

Container Opacity and Media Components Influence Rooting of Potted *Phalaenopsis* and *Doritaenopsis* Orchids

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Abstract

Two experiments were performed to determine the effects of container opacity and different media components on rooting and vegetative growth of several clones of *Phalaenopsis* and one clone of *Doritaenopsis* hybrid orchids. *Doritaenopsis* White Moon and *Phalaenopsis* Sharon Bay were grown in 12 cm translucent or opaque pots containing a bark-based media. After 30 weeks at 29°C, plants in opaque pots had formed >7 roots outside of each container, whereas <2 roots per pot had developed outside the translucent containers. In a second experiment, *Phalaenopsis* Brother Showpiece, Brother Wild Thing, and Pink Twilight were grown in opaque 12 cm plastic pots containing different ratio of medium-grade Douglas fir bark, medium-grade coconut coir, long-fibered sphagnum moss, coarse perlite, chunky peat, and fine-grade charcoal. Plants were grown for 33 weeks at 29°C with a maximum light intensity of 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$. In general, plants grown in a medium consisting of 1:1 (by volume) chunky peat:perlite or 2:1:1 perlite:chunky peat:coconut coir had fewer aerial roots than plants grown in a bark-based or 1:1 perlite:charcoal media. In addition, plants grown in the chunky peat:perlite mix or chunky peat:charcoal mix had the greatest increase in leaf span compared to the other medias. These studies provide scientific evidence for the advantages of translucent pots, and also indicate that chunky peat can be used as an alternative to a bark-based media.

INTRODUCTION

Phalaenopsis orchids have thick roots that arise from the base of the stem or lower nodes, functioning as one of three types: aerial, prostrate epiphytic, or substrate (Christenson, 2001). The primary role of substrate roots is for water and nutrient absorption, while the primary role of aerial and epiphytic roots is for adhesion to surfaces (Dycus and Knudsen, 1957). Although the apical meristem of aerial and epiphytic roots contains chlorophyll and can photosynthesize, the amount of carbon assimilation is less than the amount of carbon evolved through respiration (Dycus and Knudsen, 1957; Hew and Yong, 1997). Water and nutrient absorption through aerial and epiphytic roots is insignificant for plant growth unless these roots come in contact with the substrate (Dycus and Knudsen, 1957). Thus, aerial and epiphytic roots that do not penetrate the growing medium have limited function during commercial orchid production.

An increasing majority of commercial orchid growers throughout the world use translucent or clear containers for *Phalaenopsis* production. Clear containers allow light to penetrate, which is believed to promote the entry of aerial and epiphytic roots into the substrate (Wang et al., 2007). There are two advantages of facilitating the entry of roots into the growing medium: 1) water and nutrient absorption is greater since more roots are in contact with the media (Wang and Greg, 1994), and 2) fewer roots are damaged during handling by the producer and consumer. However, to our knowledge, no published scientific studies have compared the use of clear and opaque containers for orchid production.

Commercial growers of *Phalaenopsis* and *Doritaenopsis* orchids use many different organic and inorganic materials to formulate the growing media, including

activated charcoal, aliflor, chopped coconut husks and fiber, cork, diatomite, Douglas fir bark, expanded clay, expanded polystyrene, osmunda fiber, peat, perlite, pumice, redwood bark, rock wool, sphagnum moss, tree fern fiber, vermiculite, volcanic rock, and washed gravel (Baker and Baker, 1991; Cullina, 2004; Slump, 2004; Wang, 2005). Among all of these materials, the primary orchid medium component used in the United States is Douglas fir bark, which is usually harvested by the logging industry on the Pacific coast of the United States (Wang, 2000). Unfortunately, Douglas fir bark has several shortcomings: 1) fresh bark has a low water-holding capacity and a high carbon to nitrogen ratio; 2) small- or medium-grade bark decomposes rapidly, resulting in high water retention; 3) it has low nutrient retention and poor uniformity; and 4) some people consider fir bark to be a non-renewable resource. In addition, the availability of Douglas fir bark could be limited in the future because it may host the fungus *Phytophthora ramorum*, which causes sudden oak death disease (Wang and Barnes, 2004). In 2004, the United States' Animal and Plant Health Inspection Service (APHIS) issued a federal order restricting the interstate movement of nursery stock from all commercial nurseries in California, Oregon, and Washington (APHIS, 2004). Although both greenhouse-grown orchids and Douglas fir bark are currently exempt from this federal regulation, these exemptions may change in the future. Therefore, alternative orchid media need to be identified so that the reliance on Douglas fir bark is reduced.

