Alan Mario **Zuffo** e Jorge González **Aguilera**

(Organizadores)

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APRESENTAÇÃO

Os avanços nas Ciência Agrárias têm promovido o desenvolvimento de inúmeras tecnologias que tende a proporcionar o incremento da produção de alimentos, a melhoria da qualidade de vida da população, a preservação e sustentabilidade do planeta. Assim, nesse e-book "Agricultura 4.0" tem trabalhos que visam otimizar a produção e/ou promover maior sustentabilidade nas técnicas aplicadas nos sistemas de produção das plantas.

Ao longo dos capítulos são abordados os seguintes temas: manejo da adubação nitrogenada no algodoeiro, sistemas agroflorestais, reguladores de crescimento in vitro, escoamento de commodities agrícolas, adubação nitrogenada e inoculação com *Azospirullum Brasilense* na cana-de-açúcar, efeito do pó de rocha no milho, desfolha e adubação nitrogenada na soja.

Portanto, esses conhecimentos irão agregar muito aos seus leitores que procuram promover melhorias quantitativas e qualitativas na produção de alimentos e, ou melhorar a qualidade de vida da sociedade. Sempre em busca da sustentabilidade do planeta.

Aos autores dos capítulos, pela dedicação e esforços sem limites, que viabilizaram esta obra que retrata os recentes avanços científicos e tecnológicos na área de Ciência Agrárias, os agradecimentos dos Organizadores e da Pantanal Editora.

Por fim, esperamos que este e-book possa colaborar e instigar mais estudantes e pesquisadores na constante busca de novas tecnologias. Assim, garantir uma difusão de conhecimento fácil, rápido para a sociedade.

Os organizadores

SUMÁRIO

Capítulo VI

Residual effect of rock dust doses after two years of application in maize

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INTRODUCTION

Maize (*Zea mays* L.) is the cereal with the highest grains yield in the world. Brazil has the third position in the world ranking of maize production with 101 million tons, behind China and United States of America (USA), whose production 260.8 and 347.8 million tons in the 2019/2020 harvest, respectively (Fiesp, 2020).

In Brazil, the Midwest region has the largest grains yield in this country. Mato Grosso state is the main producing followed by Mato Grosso do Sul, Goiás and Federal District which produced in the current maize crop about 53 million t in 8 million hectares (Conab, 2020). In Mato Grosso do Sul, the estimated area with the crop is 1,840 thousand hectares for the 2019/2020 harvest, mainly due to the soybean (*Glycine max* L.) crop. With the technological package adopted by the producers, the forecast is to obtain good grains yield in this crop succession.

In general, agricultural production is dependent on genetic, nutritional, environmental, and phytosanitary factors (Ferneda et al., 2019). Crop nutrition is an essential role in its development, and for specific regions, its management determines grains yield. The maintenance of yield levels depends on the investment in technologies that improve this nutrition and that are also economically adequate.

Sources of nitrogen (N), phosphorus (P), and potassium (K) as the basis for plant nutrition in small and large crops experience high prices in the international market

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(Manning; Theodoro, 2018). More economical alternatives, such as the use of rock dust in minerals and trace elements, provide the perfect environment for natural agriculture (Ramos et al., 2015; Nunes et al. 2014; Aguilera et al., 2020, Ratke et al., 2020).

The objective was to verify the effect of doses of rock dust doses in maize cultivars grown after soybean at no-tillage (NT) conditions in the region of Chapadão do Sul in the state of Mato Grosso do Sul, Brazil.

MATERIALSAND METHODS

Experimental Field

The research as carried out in an experimental area at the Federal University of Mato Grosso do Sul in Chapadão do Sul, MS, Brazil (18°46'17.9 S; 52°37'25.0 W, and 810 m above the sea level), during the 2019/2020 harvest. The region's climate, according to the Koppen classification, is a tropical rainy type (Aw), with rainy summer and dry winter, with precipitation, average temperature, and annual relative humidity of 1,261 mm, 23, 97 ° C, 64.23%, respectively. The soils of the experimental area characterized as Rhodic Ferralsol (IUSS, 2015) and "Latossolo Vermelho distrófico" by the Brazilian survey (Santos et al., 2018).

