ASSET Series A (2007) 7 (1): 152-158

ASSET
An International Journal

RAPID LEAF AREA MEASUREMENT METHOD FOR QUEEN OF THE PHILIPPINES (*Mussaenda Philippica* A. RICH)

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ABSTRACT

Leaf area measurement of white and pink varieties of Queen of the Philippines (*Mussaenda philippica*) was carried out using non-destructive and destructive methods in the year 2002 at the University of Agriculture, Abeokuta. Leaf samples were randomly selected from the lower, middle and upper parts of the plant. Leaf length, width, product of length and width, and leaf-dry weight were assessed statistically and compared with the actual leaf area measured by graph tracing method, to test their accuracy and reliability using Y= a+bX, and Y= bX models. There was a highly significant correlation between actual leaf area and the corresponding leaf length, width, length x width and dry weight and a higher degree of accuracy with Y = a+bX than Y = bX in either white or pink variety and the combined analysis of data on both varieties. However, the correlation between actual leaf area and the product of length and width was not significantly different using both models for white or pink variety. It was concluded that model Y = a+bX was more accurate and reliable to determine the leaf area of Queen of the Philippines (*Mussaenda philippica*) than Y = bX and therefore would be very useful for field workers dealing with large samples.

Key words: Leaf area, leaf length, width, leaf-dry weight, *Mussaenda philippica*

INTRODCUTION

Queen of the Philippines (*Mussaenda philippica* A Rich) is a tropical ornamental plant belonging to the Rubiaceae family and cultivated for its showy habit, colourful scarlet, white or pink sepals and yellow petals (Rosario, 1984). It is a bushy shrub growing up to 2.00m and 3.00m for white and pink varieties respectively and both varieties are similar in morphology and ecology, but differ in physiology (Sharma et al., 1990). It is generally planted for its elegance as shrubbery borders or grown as a specimen or focal plant. It flowers luxuriantly for most part of the year and has proved to be the most popular flowering shrub in the warm humid region (Bose, 1981). The medical uses of leaves, flowers and roots of Queen of the Philippines (*Mussaenda philippica*) for various ailments have been reported in Ghana, Liberia, Sierra-Leone and China (Dalziel, 1957; Liu et al., 1986), but it is mainly used as ornamental plant. Ornamental plants are widely grown for their beauty in form of radiant and showy appearance.

The different methods used to determine leaf area of plants include using a planimeter (Nautiyal et al., 1990), tracing out on graph sheet (graph method), measuring of weight of leaves, length of midrib or width, and multiplying leaf length by width (Wahua, 1985; Aiyelaagbe and Fawusi, 1988; Aiyelaagbe, 1990; Montero et al., 2000). Based on the relationship between the actual leaf area and the corresponding length of midrib, width or leaf-dry weight or product of length and width, formulae for rapid determination of leaf had been suggested for Okra (Asif, 1977); Watermelon (Oseni and Fawusi, 1984); Pawpaw (Aiyelaagbe and Fawusi, 1988); Guava (Aiyelaagbe, 1990) and Pumpkin (Salau and Olasantan,, 2004).

The importance of rapid non-destructive and accurate measurement of leaf area in agronomic and physiological studies is well known, but a search of literature reveals scanty information for Queen of the Philippines. This study was undertaken to derive a formula for rapid estimation of leaf area of Queen of the Philippines (*Mussaenda philippica*) using non-destructive and destructive sampling methods.

