Effect of Carbon and SiO2 Nanoparticles on Rooting and Growth of Different Ornamental Plants

PI: Alfred Huo
Co-PI: Roger Kjelgren

ABSTRACT

As one of the top ornamental plant species in the U.S.A., begonia is primarily propagated through stem cuttings. Successful begonia rooting is critically important in producing high quality plants for nurseries. However, during the rooting process various pathogens develop due to warm temperature and high humidity, which can affect propagation efficiency and plant quality. Nanoparticles have received broad attraction with regards to their wide applications from food to pharmaceutical industries. Due to limited research on their applications in ornamental plant production, we examine the effect of soluble carbon nanoparticle (CNP) on rooting and shoot formation as an alternative to chemical hormones in Rex Begonia (*Begonia rex-cultorum*). Leaf petiole cuttings of Rex Begonia were dipped in 30, 50, 100, 300, 1000, 2000 mg/L CNPs, a commercial rooting hormone (Miracle-Gro Fast Root containing 0.1% Indole-3-butyric acid), and a water control. Results showed that begonia cuttings treated with a 30, 50, and 300mg/L CNPs exhibited more and longer primary and lateral roots compared to ones treated with Miracle-Gro fast rooting hormone and water only. More shoots were also observed from the cuttings treated with 30,50,1000 and 2000 mg/L CNP than commercial rooting hormone and water control. In addition, application of CNPs can significantly reduce fungal infection that have observed in the treatment with Miracle-Gro fast rooting hormone. The effect of CNPs in combination with the rooting hormone are still under investigation. In sum, CNP was instrumental to root formation and shoot formation of Rex Begonia, and more delineated results are expected from this study prior to the application of CNP to nursery production.

OBJECTIVES AND METHODS

The objective of this study is to test the effect of different concentrations of soluble carbon nanoparticles on rooting and shooting of ornamental plants for Florida nursery propagation.

Petioles of Rex Begonia (*Begonia rex* hybrid Var. OPGC 3563) were dipped 0.25"-0.75" into various solution for 5 seconds prior to being inserted into perlite media in a 6-inch pot. Ten pots were applied to each treatment. All pots were placed into mist bed at greenhouse with 28-32°C and 16-hour light. Total root emergence for each pot were counted and photographed at week 4. Total root length were measured at week 8 using ImageJ software from photos. Total new shoot/leaf were counted at week 8. Fresh weight and dry weight of newly regenerated shoots/leaves were also determined. The treatments include: 30, 50, 100, 300, 1000, 2000 mg/L CNPs, a commercial rooting hormone (Miracle-Gro Fast Root containing 0.1% Indole-3-butyric acid), and a water control. Soluble Carbon Nanoparticles with average size of 100nm were provided by Vulpes Corp., Missouri, USA. Student's t-test was performed to compare the significant difference between treatments with CNPs, rooting hormone and water treatment.

RESULTS

Soluble carbon nanoparticles significantly promote rooting of Rex Begonia

Figure 1. Representative cutting samples of Rex Begonia for rooting.

Leaf petioles were cut from different pots of healthy Rex Begonia plants. All petioles were attached with part of leaves (**Figure 1**). When these cuttings were treated with water only, the average root number is 5.5 per cutting after 4-week culture (**Figure 2 and Figure 3 A**), suggesting that Rex Begonia is a relatively-easy-to-root plant species. The cuttings treated with the commercial rooting hormone Miracle-Gro-FastRoot generated 6.6 root/cutting, and did not exhibit significant difference from the water treatment (5.5 root/cutting) (**Figure 2 and Figure 3A**). Soluble CNPs treatments could significantly improve rooting of Rex Begonia compared to the water treatment. The best beneficial effects were observed in the treatments of 30, 50, 100 and 300 mg/L CNPs, in which 9.1, 12.4, 11.7 and 11.7 roots were regenerated from each cutting, respectively (**Figure 3A**). Surprisingly, we have observed severe fungal infection in the cuttings treated with Miracle-Gro-FastRoot, while no obvious fungal infection was observed in the rest of treatments (**Figure 2**). Miracle-Gro-FastRoot contains nutrients such as Boric acid and sucrose, which can promote fungi development such as Botrytis. Botrytis is a fungus loves moisture and can infect a broad range of plant species, causing leaf spotting on foliage and stem blighting on cuttings and young plants during propagation. The spread of Botrytis is a great challenge for nursery plant propagation, and a cost-efficient and environment-friendly approach should be developed for controlling this fungus.

