Table 3. Interaction of leaching and fertilizer rates on leaf drop and electrical conductivity of leachate from *Ficus retusa* 'Nitida' pots.

	Leaf Drop (Average number of leaves dropped/pot)									
	Month 1		Month 2		Month 3		Month 4		Month 5	
Fertilizer rate (g/l)[z]	No leach	Leach	No leach	Leach	No leach	Leach	No leach	Leach	No leach	Leach
0	1.25	1.00	.00	.25	.75	.00	1.00	.50	.25	1.75
1.2	13.75	1.75	.25	.25	.25	.25	.50	1.00	.50	2.50
2.4	4.25	1.25	1.50	.50	.00	1.00	2.00	6.75	3.25	1.75
3.6	7.00	1.75	2.50	1.75	2.75	.75	27.75	9.50	9.75	4.25
4.8	2.25	1.75	3.00	.50	5.00	6.00	41.50	43.25	16.75	15.75
Significance										
Leaching x										
Fertilizer rate	NS[y]		NS		NS		NS		NS	
Leaching	NS		NS		NS		NS		NS	
Fertilizer rate										
Linear	NS		**		**		**		**	
Quadratic	NS		NS		*		**		**	
Fertilizer rate (g/l)	Electrical Conductivity (μmhos/cm)									
0	770	488	592	922	615	409	740	492	493	705
1.2	4100	5300	7250	5262	5748	4925	9250	6200	11362	7412
2.4	9000	8650	12000	7850	10075	7425	13075	8075	14409	8675
3.6	10050	9150	12975	8725	9512	7200	11250	7925	14024	9338
4.8	13925	12850	16500	11700	12850	10098	14025	10125	15375	10884
Significance										
Leaching x										
Fertilizer rate	*		NS		NS		*		*	
Leaching	NS		**		NS		*		*	
Fertilizer rate										
Linear	**		**		**		**		**	
Quadratic	NS		*		**		**		**	

[z]20-8.8-16.6 (N-P-K).
[y]NS, *, ** = Not significant, significant at the 5% level, and significant at the 1% level, respectively.

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Proc. Fla. State Hort. Soc. 102:274-276. 1989.

BIOSTIMULANT AND HIGH FERTILIZER RATES DO NOT AFFECT LEATHERLEAF FERN FROND DEVELOPMENT, YIELD OR VASE LIFE

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Additional index words. Rumohra adiantiformis, morphology, growth.

Abstract. **The effects of foliar biostimulant (NF-10) sprays and controlled-release fertilizer (CRF) applications were evaluated over a ten-month period for their effects on leatherleaf fern [*Rumohra adiantiformis* (Forst.) Ching] growing in ground beds. Biostimulant was applied weekly at four concentrations (0, 0.02, 0.09 and 0.35 ml/liter) and CRF (17-2.6-10, N-P-K) was applied bimonthly at two rates (840 and 1680 kg N/ha/yr). Treatments had no effect on frond development, morphology, postharvest water uptake, or vase life. Frond yield (numbers, fresh weight and mean frond weight) also was not influenced by treatments. No benefits resulted from the use of NF-10 or high application rates of CRF on leatherleaf fern.**

Florida Agricultural Experiment Station Journal Series No. N-00051.

Year after year, foliar biostimulants appear on the market that are touted as being able to increase crop yields and quality, and decrease production times. These products contain macronutrients, micronutrients, growth hormones and other constituents. Results from tests of these products have been quite variable.

In general, foliar biostimulant sprays have been most effective when plants were under some form of stress. Limiting factors that have been obviated using foliar sprays include bacterial spot on peppers (4), and nutrient-stress on citrus (5) and cucumbers (7). Ambiguous results have been documented for foliar applications of several biostimulants to 'Hayslip' tomatoes (3). Other research has indicated no beneficial effects from the use of foliar biostimulant sprays on cucumbers (4), squash (4), strawberries (1), and tomatoes (2). Other research has demonstrated yield reductions associated with foliar applications of macronutrients (2) and micronutrients (3) to tomatoes. Research has also indicated that foliar applications of seaweed extracts extended the shelf life of peaches (9).

