ACTION OF MICROORGANISMS IN BASALT POWDER

Lucas Dressano Pereira da Silva[1]
Antonio Carlos de Azevedo[2]
Raul A. Filho[3]
Camila de Castro (Translator) and Jayme Severance (Proofreader)[4]

Abstract

Stonemeal is the application of crushed rocks in the soil. The objective of this work was to observe the action of microorganisms (inoculated and native) on the mineralization of basalt rock dust and to measure the elements released into the soil. This assessment was done by comparing decomposing particles of basalt powder applied to humic A horizon of a soil derived from granite. The basalt powder was collected at Cavinatto quarry, situated in Limeira-SP (Brazil). The experiment is being conducted in vitro, in isolated plastic containers with the following treatments: 1) soil; 2) sterilized soil; 3) soil without sterilization and with addition of inoculated microorganisms; 4) same as the first treatment plus basalt powder; 5) same as the second treatment plus basalt powder and 6) same as the third treatment plus basalt powder. The basalt powder was applied in a single dose of 4t/ha. The experimental units are maintained with 60% field capacity, and leached every 30 days. The leachate is collected and the elements Zn, Fe, Ca, Mg and K are determined. The results suggest that the treatments with basalt powder present greater release of most of the above mentioned nutrients. The treatments that have the inoculated microorganisms show greater nutrient solubilization when compared to either the sterile soil

1 Graduando em Engenharia Agronômica, Departamento de Ciência do Solo, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo - ESALQ-USP, Av. Pádua Dias, 11 CEP: 13418-900, Piracicaba-SP, lukasdressano@hotmail.com; 2 Professor Doutor, Departamento de Ciência do Solo, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo - ESALQ-USP, Av. Pádua Dias, 11 CEP: 13418-900, Piracicaba-SP, aazevedo@usp.br; 3 Pós-Graduando em Ciência do solo e Nutrição de Plantas, Departamento de Ciência do Solo, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo -ESALQ-USP, Av. Pádua Dias, 11 CEP: 13418-900, Piracicaba-SP, raulagronomo@hotmail.com. 4 Remineralize the Earth (http://remineralize.org/)

or to the treatment containing soil and native microbiota only. Thus, partial results indicate a tendency of nutrient levels to increase in solutions that contain basalt powder since the addition of inoculated microorganisms appears to stimulate this release. These results suggest that the combined use of rock dusts and microorganisms has the potential for commercial use in agricultural production systems.

Key Words: dissolution, mineralization, atomic absorbance, stonemeal.

Introduction

Currently, the most common stonemeal practices are liming (limestone application) and phosphate fertilization (application of phosphoric materials, usually with some pretreatment to accelerate their solubilization).

Basalt is an extrusive igneous rock, with fine granulation (aphanitic). The most abundant minerals in basalt are pyroxenes, plagioclases, and in some cases, olivines. It is an alkaline rock with little resistance to chemical weathering, and an important source of Ca, Mg, and micronutrients in soils where it is found. Usually, rocks composed by aluminosilicates contain different amounts of various nutrients, whose availability depends on the solubility of each mineral that contains them, on the total content, and on the kinetics of mineral dissolution (MACHADO et al., 2005).

Basalt is widely used in Brazil for construction and paving, particularly in the areas of the Paraná basin due to its abundance in the Serra Geral Formation. During the rock crushing process for gravel production- the form when this material is used the most- the stones are crushed into finer grits. Dust is produced during this process, which can potentially cause environmental problems (suspended solids), labor problems (creating an unhealthy environment for workers and surroundings residents at the crushing stations) and issues with the production system (decrease of machinery efficiency, increase in number of breakdowns, increase wearing from abrasion, etc.). This rock dust can be reused in agriculture as a source of nutrients for crops, through stonemeal.

With the sharp increase of fertilizers' prices in the last few years, Brazil has sought alternatives to its use in agriculture. In addition, the rock powder consumer market has increased due to the expansion of organic agriculture and other production systems that do not use synthetic fertilizers as a source of nutrients for the plants. Despite this growth in demand for rock powders, there are still no adequate models to estimate the amount and the release rate of this rock's elements for the plants. In addition, it is known that microorganisms have a key role, especially in tropical environments, on solubilization of the rocks applied to soil (NAHAS, 1999; SANTOS, 2002).

It is also known that some bacteria are more efficient in the solubilization of inorganic phosphates, as those in the Pseudomonas, Bacillus, Rhizobium genera (RODRIGUEZ; FRAGA, 1999), while among the fungi the genera Aspergillus and Penicillium are the most important (SILVA FILHO et al., 2002). The species Penicillium rugulosum (REYES et al., 1999) and Penicillium radicum, stand out in the solubilization of Ca3(PO4)2, CaHPO4, FePO4. 4:02 and AlPO4 in liquid medium (WHITELAW et al.,1999).

However, it is unknown whether there is any difference between native and inoculated microorganisms, regarding their performance in solubilizing rock powders. In order to contribute to a better understanding and dissemination of stonemeal use inside the State of São Paulo, this project examines the influence of native and inoculated microorganisms in soils remineralized with basalt power.

