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GROWTH RATE AND ECONOMIC CONSIDERATIONS OF *DIEFFENBACHIA* X 'BAUSEI'

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Abstract. **Linear regression equations based on growth of *Dieffenbachia* x 'Bausei' were compared for plants grown in two different greenhouses in summer and fall. In one greenhouse, temperatures were monitored by a computer, which controlled air conditioner venting and heating controls. The other greenhouse utilized thermostats to control a fan and pad cooling system and space heaters. Stem height, leaf area, number of leaves, number of new leaves, and shoot fresh and dry weight were determined weekly for 6 weeks. Correlation coefficients of all growth data were above 0.90 and coefficients of determination for leaf area and total leaf number were 0.97 and 0.96. Comparisons of linear regression equations (total leaf number) showed it took twice as long to produce a crop with the same number of leaves in the fall as it did in the summer. Growth rate differences were considered temperature related.**

Dieffenbachia accounts for at least 7% of total sales in the 269 million dollar foliage industry (5). Plant height, leaf size and/or number, visual rating, and/or fresh weight of cuttings have been reported in most experiments to determine the best fertilizer and light level combinations for *Dieffenbachia* growth (2, 3, 4). However, no study has evaluated *Dieffenbachia* growth during different periods of the year in the same and—or different greenhouses.

Dieffenbachia growth rate was reduced when night temperatures were below 60°F (8) and foliage growers have reported *Dieffenbachia* as a chill sensitive plant genera (7). 'Bausei' originated as a cross between *D. maculata* and *D. weirii* about 1870 (1). It would be more widely grown but is extremely sensitive to viral infections (A. R. Chase, personal communication). Most *Dieffenbachia* cultivars have been partially or completely derived from *D. maculata,* one of the parents of *Dieffenbachia* X 'Bausei' (5).

The objective of this study was to determine the growth of *Dieffenbachia* X 'Bausei' in summer and fall and then to determine what plant growth parameters could be used to predict *Dieffenbachia* growth and production rates.

Materials and Methods

Expt. 1: Plants. Tip cuttings were taken from stock plants grown in two different greenhouses and propagated in the same mist bed. After 4 weeks, rooted cuttings were potted in 15-cm diameter pots using Metro Mix 500. Thirty-six potted plants were returned to each of the original greenhouses where the stock plants were kept. Media was watered as needed to keep it moist and plants were fertigated once weekly with a 300 ppm N solution prepared from a 20-10-20 N-P_2O_5-K_2O fertilizer.

Greenhouse Environment. Maximum light intensity in greenhouse 1 was 2000 fc and 2400 fc in greenhouse 2. Total photosynthetically active radiation (PAR) outdoors was reported by the Agronomy Department, University of Florida (Table 1). Temperatures in greenhouse 1 were monitored by a computer, which controlled two 1.5 ton air conditioners and the ridge vents. Air conditioners were turned on when temperatures were above 60°F and ridge vents opened when temperatures reached 95°F. Greenhouse 2 had a fan and pad cooling system with thermostats set at 80° F. Minimum night temperatures in greenhouse 1 were usually 7-8° F cooler than greenhouse 2. Minimum night temperatures in greenhouse 2 were usually 2-3° F warmer than ambient air temperatures reported by the Agronomy Department, University of Florida (Table 1). Maximum temperatures in both houses were 92-98°F at bench height.

Data. After a 3 week establishment period, 6 plants were removed from each greenhouse each week for 6 weeks beginning 17 July 1984. At each sample date, the following data were taken: plant height, leaf area, total number of leaves, number of new leaves since experiment initiation, and fresh and dry weight of leaves and stems.

Expt. 2. The experimental procedures used in Expt. 2 were the same as Expt. 1 except plant sampling began 13 Sep. 1984 and thermostats to control space heaters were set at 70° F.

Results and Discussion

When plant growth has been evaluated from seedling stage to mature plant, a sigmoidal curve is obtained (Fig. 1). Relatively complex equations are necessary to fit this

Table 1. Climatological data obtained from Agronomy Department, University of Florida, Gainesville, Fla. for specified time periods in 1984.