Experimental design and treatments

The experimental design used was randomized blocks, arranged in a 2 × 4 factorial scheme, with three replications. The treatments consisted of two maize hybrids (HB1: Defender VIP3 and HB2: Pioneer® 30F53VYHR), and four doses of basalt rock dust (0; 1,0; 3,0 and 5,0 t ha^{-1}) applied on the soil surface in the 2018/2019 crop season (Aguilera et al., 2020). Each plot consisted of seven rows spaced 0.45 m with 3 m of length. As a useful area, were considered 2 m length of the three central lines (1.8 m^2).

Conduct Field Experiment

The area was prepared with glyphosate (720 g ha^{-1}), and haloxifope-P-methyl (63 g ha^{-1}). The maize was planted 10 days after initial weed control with an air seeder prepared for no-till system (NTS). The corn seeds were deposited at a depth of 0.03 m, the spacing rows were 0.45 m, and the density was 3.4 seeds m^{-1}, reaching the final stand of 70,000 plants per hectare. The planting fertilization consisted of 150 kg ha^{-1} of MAP (11% N-ammoniacal and 52% P_2O_5). The cover fertilization was 100 kg ha^{-1} of K_2O, whose source was potassium chloride at 40 days after emergence (DAE).

During the development of plants, the management of weeds, pests, and diseases carried out using products according to the need for control in the maize crop.

Assessment

The full flowering of the maize evaluated in five plants per plot: height of the ear insertion (HEA) (cm) - a depth of the soil surface until the insertion of the first ear with the aid of a millimeter rule; plant height (PH) (cm) - specified on the soil surface until the last top leaf with the aid of a millimeter ruler; and a leaf area of the plant (LAP) (cm^2) - was applied by the non-destructive method described by Francis et al. (1969).

Statistical Analysis

The data from the assessments were used for the analysis of variance (ANOVA) (F test). When significant, the means of the hybrids compared by the Tukey test *($P < 0.05$)* and for the doses of basalt rock dust made the regression graphs. The Rbio software (Bhering, 2017) and the Sigma Plot 10.0® (Systat Software Inc.) were used to make the graphics.

RESULTS AND DISCUSSION

ANOVA results are summarized in Table 1. The analyzes show a highly significant effect only for the hybrid factor ($P<0.01$). The lack of a significant effect on the doses of rock dust was also found by Nalon and Oliviera (2009). The coefficients of experimental variation were adequate for field experiments, with values <6% showing the high homogeneity of the data obtained and the experimental precision.

Table 1. ANOVA values (F values) performed in a field experiment that assesses the effects of doses of basalt rock dust on two maize cultivars was evaluated in an experiment of field conducted in the municipality of Chapadão do Sul, MS during the 2019/2020 off-season.

Sources	GL	HEA[1] (cm)	PH (cm)	LAP (cm^2)
Cultivars (C)	1	0.00009	0.00003	0.00000
Doses PR (PR)	3	0.33121	0.15926	0.79894
C x PR	3	0.79403	0.74002	0.86763
Residual	16			
Total	23			
CV (%)		5.13	4.00	5.59
Overall Average		100.68	190.99	6031.70
Minimum		87.6	173.8	4660.39
Maximum		113.6	213.4	7107.78

[1]HEA: height of the ear insertion; PH: plant height; LAP: Leaf area of plant. CV: Coefficient of variation.

The development of the tested maize hybrids was adequate if we consider the mean values of the three variables evaluated, which were 100.68 cm, 190.99 cm, and 6031.70 cm^2 for HEA, PH, and LAP, respectively (Table 1). Climatic conditions in the period contribute to this observed response to the evaluated characteristics.

