# Effect of Air and Growing Medium Temperatures on Rhizoctonia Foot Rot of *Epipremnum aureum*[1]

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## Abstract

Air and growing medium temperatures affected severity of foot rot of *Epipremnum aureum* (pothos) caused by *Rhizoctonia solani* AG4. Maximum daily temperatures of 30°C (86°F) for either air or soil resulted in optimal disease development. Maximum daily temperatures of 35°C (95°F) decreased disease development significantly due to fungal pathogen growth reduction. A continuous temperature of 30°C (86°F) was also too high for significant disease development.

**Index words:** disease control, fungicides, pothos.

## Significance to the Nursery Industry

Fungicides for control of Rhizoctonia diseases should be applied when optimal temperatures for foot rot of pothos occur (between about 22°C [72°F] and 30°C [86°F]) and perhaps just prior to seasons when such temperatures are expected. Continuous air or growth medium temperatures of 30°C (86°F) or maximum temperatures above 35°C (95°F) result in decreased severity of foot rot and it may be advisable to allow greenhouse temperatures to reach 35°C (95°F). In addition, use of bottom heat during the winter months should be avoided since growing medium temperatures of 30°C (86°F) or higher, which are necessary to reduce foot rot severity, would also reduce pothos growth.

## Introduction

Foot rot of *Epipremnum aureum* Andre Bunt (pothos) was described by Millikan in 1955 (6). The disease, caused by *Rhizoctonia solani* Kuehn AG4, remains the most common disease on pothos. Mycelia of *R. solani* grow onto stems, petioles and leaves of pothos but most frequently cause a foot (petiole) rot near the growing medium. Foliage infections can occur, resulting in necrotic lesions on leaves. The spiderweb-like mycelia which is so common on aerial blight diseases caused by this pathogen rarely occur on pothos.

Air and soil temperatures affect severity of several diseases of foliage plants including Myrothecium leaf spot of *Dieffenbachia maculata* 'Perfection' (3), Cylindrocladium root and petiole rot of *Spathiphyllum* sp. (4), and Rhizoctonia aerial blight of *Nephrolepis exaltata* (Boston fern) (2). Rhizoctonia aerial blight of Boston fern, also caused by *R. solani* AG4, was significantly reduced when air temperatures exceeded 35°C (95°F) or growing medium temperatures were 32°C (90°F) (2). Both air and growing medium temperatures affect diseases caused by Rhizoctonia-like organisms since these pathogens are soil-borne but can cause disease of aerial portions of the plant. The following tests were performed to evaluate the effects of air and growing medium temperatures on severity of Rhizoctonia foot rot of pothos.

[1]Received for publication January 8, 1990; in revised form April 6, 1990.
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## Materials and Methods

Growing medium temperatures were maintained in special control chambers (5). Four growing medium temperatures (21, 24, 27, and 30°C [70, 75, 80, and 85°F]) were set with four maximum air temperatures (30, 32, 34, and 36°C [86, 90, 93, and 97°F]) for the duration of each test (2 weeks each). Actual temperatures were recorded daily at 8:00 am and 2:00 pm. Two isolates of *Rhizoctonia solani* AG4 were employed to complete the 4 × 4 × 2 factorial experiment. The isolates of *R. solani* were 86–91 from pothos and 87–46 from *Impatiens* sp. Six plants per treatment were included in each of three tests performed between June 14 and August 21, 1989.

Rooted pothos cuttings of a uniform size were obtained from a commercial producer and planted in 15 cm (6 in) plastic pots containing the following growing medium: Canadian peat and pine bark (1:1 by vol) amended with 3.4 kg/m$^3$ (7.5 lb/yd$^3$) dolomite, 0.45 kg/m$^3$ (1.0 lb/yd$^3$) Micromax (micronutrient source from Sierra Chemical Co., Milpitas, CA 93035), and top-dressed with 2.5 g Osmocote 19N-2.6P- 9.9K (19-6-12), slow-release fertilizer from Sierra Chemical Co. Plants were inoculated two days after growing medium temperature treatments were established. Inoculum of each *R. solani* isolate was grown on PDA (Difco potato dextrose agar) medium at 26°C (78°F) for 4 days prior to use. A mycelial slurry of each isolate was prepared by blending each plate in 200 ml of sterilized water. Ten ml of the slurry were added to the growing medium surface of each plant and watered in lightly. Temperatures were recorded for three pots per treatment at about 8:00 am and again at 2:00 pm each day. Ten days after inoculation the number of leaves with petiole rot was recorded.

