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Title

Contribution of soil organic sulphur fractions to Marandu palisadegrass sulphur nutrition

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Sulphur deficiency in plants is widespread throughout the world. Although generally plants remove low amounts of sulphur, there is an increase in areas with S deficiency. This increase has been attributed to sulphate leaching from soils, the no-sulphur application, the use of concentrated fertilizers (low in S) and the increasing S demand following N fertilization.

Sulphur in soil can be found both in organic and inorganic forms. The S available to plants is the inorganic sulphate, whose concentration in soil depends on its uptake by the plant, the use of sulphate fertilizers (Castellano and Dick, 1990), and the biochemical and biological mineralization processes of the organic S fractions (McGill and Cole, 1981). According to Tabatabai (2005), soil organic S can be classified into three main groups: (a) ester-bonded S (chemical groups C-O-S, C-N-S, and C-S-S), (b) carbon-bonded S reducible by Raney-Ni (chemical group C-S), and (c) residual S.

The contribution of the S organic fractions in meeting plant S requirements is not well known. In a classical work Freney et al. (1975) studied soil organic matter and found that all the organic fractions contributed with S to the plant nutrition. However, other studies reported that fractions like residual-S are stable (Tabatabai, 2005). In this way, this study aimed to evaluate the variation of the mineral and organic S fractions in an Entisol sustaining Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) fertilized with combined nitrogen and sulphur rates.

The experiment was carried out in a greenhouse where Marandu palisadegrass was grown in Piracicaba-SP, Brazil, from January to May 2006. The soil was collected from the 0-20 cm layer, air-dried, and sieved with 4-mm mesh screen to remove pebbles and large organic fractions such as roots and leaves. The experimental units were 3.6 litres pots filled with 5.6 kg of an Entisol. The chemical characteristics of the soil samples before treatment were: pH (CaCl₂) = 4.53, organic matter (OM) = 32.1 g kg⁻¹, phosphorus extracted by resin (P-resin) = 5.8 mg dm⁻³; potassium (K), calcium (Ca), magnesium (Mg), hydrogen plus aluminum (H + Al), sum of bases (S) and cation exchange capacity (CEC) = 2.43, 13.0, 8.67, 40.0, 24.1, and 64.1 mmol_c dm⁻³, respectively; base saturation (V) = 37.6. Considering the nutritional requirements of Marandu palisadegrass, liming was performed to increase the base saturation to 50% using CaCO₃ and MgCO₃ salts.

Combinations of five N rates (0, 100, 200, 300, and 400 mg dm⁻³) with five S rates (0, 10, 20, 30, and 40 mg dm⁻³) were evaluated in a fractionated 5² factorial. A randomized block design with four replications was used. The 13 combinations of N and S rates in mg dm⁻³ were: 0-0, 0-20, 0-40, 100-10, 100-30, 200-0, 200-20, 200-40, 300-10, 300-30, 400-0, 400-20, and 400-40. N and S were supplied as NH₄NO₃ and CaSO₄·2H₂O. Basal fertilization with P, K, Mg and micronutrients was performed for the establishment of Marandu palisadegrass. Fertilization was repeated after each harvest to provide N, S, K and Mg.

Each pot contained five Marandu palisadegrass plants. Harvesting was performed three times, at 43 days after transplant, 35 days after the first harvest, and 48 days after the second harvest. The plants were harvested at 4 cm from the soil surface, and the shoots were dried in a forced air-ventilated oven at 65°C until constant mass. After the third harvest, grass roots were collected. The total S content in the plant material was determined by wet digestion with HNO₃ and HClO₄ and quantification by turbidimetry.

The soil of the experimental units was sampled at each harvest. Soil S fractioning was performed according to Tabatabai (1982); four fractions were obtained: inorganic SO₄-S (mineral S in soil solution and adsorbed), ester-bonded S (HI-reducible S minus inorganic SO₄-S); carbon-bonded S (organic S reducible by Raney-Ni), and residual S (organic S not reducible by either HI or Raney-Ni alloy). Inorganic SO₄-S was extracted with 0.01 M Ca(H₂PO₄)₂ solution and quantified by turbidimetry.

Four N-S combinations were chosen to demonstrate the variation in the amounts of S fractions in the soil, according to the growth periods of the forage grass (Figure 1). The 400-40 mg dm⁻³ N-S combination resulted in more S removed from the soil by the grass than the treatments with N or S supply alone (400 N - 0 S and 0 N - 40 S).

Inorganic SO₄-S concentration in the soil was increased by the application of S as calcium sulphate (Figure 1; 400 N - 40 S and 0 N - 40 S). The carbon-bonded S did not change in the soil, in any sampling time during the growth period of the grass, with any N-S combination (Figure 1). On the other hand, the ester-bonded S in the soil was increased and apparently did not follow any N and S fertilizations. Except for the combination 400 N - 0 S, the residual S fraction decreased as the time progressed in the experiment.

