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EFFECT OF AMMONIUM-NITRATE RATIO ON GROWTH AND QUALITY OF *BRASSAIA ACTINOPHYLLA* AND SUSCEPTIBILITY TO *XANTHOMONAS CAMPESTRIS* PV. *HEDERAE*

J. H. BLAKE AND A. R. CHASE[1]
University of Florida, IFAS
Dept. of Plant Pathology, Gainesville, FL 32611
and
Central Florida Research and Education Center,
2807 Binion Road, Apopka, FL 32703,
respectively

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Abstract. **The effect of ammonium:nitrate ratio on growth of *Brassaia actinophylla* Endl. and its susceptibility to Xanthomonas leaf spot, caused by *Xanthomonas campestris* pv. *hederae* (Arnaud) Dye, was evaluated. Ratios of 100:0, 75:25, 50:50, 25:75, 0:100 (ammonium:nitrate) were applied for 8 weeks at the rate of 90 mg nitrogen/15.2-cm pot/week. As the ammonium concentration increased, leachate electrical conductivity increased significantly and pH decreased significantly. Plant height, number of leaflets, top quality, fresh weight of tops, and leaflet area were not significantly affected by the ammonium:nitrate ratio. The number of lesions caused by *X. campestris* pv. *hederae* was highest for plants fertilized with 50:50 ammonium:nitrate, while significantly fewer lesions were produced at either 100% ammonium or 100% nitrate.**

Bacterial leaf spot of *Brassaia actinophylla* (schefflera), caused by *Xanthomonas campestris* pv. *hederae*, is typified by sunken lesions less than 1 mm in diameter, which become tan and corky on the lower leaf surface (1). Some lesions expand to as much as 1 cm in diameter with water-soaked margins. Control of this disease has been attempted by elimination of overhead irrigation and by applications of bactericides which are usually not effective and can be phytotoxic to *B. actinophylla*.

Host nutrition affects the severity of several bacterial diseases of foliage plants (5). The most common reaction of ornamental plants to increasing rates of complete fertilizer is decreased disease severity, as occurs with *Pseudomonas cichorii* (Swingle) Stapp on *Ficus lyrata* Warb. (6). Sometimes fertilizer rate does not affect disease severity, as shown with *Erwinia chrysanthemi* Burkholder, McFadden, & Dimock on *Syngonium podophyllum* Schott. (4). Even more infrequently, an increase in disease severity with increasing fertilizer rate occurs as with *E. chrysanthemi* on *Chrysanthemum morifolium* Ramat. (10). The source of nitrogen in a fertilizer is also known to affect disease severity (9) although few reports on ornamentals are available (5).

Investigations into the effect of host nutrition on severity of Xanthomonas leaf spot (caused by *X. c.* pv. *hederae*) on *B. actinophylla* and *Schefflera arboricola* H. Ayata (dwarf schefflera) showed that increasing the rate of a slow-release fertilizer decreased disease severity on both plants without obviously affecting plant growth (7). The objectives of the following research were to determine the effects of nitrogen source on the growth and quality of *B. actinophylla* and its susceptibility to *X. c.* pv. *hederae*.

Materials and Methods

Seedlings of *B. actinophylla* from commercial producers were planted individually in 7.6-cm pots containing steam-treated (1.5 hr at 90°C) Canadian peat and pine bark (1:1, v/v). The medium was then amended with 4.0 kg dolomitic lime and 0.9 kg Micromax micronutrient source per cubic meter. Plants were top-dressed with 0.5 g Osmocote 19:6:12 and grown for one month prior to transplanting into 15.2-cm pots at test initiation.

