Characterizing the Phytotoxic Effects of Hydrogen Peroxide Root Dips on *Phalaenopsis* Orchids

Renata Goossen & Kimberly A. Williams
Department of Horticulture and Natural Resources, Kansas State University

Introduction

- Hydrogen peroxide (H_2O_2) is used as a remedy by consumers to treat pathogenic microorganisms and encourage the overall health of interior plants (e.g. Bottom, 2017, Johnson, n.d.).
- Epiphytic roots have an absorptive complex (velamen and exodermis cells) that passively takes in moisture and mineral nutrients and protects from dehydration and physical damage (Bercu et al., 2011).
- Like most home remedies, using H_2O_2 on orchid roots has not been investigated in a controlled study to determine safety or efficacy of use.

Research Objective: Determine the physical effects of H_2O_2 on phalaenopsis roots, and the rate at which it becomes phytotoxic, focusing on phytotoxicity development and not treatment efficacy. Secondarily, we studied the effects related to plant longevity and algae reduction in the root zone after treatment with H_2O_2.

Materials & Methods

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- *Phalaenopsis* 'Vivaldi' hybrids were sourced from Green Circle Growers (Oberlin, OH), shipping on January 25, arriving on January 29. Plants were acclimated for 3 weeks before the experiment start date on February 23.
- Blubonic 12% Food Grade Hydrogen Peroxide was sourced and diluted to create 3% and 6% concentrations. Dilutions were mixed using reverse osmosis water. Because H_2O_2 degrades over time, especially after the bottle seal is broken, bottles were ordered and used directly after opening.
- ANOVA was evaluated using JMP Pro ver. 15.1.0 (SAS Institute)
- All rates were applied to roots using a 3-minute subirrigation dip.

Experiment Design

Four H_2O_2 rates [rate 1 (control)=0 ppm; rate 2=30,000 ppm (3%); rate 3=60,000 ppm (6%); rate 4=120,000 ppm (12%)] applied once to phalaenopsis hybrids (4 trts x 4 reps = 16 pots).

Figure 1. Close-up of the H_2O_2 reaction during treatment.

Figure 2. Post-treatment data collection.

Data Collected

On days 0-7 & 10 after treatment (DAT):
- % Visible Root Damage
- Root Health Ratings (1-Poor; 5-Healthy)

On days 0-7, 10, 14, 16, 20 & 27 after treatment:
- % Visible Foliage Damage
- Foliage Health Ratings (1-Poor; 5-Healthy)
- % Leaf Wilt
- Flower/Bud Count

On day 27 after treatment:
- Final Root, Foliage and Flower Fresh & Dry Weights

Growing Conditions

- Temperature Set Point: D/N = 20°C (70°F) to mimic consumer interior growing environment
- Lighting: natural day length with 50% white shade cloth; 10 DAT shade cloth was doubled to further reduce light intensity
- Containers & Media: clear plastic 5" with bottom drainage; pine bark medium
- Plants were fertilized once upon arrival with ~100 ppm N from 20-10-20 and irrigated overhead daily.

Results

Table 1. Final data taken on 10 DAT (roots) and 27 DAT (foliage, flowers, fresh/dry weights).

H_2O_2 Rate	Root Health Rating (**Fig. 4**)	% Visible Root Damage	Fresh Root Weight (g)	Dry Root Weight (g)	Foliage Health Rating (**Fig. 4**)	% Visible Foliar Damage	% Foliar Wilt	Fresh Foliage Weight (g)	Dry Foliage Weight (g)	Algae Control (**Fig. 8**)	Root Initials (**Fig. 6**)
0%	5.0 a	0.0% a	77 a	6.2 a	5.0 a	0.0% a	0.0% a	132 a	8.6 a	No	Yes
3%	4.1 a	7.0% a	68 a	5.7 a	4.9 a	0.0% a	21.7% a	121 ab	8.0 a	No	Yes
6%	1.8 b	66.3% b	47 b	5.0 ab	3.5 b	27.5% ab	81.3% b	93 bc	7.0 a	Yes	No
12%	1.1 b	83.8% b	35 b	4.1 b	2.1 c	62.5% b	91.7% b	86 c	7.1 a	Yes	No

Means were compared using Tukey's HSD at a probability level of 0.05.