Aims of this experiment were to determine 1) how different media components influence root and foliar development of *Phalaenopsis* and *Doritaenopsis* orchids after transplant, and 2) the effects of container opacity and plant spacing on rooting of *Phalaenopsis*. If there are benefits to using clear containers, adequate plant spacing may be necessary to allow light to penetrate into the side walls of the container. In addition, alternative media sources for orchid production could alleviate the challenges associated with Douglas fir bark and provide growers with additional options when selecting an orchid media.

MATERIALS AND METHODS

Container Oopacity

Bare-root *Doritaenopsis* White Moon (*Doritaenopsis* White Castle × Moon World) and *Phalaenopsis* Sharon Bay (*Phalaenopsis* Sharon Cohen × French Connection) plants with an average of 5.8 and 5.3 leaves, respectively, were received and transplanted into 12 cm translucent or opaque plastic containers (Pöppelmann Plastics USA, Inc., Hickory, North Carolina, USA). The growing medium was comprised of 5:3:1:1 (by volume) medium-grade Douglas fir bark (Rexius Forest By-Products Inc., Eugene, Oregon, USA), medium-grade chopped coconut coir (Millenniumsoils Coir, St. Catharines, Ontario, Canada), coarse-grade perlite (OFE Intl. Inc., Miami, Florida, USA), and long-fibered Canadian sphagnum moss (Mosser Lee Co., Millston, Wisconsin, USA). Plants were spaced on perforated steel greenhouse benches at a density of 22 or 44 containers per m² and were grown in a glass greenhouse at a constant 29°C. The photoperiod was 16 hours (06:00 to 22:00) consisting of natural photoperiods (latitude 43°N) with day-extension lighting provided by high-pressure sodium (HPS) lamps delivering a photosynthetic photon flux (*PPF*) of 20 to 25 μmol m⁻² s⁻¹ at plant height. Light transmission was reduced using woven shade curtains and whitewash applied to the greenhouse glazing so that the maximum *PPF* at plant height was 300 μmol m⁻² s⁻¹. A vapor-pressure deficit of 1.0 kPa was maintained by the injection of water vapor. Plants were irrigated as necessary with reverse-osmosis water supplemented with a water-soluble fertilizer providing (mg L⁻¹): 125 N, 12 P, 100 K, 65 Ca, 12 Mg, 1.0 Fe and Cu, 0.5 Mn and Zn, 0.3 B, and 0.1 Mo (MSU Special, GreenCare Fertilizers, Inc., Kankakee, Illinois, USA).

After 30 weeks of growth, the number of roots on each plant that were growing over the edge of the container (aerial roots) and the number of leaves were counted, and leaf span (distance from the tip of the longest leaf to the tip of its opposite leaf) was

measured. The number of unfolded leaves and the leaf span increase were calculated. A completely randomized block design was used. Data were analyzed using SAS' (SAS Institute, Cary, North Carolina.) mixed model procedure (PROC MIXED) and pair wise comparisons between treatments were performed using Tukey's honestly significant difference test at $P \leq 0.05$.

