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Effect of Nitrogen, Phosphorus and Potassium Rates on Severity of Xanthomonas Leaf Spot of Schefflera[1]

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Abstract

Brassaia actinophylla plants were grown with various N-P-K regimes prior to inoculation with *Xanthomonas campestris* pv. *hederae*. Increased rates of N, P, and K reduced the number of lesions. The number of leaves, height, and shoot quality decreased as the nitrogen rate increased, but were not consistently affected by phosphorus or potassium rates. Severity of Xanthomonas leaf spot on *Brassaia actinophylla* can be minimized with slight to moderate increased N, P, or K rates with N rate having the greatest impact on disease severity.

Index words: *Brassaia actinophylla*, bacterial leaf spot, *Xanthomonas campestris* pv. *hederae*

Significance to the Nursery Industry

The use of slight to moderate increases in N, P, or K rate could result in decreased susceptibility of schefflera of Xanthomonas leaf spot, but care must be taken to avoid rates which cause decreased plant growth and quality. A higher N rate is apparently most effective in reducing susceptibility to *X. campestris* pv. *hederae*. Perhaps the use of a fertilizer which has slightly more N than P or K is warranted in developing a strategy to manage this disease as well as to avoid reductions in plant growth and minimize the potential for ground water contamination which can result when excessive rates of fertilizer are employed.

Introduction

Xanthomonas leaf spot incited by *X. campestris* pv. *hederae* (Arnaud) Dye (1) causes significant losses in commercial production of *Brassaia actinophylla* Endl. (schefflera) and related plants such as *Hedera helix* L. (English ivy). Commercially, control of this disease has been attempted with the use of bactericides (2, 3, 5). However, cultural conditions are important for control of bacterial diseases since bactericides rarely give adequate control. Furthermore, schefflera and English ivy are sensitive to available bactericides. The role of host nutrition in severity of several bacterial diseases of foliage plants has been examined during the past few years (4). Xanthomonas leaf spot of schefflera and dwarf schefflera (*Schefflera arboricola* H. Ayata) was reduced as the rate of complete fertilizer increased (4). Increased fertilizer rate has also been shown to reduce the severity of this disease on English ivy. The specific effects of nitrogen, potassium and phosphorus components of the fertilizer used was not examined. This paper reports effects of N, P, and K rates on plant growth and subsequent development of Xanthomonas leaf spot on schefflera.

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Materials and Methods

Preparation of plant materials. Schefflera seedlings approximately 4-6 cm (1.5-2.4 in) tall, were obtained from producers in Central Florida. Plants were established in 7.5 cm (3 in) pots containing a mixture of Canadian peat and pine bark (1:1 by vol) which had been steam-treated for 1.5 hr at 90°C. The medium was amended with 2.7 kg/m^3 (7.5 lb/yd^3) dolomitic limestone and 0.5 kg/m^3 (1.5 lb/yd^3) Micromax following steaming (90°C [194°F] for 1.5 hr). Plants were fertilized every other week with about 50 ml of a 200 ppm solution of Miller 20N-8.6P-16.6K until they were approximately 7.5-12.5 cm (3-5 in) tall with 4-5 leaves. Nutrient composition of the soluble fertilizer was 6.22% NO_3-N, 3.88% NH_4-N, 9.90% NH_4, 20% H_3PO_4, and 20% soluble K_2O. The N compounds were primarily derived from urea, ammonium phosphate, and potassium nitrate.

Preparation of inoculum and inoculation method. X. campestris pv. *hederae* was grown at 27°C (81°F) for 2 days on Difco nutrient agar amended with 0.5% sucrose. Bacteria were removed from the medium surface by flooding it with 0.01 M $MgSO_4$ and gently rubbing with a sterilized cotton swab. Suspensions were collected and adjusted to 1×10^7 colony-forming units per ml using a spectrophotometric method and dilution plating. Bacterial suspensions were applied to plants within 30 min of preparation.