Ratios of ammonium:nitrate fertilizer were formulated from laboratory chemicals as follows: 100:0 = $(NH_4)_2SO_4$, 75:25 = $(NH_4)_2SO_4$ and NH_4NO_3, 50:50 = NH_4NO_3, 25:75 = NH_4NO_3, KNO_3, and $NaNO_3$, 0:100 = KNO_3, $NaNO_3$, and $Ca(NO_3)_2$. Fertilizer was applied biweekly for 8 weeks at the rate of 90 mg N/pot/week. Plants were arranged in a randomized complete block design and watered by hand as needed. Light levels ranged from 340 to 570 μmol $sec^{-1}m^{-2}$ with temperatures ranging from 18 to 35°C depending upon time of year.

Leachate electrical conductivity (soluble salts) and leachate pH were recorded after 4 and 8 weeks of fertilization using the pour-through method (11). Plant height was measured at test initiation and completion by measuring the distance from the surface of the potting medium to the point of attachment of leaflets to the petiole of the tallest leaf. Leaflets greater than 2.5 cm long were counted at test

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[1]Graduate Research Assistant and Professor of Plant Pathology, respectively.

initiation and completion. Top quality was rated immediately prior to inoculation (after 8 weeks) using the following scale: 1= dead plant; 2= poor quality, unsalable; 3= good quality, salable; 4= very good quality, salable; and 5= excellent quality, salable.

Plants were inoculated with a strain of *X. c.* pv. *hederae* obtained from *Hedera helix* L. (English ivy). The pathogen was grown on Difco nutrient agar amended with 0.5% sucrose for 2 days at 27°C. Bacteria were removed from the agar surface by flooding with 0.01 M $MgSO_4$ solution and then gently rubbing colonies on the agar surface with a sterilized cotton swab. The resulting suspension was adjusted to approximately 1 x 10^8 colony forming units/ml (50% transmittance at 600 nm using a spectrophotometer). Plants were exposed to intermittent mist (5 sec/30 min from 0800 to 2000 hr daily) for 24 hr prior to inoculation. They were then inoculated to runoff with a pump action hand sprayer, enclosed in polyethylene bags for 24 hr and maintained under the mist system until test completion. The number of lesions per plant was recorded approximately 14 days after inoculation. Ten to 15 plants were used for each treatment in each of four tests performed between Nov. 1987 and Sept. 1988. Data from each test were analyzed for significant effects by the F test. Data were combined for all four tests when possible. Disease data were analyzed following transformation to the log (y + 1) where y= number of lesions.

Results and Discussion

Results from the four tests were similar, and data presented here are the means for all tests. Nitrogen source significantly affected leachate electrical conductivity and pH at the end of the 8-week fertilization period. As the concentration of ammonium increased from 0% to 100%, leachate electrical conductivity increased significantly (P= 0.01) from 862 to 1560 µmhos/cm and pH decreased significantly (P= 0.01) from 5.87 to 5.38.

Nitrogen source had no significant effect on plant height, number of leaflets greater than 2.5 cm, top quality, fresh weight of tops, or leaflet area (data not presented). Conover and Poole (8) also reported no significant effects of nitrogen source on growth or quality of *B. actinophylla.*

Nitrogen source significantly (P= 0.01) affected Xanthomonas leaf spot of *B. actinophylla*, with the number of lesions significantly affected in three of the four tests

Table 1. Effect of ammonium:nitrate ratio on number of lesions caused by *Xanthomonas campestris* pv. *hederae* on *Brassaia actinophylla* (schefflera).

Nitrogen source $NH_4:NO_3$[y]	Mean number of lesions per plant[z]			
	Test 1 24 March	Test 2 30 May	Test 3 30 May	Test 4 21 Sept.
0:100	27.6	3.2	20.1	4.2
25:75	39.0	17.6	17.8	17.3
50:50	47.9	25.0	32.8	28.3
75:25	25.0	6.8	28.8	46.2
100:0	3.9	11.1	31.4	25.0
P-value	0.0050	0.0008	0.0855	0.0239

[z]Means are given for 10, 14, 13, or 15 plants for Test 1, 2, 3, and 4, respectively.
[y]Nitrogen rate was standardized at 90 mg/plant/week for 8 weeks.