Growing Medium

Bare-root *Phalaenopsis* Brother Showpiece (*Phalaenopsis* Chih Shang's Stripes \times Brother Nugget), Brother Wild Thing (*Phalaenopsis* Super Stupid \times Brother Brungor), and Pink Twilight (*Phalaenopsis* Rose Girl \times Lippeglut) that had an average of 4.6, 5.0 and 5.1 leaves, respectively, were transplanted into 12 cm opaque pots containing one of four growing mediums (ratio by volume): 1) 5:3:1:1 medium-grade Douglas fir bark:medium-grade coconut coir:long-fibered Canadian sphagnum moss:coarse perlite (same sources as above), 2) 1:1 chunky peat:perlite, 3) 2:1:1 perlite:chunky peat:coconut coir, and 4) 1:1 chunky peat:fine-grade charcoal. Media components and ratio were based on preliminary studies and commercial orchid grower input. Watering decisions were made daily on individual plants because the mixes retained different amounts of the irrigation and fertilizer solution. Environmental conditions, cultural procedures, and data analysis were as previously described. Data collected were as described above, but after 33 weeks of growth at a constant 29°C.

RESULTS AND DISCUSSION

Doritaenopsis White Moon and *Phalaenopsis* Sharon Bay plants grown for 30 weeks in opaque pots had more roots outside of the media and container than plants grown in translucent pots (Fig. 1). There was a mean of 12.1 aerial roots per Sharon Bay plant grown in an opaque pot and 1.0 aerial root when grown in a translucent pot. Container opacity had no effect on the number of unfolded leaves of White Moon or Sharon Bay (means of 2.2 and 2.5, respectively) or increase in leaf span (means of 2.5 and 3.0 cm, respectively). Plant spacing had no effect on aerial rooting (Fig. 1).

In the three *Phalaenopsis* hybrids studied, generally there were fewer aerial roots when plants were grown in a medium consisting of 1:1 chunky peat and perlite (media #2) or 2:1:1 perlite, chunky peat, and coconut coir (media #3) (Fig. 2). All three hybrids grown in the chunky peat and charcoal mix (media #4) had ≥ 5.5 more aerial roots than plants grown in the chunky peat and perlite mix. In *Phalaenopsis* Brother Showpiece and Pink Twilight, plants grown in the chunky peat and perlite mix had 8.9 or 7.2 fewer aerial roots than those grown in the bark-based mix (media #1). The *Phalaenopsis* hybrids grown in a media containing 50% chunky peat (media #2 and #4) generally had a greater increase in leaf span after 33 wks compared to plants in the other growing mixes. Plants in the bark-based mix had consistently the smallest increase in leaf span, with leaf span increasing by 4.9 cm or less, while leaf span of plants grown in a mix containing 50% chunky peat increased by 8.1-14.2 cm. (Fig. 2). These results are consistent with Wang and Konow (2002) who reported that plants grown for 54 wks in a medium consisting of 70% Douglas fir bark and 30% Canadian sphagnum peat developed 1.8 more leaves and had 77% greater leaf fresh weight than plants grown in a 100% Douglas fir bark medium.

A desirable media for *Phalaenopsis* and *Doritaenopsis* orchids is one that retains an adequate (but not excessive) amount of water and nutrients, but does not provide a barrier to root entry. Additional desirable characteristics of orchid media components include: low cost; high uniformity; abundant availability; devoid of pathogens, pests, and weeds; and no or slow degradation (van der Knaap et al., 2005; Wang et al., 2007). In this study, plants grown in the chunky peat and perlite mix generally had the fewest number of aerial roots and the greatest increase in leaf span in our growing conditions. In contrast, plants grown in the traditional bark-based mix generally had the most aerial roots and a small increase in leaf span. Chunky peat mixes retain more water than bark-based media (Droll, 2005), and therefore plants grown in chunky peat in our study required longer intervals between watering events. The increased vegetative growth of plants grown in a

medium containing chunky peat could be related to the high cation exchange capacity of peat, which may increase the availability of mineral nutrients in the medium (Wang and Konow, 2002).

