Influence of Nitrogen and Potassium on Growth and Bacterial Leaf Blight of *Philodendron selloum*

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ABSTRACT

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Applications of extremely high nitrogen (N) levels significantly ($P = 0.05$) decreased severity of bacterial leaf blight of *Philodendron selloum* caused by *Erwinia chrysanthemi*. However, the high N levels that reduced disease severity of *P. selloum* grown in 15-cm pots under normal commercial practices resulted in significantly ($P = 0.05$) reduced plant growth. There was a weak trend whereby increased levels of potassium (K) increased disease severity. In most cases, however, no significant effect ($P = 0.05$) was found. Applications of high N levels resulted in significantly ($P = 0.05$) increased tissue N content and significantly ($P = 0.05$) increased tissue N content and significantly ($P = 0.05$) decreased tissue K content. Applications of various K levels had no effect on N tissue content, whereas increased K levels caused significantly ($P = 0.05$) increased K tissue content. Pot size had a direct relationship on N and K fertilizer levels and thus on plant growth. Good quality *P. selloum* plants were grown in a 3:1:1 medium (pine bark, peat moss, sand) in 15-cm pots with weekly applications of N at 350 ppm and K at 704 ppm.

Erwinia chrysanthemi McFadden, Burkholder, and Dimock is the most destructive bacterial plant pathogen of foliage plants (7) and is the major limiting factor in the production of *Philodendron selloum* Koch.

Although nutritional parameters have been more thoroughly investigated for *Philodendron scandens* subsp. *oxycardium* (3,4), little information was found in the literature concerning optimum foliar levels of nutrients and the influence of nutrient levels on the growth of *P. selloum*. Earlier studies indicated that high-quality *P. selloum* could be produced by incorporating 18-6-12 Osmocote (Sierra Chemical Co., Newark, CA), a slow-release fertilizer, into potting soil at 7–11 kg/m^3 (9). Three levels of ammonium nitrate tested in combination with four levels of 18-6-12 Osmocote did not affect plant growth (9).

Interpretation of data from our preliminary experiment completed in 1979 indicated that nitrogen (N) and potassium (K) played critical roles in the growth of *P. selloum* and suggested that higher than normal applications of N reduced severity of bacterial leaf blight (BLB). Development of cultural methods that would reduce the severity of BLB on *P. selloum* would be desirable. Objectives of this study were to determine the influence of N and K fertilizer levels on BLB as well as on the growth of *P. selloum*. Results of our preliminary study were the basis for the selection of the N and K fertilizer levels used in experiments discussed in this paper.

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MATERIALS AND METHODS

P. selloum seedlings were provided by Speedling, Inc. (P.O. Box 7098, Sun City, FL 33586) and were grown in a medium consisting of three parts by volume of composted pine bark (9 mm and smaller), one part sphagnum peat moss, and one part concrete-grade sand amended with hydrated lime, 20% superphosphate, and agricultural limestone at rates of 0.91, 1.14, and 5.45 kg/m^3, respectively. Ten-centimeter clay pots and 15-cm plastic pots were used in the first and second experiments, respectively. Plants were watered carefully by hand once a day to minimize splashing. Greenhouse night and day temperature and relative humidity (RH) ranges were 22–33 C and 40–100%, respectively.

In both experiments, plants were grown 14 wk prior to fresh weight determination, tissue analysis, and inoculation with *E. chrysanthemi*. Ammonium nitrate and potassium sulfate were the sources of N and K. Trace elements were provided by the application of S.T.E.M. (Robert Peters Co., Inc., 2833 Pennsylvania St., Allentown, PA 18104) at 0.6 g/L of water immediately after the seedlings were transplanted. The experimental design was a randomized complete block with four blocks and seven plants per plot in the first experiment and three blocks and seven plants per plot in the second experiment. Treatments in factorial combinations were N at 28, 490, and 910 ppm and K at 0, 352, and 704 ppm in the first experiment and N at 350, 700, 1,050, and 1,700 ppm and K at 117, 225, and 704 ppm in the second experiment. Nutrient solutions were applied weekly.

