Progress Report

Treatments to Enhance Resistance of Cut Rose Flowers to *Botrytis* Disease

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EXECUTIVE SUMMARY

The longevity and marketability of many cut flower species is often reduced by infection with the fungal pathogen *Botrytis cinerea*. Synthetic chemical fungicides have long been relied on to provide protection against *Botrytis* disease. However, there are increasing social and environmental concerns over their continued use. In the present study, we are investigating the potential of several alternative compounds for their capacity to provide a safer and more environmentally-friendly method for reducing *Botrytis* on cut rose flowers.

We previously showed (January 2008 report) that several relatively benign chemicals (benzoic acid, hydrogen peroxide, a proprietary oxidizer) could reduce *Botrytis* infection on rose flowers when applied as postharvest dip treatments. A 'soft' fungicide produced by Syngenta called Palladium 62.5 WG (a.i. cyprodinil and fludioxinil) was also highly effective in reducing the incidence of *Botrytis* on rose flowers. With a view to realizing the full benefits of Palladium treatment for the flower industry, we recently focused on determining (1) the optimal concentration for dip treatment, (2) its potential for use as an uptake treatment, and (3) its efficacy as a pre-harvest treatment. The results of these experiments are reported herein.

In the first experiment, 'Gold Strike' rose flowers were dipped in 0, 1, 4, 8, 16, 24 and 32 ounces Palladium/100 gallons for 10 seconds at 20 °C. Stems were then held in vase solution at 20 °C and 90% relative humidity. We found that the optimal concentrations for reducing *Botrytis* infection were 16 and 24 ounces Palladium/100 gallons. In the second experiment, 'Akito', 'Gold Strike' and 'Orlando' rose flowers were maintained in a hydration solution containing 16 ounces Palladium/100 gallons for 16 hours at 20 °C. Additional flowers were dipped in the same Palladium solution for 10 seconds before placement in a regular hydration solution. Treatment with Palladium either as a dip or uptake solution significantly reduced the incidence of *Botrytis* on flowers of all three varieties during vase life at 20 °C. In the third experiment, Palladium (4 ounces/100 gallons) and a fenhexamid-based fungicide, Elevate (5.6 grams/gallon), were applied to greenhouse-cultivated 'Akito' and 'Gold Strike' rose plants once per week for 2 weeks prior to harvest. Following harvest and storage at 0 °C for 1 week, there was no significant difference in infection rates for flowers treated with either fungicide as compared to non-treated stems. Our results suggest these fungicides only offered short-term activity under greenhouse conditions.

The results of our current study highlight an exciting opportunity to optimize the effectiveness of Palladium pre- and postharvest treatments for the control of *Botrytis* disease on cut rose flowers. Our research will also continue to evaluate the potential of other promising fungistatic compounds to reduce *Botrytis* infection. A key component of our work will be to maximize treatment activity through determining the optimal application time and conditions.

SUMMARY OF WORK COMPLETED

Palladium 62.5WG (Syngenta) is a commercial pre-mix fungicide containing cyprodinil and fludioxinil. These active ingredients operate via separate modes of action, which may reduce the risk of fungal pathogens like *Botrytis cinerea* from developing resistance. The pre-mix combination of cyprodinil and fludioxinil has been widely used under the name 'Switch' for strawberries and grapes since the mid-1990s. We detail below our recent investigation into the potential of 'Palladium' to control *Botrytis* infection on cut rose flowers.

1. Determine optimal Palladium concentration to control *Botrytis*

Our previous findings indicated that dip-treating cut rose flowers in solutions containing up to 4 ounces Palladium per 100 gallons of water were effective in reducing *Botrytis* infection. In the present experiment, we determined if use of higher Palladium concentrations would enhance treatment efficacy. 'Gold Strike' flower stems were transported from a Californian grower to our laboratory within 3-4 hours. Flowers were dipped to a depth of 10 cm in 0, 1, 4, 8, 16, 24 and 32 ounces Palladium/100 gallons for 10 seconds at 20 °C. All stems were then placed into a commercial vase solution and maintained at 20 °C and 90% relative humidity for evaluation. The optimal concentrations for reducing *Botrytis* infection were 16 and 24 ounces Palladium (**Fig. 1**). Treatment with 32 ounces Palladium/100 gallons caused damage to petals.

