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FERTILIZATION AND WATER USE OF DIEFFENBACHIA MACULATA AND PEPEROMIA OBTUSIFOLIA[1]

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Abstract. **A 3X2 experiment was initiated to determine the influence of 3 fertilizer levels and 2 water levels on growth of** Dieffenbachia maculata **(Lodd.) G. Don. cv. Perfection and** Peperomia obtusifolia **(L.) A. Dietr. and pH, conductance and volume of leachate, and pH and conductance of the soil. Best plants were produced by 100-44-83 mg/l N-P-K at each irrigation with some leaching. An increase in fertilizer levels increased amount of leachate and conductance and decreased pH.**

Fertilizer applied with each irrigation (constant fertilization) of foliage plants is a common commercial practice, but there has been little regard to volume of water applied, the emphasis being placed on ppm (mg/l) of the fertilizer elements in solution. Water usage is being examined critically throughout the nation and there is also concern regarding contamination of water supplies by excess applications of fertilizers. An ideal situation would be application of water and fertilizer in quantities that result in no loss of water or fertilizer from the plant container and produce an excellent quality plant. Because of complexities and variables associated with determination of these optimal quantities, there is little research concerning the volume usage of water by foliage plants.

Furuta et al. (1, 2) estimated evapotranspiration of 60-87 liters of water per 15 cm diameter container per year in California for woody plants outdoors, but foliage plants in 10 cm diameter pots under 1.5 klx lost 5.5-9 liters per year. Other workers in California (4) showed that chrysanthemums could be grown satisfactorily the last 4 weeks of production with 1/4 the amount of water normally used commercially. Soule (5) reported water loss of mangos in 7.6 liter cans to be approximately 2 liters over a 28 day period. Poole and Henley (3) reported 4-6 liters of water per 15 cm container to finish a crop of *Peperomia obtusifolia* and 4.7 to 6.5 liters to produce a crop of *Brassaia actinophylla.*

Materials and Methods

Rooted cuttings of *Dieffenbachia maculata* (Lodd.) G. Don. cv. Perfection, 35 cm tall and *Peperomia obtusifolia* (L.) A. Dietr. 11 cm to top node were planted one per 12 cm pot containing Florida peat, pine bark, cypress shavings (2:1:1 by volume) and maintained in a shaded glasshouse under 10 klx maximum with temperature ranging from 20-35°C.

The 3X2 experiment was initiated November 16, 1978. Pots received at each irrigation, 100-44-83 mg/l (1X) of N-P-K at 1X, 3X, or 5X rates. Plants were irrigated twice weekly. At experiment initiation pots were irrigated with sufficient water to obtain approximately 10-20% leaching or were given enough water to thoroughly moisten the medium with no leaching. At each irrigation beakers were placed under the pots for 5-10 minutes and amount of leachate determined. If solution did drain from the pots when no leaching was desired, the solution was poured on the top of the pot until it was absorbed by the soil. Volume applied was determined so that a few non leached pots lost water that was absorbed when reapplied. Volume applied to pots that were to be leached was determined by using enough water so that a minimum of 10-20% leachate was obtained. Volume applied and leachate collected at selected intervals is shown in Table 1. A series of pots with no plants was also irrigated to give some indication of amount of water lost by evaporation. At experiment termination plant grade, (1 = poor, not salable, 3 = good, salable and 5 = excellent quality), root grade, (1 = no rooting or dead roots, 3 = 50% coverage of the soil ball and 5 = 100% coverage of the soil ball with white healthy roots), height

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Table 1. Volume of solution applied to 12 cm pot and leachate collected at selected intervals.

	Volume applied (ml)						Leachate collected (ml)					
	11/17	12/31	12/15	12/29	1/12	1/26	11/17	12/31	12/15	12/29	1/12	1/26
	Peperomia obtusifolia											
Not leached	100	95	95	110	120	130	—	—	—	—	—	—
Leached	125	125	130	160	170	190	11	10	8	20	17	24
	Dieffenbachia maculata											
Not leached	75	80	80	100	110	120	—	—	—	—	—	—
Leached	100	110	115	140	160	170	11	10	10	27	32	34
	Blank—No plant											
Not leached	50	45	45	50	60	60	—	—	—	—	—	—
Leached	75	75	75	100	110	110	8	15	5	13	11	9

Table 2. Influence of fertilizer level and leaching on growth of *Dieffenbachia maculata* and *Peperomia obtusifolia*.

