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SHORT COMMUNICATION

PREDICTION OF LEAF AREA IN *PHASEOLUS VULGARIS* BY NON-DESTRUCTIVE METHOD

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Estimation of leaf area is an essential component of plant growth analysis and evapotranspirational studies. Leaf area is important for crop light interception and therefore has a large influence on growth (Boote et al., 1988), transpiration (Enoch and Hurd, 1979) and growth rate (Leith et al., 1986). Leaf area production is essential for energy transference and dry matter accumulation processes in crop canopies. It is also useful in the analysis of canopy architecture as it allows determination of leaf area index, which is important for light interception, radiation use efficiency, plant growth, etc. However, measurement of leaf area of all the leaves of any single plant is not only time consuming but also involves a large amount of labour. But, one cannot do away without measuring leaf area because estimation of leaf area is an essential part of plant growth analysis. Although many methods are available for leaf area measurements, the use of leaf area as a variable in plant growth analysis and physiological studies is limited owing to the time consuming and laborious methods involved in its measurement and though sophisticated electronic instruments provide accurate and fast leaf area measurement, is expensive especially in developing countries. Hence the need to develop economically cheaper and technically easier but sound method is needed for leaf area measurement (Korva and Forbes, 1997).

Montgomery (1911) first suggested that leaf area of a plant can be calculated from linear measurement of leaves using a general relationship $A = b \times I \times W$ where b is a coefficient. Such a mathematical equation for estimating leaf area reduces sampling effort and cost, may increase precision where sample of leaf size are difficult to handle. There are a number of prediction equations for leaf area measurement of several crops such as jute (Chaudhuri and Patra, 1972), cotton (Ashely et al., 1963), Blackgram (Balakrishnan et al., 1987), soybean (Wiersma and Bailey, 1975), frenchbean (Rat et al. 1988), pearl millet (Chanda et al., 1985), sunflower (Chanda and Singh, 1997), ramie

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(Sarkar and Maitra, 2001), wheat (Chanda and Singh, 2003), etc. However, there is no prediction equation for *Phaseolus vulgaris* for estimation of leaf area through non-destructive method. Therefore, in the present investigation an attempt has been made to develop a prediction equation which is simple, accurate and time saving method of leaf area determination in *Phaseolus vulgaris.*

The experiment was conducted at Rajkot, Gujarat, India in 2002. Rajkot is situated at N 20°58' to 23°08' latitude and N 70°20' to 70°40' longitude. The ecoclimate of Rajkot is arid to marginal semiarid. The present investigation was carried out in a green house on the black cotton soil (vertisol) which is usually found in agricultural fields in the western region of Gujarat. Certified seeds of *Phaseolus vulgaris* (L) were purchased locally. Three different salts viz, NaCl, KCl and Na_2SO_4 were used for imposing salinity. A number of concentrations of each salt were taken and their effect on seedling growth was studied in the pilot experiment. Finally, three concentrations were selected i.e. Treatment 1 (T1) = 0.2%, Treatment 2 (T2) = 0.5%, Treatment 3 (T3) = 1% for our study. T3 was harmful for the plants when the salts were NaCl or KCl; beyond this concentration plants did not survive. Therefore only two concentrations were used in these two salts. But in case of Na_2SO_4 plants were able to survive in T3 concentration also. The plants where no salt was added served as control.

For each treatment hundred polythene bags were taken and filled with 4 kg of black fertile soil. They were divided into 3–4 sets. One set comprised of control, while the others three sets were of T1, T2 and T3 treatment of each salt. Seven-Eight seeds were sown in each bag at a depth of 5–10mm., immediately after sowing, soils were watered with water or salts solutions. And there after simple tap water was added as and when required. Seedlings germinated within two days, after sowing. Sampling started from seventh day and continued up to maturity

Sampling was done at an interval of 7 days and on each sampling day, 3 bags (of control and treatment) were harvested and about 15–16 plants were harvested in each concentration of each treatment and brought to the laboratory. The plants parts were separated into root, hypocotyl and leaves. All the organs were separately oven dried at 65° to constant weight for dry weight measurement. The length of root and shoot was measured to nearest cm. The length and maximum width of all leaves was also measured. The outline of all the leaves from each plant was traced out on a graph paper which had a uniform distribution with area. The leaf shape was cut out from the graph paper and the copies were weighted, the leaf area was then gravimetrically evaluated.

Correlations coefficients for the gravimetrically determined leaf area per plant and for the dependant variables L, W, their squares (L^2 and W^2), sums of length and width (L+W) and the products of length and width (LW) were calculated for each salt treatment and together (Table 1). As a measure of fit of the regression equation, the coefficient of determination (R^2) defined as the ratio of the sum of the squares due to regression and the total sum of squares, had been considered. Regression model with

highest R^2 value was considered as best prediction equation (Abraham and Ledolter, 1983).

Table 1 Correlation coefficients r between L (length), W (width), L^2, W^2, L+W and LW of leaves and the total area per plant. All r values were significant at p<1%.

Treatment	L	W	LW	L^2	W^2	L+W	No. of observations
NaCI	0.764	0.755	0.810	0.755	0.829	0.776	126
KCI	0.916	0.903	0.927	0.903	0.914	0.922	230
Na_2SO_4	0.760	0.889	0.884	0.625	0.860	0.856	234
All together	0.82	0.86	0.87	0.74	0.86	0.86	590

In all cases correlation coefficients were significant at 1% level. The best correlation existed with L+W and with LW. The data on LW and L+W of all leaves and total leaf area per plant of all the three treatments were fitted separately and together to a linear regression equation Y = a + bx, where y represents the leaf area (Y) and x either LW or L+W (Table 2).

Table 2 Relationships between product of length and width (LW) and sum of length and width (L+W) and total leaf area per plant

Treatment	Regression equation	Standard error
NaCI	Y= 11.01 + 0.07LW	0.004
	Y = –2.65 + 1.06(L+W)	0.077
KCI	Y =10.92 + 0.56 LW	0.001
	Y = –1.36 + 0.90 (L+WJ	0.250
Na_2SO_4	Y = 12.10 + 0.05 LW	0.002
	Y =1.60 + 0.81 [L+W)	0.032
All together	Y = 11.98 + 0.06 LW	0.001
	Y = 0.11 +0.88(L+W)	0.022

The slopes (b) of the regression equation did not revel any significant difference amongst individual treatments when the independent variable was L+B. Using L+W, the Y-intercept (a) was not significantly different from 0. Hence the leaf area per plant may be calculated by the equation y=0.88(L+W). Further “t” test was performed to assess the significant difference, if any, between the calculated leaf area (using the above equation) and the gravimetrically determined leaf area, and it was found non-significant on all harvest dates. Hence this equation can be used to estimate leaf area in *Phaseolus vulgaris.*

There are many reports which suggest calculation of leaf area from leaf dry weight data (Sharrett and Baker, 1985; Ma et al., 1992) since these two parameters showed significant linear correlation. However, Marshall (1968) suggested that this relationship changes during plant growth and along with changes in environmental conditions. Studies of Chanda et al. (1995) support this conclusion. In the present study also leaf area and leaf dry weight values of all three sets of experimental data were fitted to a linear regression analysis separately as well as combined data but it did not shows significant correlation and hence leaf dry weight cannot be substituted for leaf area.

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