MATERIALS AND METHODS

The study was conducted in the year 2002 at the University of Agriculture, Abeokuta (7^0 15' N, 3^0 25' E) Ogun State. Two methods, non-destructive and destructive methods of leaf area estimation were used. For measuring the leaf area, 58 mature, fully expanded, healthy leaves from each variety were randomly selected from the lower, middle and upper parts of the plant. A total of 116 leaves were used for the combined analysis to examine the possibility of evolving a single equation for both varieties. In the non-destructive method, the length of midrib, the width and the product of length and width of each of 116 leaves were determined while for the destructive method, the leaf areas of the whole 116 leaves were estimated by graph paper tracing. The corresponding leaf dry weights were obtained after oven drying at 70^0 C for 36hrs and weighed. The actual leaf area (LA) was then regressed on their linear measurements (length of midrib, leaf length and width) and leaf dry weight values to determine their reliability and to estimate their differences from the actual leaf area. Leaf dry weight values were also regressed on their leaf length and width. Two linear regression models Y = bX, and Y = a+bX were proposed for regression analysis. Y represents actual leaf area (cm^2) while X stands for leaf length, maximum leaf width or the product of length and width (cm). Dry weights (g) of leaves were used as single variable in the regression analysis. Statistical analysis for the comparison of the two models was determined as described by Wahua (1999).

RESULTS

The relationship between leaf area and the corresponding length of midrib, leaf width and the product of leaf length and width of white and pink varieties of Queen of the Philippines (*Mussaenda philippica*) and in combined analysis is presented in Table 1. In white variety, there was a highly significant positive correlation between actual leaf area and length of midrib, or leaf width using Y = a + bX, accounting for 91 and 96%, respectively, while 84 and 90%respectively, of the total variability in the leaf area was obtained when Y = bX was used. Similarly, significant correlation was obtained between LA and leaf length and width, described by either Y = a + bX (94 and 89%) respectively, or Y = bX which accounted for 89% and 83%, respectively, of the total variability in the leaf area of pink variety of Queen of the Philippines (*Mussaenda philippica*). However, the correlation between LA and the product of leaf length and width using both models was not significant in both varieties. The regression analysis for combined data of both varieties showed a highly significant correlation between LA and leaf length, width or product of leaf length and width as described by Y = a+bX, which accounted for 89, 93 and 94% of the total variability in the leaf area (Table 1).

Table 2 shows the analysis of variance for the comparison of the two models. There was a highly significant correlation between leaf area and length of midrib, width and leaf-dry weight using equation Y = a+bX, giving (r=0.91, 0.96 and 0.96) and (r=0.94, 0.89 and 0.95), for white and pink varieties of Queen of the Philippines (*Mussaenda philippica*), respectively. The correlation coefficient between leaf area and leaf length, width and leaf dry weight using linear equation Y = bX was 0.84, 0.90 and 0.91 for white variety and 0.89, .83 and 0.93 for pink variety. However, the models were not significantly different for the relationship between leaf area and the product leaf length and width in both varieties. The results of combined analysis of both varieties to have a single equation to estimate their leaf area indicated that linear model Y = a+bX had greater r values (0.89, 0.93, 0.94, 0.80) than model Y = bX (where: r=0.087, 0.86, 0.93 and 0.68) for the leaf area and the corresponding length of midrib, leaf width, length and width and leaf dry weight in the order of arrangement.

The result of comparison of leaf area estimated by the linear models Y = a+bX, and Y = bX with the actual leaf area as determined by the graph paper tracing method is presented in Table 3. Except for the product of leaf length and width, model Y = a+bX gave accurate estimation of the leaf area of Queen of the Philippines (*Mussaenda philippica*) compared to Y = bX which either over and or under estimated the leaf area. The results shows that the two models were different and that model Y = a+bX is more appropriate when leaf length, width or leaf-dry weight is used to determine leaf area of Queen of the Philippines (*Mussaenda philippica*) than linear model Y = bX.