HB2 (Pioneer® 30F53VYHR) is a Pioneer® hybrid with Leptra® insect protection technology and with Roundup Ready ™ Maize 2 gene. Evaluated in our experiment), and in this last season, the breeders highlight its high productive potential, full adaptation with productive stability and grain quality, high response to handling and precocity (Pioneer, 2020), attributes that confirm his superiority about the HB1 for the evaluated characteristics and environmental conditions of Chapadão do Sul in the 2019/2020 off-season (Figure 1).

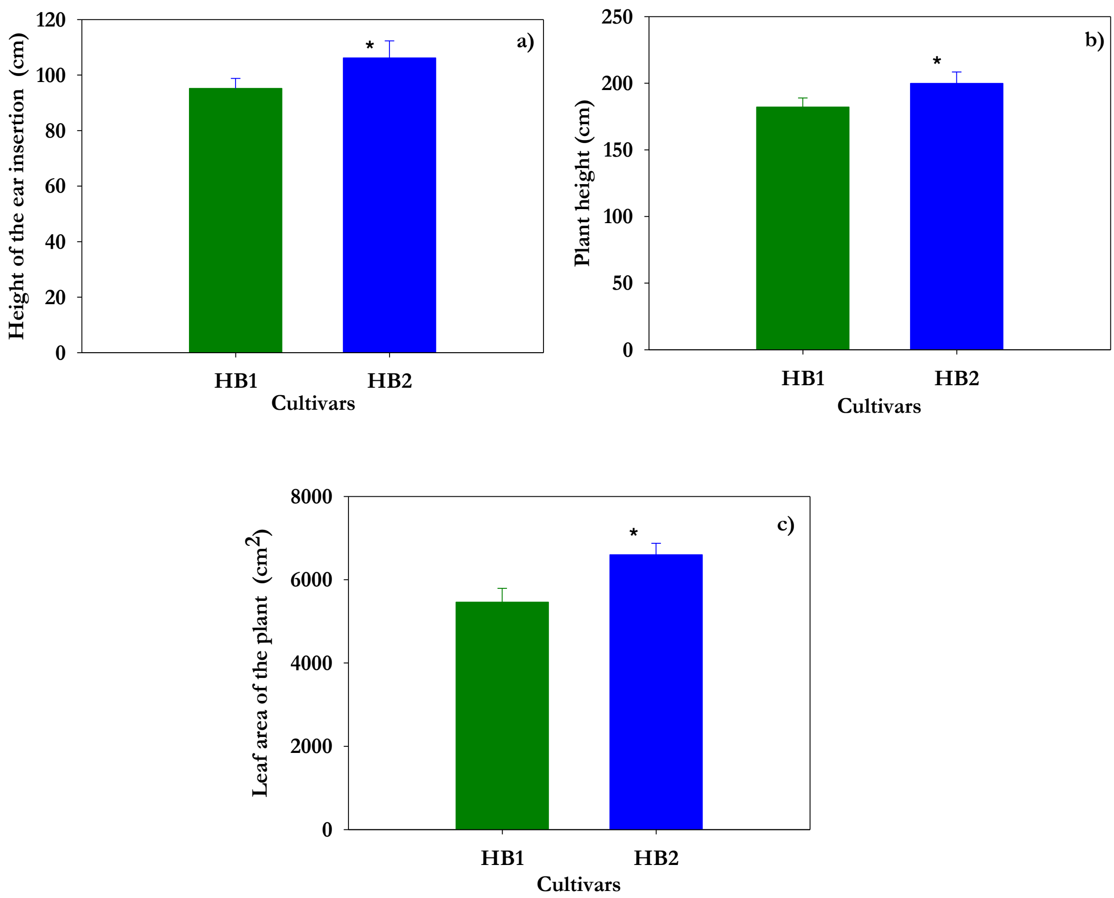

Figure 1. The behavior of two maize cultivars (HB1: Defender VIP3 and HB2: Pioneer® 30F53VYHR) when the variables height of the ear insertion (a), plant height (b) and leaf area of the plant (c) was evaluated in an experiment of field conducted in the municipality of Chapadão do Sul, MS during the 2019/2020 off-season. *It represents highly significant differences between the means ± standard deviation, by the F test (*P<0.001*). Source: The authors.