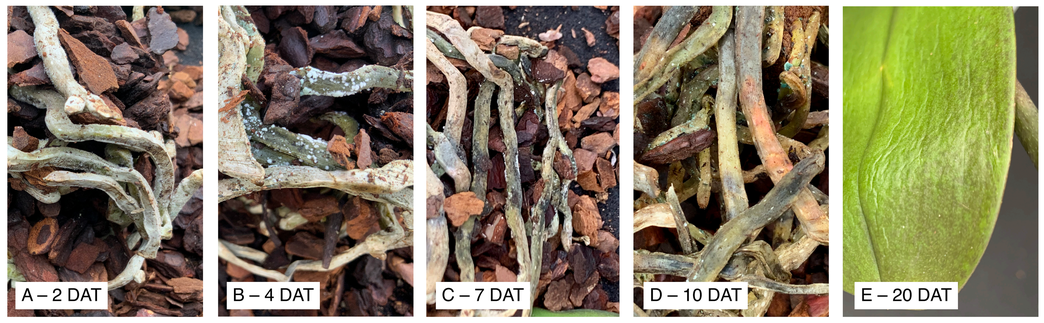

Figure 3. Phytotoxicity symptoms caused by H_2O_2 included: (A) wrinkled, dehydrated roots; (B) salt excretion on root surfaces; (C) algae death; (D) orange, brown and black discoloration and eventual decay; and (E) foliage wilt.

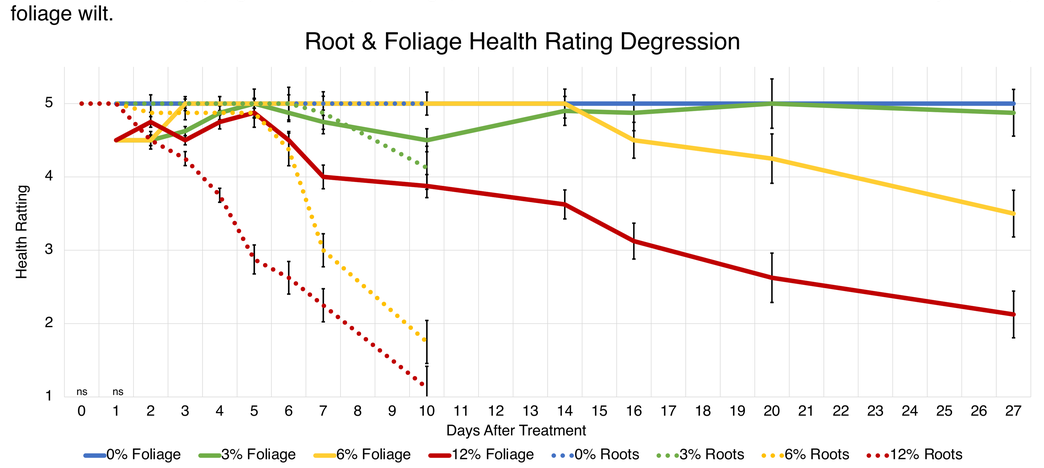

Figure 4. Root health ratings of each H_2O_2 rate are plotted against foliage health ratings (n=4; standard error bars shown around each mean).

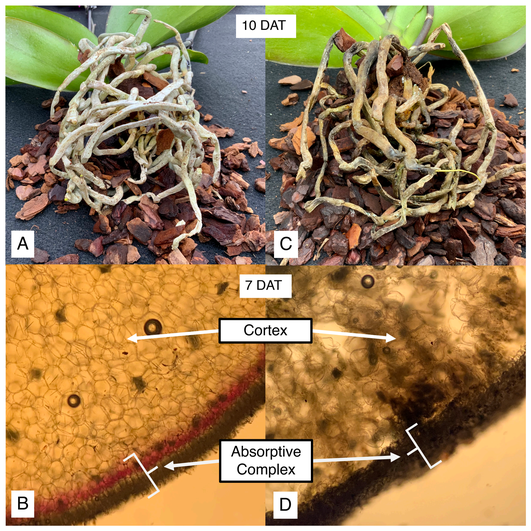

Figure 5. Macro- and microscopic comparisons of the roots of a control orchid (A & B) and an orchid treated with 12% H_2O_2 (C & D).