7 Day Period Ending	Avg temp. (°F) Min	Max	Avg PAR[z] E/m²
17 July	70.1	91.6	31.8
24 July	70.2	87.3	23.9
31 Aug.	69.1	89.9	22.6
7 Aug.	73.1	92.7	33.9
14 Aug.	71.9	95.1	40.9
21 Aug.	72.6	92.3	32.0
Average	71.1	91.5	30.8
13 Sep.	66.9	86.4	30.4
20 Sep.	68.1	89.6	28.0
27 Sep.	67.4	88.7	36.2
4 Oct.	59.6	82.1	45.2
11 Oct.	61.6	84.0	50.1
18 Oct.	62.1	86.6	51.2
Average	64.3	86.2	40.2

[z]Photosynthetic Active Radiation

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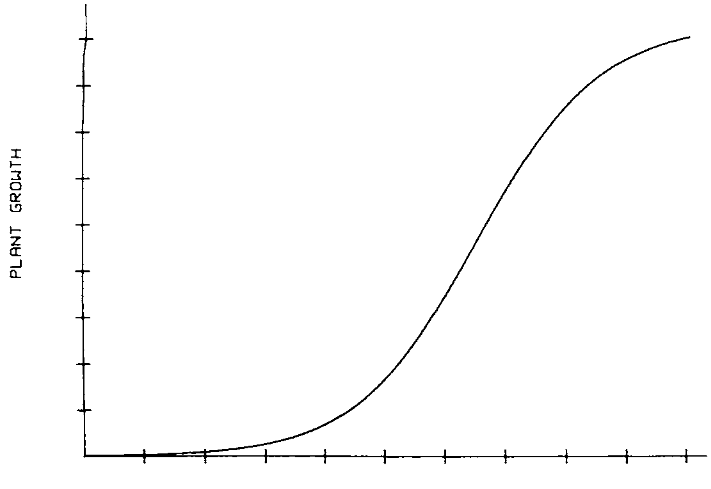

Fig. 1. Typical sigmoidal plant growth curve from seedling to mature plant.

growth curve (10). However, after early growth and before a plant matures, a linear segment is often obtained. Usually, natural logarithms of plant growth parameters are used to establish linearity (6). In some instances, linearity can be shown with untransformed data.

Regression analysis of the untransformed summer and fall growth data in both greenhouses showed a linear relationship for all growth parameters (Table 2). The correlation coefficient, r, was over 0.90 for all reported growth parameters and most coefficients of determination, r^2, were above 0.90. The close adherence to a linear equation by the untransformed data in Expt. 1 and 2 occurred because a restricted linear section of the growth curve was used.

Leaf area measurements had the most consistent coefficients of determination; all were 0.97 (Fig. 2, Table 2). However, excellent coefficients of determination were obtained with total leaf number (Fig. 3), number of new leaves, and fresh and dry weight. Height increases varied more than other growth parameters, but all but one had a coefficient of determination above 0.90.

The linear relationships exhibited by the growth parameters over the four 6-week periods in expt. 1 and 2 indicate that growers could determine *Dieffenbachia* growth rates in their own production ranges. Growth in one greenhouse could be compared to growth in another greenhouse by using linear regression equations. The linear regression equations reported here were based on sampling 6 plants per week and required 36 plants. If a grower counted leaves once a week for 3 weeks or more

Table 2. Regression analyses and slope ratios of selected growth parameters of *Dieffenbachia* x 'Bausei' for designated 6-week periods.

Parameter and 6-week period	Avg at termination	Greenhouse no.	Linear regression equation	r^2	Slope ratio period and greenhouse no.
Total leaf number					
Summer	11.5	2	y = 1.36x + 4.12	0.95	Summer 2 / Fall 2 = 1.72
Fall	8.0	2	y = 0.79x + 3.65	0.96	Fall 2 / Summer 1 = 0.96
Summer	7.0	1	y = 0.82x + 1.89	0.92	Summer 1 / Fall 1 = 1.28
Fall	5.2	1	y = 0.64x + 1.54	0.98	Summer 2 / Fall 1 = 2.13
Number new leaves					
Summer	7.7	2	y = 1.29x + 0.44	0.97	Summer 2 / Fall 2 = 1.57
Fall	4.7	2	y = 0.82x + 0.14	0.93	Fall 2 / Summer 1 = 0.93
Summer	5.5	1	y = 0.88x − 0.07	0.98	Summer 1 / Fall 1 = 1.29
Fall	4.0	1	y = 0.68x − 0.26	0.97	Summer 2 / Fall 1 = 1.90
Total leaf area (cm^2)					
Summer	1,419	2	y = 214x + 56	0.97	Summer 2 / Fall 2 = 1.69
Fall	859	2	y = 127x + 139	0.97	Fall 2 / Summer 1 = 0.98
Summer	833	1	y = 129x − 11.2	0.97	Summer 1 / Fall 1 = 1.74
Fall	478	1	y = 74x + 1.3	0.97	Summer 2 / Fall 1 = 2.90

