Calibration of Spad Meter and Rice Leaf Colour Chart for Chilli (*Capsicum annuum* L.)

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INTRODUCTION

Nitrogen (N) is an essential plant nutrient. The response of a plant to nitrogen depends on many factors such as soil conditions, species, solar radiation etc. Since the N requirement of plants cannot be supplied by soil alone, application of nitrogen fertilizer has become the norm. Blanket fertilizer recommendations result in waste of N fertilizer, low N use efficiency and increase in cost of production (Pathak and Ladha, 2007). The present blanket N recommendation available for chilli is 225 kg/ha (Kannangara and Karunathilake, 2013). Since there is no mechanism to determine the exact N requirement of plants, farmers apply higher doses of N fertilizer to the soil than what is required to obtain higher yields. As such, N fertilizer applications based on the crop requirement will be more environmentally friendly and profitable.

Green colour intensity of crop leaves is directly related to crop nitrogen status. Hand held Soil – Plant Analyses Development (SPAD) meters measure the green colour intensity and are used to predict crop nitrogen requirements. Leaf Colour Chart (LCC) is developed for rice as a cost effective tool for N management of crops and a simple alternative to SPAD meter. Pre-determined critical SPAD meter value or LCC value is used as the reference value in determining N status of a crop. If the greenness value of the crop is less than the reference value, N fertilizer should be added.

Hence LCC and SPAD meter are important tools in precision agriculture. Chilli is one of the major cash crop which requires large amount of nitrogen fertilizer. The objective of this study was to calibrate the SPAD meter and Rice LCC for chilli variety ‘MI green’ with the aim of developing a method to determine nitrogen requirement for Chilli.

MATERIALS AND METHODS

The experiment was conducted during *Yala* 2013 and 2014 at the research fields of the Field Crops Research and Development Institute, Maha-Illuppallama (8º06’ 42.73” N and 80º28’ 03.27” E, Elevation 117 m above mean sea level), DL1b agro-

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ecological region of Sri Lanka. The soil type of the tested location is Reddish Brown Earths or Typic Rhodustalfs (USDA soil Taxonomy) (Mapa *et al.,* 2010).

Five Nitrogen levels were tested, i.e., 0, 75, 150, 225 and 300 kg of N/ha to identify the critical SPAD and leaf colour chart values at different growth stages for chilli. The experiment was set-up as a Randomized Complete Block Design (RCBD) with three replicates.

Land was prepared as recommended by the Department of Agriculture (DOA) and the plot area used was 15.12 m^2. Compost made using straw and cattle manure was applied one week before planting at the rate of 10000 kg/ha and mixed well with the soil. All treatments received 67.5 kg/ha P2O5 in the form of Triple Super Phosphate and 90 kg/ha K_2O in the form of Muriate of Potash as basal dressing. Thirty five days old seedlings raised on standard field nurseries were planted in plots at spacing of 60 X 45 cm keeping two plants per hill. Nitrogen was applied in the form of urea following the recommended split of the DOA. A six panel LCC manufactured by the International Rice Research Institute and chlorophyll meter SPAD-502 manufactured by the Konica Minolta Sensing, Inc. in Japan were used. LCC and SPAD meter values were obtained from a fully expanded young mature leaf at two-week intervals starting from 25 days after field planting. The method adopted by Argenta et al., (2004) was used to find the critical SPAD values for maize. The Cate-Nelson's graphical method (Cate and Nelson, 1987) was used to determine the critical value. Here, average SPAD meter values and LCC values at different growth stages were plotted against the relative yield. The relative yield was calculated dividing individual treatments yield by the maximum yield. Relative yield, beyond which there was no significant yield increase, was selected as the horizontal critical level in the plot and the vertical critical level was selected to minimize the outliers. Analysis of Variance (ANOVA) was carried out using the Statistical Analysis System (SAS institute Inc.) to identify effects of N levels on growth and yield of chilli. Mean separation was done using Duncans' Multiple Range Test.

RESULTS AND DISCUSSION

Dry chilli yield increased with increased N levels as observed earlier (Bhuvaneswari *et al.,* 2013). The dry chilli yields obtained from the treatments applied with 150, 225 and 300 kg/ha of N were significantly higher compare to other treatments during *Yala* 2013 and it was significantly higher with 225 and 300 kg/ha of N during

Yala 2014. Although the yield is increasing beyond 225 kg/ha of N the increment was not significant. Therefore, application of higher doses may increase the cost of production.

Irrespective of the treatment, SPAD meter values increased with the age of the crop. Similar results were obtained for maize by Argenta *et al.,* (2004) and they speculated that nitrogen taken up by maize during early growth stages is used primarily for formation and expansion of leaves and stems. SPAD meter readings from the different treatments were significantly different at 53, 67, 84 and 99 days after transplanting during *Yala* 2013 and at 42 and 103 days after transplanting during *Yala* 2014. LCC values increased with the increasing N application in most of the sampling dates. LCC reading of the different N applications were significantly different at 25, 39 and 67 days after planting in *Yala* 2013 and at 29, 58 and 103 days after planting in *Yala* 2014 indicating the amounts of nitrogen absorbed by the plant is reflected in LCC and SPAD readings. The association between nitrogen and yield was tested by correlation analysis between SPAD meter readings and yield and between LCC readings and yield. The correlations were significant ($p = 0.05$) for SPAD at all growth stages while at 39, 53 and 67 days after planting for LCC during *Yala* 2013 (Table 1). LCC values were correlated with the yield at 29, 103 and 119 days after planting during *Yala* 2014 (Table 2). Since there is a correlation between SPAD readings and LCC values at all growth stages these readings can be used to determine the optimum greenness to have an optimum yield ultimately.

Table 1. Correlation coefficients for the relationship between yield and SPAD meter readings and LCC readings at different growth stages during *Yala* 2013

Days after planting	Correlation coefficients for the relationship between SPAD meter reading and yield	Correlation coefficients for the relationship between LCC value and yield
25	0.769 *	0.215
39	0.902 *	0.952 *
53	0.912 *	0.783 *
67	0.977 *	0.972 *
84	0.998 *	0.504
99	0.979 *	0.621

Note: *significant at p = 0.05

Table 2. Correlation coefficients for the relationship between yield and SPAD meter readings and LCC readings at different growth stages during *Yala* 2014

Days after planting	Correlation coefficients for the relationship between SPAD meter reading and yield	Correlation coefficients for the relationship between LCC value and yield
29	0.537	0.802 *
42	0.853	0.297
72	0.506	0.489
103	0.859 *	0.923 *
119	0.776	0.967 *

*significant at p - 0.05

Relative yield of 72.9% and 84.4% were taken as the horizontal critical level beyond which no significant yield increase was observed in *Yala* 2013 and *Yala* 2014. According to the Cate and Nelson plot, SPAD meter readings of above 40 have to be maintained at 3-4 weeks after planting and SPAD meter readings of above 55 have to be maintained after 5 weeks. The plant develops its roots system at early growth stages after transplanting. Therefore, the nutrients cannot be intensively absorbed. Such difference was identified due to the sensitivity of the SPAD meter which was however not possible with LCC. Data revealed LCC value above four has to be maintained at all growth stages for chilli variety MI green. Therefore, critical level of leaf greenness determined by the rice LCC can be used for N management in chilli.

CONCLUSIONS

To anticipate a better yield, leaf greenness has to be maintained above the critical SPAD meter and critical LCC values. For chilli variety MI green, 40 is the critical SPAD value at three to four weeks after planting and 55 is the critical SPAD value after 5 weeks. At all other growth stages, four is the critical LCC value.

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