SHORT NOTE

Estimating individual leaf area of potato from leaf length

By D. M. FIRMAN

Department of Applied Biology, University of Cambridge, Pembroke Street, Cambridge CB2 3DX

and E. J. ALLEN

Cambridge University Farm, Huntingdon Road, Cambridge

(*Received 28 November 1988*)

Measurements of the area of individual leaves in crops are useful in the analysis of canopy architecture as they allow determination of the structure of leaf area index in a vertical profile. This information may be of use in modelling leaf growth and the assessment of photosynthetic potential of different strata of the canopy with ontogeny (cf. Firman & Allen, 1988).

Leaf area measurement by photography or light-sensitive meters usually involves destructive measurement and is often fairly time consuming. Crude estimates of the area of potato leaves can be obtained by comparison with standard leaves of known area (e.g. Bald, 1943) but Epstein & Robinson (1965) found that the area of compound leaves was closely related to leaf length and a simple log–log transformation improved the relationship. Epstein & Robinson found that the relationship differed only slightly for a range of varieties and between field and glasshouse-grown plants. In the study reported here the relationship between leaf length and area in six contrasting varieties of potato grown with different amounts of nitrogen fertilizer was investigated to determine whether leaf length could be used as a predictor of leaf area over a wide range of agronomic treatments.

MATERIALS AND METHODS

Two experiments were carried out on the Cambridge University Farm in 1986. Treatments comprised all combinations of three rates of N, 0, 90 or 180 kg/ha, and two (Expt 1) or six (Expt 2) varieties. The varieties in Expt 1 were Estima and Pentland Crown, with the additional varieties Pentland Dell, Diana, Cara and Maris Piper in Expt 2. Fertilizer at the rates of 109 kg P, 207 kg K and 60 kg Mg/ha and N according to the treatments was applied by hand over the open ridges at planting. Observations were made on one plant in each of two randomized blocks for all treatment combinations (Expt 1) or plots with 90 kg N/ha only (Expt 2). The 10 most apical leaves (longer than 20 mm) were removed and the length of the compound leaf excluding the petiole was measured before measurement of the area with a leaf area meter (Lambda LI3000).

For each plant linear regressions of leaf length (cm) against leaf area (cm^2) and $\log_{10}$ (length) against $\log_{10}$ (area) were calculated and the derived slopes and constants compared by analysis of variance for treatment differences. The goodness of fit as indicated by the percentage variance accounted for (r^2 adjusted) by each regression was also computed.

RESULTS AND DISCUSSION

The relationship between leaf length and area was close fitting and improved by the log–log transformation used by Epstein & Robinson (1965), although the results could not be compared directly with those of Epstein & Robinson as their measurement of leaf length included the petiole. The mean percentage variance accounted for by regression with the transformed data was 97·6 for Expt 1, 97·8 for Expt 2 and no lower than 92·9 for any plant. This was consistently higher than for the untransformed data for which the mean percentage variance accounted for was 93·3 for Expt 1 and 88·3 for Expt 2. The relationship was not affected by N fertilizer (Table 1) despite the production of larger leaves with increasing N application and only small differences were found between varieties; Pentland Crown had a lower slope and constant than other varieties in Expt 2 (Table 1). Combining all data from both experiments a general relationship was derived: $\log_{10}$ (leaf area in cm^2) = $2·06 \times \log_{10}$ (leaf length in cm) $- 0·458$ (Fig. 1). The small number of leaves less than 30 mm long do not fit this relationship well, which suggests that these incompletely unfolded leaves have a different shape.

Table 1. *Parameters of regression equations of* log_{10} *(length) against* log_{10} *(area)*

	Variety	N (kg/ha)	Slope	Constant
Expt 1	Estima	0	1·971	−0·341
		90	2·119	−0·426
		180	2·114	−0·442
	Pentland Crown	0	2·044	−0·460
		90	1·831	−0·257
		180	1·856	−0·232
S.E.			0·0781	0·0671
Expt 2	Estima	90	2·483	−0·857
	Pentland Crown	90	1·828	−0·251
	Diana	90	2·105	−0·467
	Pentland Dell	90	2·149	−0.562
	Maris Piper	90	2·253	−0·715
	Cara	90	2·018	−0·463
S.E.			0·0731	0·0664

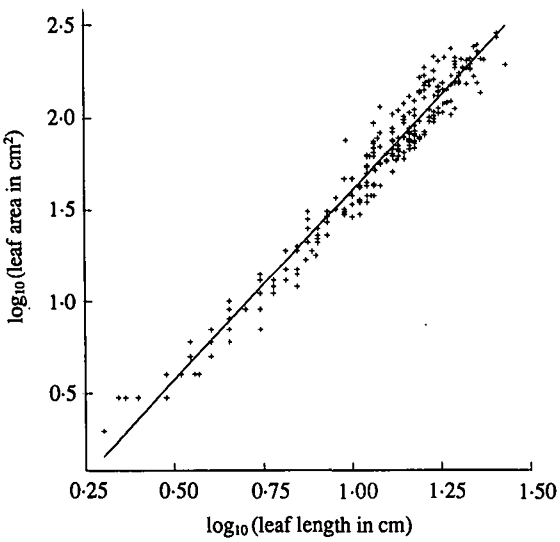

Fig. 1. Relationship between log_{10} (leaf length) and log_{10} (leaf area) for combined data from Expts 1 and 2. Solid line $y = 2·06x - 0·458$; r^2 adjusted 0·962.

Use of this general equation to estimate leaf area would give rise to little systematic error for a range of varieties, and allow measurements of leaf length from potato plants to be readily obtained for use in modelling vertical patterns of leaf area development and be of use in assessment of photosynthetic productivity at different levels in the canopy.

The financial support by Cambridge University Potato Growers Research Association for this work in the form of a research grant to D. M. Firman is much appreciated.

REFERENCES

Bald, J. D. (1943). Estimation of the leaf area of potato plants for pathological studies. *Phytopathology* **33**, 922–932.

Epstein, E. & Robinson, R. R. (1965). A rapid method for determining leaf area of potato plants. *Agronomy Journal* **57**, 515–516.

Firman, D. M. & Allen, E. J. (1988). Field measurements of the photosynthetic rate of potatoes grown with different amounts of nitrogen fertilizer. *Journal of Agricultural Science, Cambridge* **111**, 85–90.