RELATIONSHIP BETWEEN INDEX SPAD, TOTAL SOLUBLE SOLIDS AND TOTAL CHLOROPHYLATE IN NITROGEN FERTIRRIGATED BEET

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ABSTRACT: The quantification of chlorophyll in the leaves of the plants is fundamental, since it serves as the basis for estimating the amount of nitrogen present in the leaves. The objective of this study was to evaluate the relationship between SPAD index, total chlorophyll and total soluble solids of the fertirrigated beet, under the effect of different doses of nitrogen. The experiment was in a greenhouse of the Federal University of Campina Grande (UFCG). The treatments consisted of five nitrogen doses (0, 50, 100, 150 and 200 mg.dm-3 of soil), with nine replications, in a randomized block design. The SPAD index, total chlorophyll content and the total soluble solids (° Brix) were determined at 45 and 90 days after transplanting and correlations were made between the variables. The relationships were positive with coefficient of determination above 50%, being less significant at 90 days after transplanting. The leaf nitrogen content (SPAD Index) increased linearly with the increase of ° Brix and total chlorophyll. The study showed that SPAD-502 may be an indication of the need for nitrogen application and as an estimate of total chlorophyll content.

KEYWORDS: Intensity of Green, Beta vulgaris L, chlorophyllometer.

RELAÇÃO ENTRE ÍNDICE SPAD, SÓLIDOS SOLÚVEIS TOTAIS E CLOROFILA TOTAL EM BETERRABA FERTIRRIGADA COM NITROGÊNIO

RESUMO: A quantificação da clorofila nas folhas das plantas é fundamental, uma vez que serve de base para estimativa da quantidade de nitrogênio presente nas folhas. Objetivou-se com o presente estudo, avaliar a relação entre índice SPAD, clorofila total e sólido solúveis total da beterraba fertirrigada, sob aplicação de diferentes doses de nitrogênio. O experimento foi conduzido em casa de vegetação da Universidade Federal de Campina Grande (UFCG). Os tratamentos consistiram de cinco doses de nitrogênio (0; 50; 100; 150 e 200 mg.dm^{-3} de solo),

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com nove repetições, em delineamento em blocos ao acaso. Determinou-se aos 45 e 90 dias após o transplantio o Índice SPAD, teor de clorofila total e os sólidos solúveis totais (°Brix) e fez- se as correlações entre as variáveis. As relações foram positivas com coeficiente de determinação acima de 50%, sendo menos significativas aos 90 dias após transplantio. O teor de nitrogênio foliar (Índice SPAD) aumentou de forma linear com o incremento do °Brix e da clorofila total. O estudo demostrou que o SPAD-502 pode ser uma indicativo da necessidade da aplicação do nitrogênio e como estimativa dos os teores de clorofila total.

PALAVRAS-CHAVES: Intensidade de Verde, *Beta vulgaris* L, clorofilômetro.

INTRODUÇÃO

Beet (Beta vulgaris L.), a plant of the Amaranthacae family, which originates in Europe, has high nutritional value, it stands out among the vegetables for its nutritional composition, mainly rich in sugars, B vitamins and nutrients such as potassium , sodium, iron, copper and zinc, and both roots, tubers and leaves can be consumed. (Trani et al., 2013).

Among the means for the efficient use of fertilizers is fertigation, one of the main forms of split fertilization, consisting of the application of soluble fertilizers via water in the irrigation system throughout the crop cycle (Coelho et al., 2014). It is highlighted as advantages of fertigations, minimum losses of fertilizers by leaching and volatilization, and with a greater efficiency of application, being these applied close to the root system of the plants, obeying the march of absorption of the culture (Souza et al,. 2012; Silva et al., 2015).

Nitrogen is an essential element for beet and contributes to increase crop productivity by promoting expansion and mass accumulation in the tuberous root (Marschner, 1995). Among the factors that may favor the increase of this productivity, nitrogen is considered a nutrient of greater impact on crop productivity, as it is directly related to photosynthesis and to the vegetative growth of the plant (Yin et al., 2003).

Marenco & Lopes (2009) report that nitrogen has low at the soil availability and is associated with absorption by the absorbent roots, thereby limiting vegetative growth in a accented mode. Is constituent of amino acids being necessary for the synthesis of chlorophyll, exerting influence in the photosynthetic process.

The chlorophyll meter, SPAD-502 (Soil Plant Analysis Development), is capable of generating quantities related to chlorophyll content. The use of the chlorophyll meter makes it possible to estimate the concentration of N in the leaves of the plants quickly and, with this, it

can contribute to a decrease in the use of nitrogen fertilizers (Sant'ana et al., 2010). The chlorophyll content correlates with the concentration of N in the plant and also with the productivity of the crops (Silva et al., 2012).