Plants grown in a media containing bark or charcoal generally had a high number of aerial roots. This could be explained by the physical characteristics of these two media components; roots of *Phalaenopsis* and *Doritaenopsis* are thick and fleshy and generally cannot penetrate these two substances. This physical barrier could prevent or hamper the ability of roots to enter the growing medium. The fewer aerial roots and greater leaf span of plants grown in chunky peat suggest that root entry is relatively unrestricted and contact with roots is sufficient to provide adequate water and nutrients for leaf expansion.

Phalaenopsis and *Doritaenopsis* orchids grown in a translucent container had fewer aerial roots than those grown in an opaque pot, regardless of plant spacing. The translucent pots had a small amount of algae growth on the inner surface of the container, which reduced their aesthetic quality, but had no apparent effect on plant performance. The combined use of translucent pots and a media containing chunky peat, or one with little or no bark or charcoal, is suggested for commercial growers that want to maintain roots inside the container. The positive attributes of plants that grew in mixes without bark indicate that growers can reduce their reliance on Douglas fir bark and possibly improve plant growth. However, orchid growers may need to adjust their cultural practices when using chunky peat because it retains more moisture, especially during periods when evaporation and transpiration are low.

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Figures

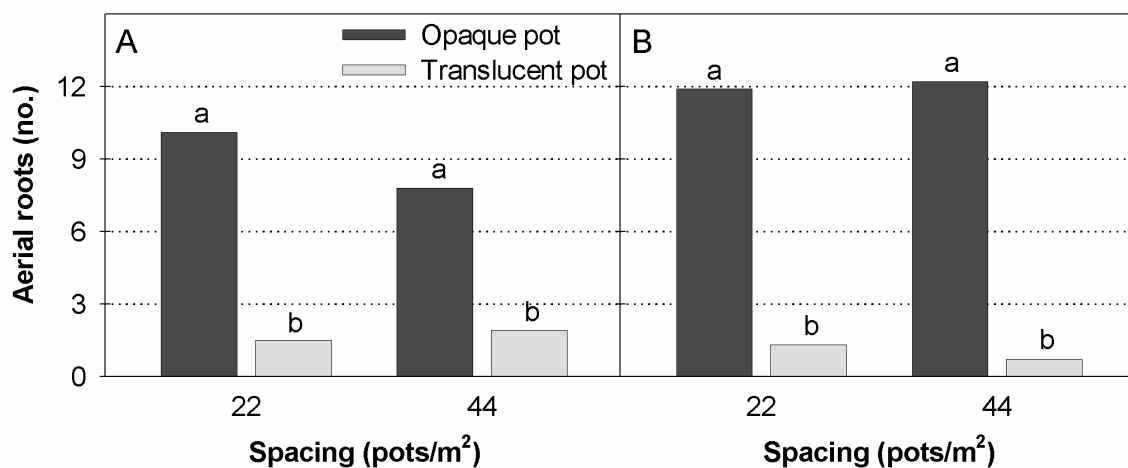


Fig. 1. The number of aerial roots of *Doritaenopsis* White Moon (A) and *Phalaenopsis* Sharon Bay (B) after 30 weeks of growth in 2 types of pots with 2 spacing at 29°C. Treatments with the same letter are not statistically different by Tukey's honestly significant difference test at $P \leq 0.05$.

