Table 6. Phytotoxicity rating scales used for evaluating *Brassaia actinophylla* and *Dieffenbachia maculata* treated with Safer's Soap.

Numerical value	*B. actinophylla*	*D. maculata*
1	No damage	No yellow leaf tips
2	1-2 leaves deformed	1-3 yellow leaf tips
3	> 2 leaves deformed	> 3 yellow leaf tips
4	> 2 dead leaves	Lesions and necrosis observed
5	Plant dead	Plant dead

the overall quality of the treated *D. marginata* was higher than the water sprayed plants since the soap left an oily residue which imparted a shiny appearance to the treated leaves and the yellow discoloration was noted on close examination only.

The *D. maculata* and *C. elegans* treated in Trial 1 were not significantly affected by the soap spray at either rate. However, there were some yellowed tips noted on the *D. maculata*. The mean ratings for *D. maculata* were 2, 2.71 and 3.43 for the water, 1x and 2x treatments, respectively. The plants tested for phytotoxicity in Trial 2 were unaffected by the 1x rate of Safer's Soap.

From these results, a 1.56% (1/2x) to 3.12% (1x) Safer's Soap spray could be used safely once a week for 3 wk for the control of spider mites on the following plants: *C. elegans, C. variegatum, C. terminalis, D. maculata* 'Perfection', *D. sanderana* and *H. helix*. *Dracaena marginata* was affected by this soap at the rates and frequencies tested, but the damage observed was minimal when compared to that caused by spider mites. *Brassaia actinophylla* should not be sprayed with Safer's Soap unless there is no other alternative.

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INFLUENCE OF NITROGEN SOURCE ON GROWTH AND TISSUE NUTRIENT CONTENT OF THREE FOLIAGE PLANTS[1]

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Additional index words. Urea, ammonium, nitrate.

Abstract. **Seven nitrogen fertilizer treatments composed of 50% NH_4:50% NO_3, 25% NH_4:75% NO_3, 75% NH_4:25% NO_3, 100% urea, 100% NO_3, 100% NH_4 and 50% NH_4:50% urea were applied to** Brassaia actinophylla **Endl.,** Calathea makoyana **E. Morr. and** Philodendron selloum **C. Koch at recommended rates. Best quality calathea were produced with NH_4-N or urea-N sources and poorest with NO_3-N. Root and color grades of calathea were also affected by N source and were closely correlated to overall plant quality. N source had no effect on quality of philodendron or schefflera. Tissue analyses on schefflera did not show differences due to N source except for phosphorus (P).**

Recommendations on N sources for production of foliage plants have been considered to be in the order of 50% NH_4-N and 50% NO_3-N (7). However, a search of the literature did not indicate these recommendations were based on research, but rather, interpretations from other ornamental crops.

With woody ornamentals, growth and foliar color of azalea were improved when they received NH_4-N versus NO_3-N *in* work reported by Colgrove and Roberts (2), while Myhre (9) found bud formation was better on *Rhododendron* 'Cynthia' when plants received N from $(NH_4)_2SO_4$ versus NH_4NO_3 or urea. More recently, Gilliam et al. (4) found total tissue N levels in cotoneaster, pyracantha and weigela were greater when N source was NH_4-N rather than NO_3-N. They also reported that Mn deficiency symptoms were associated with plants receiving NO_3-N.

On carnation, a herbaceous crop, Green and Holley (5) reported an increase in net photosynthesis when plants received NO_3-N during periods of highest solar radiation, while 1/3 NH_4-N and 2/3 NO_3-N were best during lowest periods. Several researchers have reported on N sources that optimize chrysanthemum production (*3, 6, 8, 11*). Joiner and Knoop (6) found tallest chrysanthemums were produced at high N-K levels from a higher ratio of NO_3-N to NH_4-N, while the reverse occurred at low N-K levels. Crater (3) found best year-round growth of chrysanthemum was obtained when NH_4NO_3 served as the N source and this was also substantiated in work by Klett and Gartner (8). On the other hand, Tsujita et al. (11) reported that chrysanthemums receiving NH_4-N under summer light intensity flowered earlier, had higher dry weight, larger stem diameter, stronger stems and larger flowers. They also observed that under winter light intensity NO_3-N improved keeping quality, stem strength and levels of soluble carbohydrates.

Fertilizer formulators have generally increased levels of NH_4-N or urea-N in fertilizers used by foliage plant producers because these sources of N are generally less costly than those consisting of NO_3-N. This research was initiated to determine whether NH_4 or urea N sources influenced foliage plant growth and whether the presently accepted recommendation of 50% NH_4-N:50% NO_3-N had any basis in fact.