The effect of constant temperature on disease development was tested with isolate 86–91. Plants were transferred to Percival Plant Growth Chamber E 30B's, 2 days prior to inoculation. Five plants at each temperature were inoculated as described above and completely enclosed in polyethylene bags for the test period. Continuous temperatures tested were: 10, 15, 20, 25, 30, and 35°C (50, 59, 68, 77, 86, and 95°F). Light levels of approximately 8 $\mu mols^{-1}$ $m^{-2}$ (50 ft-c) were maintained between 8:00 am and 8:00 pm. The percentage of plant with foot rot symptoms was determined after 10 days. This test was performed three times.

A second series of tests was performed in the growth

chambers to determine the effect of exposure time at 30°C (86°F) on disease expression. Temperature regimes were as follows: 0, 4, 8, 12, 16, 20 and 24 hr at 30°C (86°F). The remainder of the time each day was set at 25°C (77°F). Light conditions were those described above. Plants were inoculated as described and the test was performed three times.

The effect of temperature on *in vitro* growth of the *R. solani* isolates was evaluated in two tests. A single inoculum plug of a 4 day-old culture (5 mm [0.2 in] in diameter) cut from the advancing edge of the colony was placed in the center of a PDA plate. Five plates of each isolate were incubated at each of the following temperatures in a Percival Plant Growth Chamber E 30B: 5, 10, 15, 20, 25, 30, and 35°C (41, 50, 59, 68, 77, 86, and 95°F). Cultures were wrapped in foil and placed in a polyethylene bag during incubation. Radial growth was measured at 24 and 48 hr. This test was performed twice.

## Results and Discussion

Both air and growing medium temperatures affected severity of foot rot of pothos in the three tests. In each test, the actual mean high air temperatures are given for the four air temperature treatments. Mean maximum air temperature at 2:00 pm ranged from a low of 30.7°C (87.3°F) to a high of 36.2°C (97.2°F) in test 1, 32.2°C (89.9°F) to 36.1°C (97.0°F) in test 2 and 31.3°C (88.4°F) to 36.1°C (97.0°F) in test 3 (Table 1). In general, foot rot severity was significantly reduced when maximum air temperature was above 34.4°C (94°F) (Table 1). This was true for each of the three tests and both isolates of *R. solani* AG4. Growing medium temperatures also differed slightly between tests but were generally closer to those desired than the air temperatures. Mean growing medium temperatures ranged from about 22°C (72°F) to 31°C (88°F) in each of the test (Table 1). Severity of foot rot of pothos was less when the growing medium temperature exceeded 30°C (86°F) in each test (Table 1). Differences between isolates were significant in only one of the three tests and significance of interactions between the three factors (air and growing medium temperatures and isolate) was inconsistent.

In growth chambers maintained with constant temperatures, severity of foot rot of pothos was highest between 15°C (59°F) and 30°C (86°F) (Table 2). Generally, the optimum constant temperature was about 25°C (77°F). Since a maximum temperature of 35°C (95°F) was favorable for development of foot rot of pothos in greenhouse and growth chamber trials, the effect of varying exposure to 35°C (95°F) on development of foot rot was tested. A minimum exposure period of 4 hours at 35°C (95°F) resulted in no disease development (data not shown). Further testing with a minimum temperature of 25°C (77°F) and a maximum of 30°C (86°F) showed that the more time plants were incubated at 30°C (86°F) the lower the disease severity (Table 3). *In vitro* growth of the pathogen was highest at a constant temperature of 30°C (86°F) and was reduced at 35°C (95°F) (Table 4).

