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Scientia Horticulturae 104 (2005) 199–209
SCIENTIA HORTICULTURAE
www.elsevier.com/locate/scihorti

Photosynthetic pigments, nitrogen, chlorophyll *a* fluorescence and SPAD-502 readings in coffee leaves

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Received 23 October 2003; accepted 18 August 2004

Abstract

The chlorophyll meter (SPAD-502) is a simple, portable diagnostic tool that measures the greenness or relative content of leaves. Compared to the traditional destructive methods, the use of this equipment saves time, space and resources. The objective of this study was to establish a correlation between the photosynthetic pigments content extracted in DMSO, the total nitrogen content and the chlorophyll *a* fluorescence variables with the SPAD-502 readings in *Coffea canephora* Pierre leaves. The SPAD-502 has been shown to be a good tool to diagnose the integrity of the photosynthetic system in coffee leaves, and can thus help in the advanced interpretations of the photochemical process of these plants. The SPAD readings lower 40 show impairment in photosynthetic process. Thus, the portable chlorophyll SPAD-502 can be used to analyze the photosyn-

Abbreviations: F_0, minimal fluorescence; F_m, maximal fluorescence; F_v/F_m, ratio of variable to maximal fluorescence-maximum quantum efficiency of open photosystem II centres-quantum yield; q_p, photochemical quenching; q_N, non-photochemical quenching; Q_a, primary quinone acceptor of photosytem II; PSII, photosystem II; DMSO, dimethylsulphoxide; Chl, chlorophyll; Car, carotenoids

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0304-4238/$ – see front matter
doi:10.1016/j.scienta.2004.08.013

thetic pigments, and total nitrogen can also help in interpretation of the photochemical process in coffee plants.

Keywords: *Coffea canephora* Pierre; Portable chlorophyll meter; Chlorophyll; Carotenoids; Fluorescence

1. Introduction

The methodologies used for chlorophyll extraction in plant materials are almost always based on methods that destructively extract leaf tissue using organic solvents that include acetone (McKinney, 1941; Bruisna, 1961), dimethylsulfoxide (DMSO) (Hiscox and Israelstam, 1979) methanol, *N*,*N*-dimethyl formamide and petroleum ether (Moran and Porath, 1980; Moran, 1982; Lichtenthaler and Wellburn, 1983; Inskeep and Bloom, 1985). During the extraction and dilution, significant pigment losses may occur thus leading to a high variability in the results. Shoaf and Lium (1976) used DMSO to modify the extraction methodology to eliminate the squashing and centrifuging stage. This method allowed longer storage periods for the extracted pigment, so that the spectrophotometer analyses need not to be performed immediately after extraction.

Although a high correlation between the chlorophyll content and photosynthesis rate was not obtained (Marini, 1986), the assessment of photosynthetic pigments, and consequently their relationships, is an important indicator of senescence (Brown et al., 1991). Chlorophyll loss is associated to environmental stress and the variation in total chlorophyll/carotenoids ratio may be a good indicator of stress in plants (Hendry and Price, 1993). In addition, measuring gas exchange and chlorophyll content repeatedly on the same leaves in field may provide useful information on the relationship between these parameters (Schaper and Chacko, 1991).

The chlorophyll meter (or SPAD meter) is a simple, portable diagnostic tool that measures the greenness or the relative chlorophyll concentration of leaves (Kariya et al., 1982). The meter makes instantaneous and non-destructive readings on a plant based on the quantification of light intensity (peak wavelength: approximately 650 nm: red LED) absorbed by the tissue sample. A second peak (peak wavelength: approximately 940 nm: infrared LED) is emitted simultaneous with red LED for to compensate the thickness leaf (Minolta Camera Co. Ltd., 1989). Compared with the traditional destructive methods, this equipment might provide a substantial saving in time, space and resources.

However, to determine the chlorophyll concentration in a sample, calibration curves between meter readings and the chlorophyll concentration in the tissue sample must be made. Recent research indicates a close link between leaf chlorophyll concentration and leaf N content, which makes sense because the majority of leaf N is contained in chlorophyll molecules (Peterson et al., 1993). Chlorophyll concentration or leaf greenness is affected by a number of factors, one being N status of the plant. Since the chlorophyll meter has the potential to detect N deficiencies, it also shows promise as a tool for improving N management (Peterson et al., 1993; Smeal and Zhang, 1994; Balasubramanian et al., 2000).