Materials and Methods

Three experiments were established utilizing the 7 fertilizer treatments shown in Table 1. All test plants were potted in a medium composed of sedge peat and builder's sand, 3:1 (v/v), amended with 7 lb. dolomitic lime and 3 lb. Perk® (a micronutrient blend manufactured by Estech General Chemical Corp., Chicago, IL)/yd^3.

Experiment 1. On August 20, 1979, *Brassaia actinophylla* Endl. (schefflera) 3 plants/3 inch pot were repotted into 8-inch diameter pots in a randomized block design and replicated 8 times with 1 pot serving as an experimental

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Table 1. Sources (%) of N and K and ratios of NH_4-N, NO_3-N or urea-N supplied schefflera, calathea or philodendron.

Source	Treatment 1	2	3	4	5	6	7
	50 NH_4 50 NO_3	25 NH_4 75 NO_3	75 NH_4 25 NO_3	100 urea	100 NO_3	100 NH_4	50 NH_4 50 urea
NH_4NO_3	100	50	50	—	—	—	—
$(NH_4)_2SO_4$	—	—	50	—	—	100	50
Na NO_3	—	22	—	—	30	—	—
$CO(NH_2)_2$	—	—	—	100	—	—	50
$Ca(NO_3)_2$	—	—	—	—	42	—	—
K NO_3	—	N 28 K 100	—	—	N 28 K 100	—	—
K_2SO_4	100	—	100	100	—	100	100

unit. Fertilizer treatments were applied every 2 wk in solution with a total of 500 mg applied per pot, equivalent to 1800 lb. N and 1200 lb. K/acre/yr. Ten g per pot single superphosphate, equivalent to 1200 lb. P/acre/yr was incorporated initially to supply P. Plants were placed under 47% polypropylene shadecloth where they received 7000 ft-candles (ft-c) maximum natural illumination, irrigations as needed (usually 2/wk) and temperatures ranged from 45° (minimum) to 100°F (maximum).

Data recorded at 6 and 9 month intervals following initiation included height (inches); plant grade on a scale of 1 to 5 (1 = poor, not salable, 3 = good, but salable and 5 = excellent quality); root grade from 1 to 5 (1 = 0-20%, 3 = 41-60% and 5 = 81-100% root ball coverage with white, healthy roots); and color grade from 1 to 5 (1 = light green, 3 = medium green and 5 = dark green color). Tissue was analyzed for N, P, K, Ca, Mg, Cu, Fe, Mn and Zn at 6 months grading time.

Experiment 2. On September 25, 1979, 3-inch potted seedlings (3 plants/pot) of *Philodendron selloum* C. Koch were repotted into 8-inch diameter pots and replicated 5 times in a randomized block design. Fertilizer treatments were applied in solution with a total of 400 mg N/pot applied every 2 wk (equivalent to 1500 lb. N and 1000 lb. K/acre/yr). Phosphorus levels were the same as Expt. 1, as were the growing conditions. Data recorded at 6 and 11 months included height, plant and color grade as in Expt. 1.

Experiment 3. On September 25, 1979, divisions of *Calathea makoyana* E. Morr. (peacock plant) were potted into 6 inch diameter pots and replicated 5 times in a randomized block design with 5 to 7 sprouts per pot serving as an experimental unit. Fertilizer treatments were applied in solution with a total of 200 mg N/pot every 2 wk (equivalent to 1500 lb. N and 1000 lb. K/acre/yr). Five g per pot of single superphosphate were soil incorporated initially as a P source (equivalent to 600 lb. P/acre/yr). Plants were placed in a fiberglass greenhouse where they received 1200 ft-c maximum natural illumination, irrigations as needed (usually 2/wk) and temperatures of 55° (minimum) to 100°F (maximum). Data recorded at 6 and 9 months included plant, root and color grade as in Expt. 1.

Results and Discussion

Height, plant grade and foliar color of brassaia and philodendron were not influenced by N source, although in

Table 2. Influence of nitrogen source on growth of *Calathea makoyana*.