The only previous study conducted on leatherleaf fern dealt with frost-damaged fern and did not define fertilization regimes or evaluate effects on vase life (6). No studies have been conducted on the effects of purported biostimulants on unstressed leatherleaf fern. This study was conducted to determine the effects of a biostimulant foliar spray on leatherleaf fern frond morphology, yield and postharvest longevity.

Materials and Methods

Established beds of leatherleaf fern growing under 70% shade at the Central Florida Research and Education Center—Apopka were used in this study. The crop was mowed off 4 cm above the ground prior to the initiation of treatments on January 1987. The soil type in the 1.2 m x 1.2 m plots was Millhopper fine sand (Grossaremic Paleudult, loamy siliceous, hyperthermic). Fertilizer treatments consisted of 17-2.6-10 (N-P-K) controlled-release fertilizer containing micronutrients (Sierra, Sierra Chemical, Milpitas, CA) applied at 840 or 1680 kgs. N/ha/year. These high fertilizer rates were used so nutrients would not be a limiting factor if the biostimulant sprays increased photosynthesis as claimed. Plots were irrigated as needed using overhead irrigation.

Freshly prepared biostimulant solution containing 0.3 ml of a nonionic spreader-sticker (Plyac, Hopkins Agricultural Chemical Co., Madison, WI) per liter was applied weekly during midmorning to the point of runoff (120 ml/plot) using an 80° flat fan nozzle and 2.8 kg · cm^2 pressure. Solutions tested had 0, 0.02, 0.09 or 0.35 ml of biostimulant (NF-10, Bio Organics, Inc., New York, NY) per liter of deionized water. Treatments were replicated 5 times in this 2 X 4 factorial complete block experiment.

Emerging crosiers (fiddleheads) were tagged for growth rate studies on 22 March 1987. Frond heights and maturity were determined every week until all fronds had reached maturity.

Mature, marketable fronds were harvested March, May, August, and October, 1987 for vase life determinations. Fronds were harvested using clippers and then stored in waxed corrugated boxes for 11-15 days at 4°C. After storage, frond stipes were recut 15 cm below the basal pinna using razor blades. Stipe diameters (narrow and wide) were measured 5 mm above the razor cut using a micrometer. Fronds were held in deionized water at 24° ± 3°C, 63 ± 18% RH, and provided with 17 $\mu mol \cdot s^{-1} \cdot m^{-2}$ of light using fluorescent lamps 12 hours/day. Vase life was terminated when fronds started to yellow or show signs of desiccation. Frond surface areas were measured using an area meter (Model LI-3100, LI-COR, Inc., Lincoln, NE).

Mature, marketable fronds were harvested on 11 June 1987 and all fronds were harvested on 30 October 1987 to determine frond biomass production. Statistical analysis consisted of analysis of variance (factorial interactions), regression (biostimulant main effect) and correlation (SAS/PC, SAS Institute, Inc., Cary, NC).

Results and Discussion

Growth rate. Crosiers (fiddleheads) took 4-7 weeks to reach the teneral leaf stage (frond fully expanded but still soft and immature in color) and 5-8 weeks to mature; however, neither fertilizer nor biostimulant rate affected growth rate of fronds. (Fig. 1).

Frond morphology. There were no differences due to treatments in frond fresh weights, surface areas (SA), stipe cross-sectional areas, the ratio of frond surface area to stipe cross-sectional area, specific leaf weight (dry weight/SA), leaf density thickness (fresh weight/SA), initial frond water content or dry weights. Representative mean values for the above characteristics of fronds harvested in May and August are given in Table 1.

