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PRELIMINARY EVALUATION OF COFFEE CROPS UNDER DIFFERENT DOSES OF NITROGEN WITH A SPAD METER AND LEAF NITROGEN

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Introduction

Agriculture is under pressure to produce more to feed rising global demands, yet pollute less. Intensification of agriculture through the use of high-yielding crop varieties, fertilization, irrigation and crop protection remain the most likely options to combat these challenges. The nitrogen (N) is a nutrient required in greatest quantity, often supplied so unsatisfactory by soil in agricultural systems, being one of the most limiting nutrients to achieve high productivity. Brazilian agriculture has increased in the last years the use of fertilizers, between 2003 and 2013, fertilizer consumption increased from 22.8 million tons to 31.1 million, which set a 35% growth in the period (ANDA, 2014).

Efficient nitrogen fertilization is important in both aspects: economic and environmental. This is the same as minimizing nutrient losses to the environment, while obtain optimal crop yields. However, the agronomic efficiency in the use of N fertilization approaches 50 % of the total applied (Bouwman, 1998). Part of the N not used by the plant is not necessarily lost and can remain in the soil, probably immobilized in roots and soil organic matter (Alves et al., 2006).

Nitrogen (N) uptake by the plant can varie with the fertilizer used, soil type and climate conditions. The objective of this study was to establish correlations among the total N and the SPAD readings in Coffea arabica leaves. This study is part of a project that aims to evaluate the agronomic and environmental efficiency of nitrate-based fertilizers compared to conventional nitrogen fertilizers used in the cultivation of coffee.

Methods

The three years agronomic and environmental evaluation of the coffee crops will be conducted in three commercial areas located in the cities of Campinas (two areas - Area 1 and Area 2) and Espirito Santo do Pinhal (one area - Area 3), in São Paulo state. In the 2013 harvest, Area 1 had an overproduction and was several pruned at the end of the year. This part of the study was carried out during the 2013/2014 season, when coffee plants (Coffea arabica) were 6 years old. Area 1 and 2 had been planted in a spacing of 3.2 x 0.8 m, with the Variety Catuai Vermelho and Catuai Amarelo, with a population of approximately 3906 plants per hectare. Catuia Amarelo was also planted in Area 3 in a spacing 3.20 x 0.70 m, with a population of approximately 4464 plants per hectare.

The experimental design was a complete randomized in four block, with eight treatments and plots with eight plants. The treatment consists of 3 doses of calcium nitrate (50, 100 and 200 kg N ha^{-1}), 3 doses of urea (50, 100 and 200 kg N ha^{-1}), 1 treatment with parceled calcium nitrate + NPK application, and a control. The other nutrients are applied at recommended for culture according to the analysis of soil and crop productivity expectation doses. The fertilizer forms were applied in soil surface in plant projection, in an annual procedure.

After N fertilizer application, leaf analyses were occurred in February and June to macro and micro nutrients determination. Total N concentration was determined by dry combustion in an elementary analyzer (LECO Tru-Spec CN analyzer). An average of 30 leaves from the portable chlorophyll meter (SPAD-502, Minolta, Japan) was obtained under field conditions, in February, May, June and July.

Data were subjected to analysis of variance (ANOVA) to identify significant differences between the treatments according to the design described above. The means were compared using the Tukey test at 5% probability.

Results and discussion

Leaves with high N content have a greater maximum rate of net photosynthesis and greater total chlorophyll in bright light, than those deficient in

N (Evans 1983). Contents of N and SPAD readings were closely correlated during fruit development from January through June) with treatment.

Nitrogen concentration in leaves increased after the fertilization, comparing the February and June measurements, as presented in Table 1. The February measurements of Areas 1 and 2, the treatments are not significantly different. For the other results, a difference can be observed between the control and the others treatments, without following a pattern. Coffee plants have the biannual habit of production, a year of high yield is followed by one of low production, due to the exhaustion of reserves of assimilates and nutrients, particularly N and K, which are used for the new growth (Reis et al., 2009). This year, in 2013 all the commercial crops from the region had a high yield. Consequently, 2014 had a low production, aggravated by the lack of rain in the Southeast region of Brazil during rainy season.

