NOTAS CIENTÍFICAS

Soluble tissue sugar content and leaf blast severity in response to the application of calcinated serpentinite as a silicon source in irrigated rice

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ABSTRACT

Prabhu, A.S.; Santos, A.B. dos; Didonet, A.D. Soluble tissue sugar content and leaf blast severity in response to the application of calcinated serpentinite as a silicon source in irrigated rice. ***Summa Phytopathologica***, v.33, n.4, p.402-404, 2007.

A field experiment conducted with the irrigated rice cultivar BRS Formoso, to assess the efficiency of calcinated serpentinite as a silicon source on grain yield was utilized to study its effect on leaf blast severity and tissue sugar levels. The treatments consisted of five rates of calcinated serpentinite (0, 2, 4, 6, 8 Mg.ha^{-1}) incorporated into the soil prior to planting. The leaf blast severity was reduced at the rate of 2.96% per ton of calcinated serpentinite. The total tissue sugar content decreased significantly as the rates of serpentinite applied increased (R^2 = 0.83). The relationship between the tissue sugar content and leaf blast severity was linear and positive (R^2 = 0.81). The decrease in leaf blast severity with increased rates of calcinated serpentinite was also linear (R^2= 0.96) and can be ascribed to reduced sugar level.

Additional Keywords: *Magnaporthe grisea*, *Pyricularia grisea*, *Oryza sativa*, silicon sources.

RESUMO

Prabhu, A.S.; Santos, A.B. dos; Didonet, A.D. A brusone nas folhas e conteúdo de açucares solúveis nos tecidos em resposta a aplicação de serpentinito calcinado como fonte de silício em arroz irrigado. ***Summa Phytopathologica***, v.33, n.4, p.402-404, 2007.

Um experimento de campo, para avaliar a eficiência de serpentinito calcinado como fonte de silício na produtividade da cultura de arroz irrigado, cultivar BRS Formoso, foi utilizado para estudar seu efeito sobre a brusone nas folhas e níveis de açúcares nos tecidos. Os tratamentos consistiram de cinco doses de serpentinito calcinado (0, 2, 4, 6, 8 Mg.ha^{-1}) incorporadas ao solo antes de plantio. A severidade da brusone foi reduzida numa taxa de 2,96% por tonelada de serpentinito calcinado aplicada (R^2 = 0,83). A relação entre o conteúdo de açucares no tecido e a severidade da brusone nas folhas foi linear e positiva (R^2 = 0,81). A redução da severidade da brusone com o aumento das doses de serpentinito calcinado também foi linear (R^2= 0,96) e pode ser atribuída aos reduzidos níveis de açúcares nos tecidos foliares.

Palavras-chave adicionais: *Magnaporthe grisea*, *Pyricularia grisea*, *Oryza sativa*, fontes de silício

Rice blast caused by the fungus *Pyricularia grisea* (Cooke) Sacc. [= *Magnaporthe oryzae* (T.T.Hebert) Yageshi & Udagawa] is a major yield limiting factor in the State of Tocantins in Brazil, where irrigated rice is grown in extensive contiguous areas, in the municipalities of Formoso, Duaré and Lagoa da Confusão. At present, the widely grown rice cultivars exhibit different degrees of susceptibility to blast. As the production costs are high due to chemical control measures which include seed treatment and one or two foliar fungicide sprays, there is an imminent need for exploring alternative disease control methods. Silicon (Si) has been known to control plant diseases with the corresponding increase in grain yield. The grain yield of upland rice cultivars increased with silicon fertilization and positively correlated with Si and Ca contents in the soil (1). The effect of silicon fertilization in controlling blast and other rice diseases has been demonstrated in experiments conducted in different countries, including Brazil (2, 3, 7, 10, 11). However, the knowledge on the efficiency of Brazilian silicon sources that are available close to the rice production centers is limited.

In the State of Goiás, a residual product of asbestos mining industry located in Minaçu (SAMA-Mineração de Amianto Ltda.) with a high silicon and magnesium content (ground serpentinite) is available in large quantities. The disposal of this material has become an environmental problem. After obtaining the ISO14 001 certificate, the industry has been exploring the possibilities of utilizing the serpentinite in agriculture as a silicon source, mainly for rice, wheat and sugarcane. The calcination of this product occurs at a temperature of 1200^{o} C to eliminate fibrous crystals of crisotila. The present paper reports the efficiency of calcinated serpentinite on leaf blast severity under conditions of natural field infection and soluble sugar content of irrigated rice in the State of Tocantins.

A field experiment conducted at Embrapa Rice and Bean Research Station, located at 'Formoso do Araguaia', TO, with the widely grown irrigated rice cultivar BRS Formoso to assess the efficiency of calcinated serpentinite as a silicon source on grain yield was utilized in this study. The main objective was to determine the effect of calcinated silicon on leaf blast severity and tissue sugar levels. The soil used in this experiment was classified as Inseptisol according to USA taxonomy classification. The soil analysis showed the following characteristics: pH (H_2O) = 5.2; extractable P = 26.9 mg kg^{-1}; extractable

cations were K = 66.0 mg kg^{-1}; Ca = 15.3 cmo kg^{-1}; Mg = 4.6 cmo kg^{-1} and Al = 1.0 cmo kg^{-1}; clay = 185g kg^{-1}; silt = 153 g kg^{-1}; sand = 662 g kg^{-1}. The lay-out of the experiment was a split plot design with four replications. The treatments consisted of five rates of calcinated serpentinite (0, 2, 4, 6, 8 Mg. ha^{-1}).