Second Persegil (2012) Several experiments positively correlated the leaf nitrogen contents with the relative index of chlorophyll. Chlorophyll plays an important role in the biochemical conversion of energy, the structure and function of chlorophyll "b" are basically the same, but the leaf content of the latter is about one third of chlorophyll "a".

In view of the above, the objective of this work was to evaluate the relationship between SPAD index, total chlorophyll and total suluble solidsof the fertirrigated beet under different nitrogen rates applied by fertirrigation and associated different type of foundation fertilization

MATERIAL AND METHODS

The experiment was conducted in a greenhouse belonging to the Agricultural Engineering Unit (UAEAg), Federal University of Campina Grande, Campina Grande - PB, from June to August 2016.

The greenhouse is 15 m long, 10 m wide and 3 m on the right-hand side, covered with transparent low density polyethylene film with 150 microns thickness and sides with sombrite-type screen.

The analysis of the physical and chemical characteristics of the soil used in the experiment, at a depth of 0.0-0.2m, can be found in Table 1.

The data concerning temperature and relative humidity of the air, during the experimental period, were collected from the sensors installed inside the greenhouse (Figure 1A and 1B).

The treatments consisted of five doses of nitrogen fertilization applied through fertigation (0, 50, 100, 150 and 200 mg of nitrogen per dm^{-3} of soil). The nitrogen source used was urea, with nitrogen doses per vase corresponding to 0; 0.7; 1.4; 2.1 and 2.8 g of N per vase according to the methodology proposed by Silva & Silveira (2012), divided into three applications: the first to 20 days after transplanting (DAT), the second at 40 DAT and the third at 60 DAT.

The statistical design adopted was in randomized blocks, with nine replications. The 5 proposed treatments were arranged in 45 plots, that is, 45 vase of cylindrical shape of 12L spaced in 0.5m between plants by 1.0m between line. Each experimental unit was composed of a vase with holes in the lower part, containing a 1 cm layer of gravel 1, covered with geotextile blanket to facilitate drainage; The pots were filled with about 14 dm^3 of soil.

The beet cultivar used was the "Early Wonder", one of the most cultivated in the Brazilian northeast by small olericultores. The seedlings were produced in 128-cell expanded polyethylene trays filled with commercial substrate. Transplanting was performed using two seedlings per vase, which occurred around 20 days after sowing.

At 45 and 90 DAT were analyzed: SPAD index, total chlorophylls and total soluble solids content (° Brix). SPAD measurements were performed between 9:00 am and 9:30 am using the portable chlorophyll meter, where five measurements of the SPAD index per leaf were performed in the central region of the leaf limb of each plant of the useful plot, using the average to represent the treatments.

The total chlorophyll was removed from leaf discs with a diameter of approximately 0.771 mm from the leaf blade by means of a punch, between the edge and the central vein of the leaf, the weight of the sample varied between 50 - 200g.

The levels of chlorophyll a and b, total and carotenoids were quantified by extracting the pigments from the samples taken from the fresh leaves, which after being weighed and crushed in petri dishes in a low light environment, and then placed in containers containing 6 mL of 80% acetone, kept in the dark and refrigerated for 72 hours; Then the supernatants containing the extracted pigments are collected and the absorbance readings are carried out. The spectrophotometer equipment was used at the wavelengths at 470nm (caratenoids), 647nm (chlorophyll b) and 663nm (chlorophyll a), using 80% acetone as white

The concentration of °Brix or total soluble solids was performed using a portable manual refractometer.

The variables were analyzed statistically by the F test at 5 and 1% probability, unfolding whenever the interaction was significant. The quantitative factor relative to the nitrogen doses was analyzed statistically by means of polynomial regression (linear and quadratic) and the correlation of Person with the aid of the computational program Sisvar (Ferreira, 2008).

RESULTS AND DISCUSSION

The correlation between the SPAD index and ° Brix, evaluated at 45 days after transplanting, was highly significant (Figure 2A) and at 90 days after transplanting (Figure 2B). It is also noted that as the SPAD Index increased, there was an increase in the total soluble solids contents for both epochs of evaluation.

Silva et al., (2009) They report that the SPAD index increases with the increase in the availability of nitrogen for the plants. Second Schröder et al., (2000) N deficiency is

immediately reflected in low concentrations of chlorophylls which are recorded by low SPAD values.

The ratio of the total soluble solids with the SPAD index occurred as expected, due to the fact that with the increase of the nitrogen increment, it increased the SPAD index and consequently reflected it in high sugar contents for the cultivar studied.

At 45 days after transplanting, the cultivar presented SPAD index close to the average mentioned by Malavolta et al., (1997), who considers it appropriate for the crop, that the fourth or fifth leaf fully expanded, one month after planting presents 49 56 SPAD units.