mg/l N-P-K	Leaching	Dieffenbachia Ht., cm	Dieffenbachia Top fr. wt. g	Dieffenbachia Plant[z] grade	Dieffenbachia Root[y] grade	Peperomia Ht., cm	Peperomia Top fr. wt. g	Peperomia Plant[z] grade	Peperomia Root[y] grade
100-44-83	No	43	76	2.1	4.9	18	108	4.0	5.0
100-44-83	Yes	48	96	3.8	5.0	20	147	4.9	5.0
300-132-249	No	45	92	3.0	4.2	21	178	4.4	4.7
300-132-249	Yes	48	94	3.9	4.4	21	226	4.5	4.5
500-220-415	No	44	84	3.1	3.9	19	176	3.4	4.1
500-220-415	Yes	45	83	3.2	4.0	22	212	2.4	3.6
Fert (L)		NS[x]	NS	NS	**	NS	**	**	**
(Q)		NS	NS	NS	NS	NS	*	**	NS
Leaching		**	NS	**	NS	*	**	**	NS
F X L		NS	NS	NS	NS	*	NS	**	NS

[z]1 = poor, not salable, 3 = good, salable and 5 = excellent quality.
[y]1 = no rooting or dead roots, 3 = 50% coverage of the soil ball and 5 = 100% coverage of the soil ball with white healthy roots.
[x]NS = non significant, * = significant at .05, ** = significant at .01.

and top fresh weight and pH and mhos x 10^{-5} of the soil was determined. There were 5 pots per treatment.

Results and Discussion

As fertilizer levels increased root grade of *D. maculata* decreased (Table 2). Volume of leachate obtained from pots fertilized with the highest fertilizer level was over twice that of the lowest indicating either root damage or sufficient nutrients were absorbed by the smaller root system (Table 3). Fertilizer levels did not affect the other three growth parameters indicating that roots at the high level supported good growth, but considerable fertilizer would be wasted if the higher rates were used. Leaching the pots increased height and plant grade. A rate of 100-44-83 mg/l N-P-K with leaching appears to be best. Mhos x 10^{-5} and pH of soil of pots receiving the low rate with some leaching was 24 and 5.3 respectively (Table 4). Top fresh weight of *P. obtusifolia* was greater when fertilized with the 2X and 3X rate, but plant grade and root grade decreased as fertilizer level increased. Plant grade of *P. obtusifolia* was improved when pots given low fertilizer levels were leached but leaching was detrimental to plants irrigated with the high level of nutrition which had a pH of 4.1, and a conductance of 234 mhos x 10^{-5} (Table 4). Root grade also decreased with an increase in nutrition. When plants were given the lower fertilizer rate they benefited from the additional amount of fertilizer supplied by the extra volume of water when leached, but the additional fertilizer supplied at the high fertilizer rate was detrimental to root grade. Again the low level of nutrition with some leaching produced good plants, although the middle level of nutrition produced plants with the greatest fresh weight. *P. obtusifolia* apparently can tolerate salt levels as high as 140 x 10^{-5} and a low pH (Tables 2, 4).

Pots without plants had very little change in pH or mhos x 10^{-5} (Table 4). This could be due to smaller volume of water applied to these pots (Table 3).

Both species received approximately the same amount of solution and the volume of leachate obtained was also similar, except that volume of leachate obtained when the 3X rate was applied to *D. maculata* was approximately twice that obtained from *P. obtusifolia*.

Results from this experiment indicate that high levels of fertilizer can result in greater water loss and lower quality plants. Some leaching is desirable, even at the low level (1X) rate of fertilization.

Table 3. Volume of water applied to 12 cm pots and amount of leachate obtained. November 16, 1978-February 2, 1979.

	Total ml applied	mg l N-P-K[1]	Total ml leached	% leached
Peperomia obtusifolia				
Not leached	2455	100- 44- 83	222	6
Leached	3460	300-132-249	231	7
		500-220-415	414	12
Dieffenbachia maculata				
Not leached	2200	100- 44- 83	220	6
Leached	3400	300-132-249	402	12
		500-220-415	490	14
Pot only — No plant				
Not leached	1195	100- 44- 83	210	10
Leached	2120	300-132-249	207	10
		500-220-415	253	12

Table 4. pH and mhos x 10^{-5} of soil at experiment termination.

mg/l N-P-K	Leached	pH *Dieffenbachia maculata*	pH *Peperomia obtusifolia*	pH Blank	mhos x 10^{-5} *Dieffenbachia maculata*	mhos x 10^{-5} *Peperomia obtusifolia*	mhos x 10^{-5} Blank
100-44-83	No	5.1	5.2	5.4	34	39	32
100-44-83	Yes	5.3	5.4	5.6	24	22	26
300-132-249	No	4.2	4.6	5.4	191	103	51
300-132-249	Yes	4.0	4.2	5.2	208	140	50
500-226-415	No	4.1	4.2	5.2	258	255	75
500-226-415	Yes	4.0	4.1	5.2	236	234	80

