Tukey to 5%.

Table 2, shows the incidence expressed in percentage, where a low incidence of the pathogen *Fusarium* sp. was observed in all treatments, highlighting T3, which presented 0% incidence. These data demonstrate that maize seeds did not have a high presence of *Fusarium*s preproductive structures, external and internally before sowing. In addition, thelowpercentage of organicmatter in thefield of experimentation (0.55%) didnot favor in thepresence of pathogens in thesoil. Fungi have several methods to survive during unfavorable times, such as heat and soildrought (production of spores in fruitingbodies, chlamydospores, sclerotes, etc.). On the other hand, excessive moisture is often unfavorable to them (Wild *et al.,* 1992).

Table 2. Percentage of incidence in maize seed lings treated with fungicides in minimum and maximum doses. San Lorenzo, 2016

Treatments	Incidence (%)
T1: Carbendazin +ThiramMin.D.	2,41
T2: Carbendazin +ThiramMax.D.	0,81
T3: Carboxin+ThiramMin.D.	0
T4: Carboxin+ thiramMax.D.	2,54
T5: Metiltiofanato +ThiramMin.D.	2,91
T6: Metiltiofanato + thiramMax.D.	2,72
T7: TebuconazoleMin.D.	0,79
T8: TebuconazoleMax.D.	2,63
T9: Control	0,78
Means	1, 73

Table 3 shows the data correspondingtotheplantheight (centimeters) of maizetreated with different fungicides with minimum and maximum doses. Statistical analysis of the data showed that there was no statistically significant difference. The mean plantheightwas 72.75 cm and the C.V was 7.40%.

Table 3. Height of maizeplanttreated with different fungicides with minimum and maximum doses. San Lorenzo, 2016

Treatments	Plantheight (cm)
T4: Carboxin + Thiram Max. D.	77,93 A(*)
T9: Control	76,73 A
T7: TebuconazoleMin.D.	75,93 A
T8: TebuconazoleMax.D.	75,27 A
T6: Metiltiofanato+ Thiram Max.D.	72,73 A
T2: Carbendazin + ThiramMax.D.	70,80 A
T3: Carboxin + ThiramMin.D.	70,40 A
T5: Metiltiofanato + ThiramMin.D.	70,27 A
T1: Carbendazin + ThiramMin.D.	64,73 A
Means	72,75
C.V (%)	7,40

(*) Means followed by different letters in the vertical differ from each other bythe test of Tukey to 5%.

Maize seeds, when treated with different fungicides, were not affected with regard to plant growth. In the study by Silva et al.

(2009), soybean plants treated with carbendazim + thiram presented a height of 15.20 cm, not differing from the control, where plants presented 14.85 cm height, emphasizing that the use of fungicides for seed treatment has little or no influence on plant height. Table 4 shows the data obtained for the dry weight (grams) of maize plants treated with different fungicides at a minimum and maximum dose, without significant differences, averaging 66.81 g and with a C.V. of 26.41%.

Table 4. Drymass (g) of maize plants treated with different fungicides with minimum and maximum doses. San Lorenzo, 2016

Treatments	Drymass (g)
T4: Carboxin + ThiramMax.D.	75,52 A(*)
T7: TebuconazoleMin.D.	75,45 A
T2: Carbendazin + ThiramMax.D.	75, 29 A
T3: Carboxin + ThiramMin.D.	69,44 A
T6: Metiltiofanato + ThiramMax.D.	65,22 A
T1: Carbendazin + ThiramMin.D.	62,79 A
T8: TebuconazoleMax.D.	60,35 A
T9: Control	60,07 A
T5: Metiltiofanato + ThiramMin.D.	57,20 A
Means	66,81
C.V (%)	26,41

(*)Means followed by different letters in the vertical differ from each other by the test of Tukey to 5%.

It was determined that there were no significant statistical differences for the factor fungicide, as well as for the factor dose and the interaction fungicide-dose, thus emphasizing that the dry matter of the plants is not affected when maize seeds are treated. Azevedo&Araújo (2007) did not find statistically significant differences regarding the effect of fungicides on dry biomass, the opposite being observed in shoot biomass, where plants from seeds treated with tebuconazole (1.78g) were statistically superior to those treated with carboxin + thiram (1.38g) and those not treated (1.49g).

Conclusion

Due to the low presence of *Fusarium* sp. in the PDA and blotter tests before sowing, a low percentage was observed regarding the incidence, severity and index of damage in maize plants in the field. The fungicides used in the seed treatment did not affect the physiological quality of maize.

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