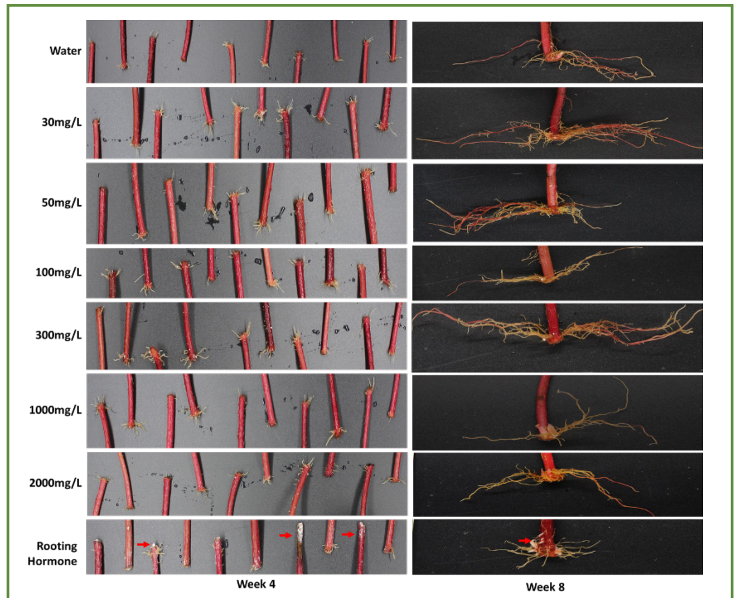

Figure 2. Petioles of Rex begonia (Begonia rex hybrid Var. OPGC 3563) were treated with various concentrations of soluble nanoparticle solutions, Miracle-Gro fast rooting hormone and water for rooting in the perlite under mist conditions for 4 weeks (left) and 8 weeks (right) . Red arrows indicated the fungal infection.

