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AERIAL AND GROUND APPLICATIONS OF FUNGICIDE FOR THE CONTROL OF LEAF DISEASES IN MAIZE CROP (*Zea mayz* L.)

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ABSTRACT: Maize crop occupies the second place in volume of grain production in Brazil and can be infected by several leaf diseases, standing out the polysora rust (*Puccinia polyssora)* and the common helminthosporiose (*Exserohilum turcicum*). The objective of the present experiment was to verify the viability of the chemical control of these diseases by means of ground and aerial applications of fungicide. The experiment was accomplished in the North region of the state of Rio Grande do Sul, Brazil and the maize, hybrid Pioneer 32R21, was grown according to the official indications. For the control of diseases, the Opera® (Epoxiconazole + Pyraclostrobin) fungicide was sprayed, via ground and via aerial equipment. The applications were carried out when the maize showed a height between 0.7 and 0.8 m (feasible height limit for entrance with ground sprayer) and in the tasseling stage and in both moments. The severity of the polysora rust as well as the helminthosporiose in the maize leaves, treated with fungicide, and in checks without application and the grain yield of maize was evaluated. The aerial applications of fungicide were more efficient than those via ground sprayer. The use of fungicide was feasible and the economic gains depended on the time of application that was adopted. Ground applications cause significant damages by tire tracks.
Key-words: application technology, crop damage by tire tracks, economical efficiency

INTRODUCTION: Maize crop can be attacked by various leaf diseases, whose impact on the grain yield will depend on the genotype, management practices and the environmental conditions that occurred during the culture cycle (JULIATTI et al., 2007). According to (REIS et al., 2004) and PIONEER (2007), among the main leaf diseases, that can reduce grain yield of maize in the South of Brazil, are found the polysora rust (*Puccinia polyssora)* and the common helminthosporiose (*Exserohilum turcicum*). The chemical control must be used when it is economically feasible, since the polysora rust and the common helminthosporiose diseases are controlled with the use of fungicides (REUNIÃO..., 2005). The best time for fungicide application on maize is next to tasseling and, if necessary, a second application can be carried out, respecting the persistence of the used product (REUNIÃO..., 2005 and PIONEER, 2007). The market offers efficient fungicides for the control of these maize diseases. Therefore, one of the difficulties found in the practice is the application technology. Both spray equipments via ground and via air can achieve applications of fitossanitary treatments successfully, since it is consider the damage by tire tracks of the grow (ANTUNIASSI, 2006). The aerial application technology has improved significantly in recent years and presents competitive costs compared with the ground spraying (SCHRÖDER, 2007). The objective of the experiment was to evaluate the effects of the fungicide application in maize on the polysora rust and common helminthosporiose control, and on the grain yield, comparing applications via ground equipment with applications via aircraft, and different application schemes (timings).

METHODOLOGY: The experiment was carried out during the season of 2006/2007, in a farm, located in the town of Coxilha in the Rio Grande do Sul, state, Brazil, where the altitude is 721 m above sea level, the latitude 28º 07' 38" S and the longitude 52º 17' 46" W. The maize, hybrid Pioneer® 32R21 was implanted under no-tillage system, traditional in the region, in growing area with soy in the previous year. The date of sowing was 20/09/2006, the spacing between lines 0.8 m, the sowing density of 60.000 plants ha^{-1}. The fertilization was performed with 250 kg ha^{-1} of fertilizer N-P_2O_5-K_2O, 6-24-18, applied in furrows and 200 kg ha^{-1} of urea (45,5 % of N) broadcasted.

Table 1 – Equipments and operations of treatments for application of Opera® fungicide in maize

Two applications of fungicide	
First application	**Second application**
1. Ground spraying 0,50 L ha^{-1}	-------------------
2. Ground spraying 0,50 L ha^{-1}	Ground spraying 0,50 L ha^{-1}
3. Ground spraying 0,50 L ha^{1}	Aerial spraying 0,50 L ha^{-1}
Single application	
4. Ground spraying – 0,75 L ha^{-1}	
5. Aerial spraying – 0,75 L ha^{-1}	
6. Check without application of fungicide	

