# Use of Linear Measurements in the Estimation of Leaf area in some Varieties of Apple

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The leaf (constant) factor 'K' of twelve apple varieties was calculated. The difference between observed and estimated leaf area was less than 0.50 per cent in all the varieties. The observed leaf area was highly correlated with estimated leaf area. Hence, the leaf area of apple varieties can be calculated by obtaining the product of leaf length breadth and 'K' factor. The 'K' factor varied with the varieties. However, the 'K' factor for apples can be taken as 0.744.

Leaf area, a component of yield has a direct bearing on the quantitative and qualitative characters of yield. Hence, simple method to estimate the total leaf area of a plant accurately will help to predict the yield. Length and breadth of leaves multiplied by a constant has been successfully used by some workers. Montgomery (1911) was one of the earliest workers who determined leaf area in maize by this method. Lal and Mehrotra (1950) and Lal and Rao (1950 and 1951) used linear measurements with slight modifications to find out the leaf area in graminaceous plants. Spencer (1962) and Vivekanandan *et al.* (1972) tried different methods and found linear measurements of leaf as the most reliable method. In some fruits such as peach, plum, pear and apricots, linear measurements were successfully used to estimate the leaf area by Ramkumar *et al.* (1977). Regression on the product of the length and breadth of the leaves was used by Garg and Mandahar (1972) in tomato and Ackley *et al.* (1958) in strawberry, raspberry and beans. However, no information is available with regard to apple varieties under South Indian conditions where chilling requirement of apples was not adequate and the growth and productivity differ from other apple growing regions.

## MATERIAL AND METHODS

Twelve varieties of apple viz. Kodaikanal-1, Irish Peach Parlin's Beauty, Winter Banana, Giant Jeniton Zouche's Pippin, Winterstein, Coonoor-3, Corrington, Israel Type II, Delicious and Tropical Beauty consituted the material for this study. Four trees of uniform age and vigour in each variety were selected and 400 leaves per tree were collected at random from all the sides during May 79 from the current season growth. The leaves collected were fully emerged and recently matured. From the above sample, forty leaves per variety were randomly drawn and observations were recorded. The length was measured from the tip of the leaf to the juncture with the petiole and width from the middle of lamina

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where it was maximum. The individual leaf surface was traced on graph paper carefully to determine the actual leaf area. The formula used for calculating the leaf area was $A2 = \leq L \times B \times KN$ where, $A2 =$ Leaf area $(L \times B \times K)$, $L =$ sum of length of leaves, $\leq B =$ sum of breadth of leaves, $K =$ leaf factor constant, $N =$ number of leaves.

The leaf area 'K' factor was determined as per the method described by Lal and Mehrotra (1950) and Lal and Rao (1950 , 1951). The correlations between leaf area and its components were also worked out.

## RESULTS AND DISCUSSION

The leaf size, leaf area, 'K' factor and per cent difference in the leaf area are presented in table 1. A perusal of the above table indicated that breadth: length ratio in all the varieties under study was not uniform suggesting length and breadth of leaves vary highly form variety to variety. This ratio was high in Israel Type II (1:1.77) whereas it was lowest in Delicious (1: 1.31) and others were intermediate. In general, the length of leaves in all the varieties were comparatively higher than the breadth showing the oblong shape of leaves. The product of leaf length and breadth ranged from 40. 16 Sq. cm (Irish Peach) to 69.05 Sq. cm (Tropical Beauty). As regards the 'K' value, Giant Jeniton recorded the maximum value (0.850) while Winterstein registered the minimum value (0.640). It is interesting to note that the variety which recorded the highest observed or estimated leaf area did not have the highest 'K' value and vice-

versa. When the estimated leaf area (ie: $L \times B \times K$) was compared with the observed area of all the above varieties, it showed that all the varieties gave a difference of less than 0.47%. The maximum difference in percentage was with the variety Giant Jeniton (0.47%) whereas the minimum was with the four varieties viz., Irish Peach, Zouche's Pippin, Winterstein and Israel Type II with a difference of 0.03% only. It is, therefore, obvious that the leaf factor 'K' for all the varieties mentioned in table I can be separately used for calculating the actual leaf area, as the difference is negligible which was less than 1.00 per cent. This result was in conformity with the findings of Ramkumar *et al.* (1977) in temperate fruits like apricot, peach, plum and pear varieties.