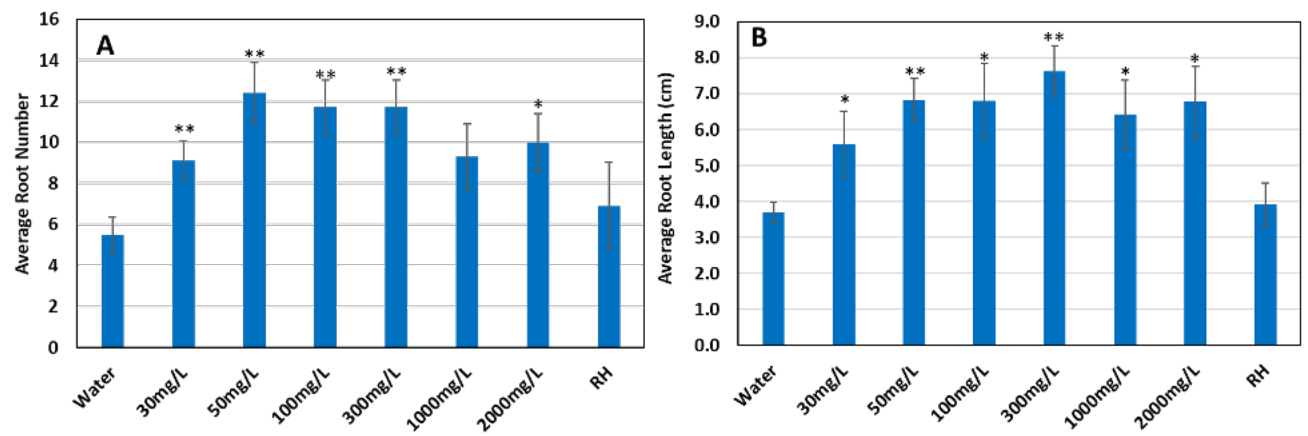

Figure 3. Average root numbers (A) at week 4 and root length at week 5 (B) after treatments of begonia petioles with different concentrations of soluble carbon nanoparticles, rooting hormone (RH) and water. * and ** denote significant difference at 0.05 and 0.01 level, respectively.

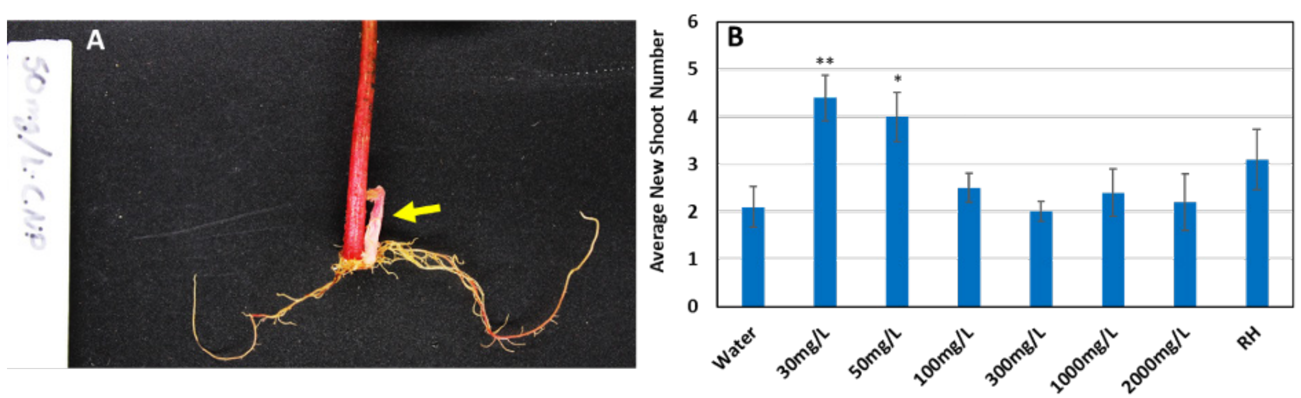

Figure 4. (A) Representative image of newly regenerated shoot (yellow arrow) from cuttings treated with 50mg/L CNPs. (B) Average new shoot number at week 8 after treatments of begonia petioles with different concentrations of soluble carbon nanoparticles, rooting hormone (RH) and water. * and ** denote significant difference at 0.05 and 0.01 level, respectively.

Soluble carbon nanoparticles significantly promote root growth of Rex Begonia

In addition to the root number, we also examined whether the treatments could promote root growth. Root length were measured at the week 5 for all treatments. Results showed that all CNPs treatments significantly promote root growth (**Figure 2B and Figure 1**). The average root length are 5.6, 6.8, 6.8, 7.6, 6.4, 6.7 cm for the cuttings treated with 30, 50, 100, 300, 1000, 2000mg/L CNPs, respectively. In contrast, the average root length for the commercial rooting hormone and water treatments are 3.9 and 3.7 cm. The mechanism underlying this beneficial effect on promoting root growth remains to be investigated.

Soluble carbon nanoparticles significantly promote shoot regeneration of Rex Begonia

We also examined the effect of different treatments on promoting shoot regeneration. Newly regenerated shoots/leaves were count at the week 8. The average number of newly regenerated shoots are 2.1 for water control, and 2.9 for rooting hormone treatment. High shoot regeneration frequency was observed when cuttings were treated with lower concentrations of CNPs such as 30 and 50mg/L. The average number of newly regenerated shoots are 4.4 and 4 for 30 and 50mg/L CNP treatments (**Figure 4 A and B**). Higher concentrations of CNPs did not improve shoot regeneration (**Figure 4 B**).