Objective

The objective was to measure the release of elements into the soil through basalt powder mineralization caused by microorganisms (inoculated or native). The evaluation was done by comparing the decomposition of basalt powder particles applied to a humic A horizon of a red-yellow dystrophic acrisol, correlating the activity with the presence of microorganisms in the soil.

Methodology

The samples were collected on July 14, 2011, in Pedra Bela, located at 1220 meters above sea level, at 22° 46 ' 43.0 "S and 46° 27 ' 09.4" W. Granite is the source material of the red-yellow dystrophic acrisol collected. The site has a slope of 26-50% and is a preserved area of the Atlantic Forest (Mata Atlantica). After collection, the samples were air-dried for two days, sieved and homogenized in order to facilitate the storage and enable laboratory tests.

The basalt powder was obtained at Cavinatto quarry, in the town of Limeira-SP. The experiment was done in vitro, in sections of 5"(120 mm) diameter PVC pipe and height (120 mm), with one end closed. A gap of about 10 mm in diameter was punctured on the closed end for leached solutions. Gauze and filter paper were placed on the bottom of these experimental units to allow the passage of leachate solutions, obtained by applying negative pressure generated through vacuum application.

The treatments used were (with 6 repetitions):

1) Soil with native microorganisms, plus inoculated microorganisms and basalt powder (SM+);
2) Sterilized soil plus basalt powder (SS+);
3) Soil with native organisms plus basalt powder (SO+);
4) Idem treatment 1 minus basalt powder (SM-);
5) Idem treatment 2 minus basalt powder (SS-);
6) Idem treatment 3 minus basalt powder (SO-).

SM+1	SE+1	SO+1	SM-1	SE-1	SO-1
SM+2	SE+2	SO+2	SM-2	SE-2	SO-2
SM+3	SE+3	SO+3	SM-3	SE-3	SO-3
SM+4	SE+4	SO+4	SM-4	SE-4	SO-4
SM+5	SE+5	SO+5	SM-5	SE-5	SO-5
SM+6	SE+6	SO+6	SM-6	SE-6	SO-6

SM = soil with native microorganisms + inoculated microorganism (Bokashi Korin); SS = Soil + sterilization; SO = soil with native microorganisms; -= No basalt powder; + = with basalt dust (4t/ha)

The experimental units were maintained at 60% of field capacity. During leaching procedures, done every 30 days, enough distilled water was added to reach field capacity (FC), and a -290 mmHg pressure was applied (approximately 0.38 atm) through a vacuum pump. The solution was collected in a kitasato flask, for approximately 1 minute. The leached volume of each unit was tagged and stored in a refrigerator for further analysis. The analysis covered the following elements, estimated by its quantity in kg m-3: K, Mg, Ca, Fe and Zn.

Results and Reflection

The figures below represent the release of elements in SM (soil with native microorganisms + inoculated microorganism) and SO (soil with native microorganisms) treatments, both with (+) and without (-) basalt addition. The SS treatment (soil + sterilization) was damaged by posterior contamination and growth of microorganisms inside the experimental units. Thus far, the release of elements in the SS treatment was quite similar to the SO treatment, and it will, therefore, not be discussed here. The sequence from 1st to 8th represents the sequence of leaching, with one leaching pulse done every month.

These partial results suggest that treatment with basalt powder show a higher release of most nutrients analyzed. The treatments that have the inoculated microorganisms show increased solubilization of the elements involved when compared to the treatments that contained only soil and endemic microbiota.

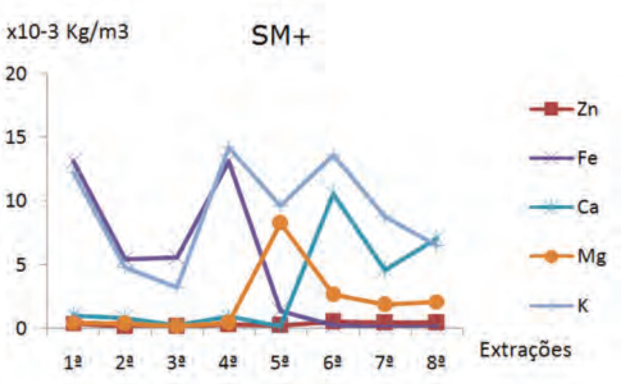

Figure 1. Soil with inoculated microorganisms and basalt powder.

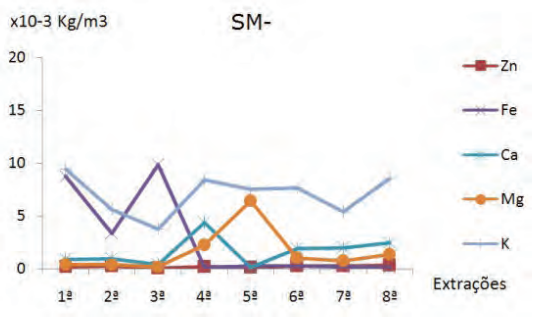

Figure 2. Soil with inoculated microorganisms and without basalt powder.

