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Application of foliar fertilizer and fungicides on white spot disease control and development of maize

M. V. Faria, R. M. Q. Lana, C. H. Brito, F. B. Agostinho, A. F. Cardoso, A. M. Brandão

Universidade Federal de Uberlândia

Author for correspondence: marcosvfagro@gmail.com

Abstract: This study aimed to evaluate the effect of forms of application of foliar fertilizers and fungicides to control fungus causing white maize spot, *Phaeosphaeria maydis*, and the growth and development of hybrids maize. The design had randomized blocks, with the use two sources hybrids maize with different reaction to white maize spot: resistant and susceptive and application with moisture of foliar chemical fungicide + cobalt foliar + molybdenum foliar + manganese and control treatment, without application consisting of four treatments and five replications. In the treatments with application of moisture were done on vegetative maize growth stage V8 (stage that determine that the number of kernel rows), VT (stage that arrives when the last branch of the tassel is completely visible) and reproductive maize growth stage R2 (kernels are white on the outside and resemble a blister). The evaluation of variables of growth of maize plants: grain dry mass, cob dry mass, leaf dry mass, culm dry mass and modified leaf ear and total plant dry mass. Harvest was carried out when the grains were 20% humidity. The application of fungicides and foliar fertilizers increased the leaves, culms, ear modified, cobs and shoot dry mass plants maize. The application of fungicides and foliar fertilizers providing returning of 11.409,5 kg ha^{-1} of shoot dry mass plants with increased of 1.296 kg ha^{-1} on soil (12,81%). In the hybrid maize the application of fungicides and foliar fertilizers provide higher dry mass grains and shoot of plants.
Keywords: *Zea mays*, fungicids, foliar fertilization, *Phaeospharia maydis*.

Introduction

Maize is a cereal of great economic importance in Brazil. In 2015 maize was planted on about 14 million hectares, producing 77 million tons of grains. Brazilian corn has two harvests per year. The main harvest is during the rainy season and a second, "dry cultivation" harvest follows during the dry season (Ibge, 2015).

A special attention to disease control should be assume in management of maize plants because it is a highly susceptible culture to a range of pathogens, many having potentially devastating consequences. Among the complex of pathogens, the fungus, *Phaeosphaeria maydis*, *Phyllosticta* sp., *Phoma sorghina, Sporormmiella* sp. and bacteria *Pantoea ananas* that cause white maize spot (WMS) (Sachs et al., 2011).

The use of hybrids with greater production potential, sometimes more susceptible to disease, they have contributed to the increase of foliar diseases in maize crop (Costa et al., 2012). Among these diseases should be highlighted white maize spot. Symptoms of WMS begins with the appearance of stains foliar irregularly shaped, green color dark, with aspect waterlogging leaf. After the necrotic injuries staining straw, may occur coalescing lesions. Symptoms are different presented in different severities as genotype of maize (Paccola Meirelles et al. 2002). At conditions of frequent and well irregular rains, the pathogen can cause more severe and affect grains yield (Sawazaki et al., 1997).

The yield in maize it influenced by several factors. One of them is the loss of leaf area that according Brito et al. (2013) that greater than 40%, regardless of the vegetative stage and the region in the plant compromises the yield. Defoliation in plants may due to the occurrence of diseases, injuries promoted by pests, drought and others. In the case of maize, foliar diseases that affect the maize crop can reach much of the leaf tissue, reducing the leaf area and hence photosynthesis. The prevalence of the disease in corn crop is growing every year, especially because of the indiscriminate use of susceptible cultivars, row crops and improper use of high technology, associated with the occurrence of favorable weather, thus contributing to the use of fungicides (JuliattI et al., 2014).

Among control measures, chemical control is the most widely used in Brazil, through the systemic fungicides. However, due to the complexity of the epidemiology of this disease, the results have often fallen short of the desired. Because it is difficult for maize producers to control the WSM, there is a need for new studies of integrated pest managements aimed at minimizing economic damage caused by pathogen complex and which are less harmful to the environment, as well as to the plant. Among the management methods, the use of fertilizers is a promising alternative to integrate the management of blackleg promoting induced resistance in plants.

The induced resistance has shown potential in the control of plant diseases which may be triggered by microbial, natural and chemical agents. This resistance is expressed locally at the site of pathogen attack and systematically in uninfected parts of the plant (Mauch-Mami & Metraux, 1998). The defense mechanisms engage a combination of physical changes such as cell wall lignification, formation of papillae or induction of various proteins involved in metabolic processes.