DISCUSSION

The models were not significantly different for the relationship between leaf area and the product of leaf length and width, indicating that either of the two models is appropriate when product of length and width is used to determine leaf area of Queen of the Philippines (*Mussaenda philippica*). However, using a single formula to estimate the true leaf area of both varieties as obtained in the combined analysis shows that linear model Y = a+bX is better than model Y = bX. The model, Y = a+bX, therefore fit leaf area estimation of Queen of the Philippines (*Mussaenda philippica*) better than Y = bX. Linear regression model (Y = a+bX) has been found to be more accurate in the leaf area determination of Watermelon (Citrullus lanatus (Thunb) Mansf) by Oseni and Fawusi (1984), Melon (Colocynthis vulgaris) by Wahua (1985), Pawpaw (Carica papaya) by Aiyelaagbe and Fawusi (1988), Guava (Psidium gajava) by Aiyelaagbe (1990) and Pumpkin (Cucurbita maxima) by Salau and

ISSN 1595—9694 © UNAAB 2003

Table 1: Coefficients of correlation (r) and determination (r^2) between leaf area (LA), length of midrib (L) width (W), length X width (LXW) and leaf dry weight (LDW) of white and pink varieties of *Mussaenda philippica*

Variable Pair	Model 1 (Y=bX) Regression Equation	r^2	r	Model 2 (Y=a+bX) Regression Equation	r^2	r
White						
LAXL	Y=4.54X	0.70	0.84	Y= -29.36+7.22X	0.82	0.91
LAXW	Y=8.29X	0.79	0.90	Y= -31.14+13.46X	0.92	0.96
LAXLXW	Y=0.737X	0.94	0.97	Y= 2.64+0.70X	0.94	0.97
LAXLDW	Y=144.3X	0.83	0.91	Y= 11.43+113.19X	0.92	0.96
(b) Pink						
LAXL	Y=4.24X	0.79	0.89	Y= -26.72+6.15X	0.88	0.94
LAXW	Y=8.98X	0.68	0.83	Y= -33.45+14.10X	0.79	0.89
LAXLXW	Y=0.639X	0.94	0.97	Y=1.32+0.612X	0.94	0.97
LAXLDW	Y=218.13X	0.87	0.93	Y=8.61+187.02X	0.89	0.95
(a&b) Combined						
LAXL	Y=4.35X	0.76	0.87	Y=-15.72+5.59X	0.80	0.89
LAXW	Y=8.66X	0.74	0.86	Y=-33.004+13.92X	0.87	0.93
LAXLXW	Y=0.672X	0.87	0.93	Y=7.25+0.59X	0.88	0.94
LAXLDW	Y=172.68X	0.47	0.68	Y=18.95+115.40X	0.63	0.80

Table 2: Analysis of variance for the comparison of the two models

Source of Variation	D.F	LAXL	LAXW	LAXLXW	LAXLDW
(a) White					
Mean (M)	1	1245410.5	125410.5	125410.5	125410.5
Reg.2 (L1)	1	136575.29	138106.01	140486.06	136572.30
Reg. 2 L2)	1	13116.00	14719.45	15084.29	14669.17
Difference	1	1951.21**	2023.94**	8.73 n.s	1407.36**
Residual	56	51.87	23.23	16.73	24.14
Total	57				
(b) Pink					
Mean (M)	1	184444.92	184444.92	184444.92	184444.92
Reg.2 (L1)	1	196325.46	194707.08	198577.67	197454.67
Reg. 2 L2)	1	13210.45	11854.16	14082.41	13418.89
Difference	1	1329.91**	1592.00**	-50.34 n.s	409.14**
Residual	56	32.03	56.25	16.46	28.31
Total	57				
(c) a & b Combined					
Mean (M)	1	307017.59	307017.59	307017.59	307017.59
Reg.2 (L1)	1	332595.04	331894.07	336366.85	322829.52
Reg. 2 L2)	1	27010.58	29317.25	29923.07	21467.42
Difference	1	1433.13**	4530.77**	573.81**	5655.49**
Residual	114	60.11	39.88	34.56	108.73
Total	115				

** - significant at P = 0.01
ns - not significant

Table 3: Comparison of leaf area(cm^2) by graph tracing method with their corresponding values using the linear equation models