Table 2. (Continued)

Parameter and 6-week period	Avg at termination	Greenhouse no.	Linear regression equation	r^2	Slope ratio period and greenhouse no.
Height (cm)					
Summer	49.2	2	y = 4.58x + 18.83	0.95	Summer 2 / Fall 2 = 2.20
Fall	39.5	2	y = 2.07x + 27.07	0.82	Fall 2 / Summer 1 = 0.59
Summer	37.8	1	y = 3.52x + 17.48	0.96	Summer 1 / Fall 1 = 1.58
Fall	34.3	1	y = 2.23x + 22.03	0.93	Summer 2 / Fall 1 = 2.05
Shoot fresh weight (g)					
Summer	118.9	2	y = 15.77x + 13.14	0.92	Summer 2 / Fall 2 = 2.03
Fall	63.5	2	y = 7.76x + 17.02	0.98	Fall 2 / Summer 1 = 1.08
Summer	66.7	1	y = 7.15x + 17.02	0.90	Summer 1 / Fall 1 = 2.04
Fall	38.5	1	y = 3.50x + 15.44	0.93	Summer 2 / Fall 1 = 4.50
Shoot dry weight (g)					
Summer	8.6	2	y = 1.18x + 0.73	0.93	Summer 2 / Fall 2 = 1.55
Fall	5.4	2	y = 0.76x + 0.88	0.97	Fall 2 / Summer 1 = 1.04
Summer	5.7	1	y = 0.73x + 0.63	0.89	Summer 1 / Fall 1 = 1.62
Fall	3.9	1	y = 0.45x + 0.95	0.94	Summer 2 / Fall 1 = 2.62

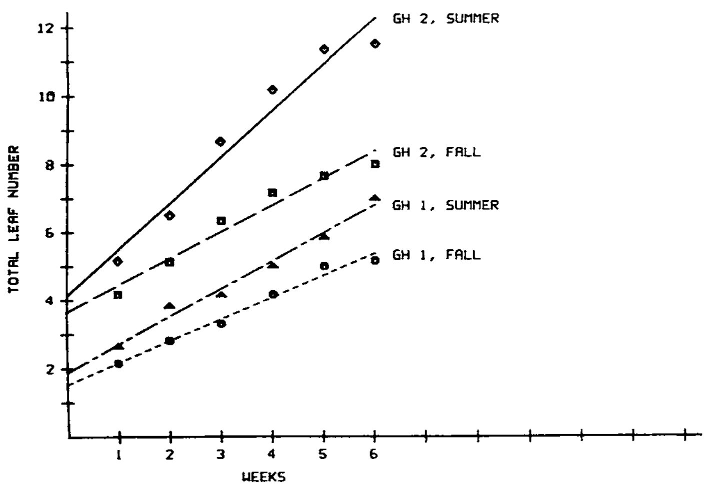

Fig. 2. Data points and predicted regression lines for leaf area of *Dieffenbachia* x 'Bausei.' Equations and coefficients of determination are listed in Table 2.

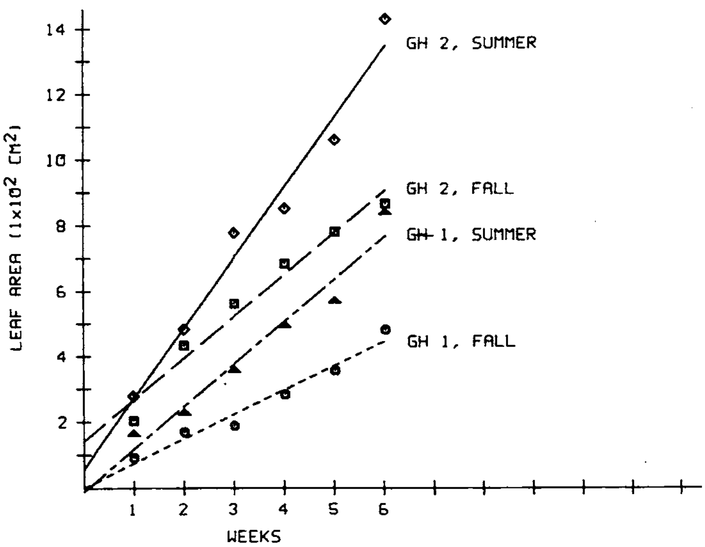

Fig. 3. Data points and predicted regression lines for total leaf number of *Dieffenbachia* x 'Bausei.' Equations and coefficients of determination are listed in Table 2.

on 6 or more plants, a linear regression equation could be determined with an inexpensive calculator.