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INFLUENCE OF WATERING FREQUENCY ON GROWTH AND ANATOMY OF LEMON VINE[1]

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Abstract. **Lemon vine,** Pereskia aculeata **'Godseffiana,' a primitive cactus was watered twice weekly, once weekly, biweekly and every three weeks. Stem elongation and number of new leaves was reduced with decreased watering frequency. Color ratings of the foliage showed that plants watered once every three weeks had dull green leaves compared to plants watered more frequently. Leaf and stem sections showed structural changes especially in number of lysigenous secretary canals. Cross and paradermal leaf sections showed palisade and mesophyll intercellular spaces were reduced as watering frequency decreased.**

Plants exhibit various alterations in growth rate and changes in leaf and stem morphology when subjected to water stress (3, 5). Most water is lost through plants leaves, and they exhibit the greatest number of anatomical changes. Smaller mesophyll cells, less extensive intercellular spaces, thicker cuticles, and increased lignification have been reported (6). Lemon vine, *Pereskia aculeata* 'Godseffiana', a primitive leafy mesophytic cactus is often used as an understock for other cacti in addition to being grown as a hanging basket plant. Observations made in the conservatory of the Department of Ornamental Horticulture indicated it tolerated severe water stress. As restrictions on water useage may be imposed on ornamental growers (2), additional information on plant reaction to water stress is needed.

Materials and Methods

Four to 5 in (10 to 15 cm) rooted tip cuttings were potted in Vergro[2], Nov. 12, 1979. Potting mix was amended with 4.2 Kg/m^3 Osmocote 14-14-14. Plants were grown in plastic 5 in (7.5 cm) black containers for the duration of the experiment in an unshaded greenhouse with maximum light intensities of approximately 85 kilolux and 60°F (15.6°C) minimum night and 90°F (32.2°C) maximum day temperatures.

Four watering regimes were established on December 20, 1979 with frequencies of twice weekly, once weekly, biweekly, and every three weeks. Pots were arranged in a completely random design with six replicates and one plant per pot as the experiment unit. Height and number of nodes were counted at experiment initiation and once monthly until termination on February 20, 1980. Then leaf, stem and petiole sections were taken, killed in FAA, dehydrated in tertiary butyl alcohol, embedded in parafin, sectioned at 10 microns and stained with toluidine blue (5).

Results and Discussion

Plants watered once every two and once every three weeks grew less than plants watered once or twice a week. Total number of new leaves produced by plants was only statistically affected when plants were watered once every 3 weeks (Table 1). Differential effects of water stress have also been reported for other plants (7). Visual color ratings of leaves at experiment termination showed a color change with watering frequency. Plants watered once or twice a week had bright green leaves variegated with yellow, while plants watered once every 3 weeks had dull greyish green leaves which lacked the color contrast typical of unstressed plants.

Table 1. Influence of watering frequency on height, number of new leaves and foliar color rating of *Pereskia aculeata* Godseffiana.[z]

Days between watering	Increase in plant ht (cm)	Number of new leaves	Visual color rating[y]
3.5	9.6a	54.5a	1
7	9.5a	49.3ab	1.1
14	4.2b	41.5ab	1.7
21	5.3b	37.8b	3

[z]Means within a column followed by the same letter are not significantly different at the 5% level (Duncan's Multiple Range Test).
[y]1=Leaf with bright green variegated foliage, 3=leaf with dull greenish appearance.

Anatomical Responses

Leaf Anatomy—Unstressed lemon vines had a single layer of unlignified epidermal cells on both upper and lower leaf surfaces covered with a thin cuticle (Fig. 1). The mesophyll was weakly differentiated with a 1 to 2 palisade cell layer, and isodiametric spongy mesophyll cells with a few intercellular spaces. Large idioblastic cells, often filled with amorphous ergastic substance permeated both layers of the mesophyll. The most noticeable difference between stressed and unstressed plants was the increased differentiation of the mesophyll (Fig. 1). Leaves subjected to high light intensities and xerophytic conditions often form an additional layer of palisade cells (1). Fewer idioblastic cells were present in the mesophyll of stressed plants compared to unstressed plants. Paradermal sections showed a decrease in

[1]Florida Agricultural Experiment Stations Journal Series No. 2760.
[2]A synthetic soil mix manufactured by Verlite Company, 56 Street and Hanna Avenue, Tampa. FL 33610.