It is apparent from these studies that when a daily maximum temperature reaches 30°C (86°F) development of foot rot of pothos is excellent, but when temperatures are constantly 30°C (86°F) or the maximum temperature exceeds 30°C (86°F), the pathogen cannot grow adequately and disease severity is reduced. As little as 4 hours exposure to 35°C (95°F) can limit disease development.

**Table 1. Effect of growing medium temperatures and maximum air temperatures on severity of foot rot of *Epipremnum aureum* caused by *Rhizoctonia solani* AG4 isolates.**

| Test 1 | | | Test 2 | | | Test 3 | | |
|---|---|---|---|---|---|---|---|---|
| Air temperature | Isolate | | Air temperature | Isolate | | Air temperature | Isolate | |
| °C (°F) | 86–91 | 87–46 | °C (°F) | 86–91 | 87–46 | °C (°F) | 86–91 | 87–46 |
| | (# dead leaves) | | | (# dead leaves) | | | (# dead leaves) | |
| 30.7 (87.3) | 3.8 | 3.6 | 32.2 (89.9) | 2.0 | 0.9 | 31.3 (88.4) | 0.1 | 0.2 |
| 34.0 (93.2) | 3.6 | 4.2 | 32.4 (90.4) | 2.2 | 1.4 | 32.2 (89.9) | 0.2 | 0.4 |
| 35.7 (96.2) | 1.2 | 1.7 | 34.4 (94.0) | 2.6 | 2.7 | 34.4 (93.9) | 1.7 | 2.7 |
| 36.2 (97.2) | 1.4 | 2.0 | 36.1 (97.0) | 1.6 | 0.7 | 36.1 (97.0) | 1.2 | 0.5 |
| Growing medium temperature | Isolate | | Growing medium temperature | Isolate | | Growing medium temperature | Isolate | |
| °C (°F) | 86–91 | 87–46 | °C (°F) | 86–91 | 87–46 | °C (°F) | 86–91 | 87–46 |
| | (# dead leaves) | | | (# dead leaves) | | | (# dead leaves) | |
| 22.4 (72.3) | 2.6 | 2.4 | 22.1 (71.8) | 3.6 | 2.0 | 24.6 (76.2) | 1.2 | 1.2 |
| 23.6 (74.5) | 2.8 | 2.4 | 23.7 (74.6) | 2.8 | 1.9 | 25.2 (77.4) | 1.4 | 1.7 |
| 30.0 (86.0) | 2.9 | 4.0 | 30.3 (86.6) | 1.4 | 1.0 | 30.2 (86.3) | 0.3 | 0.6 |
| 31.2 (88.1) | 1.6 | 2.8 | 31.3 (88.3) | 0.7 | 0.8 | 31.7 (89.0) | 0.4 | 0.4 |

| Significance[z] | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Air temperature (A) | <u>0.0001</u> | <u>0.0001</u> | <u>0.0001</u> |
| Soil temperature (S) | <u>0.0059</u> | <u>0.0001</u> | <u>0.0001</u> |
| Isolate (I) | 0.1035 | <u>0.0002</u> | 0.3015 |
| A × S | 0.1028 | 0.1749 | <u>0.0009</u> |
| A × I | 0.6138 | 0.0522 | <u>0.0003</u> |
| S × I | <u>0.0343</u> | <u>0.0148</u> | 0.8256 |
| A × S × I | 0.0977 | 0.6097 | 0.3292 |