Comparative costs can be determined by using the standard linear regression equation, y = Ax + B. The slope of the line, A, indicates the growth rate of the particular plant growth parameter over a specified time unit. In the experiments reported here, the time unit was 1 week.

In greenhouse 2 during summer, the linear regression equation was $y = 1.36x + 4.12$ (Table 2). The slope of the linear regression equation for plant leaves was 1.36. This means 1.36 leaves were produced by an average plant per week. The Y intercept or B (4.12) is the predicted starting point. When the experiment started (week 0), the average plant had 4.12 leaves. If the finished crop were to have 12 leaves, the equation becomes:

$$y = Ax + B$$
$$12 = 1.36x + 4.12$$
$$x = \frac{12 - 4.12}{1.36}$$
$x = 5.79$ weeks to produce a 12 leaf *Dieffenbachia.*

where

y = number of leaves on finished crop.
A = slope (number of leaves per week).
x = number of weeks to produce y.
B = y intercept (starting number of leaves).

In greenhouse 1 during the fall the slope was 0.64 and the average plant had 1.54 leaves when potted. Thus the time to produce a plant with 12 leaves would be determined as follows:

$$y = Ax + B$$
$$12 = 0.64x + 1.54$$
$$x = \frac{12 - 1.54}{.64}$$
$x = 16.34$ weeks to produce a 12 leaf *Dieffenbachia.*

If average greenhouse space costs were \$3.00 a ft²/year and the grower allocated 1 ft per plant, it would have cost \$0.33 to produce a 12 leaf *Dieffenbachia* in greenhouse 2 in the summer and \$0.94 in greenhouse 1 in the fall. If plants with 2 leaves (B = 2) were placed on greenhouse benches in both houses, the time to produce a 12 leaf *Dieffenbachia* would be determined as follows:

Greenhouse 2, summer	Greenhouse 1, fall
$y = 1.36x + 2$	$y = .64x + 2$
$12 = 1.36x + 2$	$12 = .64x + 2$
$x = \frac{12 - 2}{1.36}$	$x = \frac{12 - 2}{0.64}$
$x = 7.3$ weeks	$x = 15.6$ weeks

Using the \$3.00 ft²/year greenhouse space cost, production costs would be \$0.42 per plant in greenhouse 2 in the summer and \$0.90 in greenhouse 1 in the fall. Thus, it would cost a grower 2.14 times as much to grow *Dieffenbachia* in house 1 in the fall compared to house 2 in the summer. The cost comparisons can also be determined by slope ratios. This is the slope of the linear regression equation for greenhouse 2 (summer) divided by the slope of the linear regression for equation greenhouse 1 (fall) or $1.36 \div 0.64 = 2.13$.

Using slope ratios, we can compare growth parameters in same or different greenhouses during different seasons. In this series of experiments, it required 1.3 to 2.0 times longer to produce the equivalent amount of plant material in the fall as it did in the summer in the same greenhouse. Light levels did not account for this growth difference as total photosynthetically active radiation (PAR) was higher in the fall than the summer (Table 1). Photoperiod did not account for the difference as growth in greenhouse 1 during the summer was similar to growth in greenhouse 2 during the fall. The only environmental variable that showed a consistent relationship from greenhouse 1 to greenhouse 2 and from summer to fall was minimum temperatures. Although the data presented here does not conclusively prove that a difference of 7°-8° F night temperatures account for the observed differences in growth it strongly suggests that as night temperatures are lowered from 70° to 64° F, growth is reduced. This conclusion is supported by the similarity in slope ratios between greenhouse 1 in the summer and greenhouse 2 in the fall, as these houses had similar night temperatures during these periods. Conover and Poole (2) reported a 40% reduction in number of cuttings from *Peperomia* stock plants when winter yields were compared to summer yields. They also reported (9) a reduction in growth of *Dieffenbachia* when greenhouse temperatures were below 50°F for a few days during the production cycle. The growth differences observed in these experiments show that plant production costs vary by season and by greenhouse. Foliage growers can monitor the growth rate of *Dieffenbachia,* select the greenhouse(s) that have the best growth rate, and produce *Dieffenbachia* with higher profit margins.

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