The effect of soluble carbon nanoparticles on newly-regenerated leaf growth of Rex Begonia

To determine if CNPs have beneficial effects on promoting shoot/leaf growth, we have collected newly-regenerated leaves from each cuttings and measured their fresh weight and dry weight. Results from **Figure 5 A and B** showed that no significant difference was observed in the leaf growth with regard to fresh and dry weight of newly-regenerated shoots/leaves among all treatments except for the 50mg/L CNP treatment. The 50mg/L CNP treatment modestly increased the fresh and dry weight of these tested leaves, suggesting that it can partially benefit to the shoot/leaf growth of Rex Begonia.

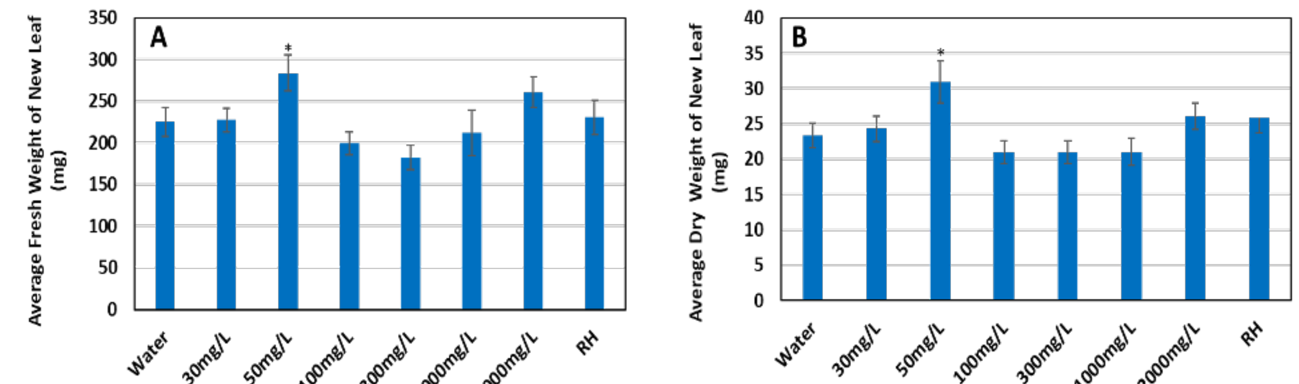

Figure 5. (A) Average fresh weight of newly regenerated leaves. (B) Average dry weight of newly regenerated leaves at week 8 after treatments of begonia petioles with different concentrations of soluble carbon nanoparticles, rooting hormone (RH) and water. * and ** denote significant difference at 0.05 and 0.01 level, respectively.

CONCLUSIONS

In this study, we have tested the effect of soluble carbon nanoparticles on Rex Begonia propagation. Our results showed that this water-soluble carbon nanoparticles could significantly promote the regeneration of shoots and roots as well as root growth. In addition, the carbon nanoparticles were able to suppress fungal infection, which is a common and severe issue for nursery plant propagation under high humidity conditions. Our results provide evidences for the potential application of water-soluble carbon nanoparticles to improve propagation efficiency of nursery plants by reducing time, cost and disease spread. Because of the pandemic situation in the spring of 2020, we are not able to fully complete this project. However, research work will be resumed soon to compare the effect of SiO2 nanoparticles on the cutting propagation efficiency of different plant species.

PUBLICATION

Matthew Creech, Hanna Baz, Abigail Plontke, Sandra Wilson, Jianjun Chen, Rick Shang, Roger Kjelgren, Heqiang Huo, Enhanced Rooting For Begonia Propagation by the Application of Soluble Carbon-Nanoparticles, Poster ASHS, Orlando, Florida ,August 9-13,2020.