Variable pair	Model 1 Y=bX	Model 2 Y=a+bX	Graph Tracing
(a) White			
LAXL	47.61	46.52	46.52
LAXW	47.83	46.52	46.52
LAXLXW	46.20	46.52	46.52
LAXLDW	44.73	46.52	46.52
(b) Pink			
LAXL	57.28	56.37	56.39
LAXW	57.20	56.37	56.39
LAXLXW	57.49	56.39	56.39
LAXLDW	55.73	56.39	56.39
(c) a & b Combined			
LAXL	52.24	51.41	51.45
LAXW	52.57	51.48	51.45
LAXLXW	50.74	51.70	51.45
LAXLDW	48.62	51.44	51.45

Olasantan (2004). The reliability of these models (Y=a+bX) for estimating leaf area in different varieties of Queen of the Philippines (*Mussaenda philippica*) proved highly satisfactory. Thus, using non-destructive method for leaf area determination, LA of white and pink variety could be estimated from this relationship with the length of midrib using linear equation Y=-29.36 + 7.22X(r=0.91) and = -5 26.72 + 6.15X (r=0.94), respectively. It could also be estimated from the relationship with width using linear equation Y = -31.14 + 13.46X (r=0.96) and Y = -33.45 + 14.10X (r=0.89) for white and pink varieties respectively. However, for the product of length and width, LA could be estimated by using either of the two linear equations, Y = 2.64 + 1.40X (r=0.97) or Y = 0.737X (r=0.97) for white variety and Y=1.32 + 0.612X (r=0.97) or Y=0.639X (r=0.97), for pink variety. This suggests that when the difference between models Y=bX, and Y=a+bX is not significant, the right model is Y=bX and that both pink and white varieties of Queen of the Philippines (*Mussaenda philippica*) are similar in leaf size. This finding corroborates the report of Sharma et al., (1990) that white and pink varieties of Queen of the Philippines (*Mussaenda philippica*) are similar in morphology and ecology but differ in physiology. An attempt to evolve a single linear equation for both varieties showed that model Y = a + bX is more accurate in estimating the leaf area of Queen of the Philippines (*Mussaenda philippica*) than linear model Y = bX. Thus, leaf area of both varieties in a single equation could be estimated from its relationship with length of midrib and width, using Y = -15.72 + 5.59X (r=0.89) and Y = -33.004 + 13.92X (r=0.93), respectively. It could also be estimated from its relationship with the product of length and width (Y = 7.25 + 0.59X (r=0.94) and leaf dry weight using Y = 18.95 + 115.40 (r=0.80).

For the destructive method, LA could be estimated using its relationship with leaf-dry weight Y=11.43 + 113.19X (r=0.96) and Y = 8.61 + 187.02X (r=0.950 for white and pink varieties, respectively. The estimated leaf area of Queen of the Philippines (*Mussaenda philippica*) using its relationship with length of midrib, width or product of length and width or leaf dry weight was more accurate and reliable with the use of linear model Y = a + bX than model Y = bX and it is, therefore, recommended for field use on growth studies dealing with large samples.

CONCLUSION

The results from this study indicate that, leaf area of pink and white varieties of Queen of the Philippines (*M. philippica*) could be estimated from its relationship with midrib length using linear equations Y = -26.72+ 6.15X (r = 0.94) and Y = -29.36+ 7.22X (r = 0.91), respectively. Also, that it could be estimated from its relationship with leaf width using equations Y = -33.45+ 14.10X (r= 0.89) for pink and Y = -31.14 + 13.46X (r = 0.96), for white varieties. However, for the product of length and width, leaf area of Queen of the Philippines could be determined by using either of the two linear equations; Y = 2.64 + 1.40X (r = 0.97) or Y = 0.737X (r = 0.97), for white and Y = 1.32 + 0.612X (r = 0.97) or Y = 0.639X (r = 0.97), for the pink varieties.

In addition, this study reveals that, a single linear equation could be used to estimate leaf area of both white and pink varieties of Queen of the Philippines from its relationship with midrib length or width using linear equations Y = -15.72 + 5.59X (r = 0.89) or Y = -33.004 + 13.92X (r = 0.93), respectively, and the product of length and width by using linear equation, Y = 7.25 + 0.59X (r = 0.94).

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