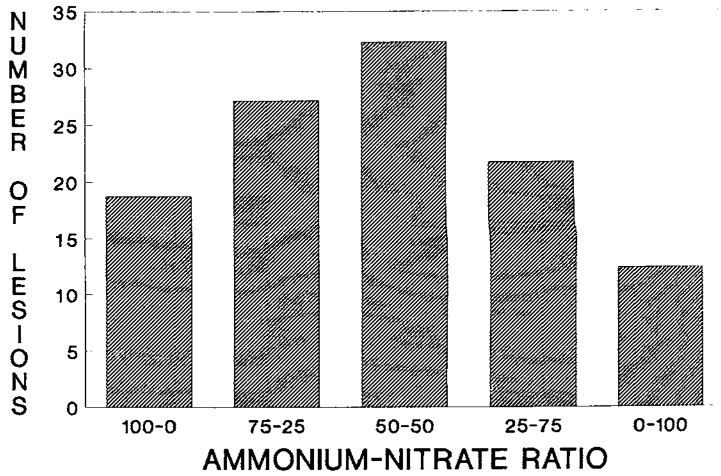

Fig. 1. Effect of ammonium:nitrate ratio on mean number of lesions caused by *Xanthomonas campestris* pv. *hederae* on *Brassaia actinophylla.* Data from four tests are combined (P-value= 0.0001).

(Table 1). Since the overall number of lesions was similar in the four tests, data were combined and analyzed; this resulted in a highly significant P-value. The highest number of lesions was recorded for plants receiving nitrogen from equal amounts of ammonium and nitrate sources (Fig. 1). Approximately 50% reduction in lesion number occurred when plants received 100% of either ammonium or nitrate nitrogen. Similar effects of ammonium:nitrate ratios have also been observed on Xanthomonas leaf spot of *H. helix* caused by the same bacterium (A. R. Chase, Univ. of Florida, personal communication).

These tests show that simple alterations in leaf area, fresh top weight, plant height, leachate pH, or leachate electrical conductivity cannot account for differences in the number of lesions among treatments. Nitrogen form affects levels of amino acids, carbohydrates, proteins, organic acids and leaf exudation (9), and one or more of these chemical constituents could affect development of lesions caused by *X. c.* pv. *hederae.* In addition, alterations in stomata, secretory cells, cuticle, or cell wall thickness could influence infection and lesion expansion.

One of the most common fertilizers used in the foliage industry is Osmocote 19:6:12 (a 3-month formulation) which contains approximately equal percentages of ammonium and nitrate nitrogen. Thus, fertilization with this or similar compounds could result in maximum expression of Xanthomonas leaf spot of *B. actinophylla* regardless of other environmental factors. Since nitrogen source does not affect the growth or quality of *B. actinophylla*, use of either 100% ammonium or 100% nitrate should produce good quality, salable plants while reducing severity of Xanthomonas leaf spot of *B. actinophylla* caused by *X. c.* pv. *hederae.* Bactericides such as cupric hydroxide and streptomycin sulfate reduce the number of lesions caused by *X. c.* pv. *hederae* by 50-75% on *B. actinophylla* (2, 3). A higher percentage of control could possibly be achieved by combining bactericide applications and fertilization with either 100% ammonium or 100% nitrate nitrogen.

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EFFECT OF FERTILIZER RATE ON SUSCEPTIBILITY OF *FICUS BENJAMINA* TO *XANTHOMONAS CAMPESTRIS* PV. *FICI*

A. R. CHASE[1]
University of Florida, IFAS
Central Florida Research and Education Center - Apopka
2807 Binion Rd., Apopka, FL 32703

Additional index words. Osmocote, weeping fig.