The doses of basalt rock dust were another factor evaluated in our experiment (Table 1), and the means of the characteristics showed in Figure 2. ANOVA found no effect for this factor, showing that the doses of basalt rock dust used had a coincident effect, not statistically exceeding the control used in our experiments (Figure 2). As it is a quantitative factor, the averages were shown in Figure 2, indicating that although the averages do not show statistical differences, the data show a tendency to increase as the doses are observed from the absence of rock dust (control) concerning the other increasing doses of basalt rock dust.

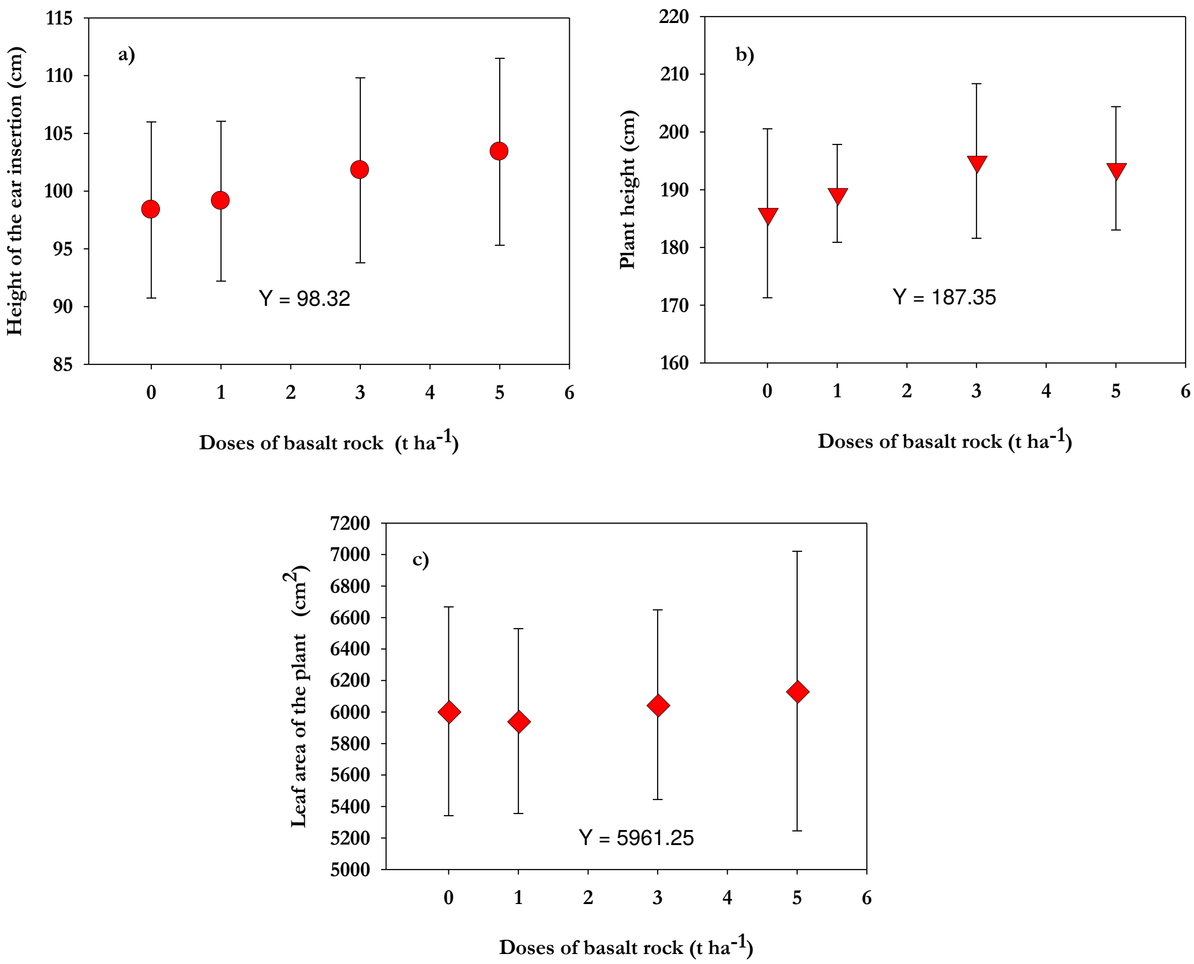

Figure 2. The behavior of maize in different doses of basalt rock dust for the variables height of ear insertion (a), plant height (b), and leaf area of the plant (c) in a field experiment conducted in the municipality of Chapadão do Sul, MS during the 2019/2020 off-season. Mean data ± standard deviation. Source: The authors.

The area where the experiment installed was the same soybean cultivated during two 2018/2019 (Aguilera et al., 2020) and 2019/2020 (unpublished data) harvests, with the residual or long-term effect being evaluated in our experiment. In this way, hat the application of basalt rock dust applied superficially in the 2018/2019 harvest can exercise residual effect the current maize crop. Aguilera et al. (2020) reported absence of effects on the yield of three soybean cultivars in the 2018/2019 harvest, the first year of experimenting, however, the doses of tested basalt rock dust contributed to obtaining a better seed size and, thus, improve the quality of the seeds obtained in the three cultivars tested. Ratke et al. (2020), after the physicochemical characterization of three powders, applied different doses (2.0; 6.0; 8.0 and 10.0 t ha^{-1}) to the soil to analyze its effects on corn plants. The authors confirmed that he rocky dust materials showed dissolution of P and K in an acid medium in the aqueous extract, and, the rocks dust collected in Gilbués-PI improved the availability of P and K and favored the development of the aerial part of the corn plants.