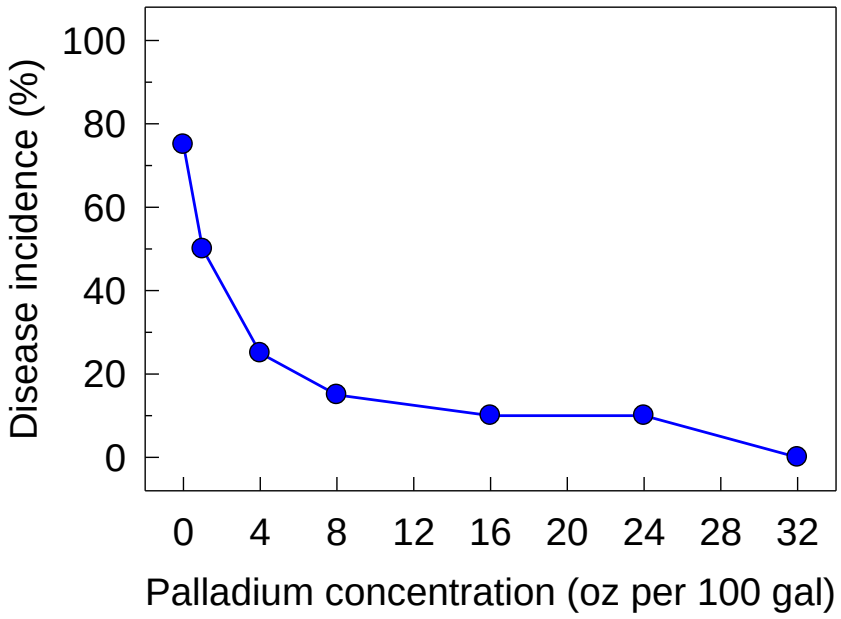

Fig. 1. The incidence of *Botrytis* infection on cut 'Gold Strike' rose flowers on day 7 of vase life at 20 °C and ca. 90% relative humidity. Harvested flowers were dipped in a solution of 0, 1, 4, 8, 16, 24 and 32 ounces Palladium/100 gallons for 10 seconds.

2. Devise Palladium uptake treatment protocols

With a view to improving Palladium treatment efficacy and convenience of application, we evaluated its potential for use as a postharvest uptake solution. 'Akito', 'Gold Strike' and 'Orlando' rose flowers were obtained from a Californian grower. Selected flower stems were placed into a hydration solution containing 16 ounces Palladium/100 gallons. Additional flowers were dipped in 16 ounces Palladium/100 gallons for 10 seconds before placement in a hydration solution. A final set of non-treated stems were placed into the hydration solution. In each case, stems were hydrated for 16 hours at 20 °C. Stems were then placed into a commercial vase solution and maintained at 20 °C and 90% relative humidity for evaluation. Treatment with Palladium either as a dip or uptake solution significantly reduced the incidence of *Botrytis* on the flowers of all three varieties (**Fig. 2A**). Applying Palladium as a dip treatment was generally more effective than the uptake solution in reducing disease. Administering Palladium as an uptake solution was very effective in reducing *Botrytis* on 'Akito' flowers but it was associated with a reduction in rates of flower opening (**Fig. 2B**). As part of our ongoing studies, we will continue to refine uptake treatment protocols for rose flowers.

