Water Requirements of Containerized Hydrangeas and Abelias

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Nature of Work: Efficient water use in nurseries is increasingly important. In recent years, a new soil moisture sensors (ECH_2O probes) have become available. These sensors are reliable and affordable (about $70 each), and require little or no maintenance. These sensors make it possible to constantly measure the moisture content of the growing medium in containers. Since these sensors can be interfaced with irrigation control systems, they could be used to turn irrigation on and off, based on the water content in the containers. The one piece of information that is currently lacking for fully-automated irrigation systems is how much water actually needs to be present in the growing medium to prevent detrimental effects of drought on plants. In this research project, we determined the effect of soil moisture on photosynthesis (growth) and plant water relations of hydrangea and abelia. Growth rates of these species were measured during two subsequent drying cycles to determine how drought affects the growth rate of these species.

Results and Discussion: Photosynthesis, which is an indicator of plant growth rate, of both species remained stable as the substrate moisture content dropped from about 25 to about 15%, with pronounced decreases in growth at lower moisture levels. Abelias and hydrangeas wilted when the substrate moisture level dropped to approximately 6.3 and 8.3%, respectively (Table 1). At wilting, abelias had much lower leaf water potential (-3.7 MPa) than hydrangeas (-1.8 MPa). After the plants were watered at the end of the first drying

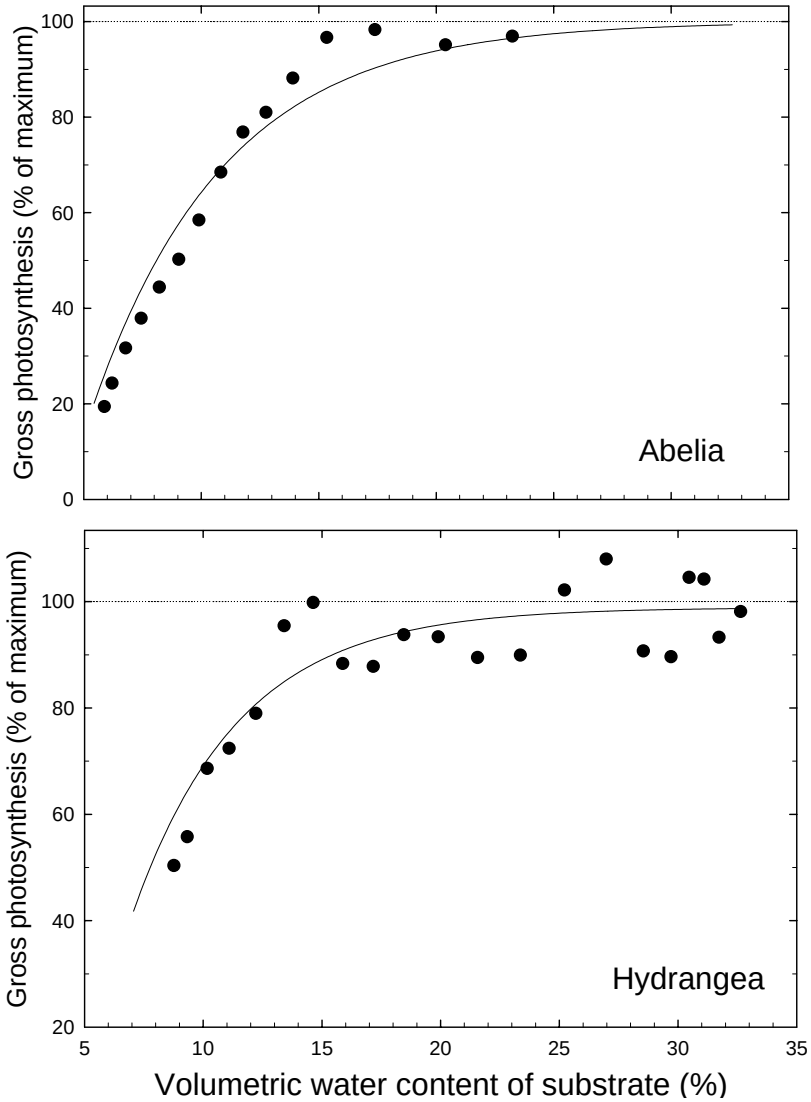

Figure 1. Gross photosynthesis of abelia (top) and hydrangea) as affected by the volumetric moisture content of the substrate.

cycle, the photosynthesis of the plants did not recover to pre-stress rates, indicating that the drought stress caused a long-term reduction in photosynthesis. Despite the more severe drought stress in the abelias (both a lower substrate water content and lower water potential at wilting), abelias recovered better from drought than hydrangeas. After the plants were watered at the end of the first drying cycle, the photosynthetic rate of abelias recovered to approximately 70%, while the photosynthetic rate of the hydrangeas recovered to only 62% of the pre-stress rate (Table 1). The recovery of the hydrangeas after drought depended on the severity of the drought stress. A lower volumetric water content at the end of the first drying cycle, resulted in a lower photosynthetic rate during the second drying cycle. This indicates that it is crucial to prevent severe drought stress in hydrangeas, since it results in long-term reductions in photosynthesis, and the magnitude of this reduction depends on the severity of the drought stress.

Significance to the Industry: The photosynthesis of abelias and hydrangeas declines as the volumetric water content of the substrate drops below approximately 15%. A drought stress severe enough to cause wilting should be avoided because it results in a long-term reduction in photosynthesis, and therefore growth. We hope to use this information to develop automated irrigation controllers that can turn the irrigation on when the substrate moisture content reaches a grower-defined set point (15% or slightly higher appears to be a good set point). The controller that we are currently developing uses 1 to 4 ECH_2O probes and the average reading of those probes determines when the irrigation is turned on. It allows growers to set the substrate moisture level at which plants are watered, the duration of each irrigation event, and a minimum duration between subsequent irrigations. The controller can either be connected directly to a solenoid valve, or can be interfaced with an existing irrigation controller.

Table 1. The volumetric water content of the substrate (VWC) at which abelias and hydrangeas wilted, the photosynthetic rate at wilting, and the maximum photosynthetic rate after the plants had recovered from the first wilting period. All photosynthetic rates are expressed as a percentage of the maximum photosynthetic rate of the plants under well-water conditions at the start of the first drying cycle.

	------- Drying cycle 1 -------		---------- Drying cycle 2 ----------		
Species	VWC at wilting (%)	Photosynthesis at wilting (%)	VWC at wilting (%)	Photosynthesis at wilting (%)	Maximum photosynthesis (%)
Abelia	6.7	28	5.7	14	70
Hydrangea	8.6	44	8.0	29	62

Table 2. Water, osmotic, and turgor potential of abelias and hydrangeas before drought, after one drying cycle, after two drying cycles, and after plants had been completely rehydrated. Lower values indicate more severe drought stress.

	Before drought	End of drying cycle 1	End of drying cycle 2	After rehydration
	---------- Water potential (MPa) ----------			
Abelia	-0.81	-3.51	-3.91	-0.59
Hydrangea	-0.42	-1.65	-1.96	-0.44
	---------- Osmotic potential (MPa) ----------			
Abelia	-1.31	-3.41	-4.07	-1.45
Hydrangea	-0.93	-1.92	-2.05	-1.31
	---------- Turgor potential (MPa) ----------			
Abelia	0.64	-0.10	0.16	0.86
Hydrangea	0.51	0.27	0.10	0.87