Advances in research involving induced resistance in plants have been followed by an emergence of new management practices (Resende et al., 2006). This objective this study to evaluate the effect of forms of application of foliar fertilizers and fungicides to control fungus causing white maize spot, *Phaeosphaeria maydis*, and the growth and development of hybrids maize.

Methods

The experiment was conducted between 2010/2011 on Fazenda Antargordense, Minas Gerais, located at at an altitude of 1020 m. The soil was classified as Red Yellow Latossoils. Before the deployment of the experiment soil samples were collected from the layer of 0-20 cm for chemical analyzes, conducted according to the methodology of Embrapa (2011), with the following characteristics: pH (H_2O) = 5,5; phosphorus = 18,2 mg dm^{-3}; potassium = 145 mg dm^{-3}; calcium = 2,3 cmol$_c$ dm^{-3}; magnesium = 0,7 cmol$_c$ dm^{-3}; Organic matter = 34 g kg^{-1}; Base saturation =48,4%; boron = 0,92 mg dm^{-3}; cupper = 5,8 mg dm^{-3} ; iron = mg dm^{-3} ; manganese = 2,9 mg dm^{-3} ; zinc = 8,4 mg dm^{-3} and cation exchange capacity = 7,0 cmol$_c$ dm^{-3}.

The experimental design had randomized blocks, with four treatments and five replications. The experimental plots were composed of 6 lines of 0.6m apart with 5,2m in length, with a total area of 12,48m^2. The treatments consisted of the following two sources hybrids maize with different reaction to white maize spot: resistant and susceptible and application with moisture of foliar chemical fungicide + cobalt foliar + molybdenum foliar + manganese and control treatment, without application.

In treatments with foliar moisture were done an application with rates fungicides: 2 kg ha^{-1} of dioticarbamate (750 g kg^{-1}), 0,3 L ha^{-1} of triazol + strobylurin (Cyprocronazole – 80 g L^{-1}; Azoxystrobin – 200 g L^{-1}, respectively) and foliar fertilizers rates 150 ml ha^{-1} of cobalt (1,5%) + molybdenum (1,8%) and 2 L ha^{-1} of manganese phosphite moisture were done on vegetative maize growth stage V8 (stage that determine that the number of kernel rows), VT (stage that arrives when the last branch of the tassel is completely visible) and reproductive maize growth stage R2 (kernels are white on the outside and resemble a blister).

The control of insects and mites, as well as fertilization and other cultural treatments, was done according to the commercial standards predetermined on the property.

The harvest of the experiment took place when maize grains showed 20% of humidity. In each plot, four plant samples were collected to evaluate growth of plants: leaf dry mass, culm dry mass, ear modificated leaf, grains dry mass, cob dry mass the by drying the samples in an oven with forced air circulation at 65 ° C for 96 hours (Embrapa, 2009). The others plants were used to evaluate the productivity.

Data were subjected by homogeneity (Levene test), normality (Shapiro Wilk test) and additive (No additives Tukey test) significance at 0.01 probability level and (F test) analysis of variance and the variables were evaluated comparing means by Tukey test at 0.01 probability level. The statistics software used by SISVAR (Ferreira, 2010).

Results and Discussion

There was interaction between maize hybrids and application of foliar fertilizers and fungicides to grain dry mass and dry mass plants (Table 1). Regarding growth others attributes verified difference of isolated variables. The maize hybrids and application of foliar fertilizer and fungicides statistical difference isolate was show of cob dry mass, leaf dry mass, and modified leaf ear. To the maize hybrids only was observe differences to culm dry mass and total plant dry mass.

The application of foliar fertilizers and fungicides provided dry mass increments of 311,64 kg ha^{-1} (9,41%) in leaf, 422,36 kg ha^{-1} (12,61%) in culms, 201,69 kg ha^{-1} (11,35%) in modified leaf, 360,31 kg ha^{-1} (21,47%) in cob and, consequently 1.296,00 kg ha^{-1} (12,81%) in total plants. Vasconcellos et al. (1998) founded leaf dry mass values between 31-39 g planta^{-1}, 106-118 g plant^{-1} in culms, 3-4 g planta^{-1} in tassel and 220-250 g plant^{-1} in bracts + cob. While, Moreira et al. (2014) determined that the leaf dry mass values between 2.243,9 e 3.368,1 kg ha^{-1}, similar accumulation in to that present study (3.310,4 kg ha^{-1}) and higher dry mass values between 4.402,3 e 7.244,9 kg ha^{-1}.