N source and ratio	Plant grade[z] 6 mo	9 mo	Root grade[y] 6 mo	9 mo	Color grade[x] 6 mo	9 mo
NH_4:NO_3 (50:50)	3.2bc[w]	2.8bc	2.4bc	2.2bc	2.8abc	3.2bc
NH_4:NO_3 (25:75)	2.4b	2.2b	2.2b	1.6b	2.0ab	2.4b
NH_4:NO_3 (75:25)	3.6c	3.8d	2.4bc	2.8c	4.0cd	3.8cd
Urea (100)	3.0bc	3.6cd	2.6bc	2.4bc	3.8bcd	3.4cd
NO_3 (100)	1.4a	1.2a	1.2a	1.2a	1.2a	1.2a
NH_4 (100)	3.6c	4.0d	3.2c	3.0c	4.8d	4.2d
NH_4:urea (50:50)	3.6c	4.0d	3.2c	3.2c	4.2cd	4.4d

[z]1 = poor, not salable, 3 = good, but salable, 5 = excellent quality.
[y]1 = 1-20%, 3 = 4-60%, 5 = 81-100% root ball coverage with white, heaythq foots.
[x]1 = light green, 3 = moderate green, 5= dark green color.
[w]Mean separation within columns by Duncan's multiple range test, 5%level.

both experiments plants grown on 100% NO_3-N tended to be lower in numerical score. At termination of both experiments, all plants were of good commercial quality and would have been salable with color and plant grades averaging 4.2 and 4.0, respectively.

Of tissue elements analyzed in brassaia, only P was influenced by N sources. However, results were variable; the difference between the highest and lowest levels was only 0.05 and did not seem to be related to whether N was derived from NH_4 or NO_3. Tissue levels of macro- and micronutrients were within recommended ranges (10). Unlike results observed on chrysanthemum (3, 11), light intensity appeared to have no effect on whether NH_4 or NO_3-N produced best growth (6 months data was taken at the end of the lowest light period and 9 months data at the peak of the high light period).

Growth of calathea was strongly influenced by N source, with poorest plant, root and color grades present on plants grown on 100% NO_3-N (Table 2). Best plant and color grades at 6 or 9 months were associated with plants that received 100% urea and 75% NH_4 and 25% NO_3-N. These data are very similar to observations on azalea (2) and blueberries (1) where N sources high in NO_3-N reduced growth and foliar color. Appearance of foliage on calathea that received higher NO_3-N levels was similar to Fe or Mn deficiency symptoms.

Although results of these experiments are variable, best overall calathea quality was produced where NH_4-N or urea-N sources provided 50% or more N, while N source had no effect on schefflera or philodendron. Based on these results it would be hard to substantiate a recommendation for 50% NH_4 and 50% NO_3 as suggested in the literature (7), especially since fertilizers high in NO_3-N are more expensive than NH_4-N or urea-based fertilizers.

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REDUCED WATER APPLICATION RATES AND COLD PROTECTION OF LEATHERLEAF FERN[1]

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Abstract. **Water application rates of 0.34 inch/hr using conventional (1.1 rpm) impact sprinklers and reduced rates (0.18 inch/hr) using frost protection (2.9 rpm) sprinklers were equally effective, under low wind conditions when used to cold protect leatherleaf fern,** Rumohra adiantiformis **(G. Forst) Ching. Under windy conditions (up to 16.5 mph) and similar air and dewpoint temperatures, 18 and 10°F, respectively, neither system cold protected immature fronds. Increases in sprinkler rotation rates and reductions in air movement in ferneries could reduce water application rates necessary to cold protect leatherleaf fern.**

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In Florida, approximately 6,000 acres are currently devoted to cut foliage production and leatherleaf fern, *Rumohra adiantiformis* (G. Forst) Ching, accounts for about 80% of the volume shipped. The estimated leatherleaf fern crop value exceeds $43,000,000 at wholesale annually and one-third of the fern is exported to Europe, making it Florida's second highest farm export to the continent (8).

Leatherleaf fern is most commonly grown on well drained sandy soils under 60-80% shade from polypropylene shade fabric. Visually detectable cold injury of immature fronds usually occurs after exposure to temperatures below 30°F (5). Almost all leatherleaf fern that is freeze protected in Florida is protected by use of overhead sprinkler irrigation, utilizing the latent heat of fusion of water. Freeze protection water application rate recommendations range from 0.3-0.44 inch/hr (3, 5, 6, 7) and appear to be based on recommendations for citrus (2). Dean (1), using conventional impact sprinklers (Rainbird® No. 20-A) with an average rotation rate of 1 rpm, concluded that maintenance of the necessary water-ice interface to protect fern under wooden slat shade, under cold, windy conditions, required 5/32 inch nozzle openings and wetting from at least 2 sprinklers op-