



Rapid Method for Determining Total Chlorophyll, Chlorophyll a and b and Carotene Content in Leaves of Elephant Foot Yam Using SPAD Meter

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Abstract

A rapid, non-destructive method for determining total chlorophyll, chlorophyll a and b and carotene content in leaves of elephant foot yam using SPAD meter readings was developed at Central Tuber Crops Research Institute, Thiruvananthapuram, India. There was significant positive correlation between SPAD readings and total chlorophyll ($r = 0.91$), chlorophyll a ($r = 0.85$) and b ($r = 0.90$) and carotene ($r = 0.86$) content in leaves of elephant foot yam. The factors (F values) derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were 0.0275, 0.019, 0.0087 and 0.0105 respectively. The coefficients of determination (r^2) values derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were 0.833, 0.713, 0.813 and 0.736 respectively. The linear regression equations ($y = a + bx$) derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were $0.028x - 0.047$, $0.02x - 0.44$, $0.008x + 0.011$ and $0.006x + 0.125$ respectively. The coefficient of determination (r^2) values between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content near to 1 indicated that the regression equations were good fit. Therefore, using the F values, the total chlorophyll, chlorophyll a and b and carotene content in leaves of elephant foot yam can be directly calculated by multiplying the SPAD readings with F values 0.0275, 0.019, 0.0087 and 0.0105 respectively.

Key words: Chlorophyll, carotene, SPAD, elephant foot yam

Introduction

SPAD is acronym for Soil Plant Analysis Development. This meter was designed originally in 1963 for N management in rice in Japan. This instrument determines the “greenness” of a leaf by measuring the transmittance / absorbance of the leaf between 400 and 500 nm (blue region) and between 600 and 700 nm (red region), which are the absorption maxima of chlorophyll a and b and carotenoid pigments. Sunlight conditions in the field do not affect its readings and so measurements can be taken in different weather conditions. However, on each measurement it measures only one spot in a leaf. Therefore, many measurements must be taken to get a reliable average. The SPAD meter

gives readings in arbitrary unit which is proportional to the amount of these pigments in leaves. The device is pressed onto the leaf surface and a relative nondestructive greenness reading is recorded in few seconds. The SPAD readout has been widely used to measure leaf chlorophyll content in leaves of many crops viz., corn, papaya, soybean, rice, coffee, wheat, peanut, sugarcane, dry bean and sorghum and well correlated with N status of crops (as most of leaf N is present within chlorophyll) and photosynthetic activity of plant leaves (Hussain, et al. 2000; Loh et al., 2002; Netto et al., 2005; Kapotis et al., 2003; Guler and Ozelik, 2007; Uddling et al., 2007; Varvel et al. 2007; Steel et al., 2008; Hawkins et al., 2009; Jangpromma et al., 2010; Ruiz-Espinoza et al., 2010). The present paper reports the rapid method for

determining total chlorophyll, chlorophyll a and b and carotene content in leaves of elephant foot yam using SPAD meter

Materials and Methods

In the present study a rapid, non-destructive method for determining total chlorophyll, chlorophyll a and b and carotene content in leaves of elephant foot yam using handheld (portable) SPAD meter readings has been developed. SPAD -502 Minolta was used for recording greenness of 51 leaves randomly selected showing greenness of different density, from elephant foot yam plants of four genotypes viz., Sree Padma, Gajendra, Sree Athira and Peermade local at 6th month after planting and cultivated under field conditions at Central Tuber Crops Research Institute, Thiruvananthapuram, India during January - July 2010. Recommended package of practices was followed. In each leaf, five SPAD read outs were recorded and the mean of these values were used for calculation. Fifty one leaves (leaflets) showing greenness of different density were collected randomly from plants of these four genotypes and chlorophyll was extracted from leaves of known weight and estimated according to Leichtenthaler (1987).

Results and Discussion

The mean SPAD read outs among 51 leaf samples varied between 12.4 and 55.4 with an average of 38.67. The estimated total chlorophyll content (Leichtenthaler, 1987) varied between 0.341 and 1.727 mg g⁻¹ fresh leaf with an average of 1.063 ± 0.367 mg g⁻¹ fresh leaf. The chlorophyll a content varied between 0.213 and 1.299 mg g⁻¹ fresh leaf with an average of 0.736 ± 0.278 mg g⁻¹ fresh leaf. The chlorophyll b content varied between 0.079 and 0.529 mg g⁻¹ fresh leaf with an average of 0.334 ± 0.106 mg g⁻¹ fresh leaf. The carotene content varied between 0.205 and 0.574 mg g⁻¹ fresh leaf with an average of 0.386 ± 0.09 mg g⁻¹ fresh leaf.

The estimated total chlorophyll content [F x

SPAD readouts method] varied between 0.341 and 1.524 mg g⁻¹ fresh leaf with an average of 1.063 ± 0.321 mg g⁻¹ fresh leaf. The chlorophyll a content varied between 0.236 and 1.053 mg g⁻¹ fresh leaf with an average of 0.735 ± 0.222 mg g⁻¹ fresh leaf. The chlorophyll b content varied between 0.108 and 0.482 mg g⁻¹ fresh leaf with an average of 0.337 ± 0.100 mg g⁻¹ fresh leaf. The carotene content varied between 0.130 and 0.582 mg g⁻¹ fresh leaf with an average of 0.407 ± 0.121 mg g⁻¹ fresh leaf.

