

NOTES

Effects of Water Level Fluctuation on *Vallisneria americana* Michx Growth

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INTRODUCTION

Wild celery (*Vallisneria americana* Michx.) is a native, submersed aquatic plant found in the eastern United States westward to South Dakota and south throughout the Gulf Coast states (Korschgen and Green 1988, USDA 2007). An important food source for waterfowl and aquatic mammals (Fassett 1957), wild celery also provides habitat for fish, sediment stabilization benefits, improved water quality and clarity, and can slow or prevent the invasion of nonindigenous aquatic plant species (Smart 1993, 1995, Smart et al. 1994, Smart and Dick 1999).

Numerous constructed reservoirs in the United States are devoid of aquatic vegetation, exhibit some degree of water level fluctuations, and lack propagule sources for timely natural establishment of wild celery to occur (Smart 1993, 1995, Smart et al. 1994, Smart and Dick 1999). Consequently, wild celery plants are widely used in efforts to introduce native plants into manmade reservoirs as well as to restore natural lakes that have been negatively impacted by human activities or environmental conditions. Because of the importance of wild celery in these restoration activities and the likelihood that systems in which it is planted will experience water level fluctuations, a basic understanding of wild celery growth response to varying depths is crucial.

The objectives of this study were to (1) determine wild celery rosette (daughter plant) number and biomass production at four depths, and (2) determine changes in rosette number and biomass production when exposed to fluctuating depths.

METHODS

Six wild celery plants (average 5 leaves per plant) were planted into each of 40 6.7-L containers (diameter 35.6 cm, depth 10.2 cm) of sterilized pond sediment amended with 1.4 g ammonium sulfate in December 2002; sediments were collected from a pond at the Lewisville Aquatic Ecosystem Research Facility, Lewisville, Texas (LAERF). Ten containers per depth were randomly distributed atop a concrete pad on the bottom of a LAERF pond at four depths: 18, 46, 91, and

122 cm. Water level was maintained by continuous low-flow from nearby Lewisville Lake.

In July 2003, six containers were harvested from each depth, processed into aboveground and belowground material, and dried at 55 C in a Blue M forced-air oven (General Signal, Atlanta, GA) to a constant weight. Rosettes (daughter plants) were counted and maximum leaf length was measured. At this time, remaining containers from the four depth treatments were placed at a same depth (91 cm) to evaluate effects of increasing, stable, and decreasing water levels on wild celery growth. After four weeks (August 2003), containers were harvested and processed as described above.

Rosette number, maximum length, aboveground, and belowground biomass means were compared using a one-way ANOVA and LSD (least significant differences) test at $p = 0.05$ level of significance (Statistix Analytical Software, Tallahassee, FL). Analyses were performed on data from both July and August harvests and between each depth change.

RESULTS AND DISCUSSION

Significant differences occurred between the shallowest depth (18 cm) and all other depths for both rosette numbers and maximum leaf lengths (Figure 1) at the July harvest. Rosette numbers decreased by more than 50% as depth increased, indicating wild celery was not allocating resources to localized expansion at greater depths. Smart et al. (1994) found that wild celery was capable of adjusting biomass allocation and morphology to maximize photosynthesis, and that under lower light conditions fewer rosettes were produced. Maximum leaf length increased with depth increases, showing a 5-fold increase between 18 cm and 122 cm by July, likely a response to lower light conditions at greater depths (Titus and Stephens 1983, Sculthorpe 1985). Aboveground biomasses for the July harvest were significantly different between the most shallow depth (18 cm) and plants grown at the two deepest depths (91 and 122 cm). Aboveground biomass production, grown at different depths resulted in plants allocating available resources differently via local expansion or elongation. Belowground biomasses were not significantly different among depths in July. Root-to-shoot ratio indicated that plants growing at the deeper depths sacrificed belowground production (roots) to increase aboveground biomass production (Figure 2). After all wild celery plants were transferred to the same depth (91 cm), the root-to-shoot ratio stabilized around 0.5,