The extent of association between the components of leaf area and the leaf area was worked out and Presented in Table II. The mean length of leaf as well as mean breadth of leaf are significantly correlated with leaf area Similarly, total leaf length and total leaf breadth are also significantly associated with total leaf area, suggesting the length and breadth of the leaf made significant contribution to the leaf area. However, the product of leaf length and breadth registered a low correlation when compared to the length or breadth of the leaf to the leaf area. Singh and Ganapathy (1975) reported in passion fruit that the product of leaf length and breadth can be used as such to determine the leaf area since its association with leaf area was very high. The correlation coefficients between 'K'

factor with total leaf area or the mean leaf area showed less association indicating that the length and breadth of leaf were more important than the leaf factor. The nature of relationship between the 'K' factor and leaf area was further analysed by the procedure suggested by Kendall (1955) with a view to measure the degree of concordance between them. It is very low, suggesting very little association between the leaf area and 'K' factor. However, the rank correlation between the observed leaf area and estimated leaf area showed a strong association highlighting that the product of length, breadth and 'K' factor could be the most reliable index for estimating the leaf area.

The formula for leaf area viz, $A = L \times B \times K$ was also tested for direct determination of total leaf area without calculating the individual leaf area as suggested by Lal and Rao (1950) as under:

$Log \lesssim A = Log \lesssim L + Log \lesssim B +$ Log K-Log N where, $\lesssim A =$ Total leaf area, $\lesssim L =$ Total leaf length, $\lesssim B =$ Total leaf breadth, K= factor for individeal variety and N=number of leaves sampled. The leaf area estimated by this formula was compared with the observed leaf area and presented in Table III. It was found that the difference in percentage between observed and estimated leaf area was very negligible, the maximum being only 0.47 per cent in the Giant Jeniton. Thus, the difference is well with in the experimental error allowed for biological measurements. Singh and Gana-

pathy (1975) corroborated this view in their studies on passion fruit.

In general, for applies the leaf factor constant varies considerable from one variety to another but it was specific for each variety. Hence, leaf area can be accurately calculated using the product of length, breadth and 'K' factor for individual varieties.

## REFERENCES

ACKLEY, W. B., P. C. GRANDALL and T. S. RUSSELL. 1958. The use of linear measurements in estimating leaf area *Proc. Amer. Sco. Hort. Sci.*, 72: 326-30.

GARG, I. D. and C. L. MANDAHAR. 1972. Note on the measurement of leaf area in tomato (*Lycopersicon esculentum* Mill.) plants from linear parameter, *Indian J. Agric. Sci.*, 42: 958 9.

KENDALL, M. G. 1955. *Rank correlation Methods*. Charles Griffin, London.

LAL, K. N. and O. M. MEHROTRA, 1950. Interrelation between leaf area, leaf indices and drought resistance in sugarcane. *Proc. Ind. Acad. Sci.*, 32: 252-66.

LAL, K. N. and M.S. SUBBA RAO. 1951. A rapid method of leaf area determination, *Nature*. 13: 167-72.

MONTGOMERY, E. C. 1911. Correlation studies of corn. 24th *Ann. Rep. Nebrask Agri. Expt. ta.* 111-59.

RAMKUMAR, R. P. SRIVASTAVA, A. K. SINGH and D. S. BANE.1977. Use of linear meaurement in the estimation of leaf area of some apricot, peach, plum, pear and guava varieties. *Indian J. Hort.* 34 : 229-36.

SINGH, H. P. and K. M. GANAPATHY, 1975 Rapid determination of leaf area in passion fruit using linear measurement. *Prog. Hort.*, 7: 23-6.

SPENCER, R. 1962. A rapid method for estimating the leaf area of cassava *Manihot utilissima* Pahl.) using liner measurement. *Trop. Agric.*, 39: 147-52.