The effects of rock dust, in general, depend in part on the applied particle size [between smaller size and better availability of nutrients, Anda et al. (2009)], chemical properties (Manning; Theodoro, 2018; Ratke et al., 2020), soil conditions and their microbial activity (Ramos et al., 2015), among other factors. The sum of these factors can show a short, medium to the long-term response. Thus, the researcher needs to evaluate more than one harvest to measure and quantify these effects in more than one culture as done by this research in the soybean (Aguilera et al., 2020), and the maize (current work).

Straaten (2006) reports that the transformation of these minerals that make up the crushed rocks, depends on the biological activity present in the soil and can be minimal (long term) or null, leading to precipitated conclusions that the rocks cannot bring benefits for agricultural soils and cultivated plants. In the case of NTS, these activities benefit from the constant supply of organic matter in this system and the stimulus to increase microbial life, and thus the possibility of improving the development of organisms that provided the nutrients that the rock dust provides.

Similar responses when working with soybeans and maize for four years were obtained by Hanisch et al. (2013). The authors found the influence of increasing doses of basalt rock dust, in the increase in the availability of Zn, Cu, Fe, Mg and P in the soil, a result obtained over time.

Although this research is not conclusive about the effects in maize cultivated after soybean with applications of doses of basalt rock dust in the soil and climate conditions of Chapadão de Sul, in the future, the research of yield and components of the production of the cultures with the applications rock dust can show other effects on the interaction of the evaluated factors in this work.

CONCLUSION

The application of rock powder did not show statistical differences between the doses used in relation to the control, however, I show an increase in the response for all tested variables.

The hybrid HB2 Pioneer® 30F53VYHR had a superior behavior for all variables measured in the experiment.

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Índice Remissivo

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