Table 1 – Variance analyse of dry mass parts of hybrids maize with or without fungicides and foliar fertilizers application.

Medium square		Variation source: Hybrids	Protection	Hyb. * Apl.	Block	Residue	CV (%)
	G.L.	1	1	1	7	21	
Leaf		961.290,7*	776.970,3*	14.547,3^{ns}	116.110,1	101.736,7	9,2
Culm		7.794,6^{ns}	1.427.084,3*	15.038,7^{ns}	227.979,2	93.002,1	8,6
Modificated Leaf.		204.860,8*	325.432,5*	32.792,3^{ns}	46.706,7	46.839,4	11,5
Cob		809.112,8*	1.038.583,5*	201.754,9^{ns}	88.214,5	94.858,7	16,6
Total plant		198.261,0^{ns}	13.436.928,0*	780.375,3^{ns}	1.407.018,7	972.715,6	9,2
Grains		1.352,00^{ns}	19.722.789,2*	16.225.463,4*	1.388.454,5	1.543.524,9	10,2
Total plants		232.366,9^{ns}	65.718.199,8*	24.122.794,7*	5.430.967,3	4.795.053,9	9,5

Hyb. - Hybrid; Apl.- Application; CV – Variation Coefficient; ^{ns} not significantly and * significantly (F test, p≥ 0,05)

This increase is of great importance in the production cycle, as well as in the management and conservation of the soil, because, after the harvest of grains, all shoot of the plants remains in the field. The return to the soil of 11,409.5 kg ha^{-1} shoot dry mass plants, this means that reaching a difference of 1,296 kg ha^{-1} (12.81%) dry mass, in treatments with application of foliar fertilizers and fungicides (Table 2).

The shoot dry mass incorporate in soils promotes the protection of the soil, reducing erosion, evaporation of water, increasing the amount of available water, favoring the beneficial microorganisms, recycling and diffusion of nutrients, especially the low mobility (P and Zn). With greater dissemination, for greater absorption of P, higher root growth and, consequently, greater recycling of nutrients. The largest recycling of nutrients for subsequent crops, as soybeans, can increase the grains production, promote the maintenance of the no-tillage system and reduce the environmental impact, ensuring a sustainable production.

The persistence of residues (shoot dry mass) during critical times of the year in the Brazilian savannah, as the dry season after the first rains and during the early development of commercial culture, will mitigate the direct sunlight and the action of erosion agents, as the impact of raindrops, common in those periods (Sodré Filho et. al., 2004).

The ground cover provided by cultural waste is a major source of nutrients to agricultural systems, once the plants absorb the sub-surface layers of soil being subsequently released into the surface layer by decomposition (Krutzmann et al., 2013). The refund depends on the rate of mineralization, the organic matter is five to ten times greater in the region of the Brazilian savannah than in temperate regions (Costa et al., 2014).

For the grains dry mass, there was interaction between hybrids and application of foliar fertilizers and fungicides (Table 2).

Table 2 – Leaves, modified leaf ear, shoot plant, culm, cob, grains and total dry mass of maize hybrids (kg ha^{-1}), with or without application.

Hybrids	Leaves			Culm		
	Without	With	Average	Without	With	Average
Resistant	3505,0	3774,0	3639,5 a	3355,0	3734,0	3554,5 a
Susceptive	3115,7	3470,0	3292,9 b	3342,9	3808,6	3575,7 a
Average	3310,4 B	3622,0 A		3348,9 B	3771,3 A	
	W = 0,96; F_{Levene} = 2,17; $F_{no\ additivity}$ = 10,42			W = 0,95; F_{Levene} = 2,12; $F_{no\ additivity}$= 3,28		
	Modified leaf ear			Cob		
	Without	With	Average	Without	With	Average
Resistant	1888,3	2026,0	1957,2 a	1600,0	1798,0	1699,0b
Susceptive	1664,3	1930,0	1797,1 b	1755,7	2278,3	2017,0a
Average	1776,3 B	1978,0 A		1677,9 B	2038,2 A	
	W = 0,98; F_{Levene} = 2,58; $F_{no\ additivity}$ = 14,62			W =0,88; F_{Levene} = 1,67; $F_{no\ additivity}$ = 4,50		
	Shoot plant			Grains		
	Without	With	Average	Without	With	Average
Resistant	10348,3	11332,0	10840,2 a	12160,0 aA	12306,0 bA	12233,0
Susceptive	9878,6	11486,9	10682,7 a	10722,9 bB	13717,1 aA	12220,0
Average	10113,5 B	11409,5 A		11441,4	13011,6	
	W = 0,96; F_{Levene} = 3,27; $F_{no\ additivity}$ = 5,48			W = 0,95; F_{Levene} = 2,56; $F_{no\ additivity}$ = 5,96		
	Total plant					
	Without	With	Average			
Resistant	22508,3 aA	23638,0 aA	23073,2			
Susceptive	20601,4 aB	25204,1 aA	22902,7			
Average	21554,9	24421,0				
	W = 0,95; F_{Levene} = 2,94; $F_{no\ additivity}$ 6,85					