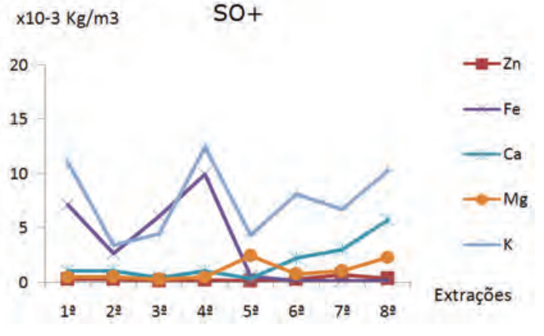

Figure 3. Soil with endemic microbiota with basalt powder.

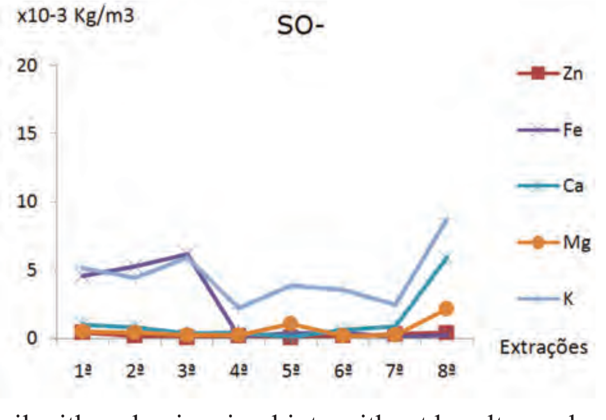

Figure 4. Soil with endemic microbiota without basalt powder.

The Potassium (K) released is probably from the granite's potassic micas, which is the rock that originated the soil used. Still, it is observed that the microbial activity stimulation promoted an increase in the release of this element in the soil. This soil was chosen for this experiment for having its humic A very rich in organic matter and microorganisms.

Calcium (Ca) is probably from the dissolution of calcic feldspar and pyroxene, whereas iron (Fe) is probably from the amphiboles- all of them present in basalt powder.

The release of magnesium seems to depend more on the presence of inoculated microorganisms than the presence of basalt dust.

The diffractometric x-ray analysis in progress might identify or at least suggest which minerals are being dissolved more intensely in each treatment. Works evaluating microbial activity have, typically, a wide variation, being this variable a very difficult one to control.

Conclusions or Recommendations

In general terms, these partial results indicate that the levels of nutrients tend to increase in solutions with basalt powder. The findings also suggest that adding inoculated microorganisms to the soil microbiota seems to stimulate the release of nutrients. Another interesting aspect is the stimulus for microorganisms to solubilize minerals caused by the presence of basalt powder. This results in a greater release of K, which is probably derived from the mica/illite in granite- and is the material that originated the soil studied. These results suggest that the combined use of rock powders and microorganisms can be quite interesting in agricultural production systems.

Referências Bibliográficas

MACHADO, C. T. T. et al. Potencial de rochas silicáticas no fornecimento de K para culturas anuais: II. Fertilidade do solo e suprimento de outros nutrientes. In: CONGRESSO BRASILEIRO DE CIÊNCIA DO SOLO, 30., 2005, Recife. Resumos... Recife: SBCS/UFRPE, 2005. CD-Rom.

NAHAS, E. Solubilização microbiana de fosfatos e de outros elementos. In: SIQUEIRA, J.O.; et al. (Eds.). Interrelação fertilidade, biologia do solo e nutrição de plantas. Lavras: Universidade Federal de Lavras, 1999. p. 467-486.

SANTOS, K.S. Atuação de fosfato natural com adição de enxofre com Acidithiobacillus na solubilização de fósforo e no desenvolvimento de sabiá (Mimosa caesalpiniaefolia) em solo de tabuleiro. 2002. 68 f. Dissertação (Mestrado) - Universidade Federal Rural de Pernambuco, Recife. 2002.

RODRIGUEZ, H.; FRAGA, R. Phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnology Advances, New York, v.17, p.319-339, 1999.

SILVA FILHO, G.N.; NARLOCH, C.; SCHARF, R. Solubilização de fosfatos naturais por microrganismos isolados de cultivos de Pinus e Eucalyptus de Santa Catarina. Pesquisa Agropecuária Brasileira, Brasília, v. 37, n. 6, p. 847-854, 2002.

REYES, I. et al. Effect of nitrogen source on the solubilization of different inorganic phosphates by an isolate of Penicillium rugulosum and two UV-induced mutants. FEMS Microbiology Ecology,Amsterdam, v. 28, p. 281-290, 1999.

WHITELAW, M.A.; HARDEN, T.J.; HELYAR, K.R. Phosphate solubilization in solution culture by the soil fungus Penicillium radicum. Soil Biology and Biochemistry, Elmsford, v. 31, p.655-665, 1999.