INDIRECT METHODS FOR MEASURING OIL PALM LEAF AREA INDEX (LAI)

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One of the important parameters in crop growth is leaf area index (LAI). It represents the leafiness of the crop as measured by the ratio of leaf to ground surface area. This index is often used in radiation conversion efficiency models, and in modelling photosynthetic response of the canopy to incident light (Dufrene *et al.*, 1993). The available LAI data would now be one of the more important parameters to be included in the GIS mapping for the precision agriculture. However, accurate direct measurement of LAI is laborious and time consuming. According to the conventional method, LAI of oil palm is determined by the following formula:

LAI = frond number per palm x leaf area per frond x planting density / 10 000

where leaf area is based on vegetative measurements done on frond number 17.

As an alternative, various methods of measuring foliage area and foliage angles have been developed to facilitate LAI measurements. The LAI-2000 Plant Canopy Analyser (Li-Cor Incorporated, Lincoln, NE USA) is one such instrument developed to measure LAI. It uses a fish-eye light sensor that measures diffuse radiation simultaneously in five distinct angular bands about the zenith point (Welles, 1990). The amount of foliage in a vegetation canopy can be deduced from measurements of how quickly radiation is attenuated as it passes through the canopy.

MATERIALS AND METHODS

Measurements of LAI using the LAI-2000 Plant Canopy Analyser are made by positioning the optical sensor and pressing a button. Both above and below canopy readings are needed. The data are automatically logged and after readings taken, the control unit performs all the calculations and the results are available for immediate on-site inspection. The LAI is computed using a radiative transfer model. The two different techniques used to determine the LAI are as follows:

1. Measuring individual palms using the LAI-2000 (*Figure 1*), by taking one *above canopy* reading in the open area followed by four *under canopy* readings at half-frond length distance from the palm.

2. Measuring the whole palm canopy by following a zigzag pattern (*Figure 2*), by taking one *above canopy* measurement in the open space followed by four readings *under the canopy* (*Figures 3* and *4*) in between adjacent palms. The first reading was made at about half-frond length distance and the next three readings at 2 m intervals.

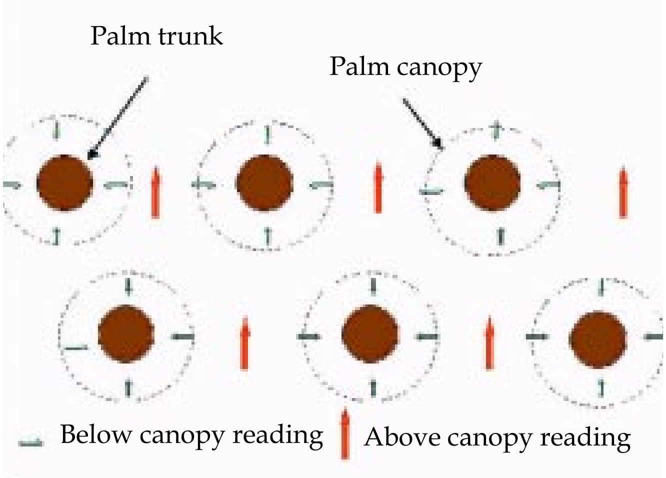

Figure 1. Single palm method.

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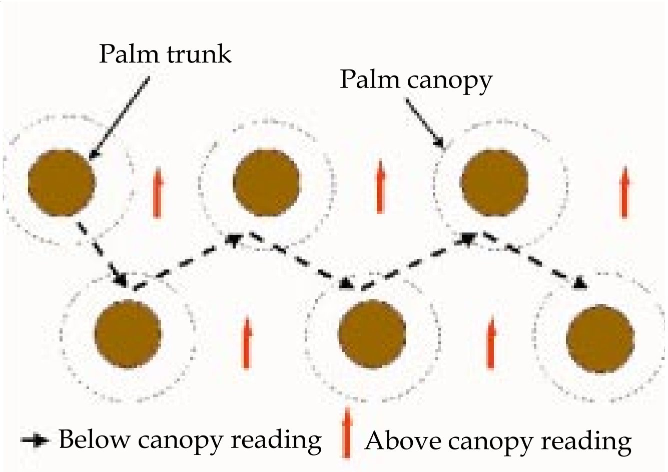


Figure 2. Zigzag pattern.