At the termination of each experiment, three plants per treatment of each block were cut at the soil line and weighed. Young, expanding tissue, generally one leaf per plant, was separated from the remaining mature tissue and analyzed separately. Leaves combined with petioles were washed in distilled water, dried at 70 C for 48 hr, and ground in a 20-mesh stainless steel Wiley mill. Total N was determined by a modified Kjeldahl procedure (2) and K by flame spectrophotometry. Fresh weights and leaf content data were analyzed by an LSD mean separation test where an analysis of variance test showed significance at the 0.05 level of confidence.

Four plants per treatment of each block in both experiments were taken to a greenhouse with temperature and relative humidity ranges of 22–28 C and 40–100%, respectively. Wounded and unwounded leaves were inoculated by being sprayed with an atomizer at 10 psi to runoff with 2×10^8 colony-forming units per milliliter as previously described (6). Plants were placed in a mist chamber maintained at 100% RH by intermittent mist for 24 hr, after which time they were placed on a greenhouse bench. Disease severity ratings (DSR) based on a 1–7 scale where 7 was most severe (6) were made 7 days after inoculation.

RESULTS AND DISCUSSION

Data concerning N and K tissue contents of mature leaves are presented in this paper because mature leaves are much more susceptible to *E. chrysanthemi* than young, expanding leaves (5). Fresh weights were reflections of plant quality, as the most desirable plants for commercial purposes were those with the highest fresh weights. Leaf numbers varied from six to eight for treatments in both experiments.

There was no significant interaction between the applied N and K levels on the foliar content of N or K, but there were significant differences due to main effects (N and K levels) (Table 1). Tissue content of N increased significantly as N levels increased from 28 to 490 ppm but not from 490 to 910 ppm. Increased N application at the higher rates resulted in increased uptake and growth such that the concentration of N remained constant. Increased N from the low to high levels caused a decrease in K content. Applied K levels had no effect on N tissue content, but increases from 0 to 704 ppm increased K contents significantly.

Increased N levels resulted in significantly higher fresh weights at all K levels (Fig. 1). K levels had no effect on fresh weight when N was applied at 28 ppm. However, at N levels of 490 and 910 ppm, the higher K levels resulted in significantly higher fresh weights, but an increase of the K level from 352 to 704 ppm had no effect on fresh weights.

Varying levels of N and K had similar effects on DSR of wounded and unwounded leaves (Fig. 2). Increased K levels resulted in elevated DSR at the lower N levels but had no effect on DSR at the high N level. At lower K levels, increased N levels from 28 to 490 ppm caused an increase in DSR. However, at the K level of 704 ppm, an increase in N levels from 28 to 490 ppm resulted in increased DSR, whereas an increase in N levels from 490 to 910 ppm resulted in significantly lower DSR.

Results of the first experiment confirmed data obtained in the preliminary experiment that indicated that N and K rates significantly influenced disease severity. Data from this experiment showed that increased K levels at lower N levels resulted in increased DSR whereas K levels had no effect on DSR at the highest N level. Also, an increase of the N level from 490 to 910 ppm at the highest K level resulted in decreased DSR. This experiment reemphasized the importance of N and K levels on the growth of *P. selloum*.

P. selloum seedlings were grown in 15-cm pots in the second experiment to determine whether excessive rates of N could be applied under typical commercial conditions to reduce disease severity without decreasing plant growth and quality.

There was no interaction of significance in the second experiment between applied N and K levels in relation to DSR or to N and K contents of mature leaves. Variances due to each main effect (N and K level) were significant in relation to DSR and tissue N and K contents of leaves (Table 2). Similar trends in DSR were observed on wounded and unwounded leaves as was also the case in the previous experiment. No significant differences in DSR were detected between treatments receiving 350–1,050 ppm N in which N content of leaves increased and K levels decreased. However, there was a significant decrease in DSR of wounded leaves after the N level was increased from 1,050 to 1,700 ppm. This increase resulted in an increased K tissue content but had no effect on N content. No differences in disease severity ratings occurred between treatments receiving K at 117 and 225 ppm. An increase of K level from 225 to 704 ppm resulted in a significant increase in DSR of unwounded leaves and a trend toward increased DSR of wounded leaves. Increased K levels did not affect N tissue content but caused significantly higher K tissue contents. The same phenomenon was observed in the prior experiment and in experiments with *P. scandens* subsp. *oxycardium* (3).