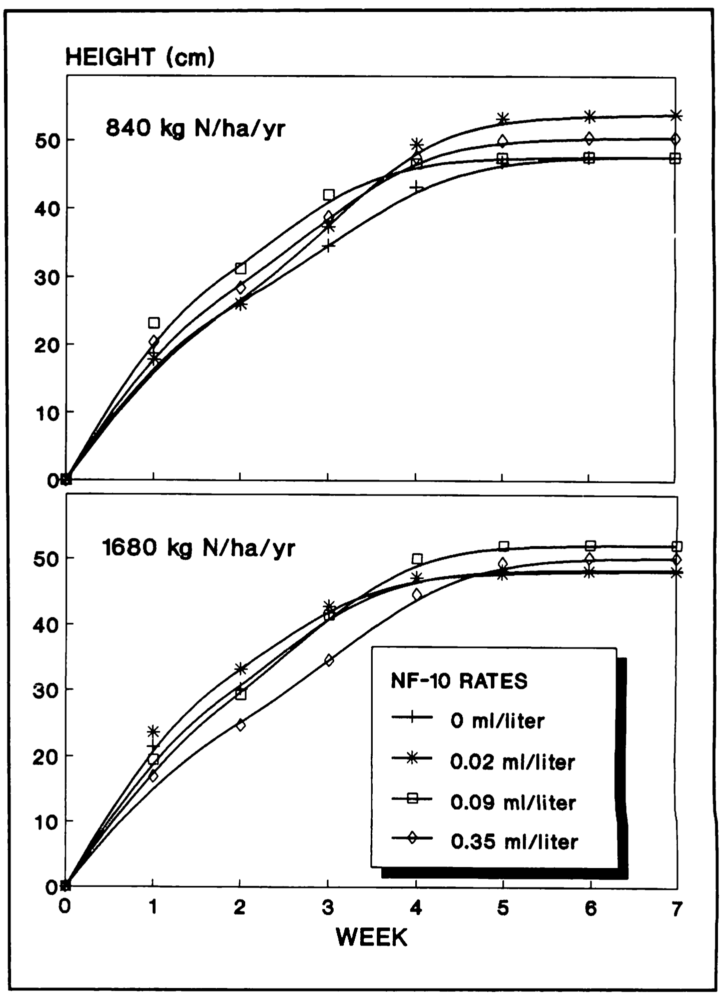

Fig. 1. Foliar biostimulant and fertilizer rates did not influence rate of frond development.

Table 1. Mean values for leatherleaf fern fronds from the May/August harvests.

Controlled-release fertilizer rate (kgs N/ha/year)	NF-10 rate (ml · liter⁻¹)	Surface area (cm²)	Fresh weight (g)	Leaf density thickness[z] (mg · cm²)	Dry weight (g)	Specific leaf weight[y] (mg · cm²)	Initial water content (%)	Stipe cross-sectional area (cm²)	Ratio of surface area to stipe area
840	0	227/372	8.2/13.7	35/44	2.2/4.1	9.4/10.9	73/75	0.065/---	3462/---
	0.02	295/396	10.6/14.6	35/44	3.2/4.1	10.6/10.3	69/76	0.076/---	3990/---
	0.09	288/334	7.5/14.2	31/50	2.7/3.8	9.1/11.7	71/76	0.068/---	4181/---
	0.35	300/387	9.0/14.5	34/42	3.0/3.9	10.2/10.0	70/76	0.076/---	3985/---
1680	0	311/430	10.6/15.7	33/39	2.9/4.2	9.3/ 9.7	71/75	0.079/---	4021/---
	0.02	272/368	8.4/14.2	29/44	2.7/3.7	10.0/10.1	65/77	0.060/---	4470/---
	0.09	319/453	11.7/17.4	34/48	2.9/4.8	8.8/10.7	75/77	0.090/---	3579/---
	0.35	248/374	8.8/14.4	37/49	2.7/4.2	10.8/11.2	70/77	0.064/---	3927/---

[z]Fresh weight/surface area.
[y]Dry weight/surface area.