Abstract. **_Ficus benjamina_ plants were fertilized with 4 to 24 g/12.5-cm pot of a slow release 19:6:12 fertilizer. The recommended rate for this plant is approximately 4 g per 12.5-cm pot. Plant height, number of leaves and top grade were not affected over this range of fertilizer. Electrical conductivity of leachate ranged from 150 to 7000 µmhos/cm. Potassium, calcium and magnesium content of mature leaves decreased as the fertilizer level increased. Amounts of elements were unaffected. Plants were inoculated with _Xanthomonas campestris_ pv. _fici_ 2 months after fertilization. Number of lesions decreased as fertilizer rate increased 4 and 8 weeks after fertilization but was not observed at 12 weeks.**

The effects of fertilizer rate on susceptibility of foliage plants to bacterial diseases has been researched occasionally during the past 15 years. Nutrient balance is important as well as the amount of a balanced fertilizer in affecting severity of some bacterial diseases. Since chemical control of bacterial diseases is often unsatisfactory, reducing host susceptibility by altering the fertilizer applied to the host should be included in a disease control program whenever possible. The following research was performed to evaluate susceptibility of *Ficus benjamina* L. (weeping fig) fertilized with different levels of a slow release fertilizer (Osmocote™ 19:6:12) to *Xanthomonas campestris* pv. *fici*.

Materials and Methods

Rooted cuttings of *Ficus benjamina* with three to five leaves were planted in a steam-treated potting medium consisting of Canadian peat and pine bark (1:1 by volume). The potting medium was amended with dolomite (4.2 kg/cubic meter) and Micromax (0.9 kg/cubic meter). Plants were established in 10-cm plastic pots and top-dressed with Osmocote 19:6:12 (19N:3P:10K) at various rates. Maximum light level was 380 µmol/s/m and daily temperatures ranged from 15 to 35°C. Plants were irrigated by hand three times a week. Ten single pot replicates were included for each of the following treatments: 4, 8, 12, 16, 20 and 24 g Osmocote per 12.5-cm pot. The recommended rate for this plant is approximately 4 g per 12.5-cm pot (4). Electrical conductivity (EC) of leachate was determined monthly by the following method: deionized water was added to the potting medium surface until 100 ml of the resulting leachate was collected in the beaker (7). The EC of the resulting leachate was determined using a Hach conductivity meter. Top grade was assessed visually on the following scale: 1 = dead; 2 = poor, unsalable; 3 = moderate, salable; 4 = good, salable; and 5 = excellent, salable. Final growth ratings were recorded approximately 8 weeks after initial fertilization and prior to inoculation. In the second test, mature leaves from representative plants were harvested for tissue nutrient content prior to inoculation (6).

Plants were inoculated with a suspension of *X. campestris* pv. *fici* adjusted to 1 x 10^8 bacteria/ml. The suspension was sprayed directly onto leaves without any wounding and plants were placed in plastic bags for two days. Intermittent misting (5 sec/30 min for 12 hours/day) was initiated one day before inoculation and continued until test completion. The number of lesions per plant was recorded 7 days after inoculation. This test was performed twice between 20 Sept. and 19 Jan. 1988. Two other tests were conducted between 15 May and 15 Aug. 1988 in a similar manner except that plants were inoculated 4, 8, and 12 weeks after fertilization.

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[1]Professor of Plant Pathology. Appreciation is extended to A & L Southern Agricultural Laboratories for donating tissue analyses.

Results and Discussion

The response of these plants to infection with *X. campestris* pv. *fici* was dramatic. Plant susceptibility was very high for those fertilized at the 4.0-g rate and decreased as fertilizer rate increased (Figure 1). Plants inoculated 4 weeks after fertilization had mean lesion numbers of 20.5, 6.1, and 1.9 for low, medium and high fertilizer levels, respectively. Results after 8 weeks were similar. Plants inoculated twelve weeks after fertilization had lesion numbers of 32.5, 30 and 22.5 for low, medium, and high fertilizer levels, respectively. The differences at 12 weeks were not statistically significant.