Plants were placed in intermittent mist (5 sec every 30 min from 0800 to 2000 hr each day) starting 24 hr prior to inoculation. Inoculum was applied to leaf surfaces with a pump-action hand sprayer. After inoculation, plants were covered with polyethylene bags for 24 hr while misting continued. After approximately 14 days, the number of lesions per plant was recorded. Data for disease (no. lesions) were transformed to log (no. lesion + 1) prior to statistical analysis.

Effect of variable rates of nitrogen, phosphorus, and potassium on disease severity. The effect of rates of N, P, and K was tested using schefflera plants in 10 cm (4 in) pots. Two rates each of N (from NH_4NO_3) and K (from KCl) were used with three rates of P (from H_3PO_4) in a factorial experiment. The rates of N were 50 and 250 mg

N/pot/wk and the rates of K were 30 and 150 mg K/pot/wk. The rates of P were 15, 40, and 65 mg P/pot/wk. Fertilizer was applied with each irrigation 2 or 3 times per week, as plant water use changed, with rates adjusted accordingly. Ten replicate pots were used for each treatment in Experiments 1 and 2 and 15 pots were used per treatment for Experiment 3. Experiment 1 was conducted from March 3 to May 11, 1988 with a maximum light level of 400 μmol/m^2/s (2100 ft-c) and temperatures from 15 to 30°C (60 to 86°F). Experiment 2 was conducted from June 8 to July 28, 1988 with a maximum light level of 420 μmol/m^2/s (2200 ft-c) and temperatures between 25 and 37°C (77 and 99°F). Experiment 3 was conducted from October 14 to December 30, 1988 with a maximum light level of 380 μmol/m^2/s (2000 ft-c) and temperatures from 20 to 35°C (68 to 95°F). Leachate electrical conductivity (EC) was determined monthly using a Hach Conductivity Meter #2511 (7, 8). Leaflet number and plant height also were recorded monthly with plant shoot quality recorded just prior to inoculation. Shoot quality was rated visually on the following scale: 1 = dead; 2 = poor, unsalable; 3 = moderate, salable; 4 = good, salable; and 5 = excellent, salable. Five replicate plants per treatment were harvested for tissue analysis. Mature leaves were removed from plants, dried at 60°C (140°F) and ground. Elemental content was determined by A & L Southern Agricultural Laboratories in Pompano Beach, FL 33064 (6). Plants were inoculated as described and number of lesions recorded 2 wk after inoculation.

Results and Discussion

Leachate EC was significantly affected by N and K rates, but not by P rate (Table 1). An interaction between these two nutrients additively increased leachate EC as well. Leachate EC was affected by time of year with highest levels occurring when temperatures were relatively low and plant growth was lower reducing both water use and fertilizer use. Shoot quality response of scheffleras was similar for tests 1 and 3 and data were combined for statistical analysis. Overall, only N and P affected shoot quality, with increased rates resulting in decreased shoot quality (Table 2). Increases in N rate by decreasing the quality had a greater effect on shoot quality than increases in P. Number of leaves and plant height were affected by N rate and again decreased as N rate increased (Table 3). Tissue elemental analyses for N, P, K, magnesium (Mg), and calcium (Ca) revealed that N rate affected each of these elements (Table 4). As N rate increased, levels of N and P increased but levels of K, Mg, and Ca decreased in the leaf tissue.

Disease severity data for the N-P-K tests were similar to those of the N-K tests. Increased rates of all three elements resulted in decreased susceptibility of scheffleras to *X. campestris* pv. *hederae* (Table 5). In general, increased rates of N resulted in the largest reduction in lesion numbers with lowest number of lesions found on plants receiving the highest rate of all three nutrients.

A single test was completed with 65 scheffleras grown at a single fertilizer rate (low levels of N-P-K). Plants were grown for 8 weeks before 50 were inoculated with *X. campestris* pv. *hederae* and 15 were utilized for tissue elemental content. The number of lesions per plant ranged from 0 to 300 for the 50 plants inoculated with the pathogen showing the extreme variability inherent in the susceptibility of the seedling population. There was also extreme variability in the tissue elemental content despite the fact that all plants received the same fertilizer treatment (Table 6).