At 90 days after planting, SPAD index values ranged from 28.45 to 60.05 SPAD units. These values show that when the beet plant is in an advanced stage of development, the leaves begin to gradually reduce the accentuated green coloration. Thus, the SPAD index can be used as a tool to indicate the most correct time to harvest the tubers in a given cultivar.

Barreto et al., (2013) When studying the Brix content of beet as a function of the application of nitrogen doses verified maximum values of 14.81 and 15.08 for beet cultivars Early Wonder and Itapuã, respectively, these results were close to those obtained in the present work.

Marques et al., (2010), In a research with beets fertilized with increasing doses of manure verified levels of ° Brix ranging from 10,26 to 11,10, results consistent with those obtained in the present study, despite the use of different organic compounds. The relationship between reading with a portable chlorophyll meter and extractable total chlorophyll content shows that chlorophyll readings adequately estimate the degree of greening of the beet leaf, that is, the relative chlorophyll content in the leaf, regardless of the stadium evaluated and of culture (Figure 3 A e B).

The critical levels of the SPAD Index for the 45 DATs were 59 and 60 SPAD units, and for total chlorophyll were 1.8 and 2.0 (mg g-1 MF), presenting a direct correlation between those of 0.88, and a positive relationship between variables (Figure 3A). However, it can be observed that during the beet cycle, this ratio decreased, so that at 90 DAT SPAD and total chlorophyll content values were well below those observed at 45 days after transplantation, a fact that can be justified due to the senescence period of the plants.

Argenta et al., (2001) report that because of the strong correlation the portable meter can effectively replace the chlorophyll content determination in a destructive way, since the data are reliable.

In a study conducted by (Porto et al., 2011) that evaluated the total chlorophyll content and the SPAD index, the results showed a very similar performance, with a quadratic response as a function of the elevation of N.

For the relationship between the SPAD index and total chlorophyll at 90 DAT, it was possible to observe a low correlation between them of 0.61. At 90 DAT there was an increase of 29.36% in the SPAD unit, and total chlorophyll of 24.49% in relation to the results obtained at 45 DAT.

Corroborating the study carried out by Cardoso et al., (2011) with three beet cultivars Àgata, Monalisa and Vivaldi grown on soil fertilized with different doses of N, in which there was a reduction in SPAD units due to the physiological development of beet.

CONCLUSION

The SPAD index, ° Brix or total soluble solids and total chlorophyll increased concomitantly linearly as a result of the increase in nitrogen doses in the form of urea, for the 45 as well as the 90 DAT there was an exponential increase

Fertilization by fertigation provides the highest efficiency of photosynthetic pigments and soluble solids content Brix relative to the fertilization only of foundation.

Increasing nitrogen doses increased the SPAD index value and the chlorophyll content in leaf limb of beet cultivar.

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TABLES AND GRAPHICS

Table 1. Physical and chemical characteristics of the soil used in the experiment in the depth of 0.0 - 0.2 m.

pH	M.O	P	K	Na	Ca	Mg	Al	H
	(%)	mg/100g		----------mmol$_c$dm^{-3}----------				
5,9	0,65	1,43	0,14	0,07	1,9	0,66	0,2	1,88
		Density	Sand		Silt		Clay	
		(g cm^{-3})	---------- (%) ----------					
		1,39	74,7		16,11		9,19	

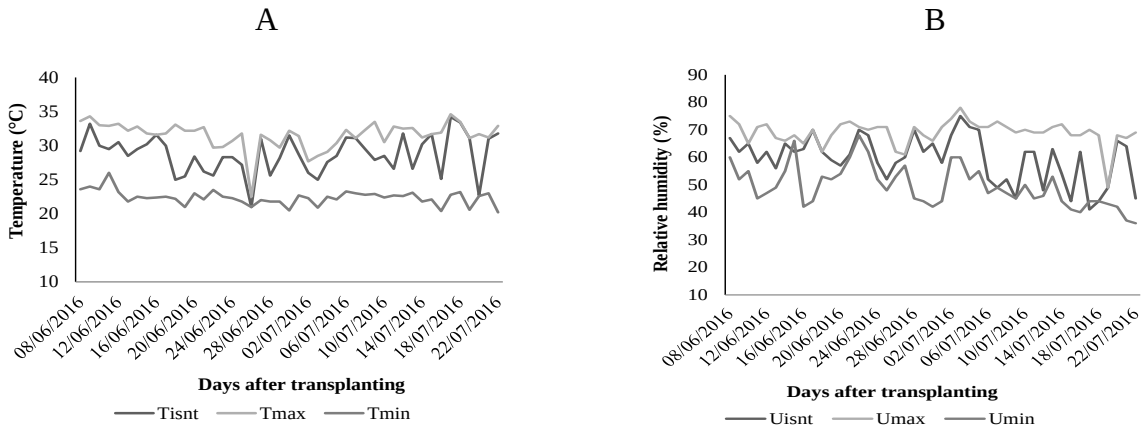

Figure 1. Instantaneous, maximum and minimum air temperature (1A) and relative humidity of the instantaneous, maximum and minimum air (1B) during the experimental period.

