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AgriCulture Congress 2009

Tropical Agriculture in a Changing Climate and Energy Scenario

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Agriculture Congress 2009

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27 – 29 October 2009
Palace of the Golden Horses, Seri Kembangan
Selangor, Malaysia

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Published by
FACULTY OF AGRICULTURE
UNIVERSITI PUTRA MALAYSIA
43400 UPM SERDANG, SELANGOR

Perpustakaan Negara Malaysia Cataloging-in-Publication Data

Agriculture Congress – Tropical Agriculture in a Changing Climate and Energy Scenario (2009: Seri Kembangan)
Book of extended abstracts of AGRICONGRESS 2009
Palace of the Golden Horses, Selangor, Malaysia, 27 – 29 October 2009
Edited by Dzolkhifli Omar et al., 2009
ISBN 978-967-344-097-9

ISBN 978-967-344-097-9

9 789673 440979

Papers published in the proceedings have not been refereed. The responsibility of the content rests with the authors.

Printed by:
Polishines Enterprise

NON-DESTRUCTIVE ESTIMATION OF MAIZE LEAF AREA, FRESH WEIGHT, AND DRY WEIGHT USING LEAF LENGTH AND LEAF WIDTH

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EXTENDED ABSTRACT:

Leaf area (LA) plays an important role in plant growth analysis. LA and leaf weight measurements are required to calculate several growth indices, which are leaf area index (LAI), net assimilation rate (NAR), specific leaf area (SLA), specific leaf weight (SLW) and leaf area duration (LAD), (Gardner et al., 1985). There are various methodological approaches to measure the leaf area of plants. Direct leaf area measuring is usually time consuming and labour intensive. This measurement also damages the canopy. Leaf area can be estimated non-destructively by applying mathematical formulae, which require only simple measurements of leaf lamina. Serdar and Demirsoy (2006) developed a mathematical equation to estimate leaf area in chestnut by measuring leaf length and leaf width and calculated different combination of them. Montgomery (1911) as cited in (Mckee, 1964; Dwyer and Stewart, 1986; Pearce et al. 1975) reported a general equation to estimate individual leaf area on maize (Eq.1).

$$LA = L \times w \times A \qquad (1.1)$$

where LA, L, W and A are leaf area, leaf length, leaf maximum width and a constant (A= 0.75) respectively, but other researchers obtained A differ values between 0.72 to 0.79 such as 0.72 (Keting and Wafula,1992), 0.73 (Mckee, 1964; Dwyer and Stewart, 1986), 0.734 (Stewart and Dwyer, 1999), and 0.79 (Birch et al., 1998). Elings (2000) showed that if the total number of leaves of tropical maize and area of the largest leaf are known, total plant leaf area can also be estimated directly, making use of the facts that the area of the largest leaf relative to total plant leaf area is constant, and that this constant is linearly related to total leaf number. The objectives of this study were to develop equations to estimate leaf area (LA), leaf fresh weight (LFW) and leaf dry weight (LDW) of maize based on leaf length and width. The accuracies of the equations were tested on maize at various planting densities, plant growth stages and planting dates.

In order to evaluate non-destructive leaf area estimation for different planting dates, different planting densities and different plant growth stages on maize, all leaves from 144 plants (1314 leaves) were selected from an experiment that was conducted in Agricultural Research Center of (Golestan-Iran) (36° 53' N, 54° 21' E) in 2008. Planting dates were included 19 Apr, 4 May, 19 May and 3 June. Planting densities were included 45000, 65000 and 85000 plants ha-1and plant growth stages were included 5-leaf stage, 8-leaf stage, tassel appearance stage and grain filling stage. In each sampling, three plants were cut above ground. Leaf length and maximum leaf width in all leaves were measured manually, and leaf area of each leaf was measured using leaf area meter. Leaf fresh weight of each leaf was measured immediately after it was removed from the stalk and then dried to a constant weight at 75°C. The data from 855 leaves were used to fit the equations. A curve-fitting software called Table Curve 3D ® (version 4) (Systat, Inc, USA) was used to fit the best equation for estimation of leaf area, leaf fresh weight and leaf dry weight. To evaluate the accuracy of equations the data of the rest

of the 459 leaves were used. The validity of the models was tested by three goodness of fit indicators including Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and index of agreement (d). The proposed equations for estimating leaf area ,leaf fresh weight and leaf dry weight were: Ln(LA)= -0.99 + 1.231 Ln(L) + 0.855 Ln(W), R2=0.977; Ln(LFW) = -5.469 + 1.418 Ln(L) + 0.829 Ln(W), R2= 0.965; and Ln(LDW) = -8.704 + 1.171 Ln(L) + 2.079 Ln(W), R2= 0.87, where LA is leaf area, L leaf length, W leaf width, LFW leaf fresh weight and LDW leaf dry weight. To evaluate the equations some goodness of fit indicators includes mean absolutely error (MAE), root mean square error (RMSE) and index of agreement (d) were used. The values of RMSE, MAE, and d for LA were (35.6 (cm2), 26.1 (cm2), 0.934), respectively, for LFW (1.52 (g), 1.12 (g), 0.91) and for LDW (0.65 (g), 0.49 (g), 0.832) respectively. The result showed that the equations can estimate leaf area, leaf fresh weight and leaf dry weight with in strong agreement with the measured value; however leaf dry weight had a slightly lower agreement with the measured value.

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