Xanthomonas leaf spot of schefflera was affected by the rate of N, P, and K supplied to the host, but not by the

Table 1. Effect of nitrogen, phosphorus, and potassium rates on leachate electrical conductivity (EC) of *Brassaia actinophylla*.

Nitrogen	Phosphorus	Potassium	Leachate EC (μmhos/cm)[y]		
	(mg/pot/wk)[z]		Exp 1 (April 27, 88)	Exp 2 (July 18, 88)	Exp 3 (Nov. 8, 88)
50	15	30	4775	1385	3100
50	40	30	4312	1150	3050
50	65	30	3850	2470	2900
50	15	150	9688	3900	5000
50	40	150	9875	4950	5400
50	65	150	10250	3900	5450
250	15	30	12062	6700	8700
250	40	30	13625	8200	8700
250	65	30	14375	7200	9050
250	15	150	15312	10500	11150
250	40	150	15625	10550	10750
250	65	150	14000	9000	11200

Significance (combined data − Pr>F)[x]			
Test (T)	0.0001	N * P	0.7079
Nitrogen (N)	0.0001	K * P	0.3059
Phosphorus (P)	0.5063	T * N * K	0.0006
Potassium (K)	0.0001	T * N * P	0.5396
T * N	0.0410	N * P * K	0.1229
T * K	0.0501	T * P * K	0.6937
T * P	0.8309	T * N * P * K	0.3565
N * K	0.0138		

[z]Fertilizer was applied in a liquid form at each irrigation.

[y]Leachate EC was measured by adding 100 ml of deionized water to the potting medium surface and collecting in a beaker below the pot. Four pots per treatment were included.

[x]Significance of the F value is greater than 5% when underlined.

Table 2. Effect of nitrogen, phosphorus, and potassium rates on shoot quality of *Brassaia actinophylla*.

Nitrogen	Phosphorus	Potassium	Shoot quality[y]	
	(mg/pot/wk)[z]		Exp 1 (April 27, 88)	Exp 2 (Dec. 5, 88)
50	15	30	4.0	3.8
50	40	30	4.0	3.8
50	65	30	4.4	3.9
50	15	150	4.2	3.7
50	40	150	3.9	4.1
50	65	150	3.5	3.8
250	15	30	3.2	2.9
250	40	30	3.2	2.6
250	65	30	2.8	2.6
250	15	150	3.2	2.8
250	40	150	2.7	2.6
250	65	150	2.4	2.7

Significance (combined data – Pr>F)[x]			
Test (T)	0.0076	N * P	0.1325
Nitrogen (N)	0.0001	K * P	0.3713
Phosphorus (P)	0.0441	T * N * K	0.9351
Potassium (K)	0.2954	T * N * P	0.2528
T * N	0.4890	N * P * K	0.1597
T * K	0.9675	T * P * K	0.3252
T * P	0.0011	T * N * P * K	0.6071
N * K	0.1006		

[z]Fertilizer was applied in a liquid form at each irrigation.

[y]Shoot quality was rated on the following scale: 1 = dead; 2 = poor, unsalable; 3 = moderate, salable; 4 = good, salable and 5 = excellent, salable. Data are means for 10 plants (Test 1) or 15 plants (Test 3).

[x]Significance of the F value is greater than 5% when underlined.

ratio of these elements. In general, increased applications of any of these nutrients resulted in decreased plant growth (no. leaves, height, and shoot quality) as well as decreased susceptibility to the pathogen. Tissue elemental content was affected consistently only by N rate. It is interesting that significant effects on disease severity were obtained for N, P, and K rates in light of the extreme variability in susceptibility to *Xanthomonas campestris* pv. *hederae* found in the seedling populations. Since the variability between seedlings is so great, the use of tissue analyses to evaluate nutritional status of schefflera is questionable. Plant appearance may be better indicator of nutrient status.