Figure 3. Above canopy *reading using the LAI-2000*.

Figure 4. Below canopy *reading using the LAI-2000.*

RESULTS

Measurements taken on a single palm from 28 plots at 6 palms plot^{-1} produced a mean LAI value of 2.19 ± 0.09. This value is expected for this five-year-old palms and is higher than that obtained using the zigzag pattern that gave a mean LAI value of only 1.71 ± 0.05. The conventional method gave a mean LAI of 2.18 ± 0.04 and was relatively close to the single palm measurement as shown in *Figure 5*. Henson (1992) reported that the LAI for three-year-old palms in a dry site was 1.523 and 1.935 for a wet site. Thus, these LAI values measured with five-year-old palms are acceptable. LAI is determined by many factors such as genotype, plant age, environment, management practices and cropping system. It is possible that the variation in LAI values between plots was due to different numbers of fronds and frond sizes. The single palm technique reflects the individual palm canopy and the zigzag pattern represents the total area. By measuring the LAI through inter-row transects, we are actually covering the spaces between palms. That is why the zigzag LAI values were lower than for the single palm technique. When Lamade and Setiyo (1996) measured LAI by using two Plant Canopy Analysers and five transects, there were eight measurements per transect taken. With 40 readings recorded, one reading every 2 min was considered rapid. However, the present method simplifies this further by taking the *above* and *below* canopy readings alternately.

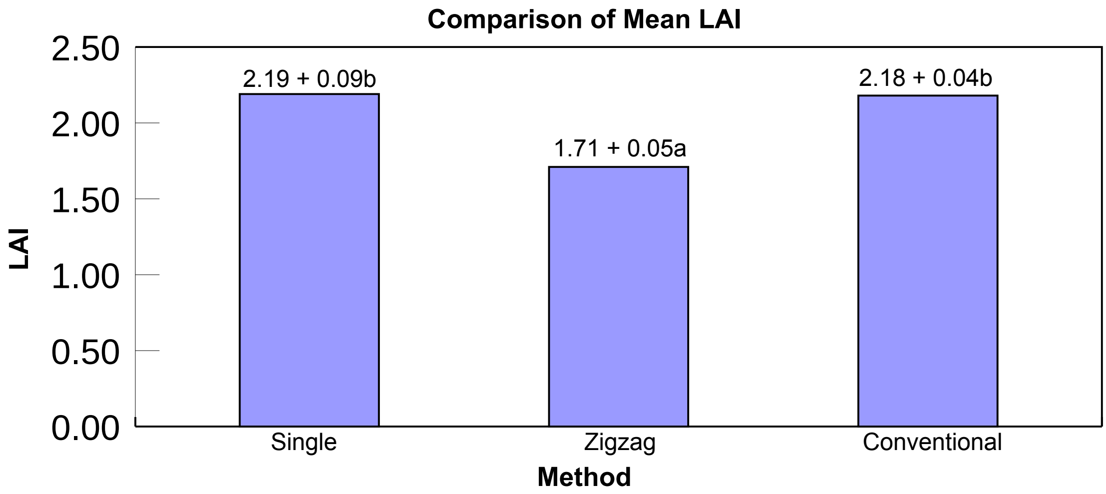
BENEFITS

Using the LAI-2000 has numerous benefits compared to the conventional method:

- it is a rapid method for measuring LAI for palm growth evaluation;
- it is non-destructive;
- it allows on-site evaluation of LAI data; and
- it saves labour.

CONCLUSION

LAI is one of the more important parameters measured in oil palm physiological studies. Since the present method in determining the LAI is laborious and time consuming, this alternative technique is deemed useful. The study here shows that it is possible to rapidly determine LAI using the LAI-2000 Plant Canopy Analyser. This rapid and non-destructive method saves labour compared to direct measurements.



Note: * mean values followed by the same alphabet are not significant at p<0.05.

Figure 5. LAI measurements using different techniques.

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