Figure 6. Root initial (circled) present in 3% treatment on 10 DAT.

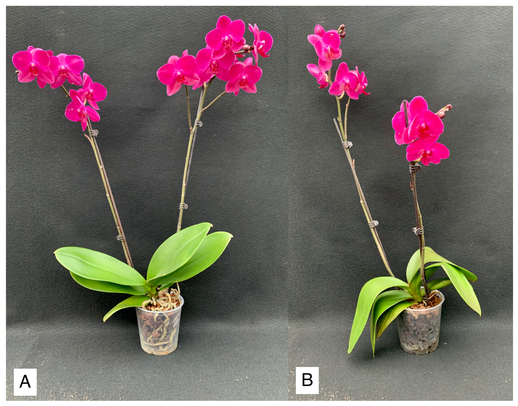

Figure 7. Comparison of the same orchid treated with 12% H_2O_2 on 0 DAT (A) and 27 DAT (B).

Figure 8. Comparison of algae health in the 12% treatment on 1 DAT (A) and 7 DAT (B).

Discussion

Phytotoxicity symptoms caused by H_2O_2 sequentially progressed as shown in **Figure 3.**

While root and foliage health decreased as H_2O_2 concentration increased, a significant effect on flowers was not seen during the duration of the trial (**Table 1 & Figure 4**; flower data not shown).

The roots of the orchids treated with 6% or 12% H_2O_2 were damaged beyond recovery leading to root death **(Table 1 & Figures 4, 5 & 7).** Severe decay in the roots' outer cellular layers (rhizodermis, velamen, exodermis and inner cortex) resulted but had not reached the endodermis and conductive tissue by 10 DAT. Even though the conductive tissue remained intact, because the outer root layers decayed, roots failed to support the plant **(Figure 5).**

While 3% H_2O_2 did result in minor symptoms of root discoloration, wrinkling and decay, viable roots were still retained. Though few as compared to the control, new root initials were present when final data was collected **(Table 1 & Figure 6).** Long-term phytotoxic effects associated with a single 3% H_2O_2 root dip is difficult to project, but our observations indicate that orchids treated with this rate have potential to rebound.

Algae was not completely killed using a single 3% H_2O_2 root dip **(Table 1),** bringing into question the potential efficacy of using H_2O_2 to treat microorganisms in the root zone with a single application. Further study would be necessary to determine treatment efficacy.

H_2O_2 root dips have the potential to cause root failure rather than treat roots and encourage growth. Even 3% H_2O_2 caused limited health decline in the root zone, potentially setting back plant health rather than boosting it **(Table 1 & Figure 4).**

Conclusion

Based on these results, 3% is the maximum H_2O_2 concentration that should be considered for application to phalaenopsis orchids as a single root dip to avoid causing complete root failure. While 3% H_2O_2 did not result in severe symptoms of phytotoxicity, long-term plant health effects are unknown.

The larger issue is that the mode of action of H_2O_2 as a surface disinfectant is not well-matched with the anatomy of epiphytic orchid roots. Rather than treating root decay, H_2O_2 has the potential to cause or further root decay.

For these reasons, we do not believe that H_2O_2 should be recommended as a home remedy for root decay on phalaenopsis orchids.

References

Bercu, R., Bavaru, A., & Broasc, L. (2011). Anatomical aspects of Phalaenopsis amabilis (L.) Blume. *Ann. Rom. Soc. Cell Bio.* 16(2): 102-109.

Bottom, S. (2017). *Hydrogen peroxide*. St. Aug. Orchid Soc.

Johnson, K. (n.d.). *How to cure root rot with hydrogen peroxide*. Hunker.

Acknowledgments

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