Table 3. Effect of nitrogen, phosphorus, and potassium rates on height and number of leaflets of *Brassaia actinophylla*.

Nitrogen	Phosphorus	Potassium	Height[y] (cm)	Number leaflets[y]
	(mg/pot/wk)[z]			
50	15	30	26.3	26.0
50	40	30	26.2	26.2
50	65	30	27.0	26.9
50	15	150	26.4	24.4
50	40	150	26.9	25.2
50	65	150	26.9	25.1
250	15	30	22.8	21.9
250	40	30	22.9	21.1
250	65	30	21.7	21.2
250	15	150	22.7	19.9
250	40	150	21.7	20.4
250	65	150	22.1	21.0

Significance (Pr>F)[x]		
Nitrogen (N)	0.0001	0.0001
Phosphorus (P)	0.8903	0.2663
Potassium (K)	0.6954	0.1362
N * P	0.1475	0.8303
N * K	0.3042	0.7492
P * K	0.9689	0.1613
N * P * K	0.6103	0.6165

[z]Fertilizer was applied in a liquid form at each irrigation.

[y]Data are means for all three tests (total of 35 plants).

[x]Significance of the F value is greater than 5% when underlined.

Table 4. Effect of nitrogen, phosphorus, and potassium rates on tissue elemental content of *Brassaia actinophylla* (data are for Test 3).

Nitrogen	Phosphorus	Potassium	% dry weight				
	(mg/pot/wk)[z]		N	P	K	Mg	Ca
50	15	30	3.6	0.49	3.8	0.58	1.68
50	40	30	3.2	0.48	5.4	0.49	1.48
50	65	30	3.9	0.54	3.3	0.43	1.54
50	15	150	3.5	0.53	5.0	0.42	1.41
50	40	150	3.6	0.54	3.6	0.54	1.58
50	65	150	3.6	0.48	5.3	0.47	1.44
250	15	30	5.7	0.62	3.0	0.31	1.17
250	40	30	4.8	0.49	3.8	0.32	1.10
250	65	30	4.3	0.68	3.0	0.29	1.07
250	15	150	4.2	0.57	3.7	0.31	1.08
250	40	150	4.9	0.61	2.5	0.30	1.10
250	65	150	4.6	0.58	3.5	0.26	0.87

Significance[y]	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium
Nitrogen (N)	0.0001	0.0044	0.0001	0.0001	0.0001
Phosphorus (P)	0.0030	0.9506	0.1114	0.2558	0.5766
Potassium (K)	0.1732	0.2251	0.1555	0.1492	0.1728
N * K	0.0259	0.0248	0.0001	0.2528	0.0128
N * P	0.5983	0.2575	0.0035	0.2738	0.5431
K * P	0.3760	0.9159	0.7633	0.6745	0.5805
N * K * P	0.5323	0.4790	0.8020	0.8464	0.5599

[z]Fertilizer was applied in a liquid form at each irrigation.

[y]Significance of the F value is greater than 5% when underlined.

Table 5. Effect of nitrogen, phosphorus, and potassium rates on number of lesions per plant for *Brassaia actinophylla* inoculated with *Xanthomonas campestris* pv. *hederae*.

Nitrogen	Phosphorus	Potassium	Number lesions per plant[y]		
	(mg/pot/wk)[z]		Exp 1 (May 11, 88)	Exp 2 (July 28, 88)	Exp 3 (Dec. 30, 88)
50	15	30	17.7	66.3	67.5
50	40	30	20.9	24.0	61.0
50	65	30	10.7	57.0	105.5
50	15	150	1.7	14.0	23.5
50	40	150	5.3	37.8	61.1
50	65	150	0	8.2	65.5
250	15	30	1.8	5.8	17.5
250	40	30	0.6	1.5	13.5
250	65	30	6.1	7.6	46.3
250	15	150	0.8	3.6	38.7
250	40	150	1.9	3.9	35.0
250	65	150	0	0.4	51.7

Significance (Pr>F for log [# lesions + 1])[x]			
Nitrogen (N)	0.0004	0.0001	0.0031
Phosphorus (P)	0.0020	0.0455	0.2073
Potassium (K)	0.0006	0.0002	0.5031
N * K	0.5046	0.1284	0.1240
N * P	0.0002	0.1541	0.3888
K * P	0.6578	0.8711	0.0681
N * P * K	0.4759	0.8362	0.5863

[z]Fertilizer was applied in a liquid form at each irrigation.