According the results in the Figure 1, the variations of the S organic fractions in soil during the three growth periods of Marandu palisadegrass indicate that part of the S requirement of Marandu palisadegrass may be supplied by the residual S fraction. Castellano and Dick (1990), and McGill and Cole (1981) also postulated that the residual S fraction may add to the inorganic SO₄-S content in soil and/or be converted by microorganisms and incorporated into the ester-bonded S fraction, which can explain partially the increase of the S organic fraction in soil during the plant growth.

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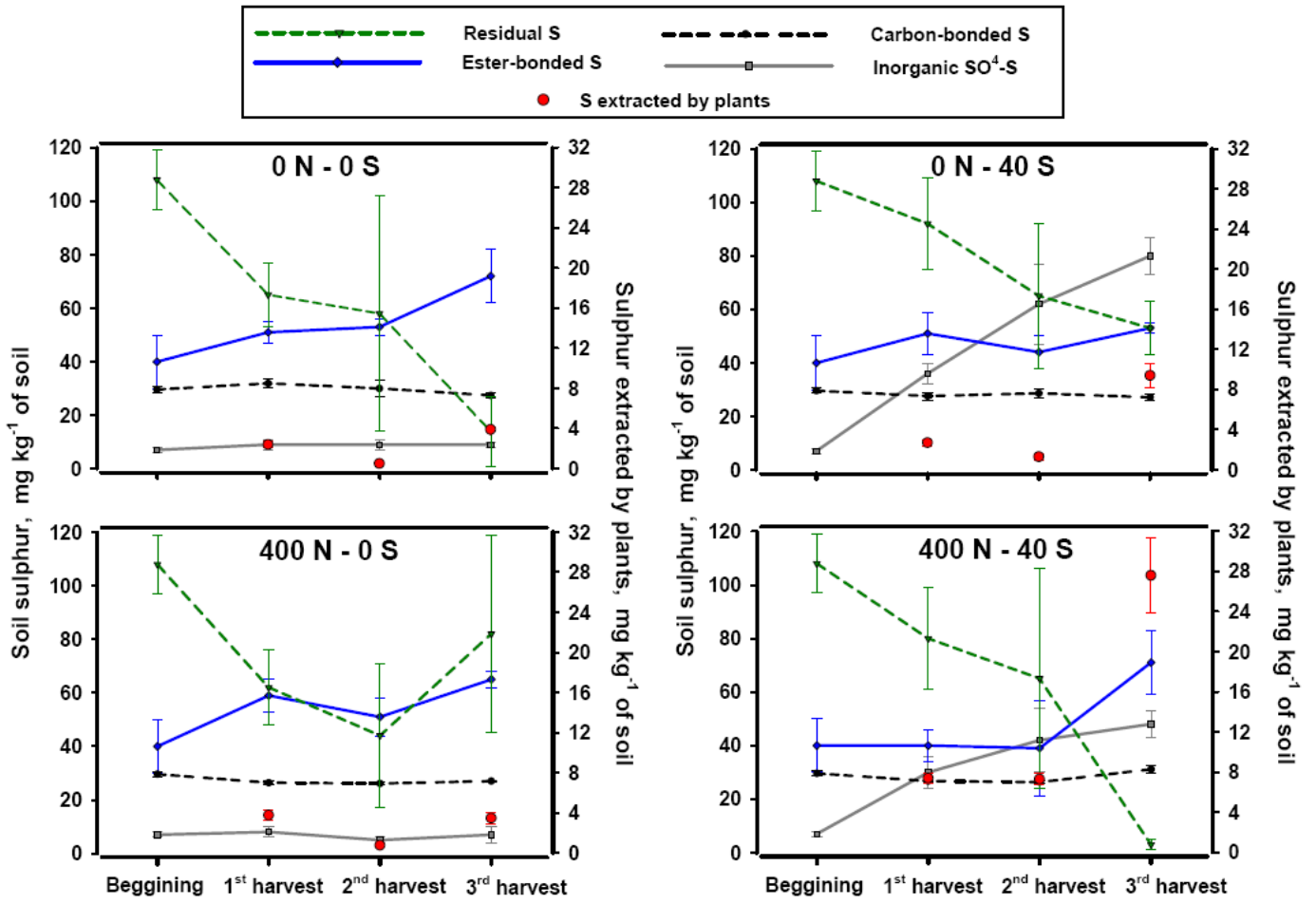


Figure 1. Sulphur extracted by plants and variation of soil sulphur fractions at the first, second and third harvests of *Marandu palisadegrass* fertilized with N and S combinations.