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

**Table 2. Effect of continuous temperature on severity of foot rot of pothos (*Epipremnum aureum*) caused by *Rhizoctonia solani* AG4.**

| Temperature °C (°F) | Mean no. diseased leaves ± SD[z] | | | |
|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Test mean[y] |
| 10 (50) | 1.2 ± 0.4 | 1.0 ± 0 | 1.0 ± 0 | 1.1 ± 0.1 |
| 15 (59) | 2.6 ± 0.5 | 1.0 ± 0 | 1.8 ± 0.4 | 1.8 ± 0.3 |
| 20 (68) | 3.2 ± 0.8 | 2.2 ± 0.4 | 3.4 ± 0.5 | 2.9 ± 0.5 |
| 25 (77) | 3.2 ± 1.3 | 2.2 ± 0.8 | 3.8 ± 1.1 | 3.1 ± 0.4 |
| 30 (86) | 1.6 ± 0.9 | 2.0 ± 0.7 | 2.4 ± 0.5 | 2.0 ± 0.4 |
| 35 (95) | 1.0 ± 0 | 1.4 ± 0.5 | 1.0 ± 0 | 1.1 ± 0.2 |

[z]Mean number of diseased leaves per five pots with the standard deviation (SD).
[y]Overall means for the three tests with a significance level of Pr > F (0.0001).

**Table 3. Effect of exposure to 30°C (86°F) on severity of foot rot of pothos (*Epipremnum aureum*) caused by *Rhizoctonia solani* AG4.**

| No. hours at 25°C (77°F) | 30°C (86°F) | Mean no. diseased leaves ± SD[z] | | | |
|---|---|---|---|---|---|
| | | Test 1 | Test 2 | Test 3 | Test mean[y] |
| 24 | 0 | 1.0 ± 1.0 | 2.2 ± 0.8 | 1.4 ± 1.9 | 1.5 ± 0.5 |
| 20 | 4 | 1.8 ± 1.9 | 2.8 ± 0.8 | 2.0 ± 1.2 | 2.2 ± 0.8 |
| 16 | 8 | 1.4 ± 1.9 | 2.6 ± 2.3 | 1.4 ± 1.3 | 1.8 ± 0.8 |
| 12 | 12 | 1.2 ± 1.3 | 2.4 ± 1.5 | 0.8 ± 1.3 | 1.5 ± 0.6 |
| 8 | 16 | 1.2 ± 1.3 | 2.4 ± 1.5 | 0 | 1.2 ± 0.4 |
| 4 | 20 | 0.4 ± 0.5 | 1.4 ± 1.1 | 0.4 ± 0.5 | 0.7 ± 0.5 |
| 0 | 24 | 0.2 ± 0.4 | 0.8 ± 0.8 | 0.4 ± 0.5 | 0.5 ± 0.3 |

[z]Mean number of diseased leaves per five pots with the standard deviations (SD).
[y]Overall means for the three tests with a significance level of Pr > F (0.0015).

**Table 4. Effect of temperature on radial growth of *Rhizoctonia solani* AG4 isolates 86–91 and 87–46 on potato dextrose agar medium.**

| Temperature °C (°F) | Mean radial growth ± SD (mm)[z] | |
|---|---|---|
| | 86–91 | 87–46 |
| 5 (41) | 5.0 ± 0[y] | 5.0 ± 0[y] |
| 10 (50) | 5.0 ± 0 | 5.1 ± 0.3 |
| 15 (59) | 32.7 ± 4.7 | 25.2 ± 5.8 |
| 20 (68) | 46.5 ± 4.1 | 49.7 ± 6.6 |
| 25 (77) | 72.5 ± 7.3 | 76.1 ± 5.4 |
| 30 (86) | 77.1 ± 3.9 | 82.8 ± 2.4 |
| 35 (95) | 31.0 ± 2.7 | 35.5 ± 6.8 |

[z]Mean radial growth for 10 plates with the standard deviation (SD).
[y]Pr > F (0.0001).

While optimum air temperature is not known for pothos growth, tests with growing medium temperature indicate that rooting of pothos cuttings is affected by temperature (1). Faster rooting occurred at 21°C (70°F) minimum air temperature compared to 16°C (60°F) minimum air temperature (7, 8, 9). A maximum air temperature of 33°C (90°F) is recommended to maintain good plant growth (10).

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