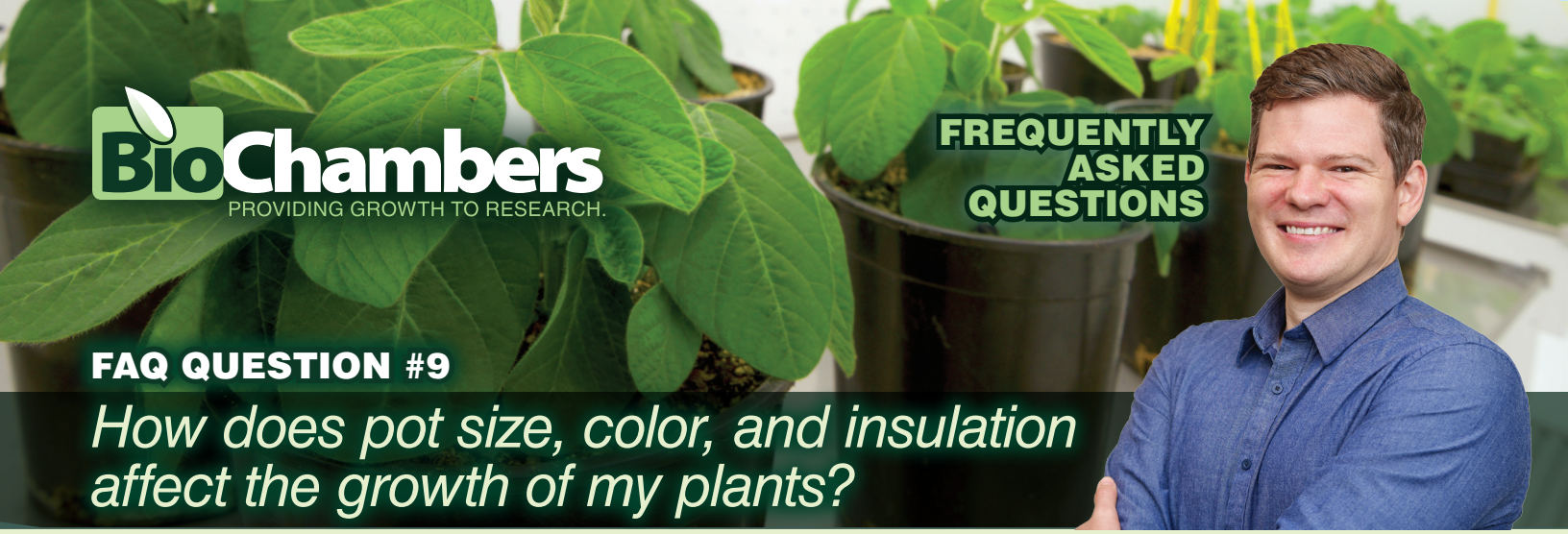

FAQ QUESTION #9

How does pot size, color, and insulation affect the growth of my plants?

Pot size can impose a volume restriction on roots, depending on the genetic size potential of your plant. A volume restriction on roots can restrict total plant growth independent of water status, nutrition, or any other factor (Hess & De Kroon 2007, McConnaughay & Bazzaz 1991, Poorter et al 2012). The degree of growth restriction depends on the amount of root volume restriction and plant species (Bar-Tal et al 1995, Carmi & Heuer 1981, Yong et al 2010). A meta-analysis found that a doubling of pot size increases plant biomass by 43% on average, or conversely halving pot size decreases biomass by 43%. To escape these "root bound" effects Poorter et al (2012) recommend 1L of pot volume g^{-1} total plant dry biomass. Recently published research with wheat (*Triticum aestivum* L.) indicates that the growth reduction from reduced root volume is a two phase process whereby plants proactively sense a limited root volume and adjust growth accordingly (Wheeldon et al 2020). If your plant growth goals or experiments are related to growth rate or overall plant growth, consider your pot size and whether it may restrict growth. In our own experiment with a medium sized variety of commercial soybean (*Glycine max* L.), we established a strong relationship between pot volume and growth, which is comparable to another study (Figures 1 & 2, Ray & Sinclair 1998).

Other factors that may affect your experiment or plant growth goals are pot color and insulation. Darker colored pots absorb more radiant heat from growth chamber lights compared to lighter colored pots, potentially causing faster soil drying and higher root temperatures than chamber set-point. Pot size also affects how quickly roots achieve thermal equilibrium with chamber temperature; smaller pots have a greater surface area to volume ratio and less thermal mass, and therefore roots cool down and warm up faster compared to larger pots. Rapid root tip temperature changes from high or low temperature stress experiments can be artificial, especially with deeper-rooted plants. Outside, the soil acts as a strong thermal buffer for roots, and here soil/root temperature changes slowly and rarely matches air temperature at depths >10cm (Oliver et al 1987). Snow acts as an insulator and further decouples soil/root and air temperatures (Friesen et al 2015). If your goal is to study the above-ground stress response, insulating pots can slow temperature changes of the soil/roots, especially where airflow comes up from the floor of the chamber (Friesen et al 2014, Friesen & Sage 2016).

Figure 1: How pot size affects the growth of a medium sized commercial variety of soybean (*Glycine max* L.). Plants were grown at 28/22°C, 16 hour photoperiod, 600 PPFD averaged across the upper leaves, and a vpdL of 1.1 to 2.1 kPa. Plants were fully fertilized and carefully watered to isolate the effects of root volume restriction. Plants were cut 1 cm from the soil surface 31 days after planting and dried to a constant weight at 65°C. Symbols are the average of 3 plants (pot sizes) +/- standard error and dotted line is a best fit regression curve.

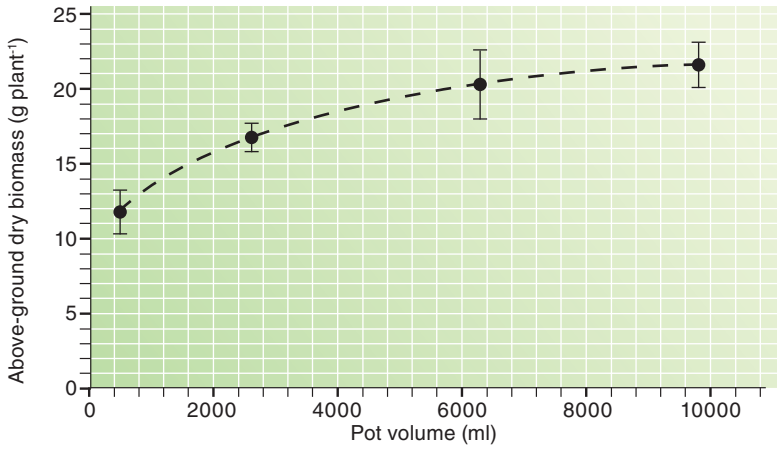

Figure 2: Pictures of soybean plants used in the pot size experiment.

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