The calcinated serpentinite has the following chemical composition (g kg^{-1}): SiO_2=455.0; Ca (CaO)= 2.8; Al_2O_3= 3.5; Mg= 185.6; Fe (Fe_2O_3)= 48.5; Mn (MnO)= 8.9; PPC= 124.4. Calcination was done in furnace at a temperature of 1200°C under atmospheric pressure. The serpentinite was incorporated in the soil with a harrow prior to planting the experiment. Seeds were drill planted in each 70 m^2 subplots at the rate of 80 seeds per meter and 0.17 m between the rows.

Plots were fertilized at planting with 400 kg ha^{-1} of NPK (4-30-16+Zn) in addition to top dressing with 35 kg ha^{-1} of N as urea at tillering and initiation of floral primordium. Rice plots were flooded about 30 days after sowing to a depth of 10 to 15 cm of standing water, remained flooded during the crop growth period, and drained one week before harvest. The percentage leaf area affected with blast was determined on fully opened penultimate leaf of main tillers in the four central rows of each plot. A 10 grade scale (0; 0.5; 1.0; 2.0; 4.0; 8.0; 16.0; 32.0; 64.0; 82.0% of leaf area affected) was used to assess the leaf blast severity according to Notteghem (5), 35 days after planting. The extraction and quantification of soluble and total sugars in leaves was performed according to Passos (6) and expressed on the basis of dry matter content. For analysis only the leaf blast measurements and tissue sugar content data were considered. The regression analysis was carried out to establish the relationships of tissue sugar content with leaf blast severity and serpentinite rates.

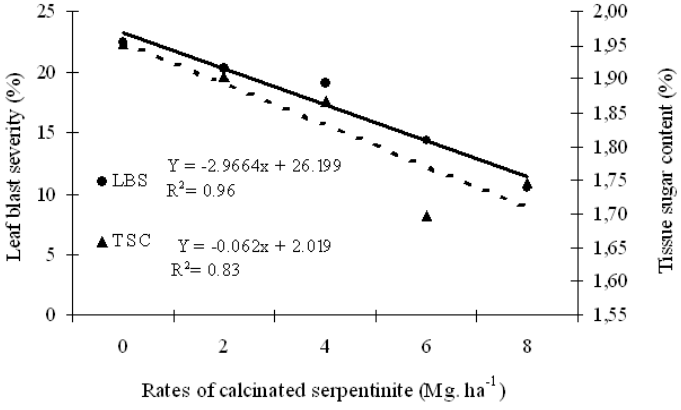

Figure 1. Relationships of leaf blast severity (LBS) and tissue soluble sugar content (TSC) to rates of calcinated serpentinite applied as a silicon source to irrigated rice. (The leaf blast data were based on assessment, under natural condition of infection in the field).

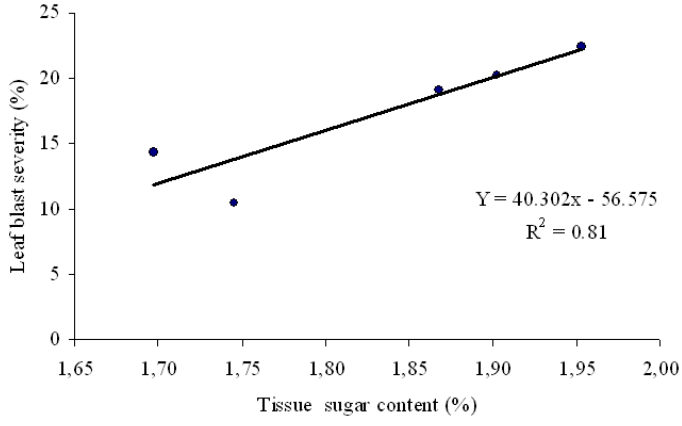

Figure 2. Relationship between soluble tissue sugar levels in rice leaves and leaf blast severity.

Leaf blast severity was reduced significantly with the increase in rates of calcinated serpentinite 32 days after the plant emergence. The relationship between rates of serpentinite and leaf blast severity as well as tissue sugar content in the leaves was linear and negative (Figure1).

Disease severity, under natural field conditions was reduced at the rate of 2.96% per ton of calcinated serpentinite, applied to the soil prior to planting. The results in the present investigation are consistent with the several earlier reports of leaf blast reduction with increase in silicon rates (2,3,11).The analysis of penultimate leaves showed significant reduction of sugar content. The relationships between the sugar content and quantity of serpentinite applied as well as the relationship between tissue sugar content and leaf blast severity were linear (Figure 2).

The role of silicon in blast resistance has been considered mainly mechanical by the formation of physical barrier to penetration by the pathogen (3, 9). Ultrastructural and cytochemical studies showed that Si may modulate rice defense responses by the synthesis of antifungal compounds within epidermal cells upon penetration by the fungus *P. grisea* (8). Rodrigues et al. (9) demonstrated that higher levels of momilactones A and B were found in leaf extracts of rice plants inoculated with *P. grisea* and amended with silicon than in non-inoculated and non-amended.ones.

The susceptibility of rice plant to leaf blast has been known to increase at higher nitrogen rates. Nitrogen is an essential element for synthesis of amino acids, proteins, phenols and phytoalexins involved in diverse defense mechanisms. Carbohydrate changes occur in the host tissue when the plants are grown under different nutritional conditions. High plant sugar content of the tissue favors some pathogens such as *P. grisea* (5). Plants presumably become resistant when tissue sugar content decreases to a certain level and this may be achieved by silicon fertilization. Rice blast is a high sugar disease and the results in the present work showed that the application of calcinated serpentinite decrease cellular sugar levels and increase resistance to rice blast pathogen under natural conditions for leaf blast progress. The nature of host defense, related to sugar and nitrogen metabolism and its relation to specific resistance mechanisms such as phytoalexin production needs further investigation.

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