Médias followed by different letters, capital letters on the line and lower the column, differ by Tukey test at 0.05 significance. Values in bold indicate normality, the Shapiro-Wilk test (W), homogeneity, the Levene test (F) and non-additivity, by Tukey test (Fnão-additivity), the 0.01 significance; Values without bold indicate lack of normality, the Shapiro-Wilk test (W), lack of homogeneity, the Levene test (F), and additivity, by Tukey test at 0.01 significance level.

To the resistant maize hybrids were no incremented in rains dry mass with application of moisture. It is a fact that the moisture promoted an increase set in all parts of maize plants, demonstrating the effectiveness of foliar treatment on photosynthetic achievement extension. However, the energy cost with hybrid resistance causes the plant does not get enough to boost assimilates translocate to grain productivity, and these accumulated in other parts of plants.

On the contrary, the susceptible hybrid, showed an increment of 2,994.28 kg ha^{-1} (27.92%), i.e. 49.9 sacks ha^{-1} (table 2). Costa et al. (2012) reported that among the main measures recommended for the management of the white spot disease, the use of resistant cultivars and fungicides are the most used. And yet, in susceptible cultivars crops or with moderate resistance, the use of fungicides have been a measure widely used, and the use of fungicides with azoxystrobin + Cyproconazole are efficient in the control of white spot disease.

When they analyzed the hybrids (table 2), it was evident the difference between them, in treatment without application of foliar fertilizers and fungicides the resistant hybrid presented higher productivity 1,437.14 kg ha^{-1} (13.40%), equivalent 24.0 sacks ha^{-1}. The application of moisture in susceptible hybrid maize provide higher grains productivity 1,411.14 kg ha^{-1} (11.46%), equivalent 23.52 sacks ha^{-1}.

This result show that the application of foliar fertilizers and fungicides provide photosynthetic apparatus in leaves along with the foliar nutrition allows the expression of the productive potential of selected materials for genetic improvement available in actually market and that have some disability that can express themselves in a negative way in certain conditions.

The highest productivity, in this case, due to the fact the plant with greater susceptibility does not have excessive energy expenditure on defense. Then these plants invest in accumulation in grain weight, since the diversion of carbohydrates the main metabolic pathway of grain formation and growth for the secondary metabolic pathway of plant defense occurs more pronounced in the presence of the inductor.

Duarte et al. (2009) evaluating the application of fungicides (Azoxystrobin + Cyproconazole) in maize crop, were observed efficient in the foliar control of maize diseases and an increase in the percentage of leaf area and grains productivity maize. These authors found increases of up to 35.8 sacks. ha^{-1} of grains maize, or 34.0%, with two applications of fungicides in relation to the control.

The increase in productivity results corroborate with those obtained by Juliatti et al. (2014) who observed higher response in grain productivity, with the application of fungicides (Azoxystrobin + Cyproconazole) along with the adjuvant (Nimbus) which found increased to 60.12 sacks ha^{-1} of grains maize, or 41.8%, with two applications of fungicides in relation to the control. In this same way, Manerba et al. (2013) with the use of the Mancozeb fungicide, in two seasons (V8 and before flowering), observed positive effect in the control of white spot disease, as well as, increased productivity maize.

However, it is noteworthy that, in addition to chemical control, foliar fertilization also has importance for increasing the productivity of corn, and this practice of nutritional supplementation of micronutrients is economically viable. The balanced nutrition of plants, especially with respect to manganese (Mn), can mitigate the severity of diseases. This nutrient is relate in defense mechanisms of plants.

For the variable dry mass plants, there was interaction between hybrids and application of foliar fertilizers and fungicides in maize crop. The dry mass plants of susceptible hybrid presented increase of 4,602.62 kg ha^{-1} (22.34%), when used the moisture. On the other hand, the resistant hybrid showed no increase in total dry matter production of plants, as well as maize hybrids no showed difference regarding the dry mass plants (table 2).