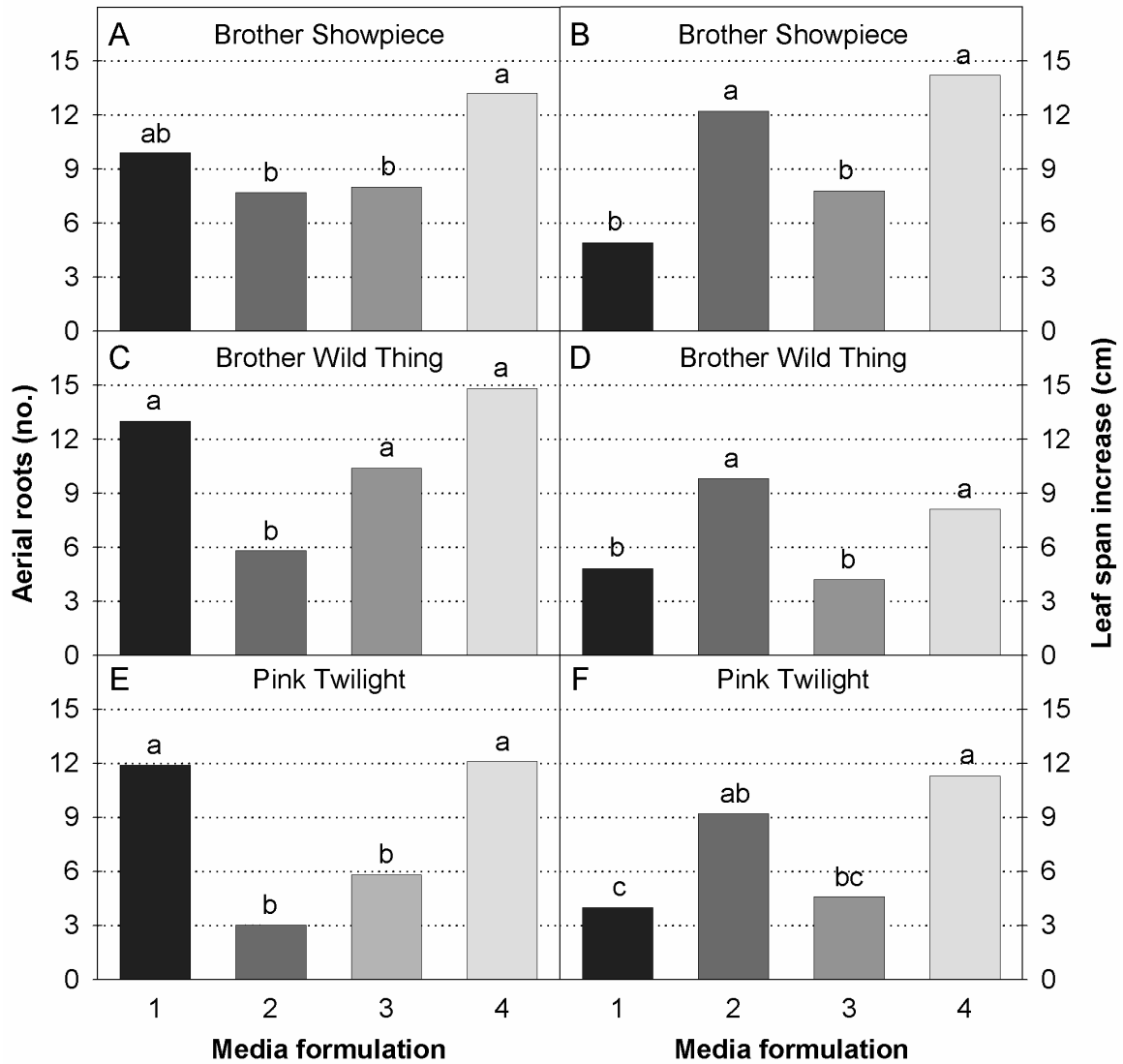


Fig. 2. The number of aerial roots (A, C, E) and leaf span increase (B, D, F) in three *Phalaenopsis* orchid hybrids after 33 weeks of growth in 4 media at 2°C. The four media formulations (ratio by volume) were: 1) 5:3:1:10 Douglas fir bark: coconut coir:sphagnum moss:perlite, 2) 1:1 chunky peat:perlite, 3) 2:1:1 perlite:chunky peat:perlite, and 4) 1:1 chunky peat:charcoal. Treatments with the same letter are not statistically different by Tukey's honestly significant difference test at $P \leq 0.05$.