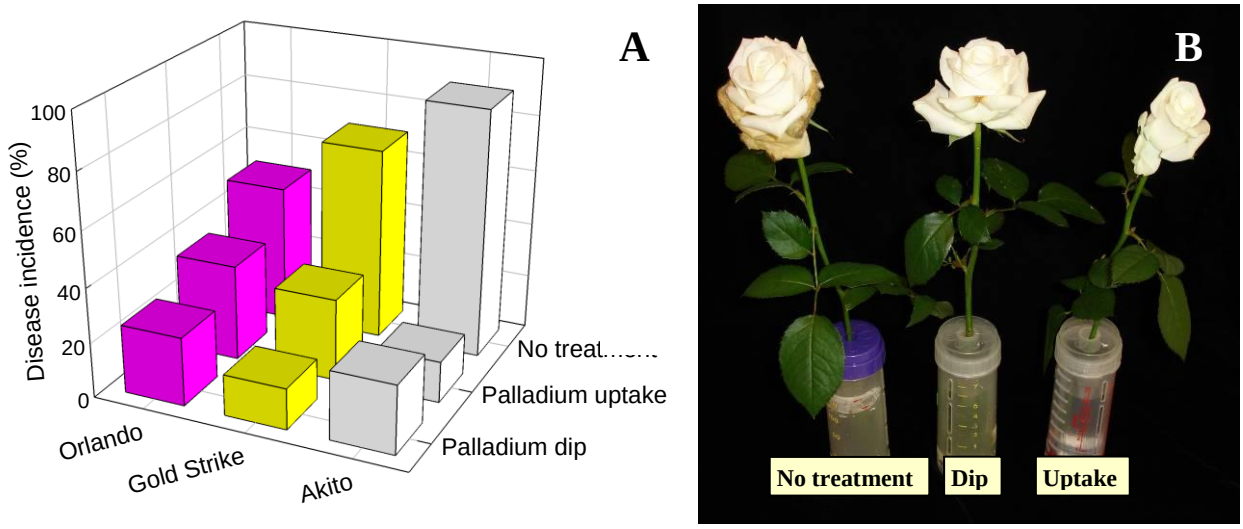

Fig. 2. (A) The incidence of *Botrytis* infection on 'Akito', 'Gold Strike' and 'Orlando' rose flowers that were either dipped or placed into an uptake solution containing 16 ounces Palladium/100 gallons. (B) Photograph of 'Akito' flowers following Palladium dip or uptake solution treatment showing varying degrees of *Botrytis* infection. Note the reduced opening of the flower placed in the uptake solution.

3. Determine efficacy of Palladium as a pre-harvest treatment

Routine fungicide spraying in the greenhouse is widely recommended to help reduce the presence of *Botrytis* spores, the inoculum source of postharvest flower infection. Based on our findings that postharvest treatment of rose flowers with Palladium can significantly reduce *Botrytis* infection, we determined the effectiveness of Palladium as a pre-harvest spray treatment. Palladium (4 ounces/100 gallons) and a fenhexamid-based fungicide, Elevate (5.6 grams/gallon),

were applied to greenhouse-cultivated 'Akito' and 'Gold Strike' rose plants with a hand sprayer once per week for 2 weeks prior to harvest. Additional plants were not treated. Harvested stems were packed into flower boxes and held at 0 °C for 1 week to simulate transport and storage. Stems were then placed into a commercial vase solution and maintained at 20 °C and 90% relative humidity for evaluation. We found that there was no significant difference in overall infection rates for 'Akito' flowers treated with Palladium and Elevate versus those that were not treated (**Table 1**). Similar observations were recorded for 'Gold Strike' flowers. Our results suggest that the fungicides only offered short-term residual activity and highlight the difficulties in controlling latent fungal pathogens such as *Botrytis*. Use of a higher Palladium concentration and a more frequent spraying regime may improve treatment efficacy.

Table 1. The severity of *Botrytis* infection on 'Akito' rose flowers during vase life at 20 °C after pre-harvest treatment with Elevate and Palladium fungicides. There were no significant differences among treatments. Score: 0 = no infection, 4 = extensive infection.

Treatment	Mean Daily *Botrytis* Severity Score			
	Day 4	Day 5	Day 6	Day 7
No Treatment	2.3 a	2.5 a	2.6 a	2.6 a
Elevate	1.8 a	2.3 a	2.4 a	2.4 a
Palladium	2.1 a	2.5 a	2.7 a	2.7 a

CONCLUSION

Taken collectively, our findings highlight the potential for Palladium to be used as a postharvest dip or uptake solution treatment for the control of *Botrytis* on cut rose flowers. Presumably owing to its short-term residual activity under greenhouse conditions, pre-harvest treatment with Palladium did not reduce postharvest *Botrytis* infection. Research into optimizing pre- and postharvest application protocols for Palladium and other promising fungistatic compounds to provide the flower industry with safer and more effective control measures against *Botrytis* remains an ongoing activity in our laboratory. A core focus of our work is to determine the optimal treatment time and conditions (temperature, relative humidity) for maximizing anti-fungal activity of the selected compounds.