Currently have become economically viable use of triazole fungicides and their mixtures with estrobilurinas, and with benzimidazoles in production systems of medium and high technology, which ensures the productive potential hybrids (Duarte et al., 2009).

The average dry mass accumulation by different parts of two maize hybrids at descending order followed: 12,262.5 kg ha^{-1} (53.18%) grains maize > 3,565.10 kg ha^{-1} (15.50%) culm > 3,466.18 kg ha^{-1} (15.07%) leaves > 1,877.16 kg ha^{-1} (8.16%) modificated leaf > 1,858.02 kg ha^{-1} (8.08%) cob. The total dry mass plants were 22,987.95 kg ha^{-1} and the exportation was 12,262.5 kg ha^{-1} (53.18%) by grains, 10,761.45 kg ha^{-1} (46.82%) by shoot of plants that return to soil (table 2).

Pereira et al. (2011) claim that the shoot of plants and cob fractions totaling about 65% of the dry mass hybrids maize, different values that present work to same variables (46.82%) .According to Alves et al. (2013), the structural composition of the maize plant cans determine the productive potential of the hybrids.

The grains maize production and dry mass plants followed by others authors were 5.1 t ha^{-1} and 11.6 t ha^{-1}, respectively. Duarte et al. (2003) to same variables followed 14.6 t ha^{-1} and 29.6 t ha^{-1}, respectively. The others author followed large variation by total dry mass and grains production

(Pereira et al., 2011; Carvalho et al. 2011; Moreira et al. 2014).

França et al. (2011) observed shoot dry mass maize of 8,725 and 1,425 kg ha^{-1}, respectively, at 99 days after emergence and values of 39,710 and 8,507 kg ha^{-1} at maize harvest to same variables. Bergonci et al. (2001) used irrigation system obtained shoot dry mass plants of 22,201 at 27.838 kg ha^{-1}.

Conclusions

The application of fungicides and foliar fertilizers increased the leaf, culms, ear modified, cobs and shoot dry mass plants maize.

The application of fungicides and foliar fertilizers providing returning of 11.409,5 kg ha^{-1} of shoot dry mass plants with increased of 1.296 kg ha^{-1} on soil (12,81%).

The hybrid maize the application of fungicides and foliar fertilizers provide higher dry mass grains and shoot of plants.

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References

ALVES, V.B., CECCON, G., LEITE, L. F. Morfologia e produtividade de híbridos de milho safrinha solteiro e consorciado com braquiária. Revista Brasileira de Milho e Sorgo, 12: 152-163, 2013.

BERGONCI, J. I., BERGAMASCHI, H., SANTOS, A. O., FRANÇA, S., RADIN, B. Eficiência da irrigação em rendimento de grãos e matéria seca de milho. Pesquisa Agropecuária Brasileira, 36: 949-956, 2001.

BRITO, A. H., VON PINHO, R. G., PEREIRA, J. L. A. de R., BALESTRE, M. Controle químico da Cercosporiose, Mancha-Branca e dos Grãos Ardidos em milho. Revista Ceres, 60: 629-635, 2013.

CARVALHO, R. P., VON PINHO, R. G., DAVIDE, L. M. C. Desempenho de cultivares de milho quanto à eficiência de utilização de nitrogênio. Revista Brasileira de Milho e Sorgo, 10: 108-120, 2011.

COSTA, N. R. Acúmulo de macronutrientes e decomposição da palhada de braquiárias em razão da adubação nitrogenada durante e após o consórcio com a cultura do milho. Revista Brasileira de Ciência do Solo**,** 38: 1223-1233, 2014.

COSTA, R. V. da, COTA, L. V., SILVA, D. D. da, LANZA, F. E., FIGUEIREDO, J. E. F. Eficiência de fungicidas para o controle da mancha branca do milho. Revista Brasileira de Milho e Sorgo**,** 11: 291-301, 2012.

DUARTE, R. P., JULIATTI, F. C., FREITAS, P. T. de. Eficácia de diferentes fungicidas na cultura do milho. Bioscience Journal**,** 25: 101-111, 2009.

DUARTE, A. P. KIEHL, J. de C., CAMARGO, M. A. F. de, RECO, P. C. Acúmulo de matéria seca e nutrientes em cultivares de milho originárias de clima tropical e introduzidas de clima temperado. Revista Brasileira de Milho e Sorgo 2: 1-20, 2003.

EMBRAPA – EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Manual de análises química de solos, plantas e fertilizantes. Embrapa informaçãos tecnologica, Brasilia, 2009. 627 p.

EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisas de Solos. Manual de métodos de análises de solos, Rio de Janeiro: Embrapa Solos, 2011. 230p.

FERREIRA, D. F. Sisvar: a computer statistical analysis system. Ciência & Agrotecnologia, Lavras, 35: 1039-1042, 2010.

FRANÇA, S., MIELNICZUK, J., ROSA, L. M. G., BERGAMASCHI, H., BERGONCI, I. Nitrogênio disponível ao milho: crescimento, absorção e rendimento de grãos. Revista Brasileira de Engenharia Agrícola e Ambiental, 15: 1143–1151, 2011.

IBGE. Instituto Brasileiro de Geografia e Estatística. 2015. http://www.ibge.gov.br/home/estatistica/pesquisas/pesquisa_resultados.php?id_pesquisa=15

JULIATTI, F. C., BELOTI, I. F., JULIATTI, B. C. M., CRATO, F. F. do. Eficácia da associação de fungicidas e antibióticos no manejo da mancha branca do milho e seu efeito na produtividade. Revista Bioscience Journal, 30: 1622-1630, 2014.

KRUTZMANN, A., CECATO, U., SILVA, P. A., TORMENA, C. A., IWAMOTO, B. S., MARTINS, E. N. Palhadas de gramíneas tropicais e rendimento da soja no sistema de integração lavoura pecuária. Revista Bioscience Journal, 29: 842-851, 2013.

MANERBA, F. de C., SOUZA, P. E. de, VON PINHO, R G., DORNELAS, G. A., MONTEIRO, F. P. Antibióticos no Controle da Mancha Branca do Milho. Comunicata Scientiae, 4: 361-367, 2013.

MAUCHI-MANI, B., METRAUX, J.P. Salicylic acid and systemic acquired resistance to pathogen attack. Annals of Botany, 82: 535-540, 1998.

MOREIRA, S. G., LUPP, R. M., LIMA, C. G. de, MARUCCI, R. C., RESENDE, A. V. de, BORGES, I. D., Massa seca e macronutrientes acumulados em plantas de milho cultivadas sob diferentes espécies de cobertura. Revista Brasileira de Milho e Sorgo**,** 13: 218-231, 2014.

PACCOLA-MEIRELLES, L. D., MEIRELLES, W. F., PARENTONI, S. N, MARRIEL, I. E., FERREIRA, A. S., CASELA, C. R. Reaction of maize inbred lines to the bacterium Pantoea ananas isolated from Phaeosphaeria leaf spot lesions. Crop Breeding and Applied Biotechnology, 4: 578-590, 2002.

PEREIRA, J. L. de A. R., VON PINHO, R. G., SOUZA FILHO, A. X. de, SANTOS, A. de O., FONSECA, R. G. *A*valiação de componentes estruturais da planta de híbridos de milho colhidos em diferentes estádios de maturação. Revista Brasileira de Milho e Sorgo, 10: 47-55, 2011.

RESENDE, A. V., FURINI NETO, A. E., ALVES, V. M. C., MUNIZ, J. A., CURI, N., FAQUIN, V.; KIMPARA, D.I., SANTOS, J. Z. L., CARNEIRO, L. F. Fontes e modos de aplicação de fósforo para o milho em solo cultivado da região do cerrado. Revista Brasileira de Ciência do Solo, 30: 453-466, 2006.

SACHS, P.J.D., NEVES, C.C.S.V.J., CANTERI, M.G.; SACHS, L.G. Escala diagramática para avaliação da severidade da mancha branca em milho. Summa Phytopathologica, 37: 202-204, 2011.

SAWAZAKI, E., DUDIENAS , C., PATERNIANI ,M. E. A. G. Z., GALV ÃO, J. C. C., CASTRO , J. L., PEREIRA , J. Reação de cultivares de milho à manchade Phaeosphaeria no estado de São Paulo. Pesquisa Agropecuária Brasileira, 32: 585-589, 1997.

SODRÉ FILHO, J.; CARDOSO, A. N.; CARMONA, R.; CARVALHO, A. M. Fitomassa e cobertura do solo de culturas de sucessão ao milho na Região do Cerrado. Pesquisa Agropecuária Brasileira, 39: 327-334, 2004.

VASCONCELLOS, C. A., VIANA, M. C. M., FERREIRA, J. J. Acúmulo de matéria seca e de nutrientes em milho cultivado no período inverno-primavera. Pesquisa Agropecuária Brasileira, 33: 1835-1845, 1998.