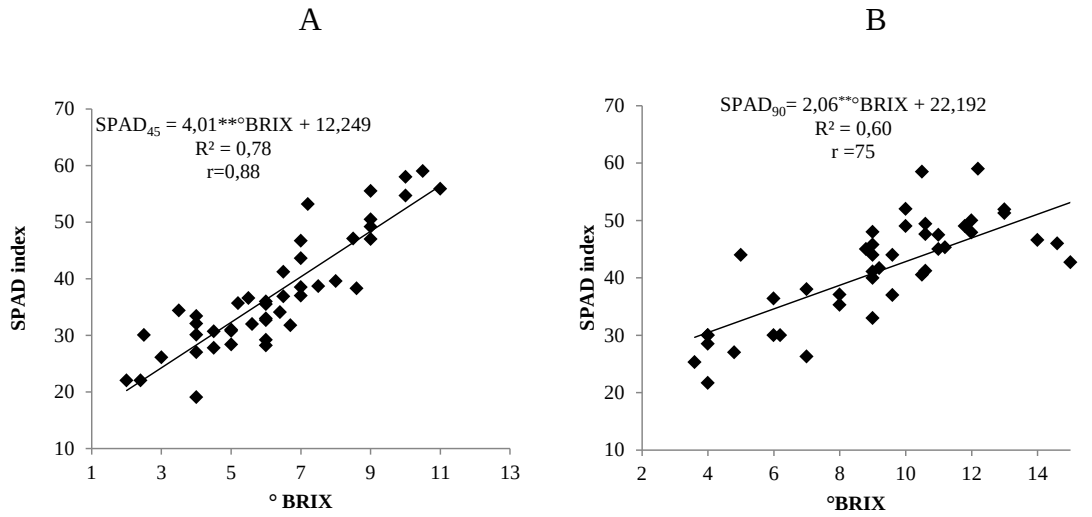

Figure 2. Correlation between SPAD index and ° Brix at 45 days after transplanting (A) and at 90 days after transplanting (B).

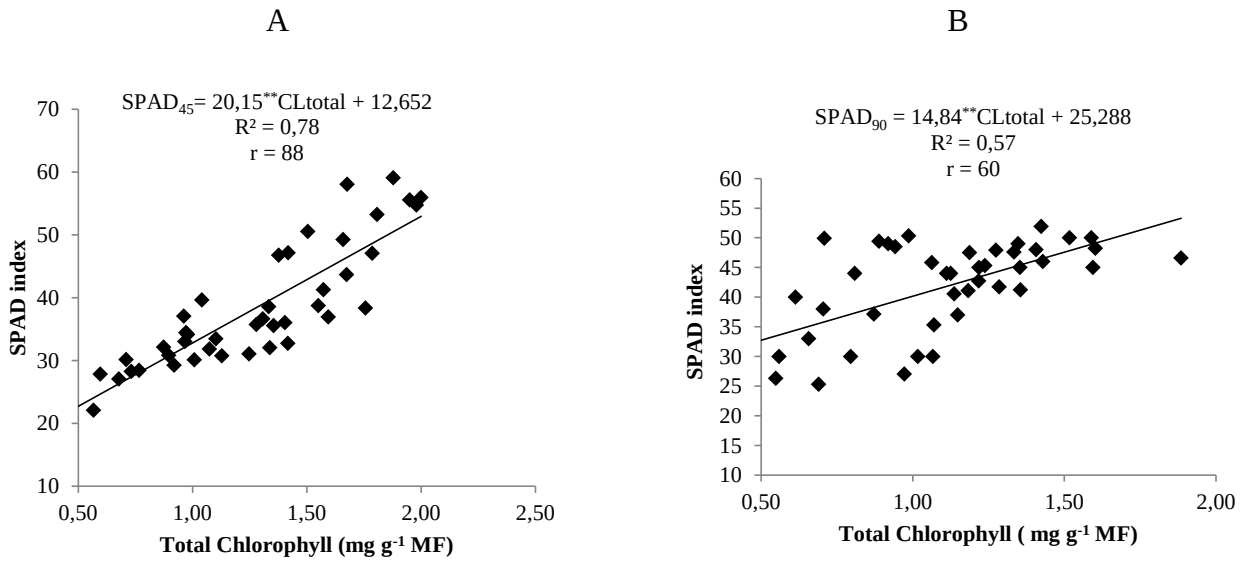

Figure 3. Correlation between SPAD index and total chlorophyll at 45 days after transplanting (A) and at 90 days after transplanting (B).