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263-9 Leaf Area Determination through Mathematical Models Based On Image Analysis

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INTRODUCTION

Total leaf area (TLA) is one of the most relevant features for estimating yield and productivity in horticultural plants. Direct methods used to estimate TLA cause damage to the plants and are time consuming. Indirect methods, such as image analysis, demand accuracy in the set up of the measurement procedure, which is sometimes difficult to achieve. Computer tools might be the solution in the search for new indirect and reliable approaches for producers and researchers.

OBJECTIVE

The aim of this work was to build mathematical models based on indirect measurements to estimate TLA in coffee plants. These indirect measurements were image analysis, light intensity and leaf area index (LAI) obtained via the LAI-2000 system. Total leaf area data obtained by using a destructive method (Li-3100c) were used as a reference.

MATERIALS AND METHODS

Coffee plants, cultivar Topazio, with a canopy ranging from 0.43 to 1.14 m height were used in the experiments performed at the Federal University of Lavras, Brazil. Two models were developed based on image analysis and on measurements of canopy height, width and their projected area. Also, a fisheye lens fitted to a digital camera was used to produce one image taken above the plant and another four taken from below, from which two other models were built. In addition, three other models were also developed via luximeter data measurements and via the LAI-2000 system.

Figure 1. Coffee tree images (a) actual image; (b) thresholded image.

RESULTS

Comparing the models, the results showed an R^2 of 0.94 for 30 plants for the projected area model, an R^2 of 0.82 for a plant height and width model and an R^2 of 0.83 for the fisheye lens model (above image). The results suggest that these models can be used to estimate TLA in coffee plants. The other models, based on the luximeter and on the LAI 2000, presented lower R^2 values, and further studies are necessary until they can be properly used.

Projection area (m2)

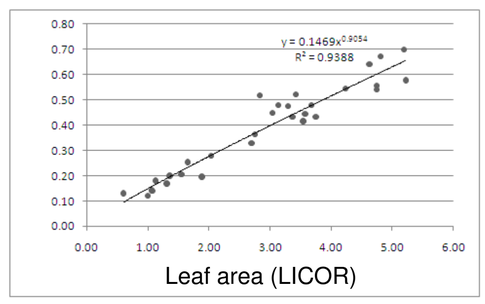

Figure 2 Projection area for 30 plants

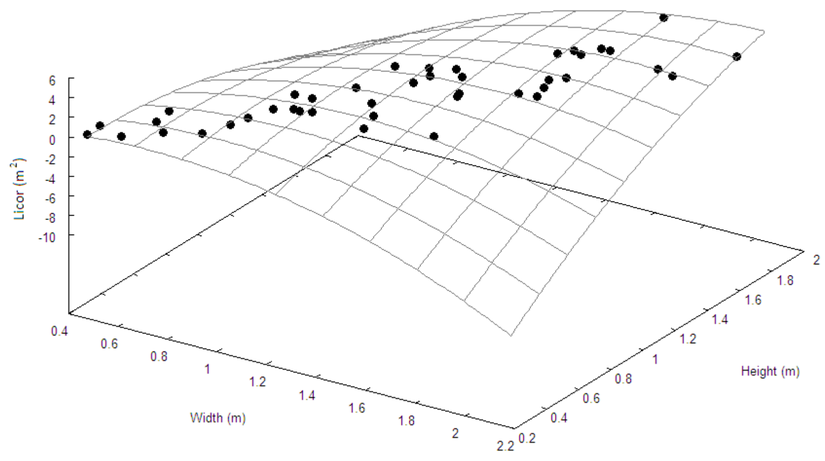

Figure 3. Model of height and width versus actual area

Top view area from fish eye (m2)

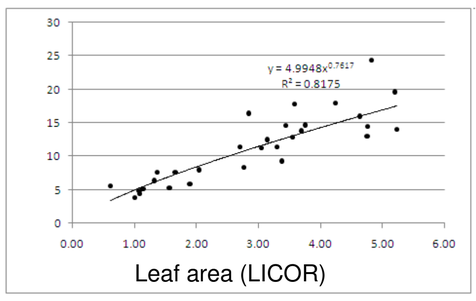

Figure 4. Top view area versus actual area

CONCLUSIONS

The optical models fitted well for leaf area prediction, showing a potential application to use of these methods in particular projection image and size values model.

REFERENCES

Ushada, M.; Murase, H.; Fukuda, H. Non-destructive sensing and its inverse model for canopy parameters using texture analysis and artificial neural network. Computers and Electronics in Agriculture, Davis, v. 57, p. 149-165, 2007.

Tavares-Junior, J. E.; Favarin, J. L.; Dourado-Neto, D.; Maia, A. H. N.; Fazuoli, L. C.; Bernardes, M.S. Análise comparativa de métodos de estimativa de área foliar em cafeeiro. Bragantia, Campinas v. 61, n. 2, p. 199-203, 2002.

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