Increases in K levels generally resulted in high *P. selloum* fresh weights (Fig. 3). This was also observed in the previous experiment and in experiments with *P. scandens* subsp. *oxycardium* (3,4). An increase in the N level from 350 to 700 ppm had little effect on fresh weight when applied with K at 117 and 704 ppm. N levels above 700 ppm usually resulted in significantly lower fresh weights at all K levels. The application of excessive N rates to *P. scandens* subsp. *oxycardium* also caused reductions in fresh weight (3,4).

Fresh weights as well as N and K tissue contents were higher in the second experiment than in the first one. Pot size evidently has a direct relationship to fertilization rates. *P. selloum* grown in 10-cm pots would probably require higher rates or more frequent applications of fertilizer to achieve the same growth rates as plants grown in 15-cm pots

Table 1. Influence of three nitrogen (N) and three potassium (K) rates on N and K tissue content of *Philodendron selloum* grown in 10-cm pots

Treatment (ppm)	Mean % of dry weight leaf tissue N	K
Nitrogen		
28	1.78 a[z]	5.23 b
490	2.72 b	2.74 a
910	2.68 b	2.63 a
Potassium		
0	2.34 a	2.27 a
352	2.48 a	3.78 b
704	2.37 a	4.53 c

[z] Means within columns followed by the same letter are not significantly different ($P = 0.05$) as calculated by the method of least significant difference.

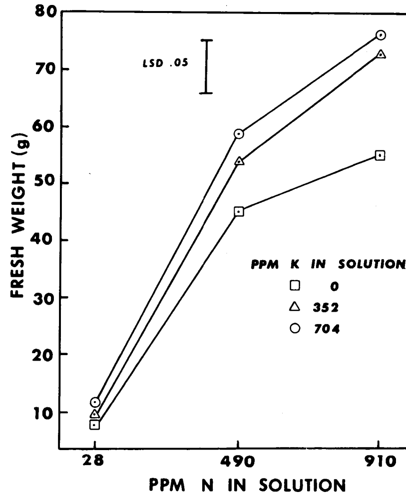

Fig. 1. Influence of three nitrogen and three potassium rates on fresh weight of *Philodendron selloum* grown in 10-cm pots.

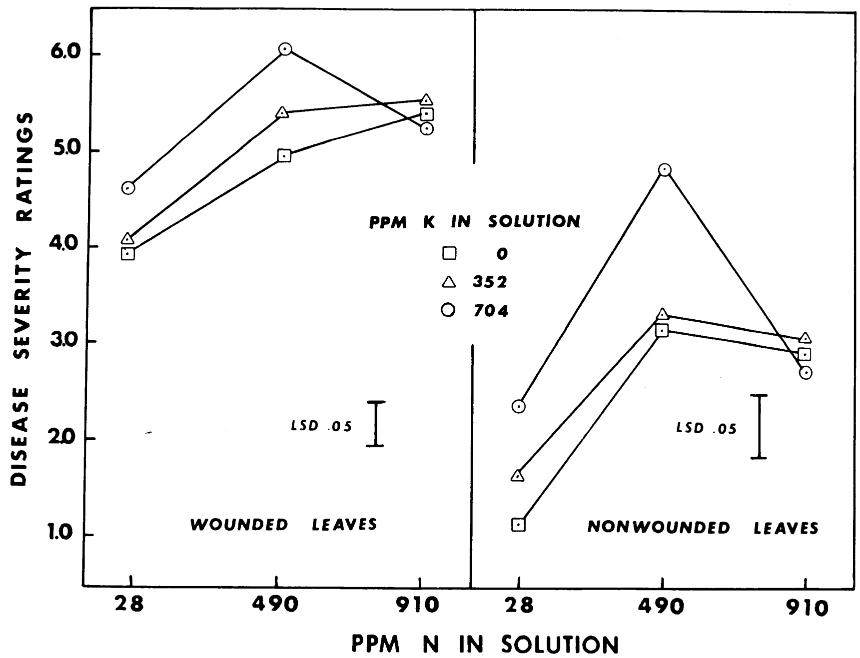

Fig. 2. Influence of three nitrogen and three potassium rates on bacterial leaf blight of *Philodendron selloum* grown in 10-cm pots. Disease severity ratings were made 7 days after inoculation with *Erwinia chrysanthemi* at 2×10^8 colony-forming units per milliliter and were based on a 1–7 scale with 1 being no disease and 7 being most severe disease.