Nitrogen plays its role in yield formation through the participation in many compounds such as amino acids, proteins, enzymes, and pigments. SPAD reading is a rapidly indicator of change in N nutrition correlated to chlorophyll. The results presented in Figure 1 (A and B) shown a difference between the measurement of February and the last two. For Area 3 (C), the results from the first and second measurement data are equal and differ from the last two.

A correlation between N concentration and SPAD measurement was only found in Area 3 (0.8642). The results for Area 1 and Area 2 had no correlation, probably because of the lack of rain and the higher temperatures compared to Area 3.

Conclusion

SPAD readings are an important tool to indicate changes in N nutrition, considered suitable for rapid diagnosis and decision making.

Improvements should be made in the next two or three seasons for this trial with a more constant monitoring of the correlation between N concentration and SPAD measurement.

Keywords:Total nitrogen concentration, SPAD reading, coffee crop

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Table 1. Coffee leaf nitrogen concentration measured in two periods during the 2013/2014 season

	Total Nitrogen Concentration (N)							
	T1	T2	T3	T4	T5	T6	T7	T8
	------ *g kg^{-1}* ------							
Área 1								
February	32,0 ± 1,1	32,2 ± 2,2	31,1 ± 0,5	31,6 ± 1,8	33,2 ± 1,0	32,9 ± 1,0	32,4 ± 0,7	31,7 ± 1,3
June	35,3 ± 0,5 ab	35,6 ± 1,4 ab	35,2 ± 0,8 ab	35,8 ± 0,8 a	35,8 ± 0,4 a	35,6 ± 0,9 a	36,2 ± 0,6 a	33,4 ± 0,7 b
Área 2								
February	32,3 ± 1,7	31,9 ± 2,4	32,2 ± 2,9	31,1 ± 1,3	32,5 ± 2,6	32,9 ± 2,0	31,8 ± 1,6	31,7 ± 1,2
June	33,9 ± 1,7 a	34,6 ± 1,1 a	34,7 ± 1,4 a	34,6 ± 1,0 a	34,6 ± 1,2 a	33,1 ± 0,7 ab	35,5 ± 1,3 ac	30,8 ± 1,4 bd
Área 3								
February	25,9 ± 1,5 a	28,5 ± 2,7 a	28,0 ± 0,9 a	24,7 ± 0,9 ab	24,2 ± 1,5 a	26,7 ± 0,1 ab	27,5 ± 0,1 a	21,9 ± 0,5 b
June	36,4 ± 1,1 a	37,3 ± 0,7 a	38,7 ± 0,6 ab	33,5 ± 1,2 ac	36,0 ± 0,9 a	36,6 ± 1,3 a	39,5 ± 2,2 ab	27,9 ± 1,4 dc

Mean values followed by the same lowercase letter in rows do not differ by Tukey test (5% probability).

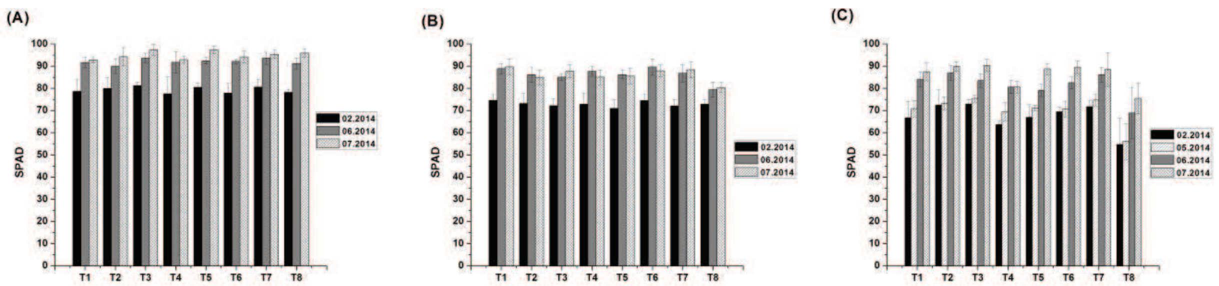

Figure 1. SPAD measurement made in subsequently data at Area 1 (A), Area 2 (B) and Area (3)