In the treatments with two applications, the first application was accomplished on day 10/11/2006 (50 days after sowing) with a spray volume of 140 L ha^{-1}, using the ground sprayer. The maize plants presented the maximum limit height for one spraying with assembled or tractor pulled sprayer (between 0.7 and 0.8 m). The second application happened at the time of maize tasseling, with the land spray applying tail volume of 140 L ha^{-1}. For application via air, the spray volume was of 15 L ha^{-1}, adding 0.5 L ha^{-1} of vegetable oil Agróleo®. The treatments with single application were applied on the same day of application of the second treatment of the treatments with two applications. The ground equipment was a self-propelled sprayer, brand Jacto® model Uniport 2000, with volumetric capacity of 2000 liters, equipped with bar of 21.5 m and 43 double plain jet nozzles with air induction, series Micron® DB AIR 11004, spaced in 0.5 m. The dislocation velocity of the ground sprayer was of 16 km h^{-1} and the spray pressure was of 400 kPa. The volume median diameter (VMD) of the droplets collected in water and oil sensible cards, was of 606 µm. The application via air was achieved with an agricultural aircraft Ipanema® model EMB 201-A, that was led three to five meters above the top of the maize plants. The aircraft was equipped with eight screen rotating atomizers, brand Microspin® (similar to the atomizers Micronair® model AU-5000) and the VMD of the droplets collected in sensible cards placed on the maize leaves was of 175 µm. During the second application of fungicide, the average atmospheric conditions were the following: wind velocity 17 km h^{-1}, air temperature 20.7 ºC and air relative humidity 58 %. Both equipments used (ground sprayer and agricultural aircraft) applied the treatments in lanes with width of 110 m and inside each lane it was randomly placed samples to evaluate the diseases and the grain yield. The predominant diseases were polysora rust (*Puccinia polyssora)* and common helminthosporiose (*Exserohilum turcicum*). To assess the evolution of rust, weekly readings of the number of pustules in a standard area of 21 cm² and to the helminthosporiose, the leaf area rotted by the disease was measured. The leaf samples were randomly collected in 30 plants of each treatment. The control of the diseases was calculated by comparing the mean severity of the samples with the average severity of the check. At harvest time, the collecting of samples was achieved in rows, measuring 12 m length, on day 31/01/2007, with maize grains showing 27 % humidity. To determine the grain yield in areas with damage by tire tracks of ground equipment, the obtained results were divided by a constant (1.79) since the length of the collected rows was not the same as the distance between the tracks of the machine on the ground. The results were submitted to the analysis of variance and to the Tukey test to the level of 5 % error probability.

RESULTS AND DISCUSSION: The obtained results are presented in Tables 2 and 3. Table 2 shows that for the control of polysora rust of the hybrid maize P32R21 (susceptible genotype), only one application of fungicide was not enough to keep the intensity of the disease reduced over the assessment period (December 2nd of 2006 to mid of January 2007). The control of the polysora rust with two applications of fungicide with a dose of 0.50 L ha^{-1}, in 50 days after maize sowing in the tasseling, was more efficient than with a single application of 0,50 L ha^{-1} in 50 days after maize sowing or of 0,75 L ha^{-1} in the tasseling, not having significant differences among the equipments. With a single dose of Opera® at 0.75 L ha^{-1}, the aerial application was superior to the ground application, which did not differ from the check without application of fungicide. These observations allow inferring that the application of the fungicide once in the tasseling happened very late regarding the polysora rust infection. Therefore, the results that show a better control of the polysora rust, when the fungicide is applied via air, must be attributed to a greater homogeneity of the droplets created by the rotating equipment used in the aircraft and by the best allocation of drops (fine category), on the maize plants that this application method provides (VILELA, 2007 and SCHRÖDER, 2007). For the control of helminthosporiose, two applications of fungicide at 0.50 L ha^{-1} (in 50 days after sowing and tasseling) were similar to the single application with a dose of 0.75 L ha^{-1} in the tasseling. These results show that to control this disease, the later applications were more effective than the early ones.

Table 2 – Control percentage of polysora rust (*Puccinia polyssora)* and of common helminthosporiose (*Exserohilum turcicum*) in hybrid P32R21 maize, resulting from different treatments of fungicide application with ground and aerial equipments.