VIVEKANANDAN. A. S., H. P. M. GUNASENA and T. SIVANAYAGAM. 1972. Statistical evaluation of the accuracy of three techniques used in the estimation of leaf area of crop plants. *Indian J. agric. Sci.* 42 : 857-60

Table 1. Mean values of size, leaf area, 'K' and percentage difference in the leaf area of apple varieties.

| Name of the variety | Leaf size | | B : L ratio | L + B (sq cm) | Mean values for | | | |
|---|---|---|---|---|---|---|---|---|
| | Length (L) (cm) | Breadth (B) (cm) | | | Observed area (sq cm) | Value of 'K' | Estimated leaf area (sq cm) | Difference (%) |
| Kodikanal-1 | 9.55 | 6.07 | 1:1.57 | 57.97 | 45.17 | 0.779 | 45.12 | 0.11 |
| Irish Peach | 8.08 | 4.97 | 1:1.63 | 40.16 | 30.38 | 0.756 | 30.37 | 0.03 |
| Parlin's Beauty | 9.24 | 5.90 | 1:1.57 | 54.52 | 44.63 | 0.817 | 44.52 | 0.25 |
| Winter Banana | 9.83 | 6.06 | 1:1.62 | 59.57 | 45.34 | 0.761 | 45.36 | 0.04 |
| Giant Jeniton | 8.71 | 5.46 | 1:1.60 | 47.56 | 40.42 | 0.850 | 44.61 | 0.47 |
| Zouche's Pippin | 6.84 | 5.90 | 1:1.59 | 40.36 | 31.67 | 0.785 | 31.66 | 0.03 |
| Winterstein | 8.67 | 6.08 | 1:1.43 | 52.71 | 33.74 | 0.640 | 33.78 | 0.03 |
| Coonoor-3 | 8.98 | 5.33 | 1:1.68 | 47.86 | 32.51 | 0.679 | 32.46 | 0.15 |
| Carrington | 8.35 | 5.04 | 1:1.66 | 42.08 | 31.23 | 0.742 | 31.20 | 0.10 |
| Israel Type II | 8.84 | 5.00 | 1:1.77 | 44.20 | 33.93 | 0.768 | 33.92 | 0.03 |
| Delicious | 9.37 | 7.17 | 1:1.31 | 67.18 | 48.11 | 0.716 | 48.09 | 0.04 |
| Tropical Beauty | 10.08 | 6.85 | 1:1.47 | 69.05 | 46.23 | 0.670 | 46.26 | 0.06 |

Table 2   Association between leaf area and its components

| Components of leaf area | Correlation coefficient (r) |
|---|---|
| Mean length of leaf | 0.7634** |
| Mean breadth of leaf | 0.7663** |
| Product of length and breadth of leaf | 0.5024 |
| 'K' factor | 0.1517 |
| Total leaf length (with total leaf area) | 0.8298** |
| Total leaf breadth (with total leaf area) | 0.8535** |
| 'K' factor (with total leaf area) | —0.3043 |
| Rank correlation between estimated leaf area and observed leaf area (rs) | 0.9998** |
| Kenall's Rank correlation (J) between 'K' factor and leaf area | —0.0303 |

Table 3   Comparison of observed anb estimated total leaf area of apple varieties.

| Variety | Observed total leaf area (sq. cm) | Estimated total leaf area (sq. cm) | Difference (%) |
|---|---|---|---|
| Kodaikanal | 1806.6 | 1808 | 0.08 |
| Irish Peach | 1215.2 | 1214 | 0.96 |
| Parlin's Beauty | 1785.3 | 1781 | 0.24 |
| Winter Banana | 1813.6 | 1813 | 0.03 |
| Giant Ueniton | 1616.0 | 1610 | 0.42 |
| Zouche's Pippin | 1266.7 | 1267 | 0.02 |
| Winterstein | 1349.5 | 1345 | 0.26 |
| Coonoor-3 | 1300.2 | 1298 | 0.17 |
| Carrington | 1249.3 | 1247 | 0.18 |
| Israel Type II | 1357.3 | 1357 | 0.02 |
| Delicious | 1924.4 | 1921 | 0.18 |
| Tropical Beauty | 1849.0 | 1850 | 0.05 |