[y]Mean number of lesions for 10 plants (Tests 1, 2) or 15 plants (Test 3).

[x]Significance of the F value is greater than 5% when underlined.

Table 6. **Effect of seedling variability on tissue element content of *Brassaia actinophylla* receiving the recommended rate of N-P-K fertilizer.**

Element	% dry weight[z] Mean $\bar{x}$	Range
Calcium	1.28	1.00 to 1.50
Magnesium	0.37	0.28 to 0.50
Nitrogen	3.37	2.70 to 4.40
Phosphorus	0.55	0.45 to 0.76
Potassium	2.98	2.60 to 3.70
Sodium	0.09	0.04 to 0.14
Sulfur	0.22	0.16 to 0.37

Element	ppm Mean $\bar{x}$	Range
Aluminum	115	60 to 190
Boron	26	17 to 35
Copper	14	10 to 18
Iron	17	72 to 110
Manganese	597	360 to 860
Zinc	241	138 to 388

[z]Means are given for 15 plants.

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Chemically Induced Branching of Woody Landscape Plants[1]

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Abstract

Axillary budbreak of *Ilex crenata* Thunb. 'Helleri' and *Ilex vomitoria* Ait. 'Stoke's Dwarf' hollies was promoted by a single BA (N-(phenylmethyl)-1H-purin-6-amine) application of 125–1000 ppm compared to an unpruned control. Budbreak of *Photinia* x *Fraseri* Dress was stimulated by 500–2500 ppm BA and 2000–5000 ppm Promalin (BA + GA_{4+7}). Budbreak in *Nandina domestica* Thunb. 'Harbour Dwarf' increased with 1000–2500 ppm BA and 2000–5000 ppm Promalin application. Budbreak of *Rhododendron* x 'Formosa' azalea was promoted by 2000 and 2500 ppm BA and 2000–5000 ppm Promalin. Axillary budbreak of *Ternstroemia gymnanthera* (Wight & Arn.) T. Sprague) and *Raphiolepis indica* (L.) Lindl. was not affected by BA or Promalin application.

Index Words: cytokinin, gibberellins, Promalin, growth regulators, BA

Growth Regulators Used in This Study: BA (N-(phenylmethyl)-1H-purin-6-amine); Promalin (BA + GA_{4+7}).

Species Used in This Study: Helleri holly (*Ilex crenata* Thunb. 'Helleri'); Stoke's Dwarf holly (*Ilex vomitoria* Ait. 'Stoke's Dwarf'); Fraser photinia (*Photinia* x *Fraseri* Dress); Indian hawthorn (*Raphiolepis indica* (L.) Lindl.); Formosa azalea (*Rhododendron* x 'Formosa'); cleyera (*Ternstroemia gymnanthera* (Wight & Arn.) T. Sprague); Harbour Dwarf nandina (*Nandina domestica* Thunb. 'Harbour Dwarf')

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Significance to the Nursery Industry

Plant species used in this study typically require multiple prunings during production for the development of a well-branched, compact plant. On the other hand, chemical stimulation of axillary budbreak potentially can reduce the number of mechanical prunings necessary to produce a well-branched, marketable plant. However, species do respond differently to rates of BA and Promalin. Results with Helleri and Stoke's Dwarf hollies, Fraser photinia, Formosa azalea, and Harbour Dwarf nandina are promising. However, it is suggested that before committing to large scale use of plant growth regulators for lateral branch induction, an evaluation with a few plants first be conducted. Promalin appears also to have merit in increasing cuttage of Harbour Dwarf nandina stock plants.