Treatment	**Rust control (%)**	**Helminthosporiose control (%)**
1. Ground – 0.50 L ha^{-1}	27.99 cd	17.4 b
2. Ground – 0.50 L ha^{-1} + 0.50 L ha^{-1}	62.57 ab	98.9 a
3. Ground + aerial – 0.50 L ha^{-1} + 0.50 L ha^{-1}	80.12 a	69.2 ab
4. Ground – 0.75 L ha^{-1}	2.74 de	96.6 a
5. Aerial – 0.75 L ha^{-1}	47.72 bc	96.3 a
6. Check without application of fungicide	0.00 e	0.0 c
Coefficient of variation (%)	56.74	87.44

Averages, followed by the same letters, in each column, does not differ significantly among themselves, to the level of 5 % error probability, by the Tukey test.

Table 3 shows that the grain yield of maize answered to the treatments, having important variations due to damage caused by the traffic of the ground sprayer. The minor damage caused by tire tracks (52 kg ha^{-1}) was observed when the spraying with fungicide was carried out only once, at 50 days after sowing. In the later applications, the damage by tire tracks increased considerably. The greatest damage caused by tire tracks (656 kg ha^{-1}) corresponded to the treatment where two ground applications were carried out. In the treatment, in which the first application of fungicide was with ground sprayer, and the second one with aircraft, the damage by traffic represented 604 kg ha^{-1} and in the treatment with a single application via ground in the tasseling, 226 kg ha^{-1}.These data reinforce the observations of ANTUNIASSI (2006) about damage by tire tracks of the crop. Further, regarding to traffic, it is possible to comment that, the smallest damage obtained in late applications (226 kg ha^{-1}) corresponds to the double of the application cost via air. Besides these considerations, the results show that the treatment which provided significantly superior grain yields to the check, was the one where the fungicide was applied in single dose of 0,75 L ha^{-1}, via air, showing the superiority of this method over the application via ground, in these use conditions. The data show that the use of the fungicide for the control of polysora rust (*Puccinia polyssora)* and the common helminthosporiose (*Exserohilum turcicum*) in maize, make economic gains, between 95,00 and 495,00 North American dolars per grown hectare (prices of products and market exchange of March 2007) possible, in comparison to the check, depending on the used time and equipment of application. The gain provided by the use of applications via air, regarding the treatments via ground (discounting the costs of both of them) vary between 40,00 and 200,00 dolars per hectare, what proves to be more interesting to apply fungicide in maize via air than via ground. These results agree with the reports of JULIATTI et al. (2007).

Table 3 – Hybrid P32R21 maize grain yield (kg ha^{-1}) resulting from ground and aerial fungicide application methods and damage by tire tracks. Passo Fundo, RS – FAMV/UPF

Treatment	Grain Yield (kg ha^{-1})
1a. Ground – 0.50 L ha^{-1} without damage by tire tracks	8291 ab
1b. Ground – 0.50 L ha^{-1} with damage by tire tracks	8239 ab
2a. Ground – 0.50 L ha^{-1} + 0,50 L ha^{-1} without tire tracks	8311 ab
2b. Ground – 0.50 L ha^{-1} + 0,50 L ha^{-1} with damage by tire tracks	7655 b
3a. Ground + aerial – 0.50 L ha^{-1} + 0.50 L ha^{-1} without tire tracks	8608 ab
3b. Ground + aerial – 0.50 L ha^{-1} + 0.50 L ha^{-1} with damage by tracks	8004 b
4a. Ground – 0.75 L ha^{-1} without damage by tire tracks	9298 ab
4b. Ground – 0.75 L ha^{-1} with damage by tire tracks	9072 ab
5. Aerial – 0.75 L ha^{-1}	10690 a
6. Check without application of fungicide	6930 b
Coefficient of variation (%)	15,92

Averages followed by the same letters, does not differ significantly from themselves, by the Tukey test at the level of 5 % error probability.

CONCLUSION: The use of Opera® fungicide for the control of polysora rust (*Puccinia polyssora)* and the common helminthosporiose (*Exserohilum turcicum*) in maize genotypes, susceptible to these diseases, makes significant economic gains possible, varying with the method (time) and the used equipment of application. The applications of fungicide via air show superior performance, when compared to those carried out via ground, once the damage by traffic, caused by the ground sprayer, is a relevant factor at the moment of comparing both techniques.

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