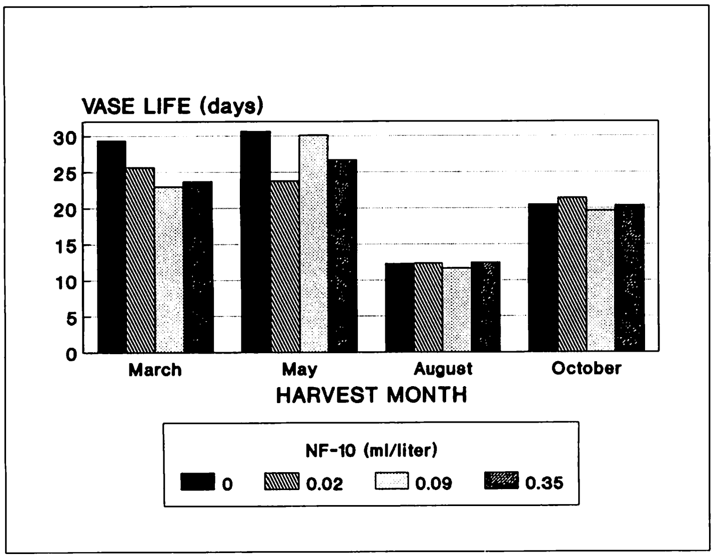

Fig. 2. Vase life of leatherleaf fern fronds was not influenced by biostimulant application rate.

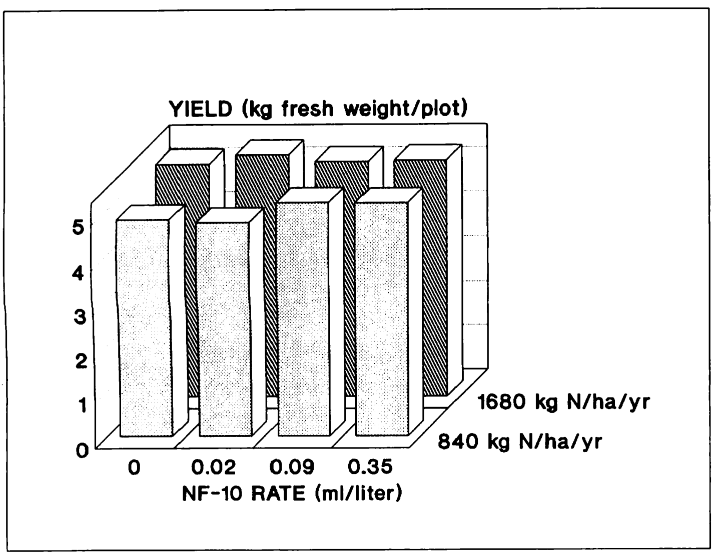

Fig. 3. Biostimulant application rate did not affect frond yield.

Vase life. Vase life was not correlated with any of the morphological characteristics measured. Treatments had no effect on water uptake of harvested fronds (data not shown). Fertilizer and biostimulant application rates did not affect frond weight changes or vase life (Fig. 2). Vase life data show the typical decrease in postharvest longevity associated with fronds produced during the summer (8, 10). Average discard weights (% of initial weight) followed a similar pattern; for example, the average discard weight percentage for fronds harvested in May was 101% while for the August harvest it was 87%. The results show that fronds produced and harvested during the summer in Florida attain a negative water balance more rapidly than fronds harvested at other times of the year.

Yield. Treatments did not affect frond numbers, average frond weight (data not shown) or total fresh weight of fronds produced per plot (Fig. 3).

In summary, no benefits resulted from the use of NF-10 or high application rates of controlled-release fertilizer on leatherleaf fern. Elimination of the use of excessive fertilizer would decrease production costs slightly and reduce the potential for fertilizer leaching and/or runoff into ground or surface waters.

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