Table 2. Influence of four nitrogen (N) and three potassium (K) rates on bacterial leaf blight and N and K content of *Philodendron selloum* grown in 15-cm pots

Treatment (ppm)	Mean disease severity rating of leaves[y]		Mean % of dry weight leaf tissue	
	Wounded	Unwounded	N	K
Nitrogen				
350	4.99 b[z]	2.76 a	3.19 a	3.79 c
700	4.85 ab	2.90 a	3.75 b	3.38 b
1,050	5.22 b	3.18 a	3.95 c	2.95 a
1,700	4.22 a	2.81 a	3.92 c	3.37 b
Potassium				
117	4.79 a	2.68 a	3.76 a	2.15 a
225	4.59 a	2.58 a	3.71 a	3.07 b
704	5.08 a	3.48 b	3.66 a	4.90 c

[y] Values are average disease severity ratings based on a 1–7 scale with 1 being no disease and 7 being most severe disease of 24 different leaves 7 days after inoculation with *Erwinia chrysanthemi*.
[z] Means within columns followed by the same letter are not significantly different ($P = 0.05$) as calculated by the method of least significant difference.

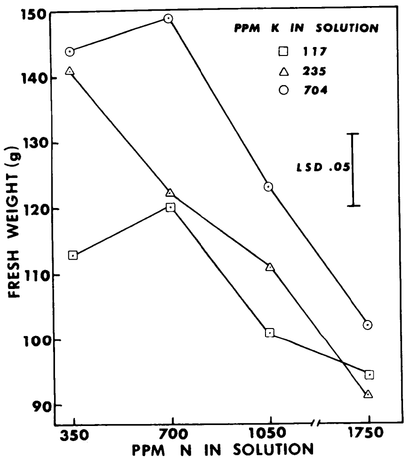

Fig. 3. Effects of four nitrogen and three potassium levels on growth of *Philodendron selloum* in 15-cm pots.

because of limited media volume and heavy leaching. Other differences caused by pot type that might have a bearing on results of this study are a) the higher light intensity immediately inside the wall of the plastic pots and b) the higher rate of evaporation of water from soil in clay pots, which might lower the soil temperature.

Increasing N fertilization has been found to reduce disease severity of at least four other bacterial diseases (1,3,8,10). An increase in the N level from 490 to 910 ppm when applied with K at 704 ppm significantly reduced DSR and increased the fresh weight of *P. selloum* grown in 10-cm pots. However, DSR of *P. selloum* grown in 15-cm pots was reduced only after the application of N at 1,700 ppm. Unfortunately, N toxicity levels were reached at this extremely high N level, and plant growth was greatly reduced. Therefore, it does not appear likely that BLB of *P. selloum* can be decreased by manipulation of N and K fertilization rates under normal commercial practices. There was a weak trend in this study whereby increased levels of K caused increased disease severity. In most cases, no significant effect was found.

Increases in the applied concentration of N and K resulted in changes in the uptake of some other nutrient elements. Increased K application was associated with decreased magnesium and manganese levels in the plants, whereas increased N application resulted in increased iron, manganese, and zinc concentrations in the tissue. The K interactions were probably the result of an uptake antagonism. The N interactions most likely related to a drop in root medium pH caused by increased application of ammonium nitrate. In all cases, the interacting nutrients remained within an acceptable concentration range for greenhouse crops in general. It seems unlikely that the changes in these other nutrients had an effect upon the disease in question.

Maximum growth was obtained with applications of N at 350 and 700 ppm in combination with K at 704 ppm. The contents of N and K in mature tissue resulting from these treatments ranged from 3.1 to 3.7% and 3.3 to 5.6%, respectively. These ranges might serve as tentative optimum standards for tissue N and K contents until more definite studies are conducted.

Some interesting phenomena are shared by *P. selloum* and *P. scandens* subsp. *oxycardium*: a) young, expanding leaves are more resistant to bacterial pathogens than mature tissue (3,5); b) increased levels of N result in decreased DSR of some bacterial and fungal diseases (3,4); and c) increased levels of K often result in increased DSR of BLB of *P. selloum* and Phytophthora leaf spot of *P. scandens* subsp. *oxycardium* (4). These phenomena are atypical of a larger percentage of host-pathogen relationships and should lead to some productive research.

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