There was significant positive correlation between SPAD readings and total chlorophyll ($r = 0.91$), chlorophyll a ($r = 0.85$) and b ($r = 0.90$) and carotene ($r = 0.86$) content in leaves of four varieties of elephant foot yam. The factors (F values) derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were 0.0275, 0.019, 0.0087 and 0.0105 respectively. The coefficients of determination (r^2) values derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were 0.833, 0.713, 0.813 and 0.736 respectively. The linear regression equations derived between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content were $0.028x - 0.047$, $0.02x - 0.44$, $0.008x + 0.011$ and $0.006x + 0.125$

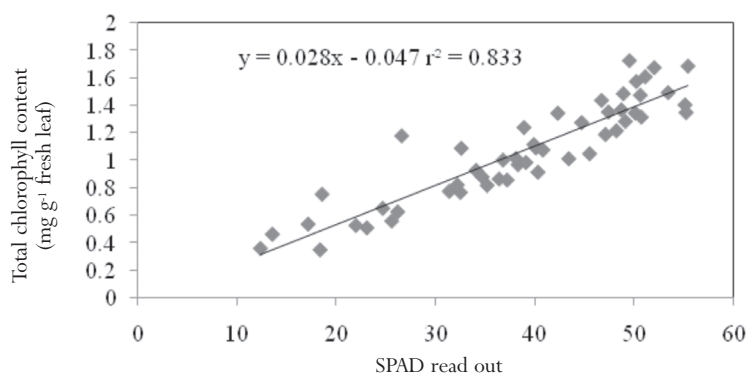


Fig. 1. Relation between SPAD read out and total chlorophyll content in elephant foot yam leaf

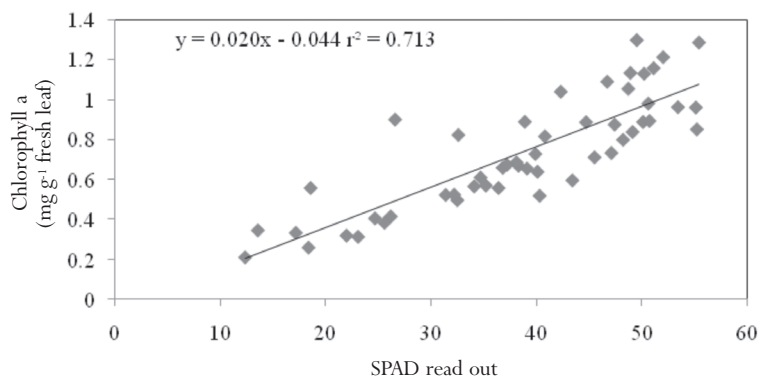


Fig. 2. Relation between SPAD read out and chlorophyll a in elephant foot yam leaf

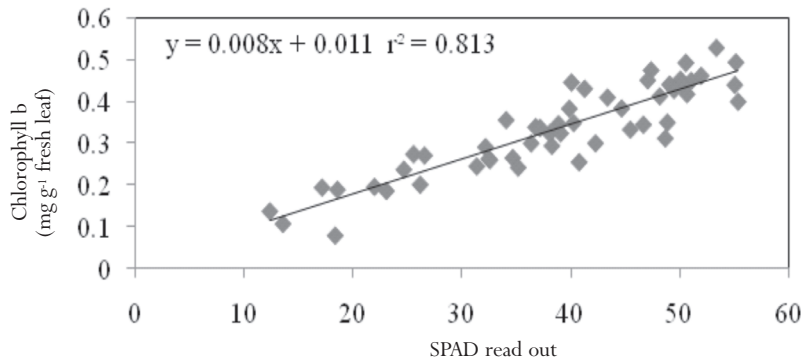


Fig. 3. Relation between SPAD read out and chlorophyll b in elephant foot yam leaf

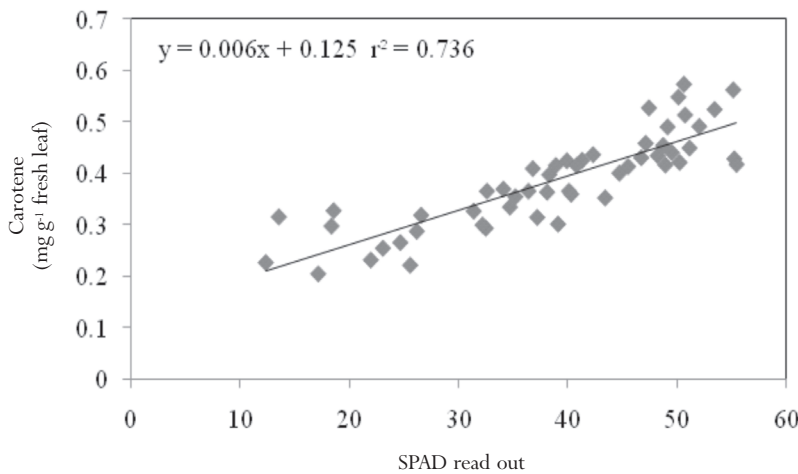


Fig. 4. Relation between SPAD read out and carotene content in elephant foot yam leaf

respectively (Fig. 1, 2, 3 and 4). The coefficient of determination (r^2) values between SPAD readings and total chlorophyll, chlorophyll a and b and carotene content near to 1 suggested that the regression equations were good fit. Therefore, using the F value, the total chlorophyll, chlorophyll a and b and carotene content in leaves of elephant foot yam can be directly calculated by multiplying the SPAD readings with F values 0.0275, 0.019, 0.0087 and 0.0105 respectively (Fig. 1 to Fig. 4).

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