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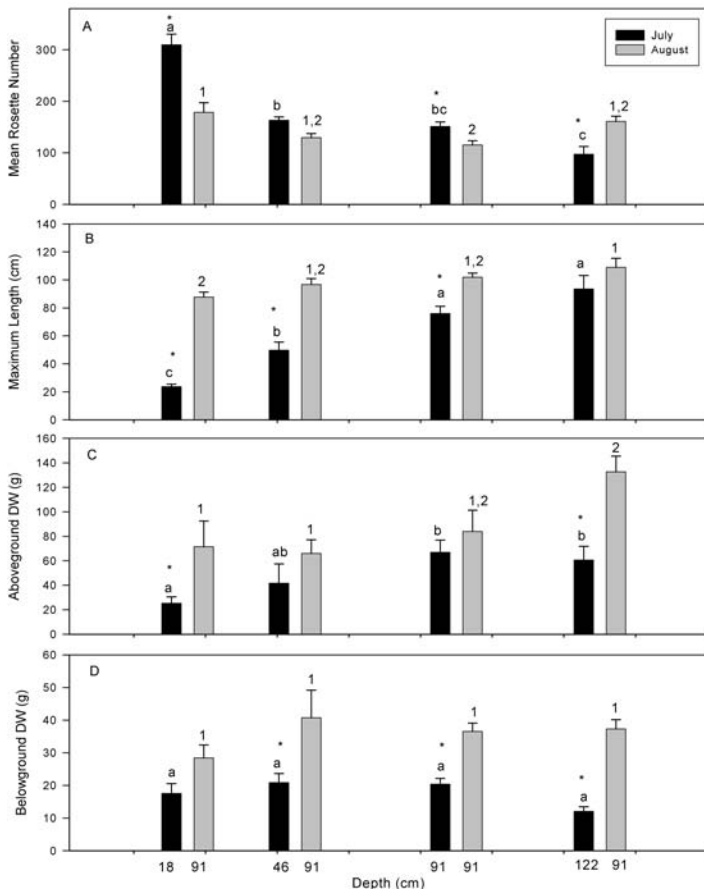


Figure 1. Productivity of wild celery at different depths and the effect of change in depth (from original depth to 91 cm) on productivity. Graph bars represent the mean of 6 or 4 containers (in July and August, respectively) with standard error bars. Lower case letter indicates significant differences between July sampling, and * indicates significant differences between July and August sampling for depth change. (A) Average rosette number for July ($p = 0.0000$), August ($p = 0.0118$) and depth change to 91 cm from 18 ($p = 0.0022$), 46 ($p = 0.0102$), 91 ($p = 0.0196$) and 122 ($p = 0.0144$) cm. (B) Maximum leaf length (cm) for July ($p = 0.0000$), August ($p = 0.0347$) and depth change to 91 cm from 18 ($p = 0.0000$), 46 ($p = 0.0004$), 91 ($p = 0.0048$) and 122 ($p = 0.2703$) cm. (C) Aboveground dry weight (g) for July ($p = 0.0643$), August ($p = 0.0460$) and depth change to 91 cm from 18 ($p = 0.0316$), 46 ($p = 0.2952$), 91 ($p = 0.3843$) and 122 ($p = 0.0030$) cm. (D) Belowground dry weight (g) of wild celery for July ($p = 0.0582$), August ($p = 0.4093$) and depth change to 91 cm from 18 ($p = 0.0557$), 46 ($p = 0.0311$), 91 ($p = 0.0007$), and 122 ($p = 0.0000$) cm.

except for the plants that had been growing at the 122 cm depth (Figure 2).

Statistical differences occurred between months (July and August for same treatment, different depth) for most parameters (Figure 1), and these differences were driven primarily by changes in depth, elongation over time (even at the same depth), and plant maturation. Four weeks after wild celery grown at different depths were moved to the same depth (91 cm) plants shifted resource allocation and exhibited changes in growth patterns (Figure 1). Rosette numbers in the shallowest depth plants (18 cm) decreased by almost 40% after greater inundation due to self-thinning. As self-thinning occurred, rosette numbers decreased, leaves elongated by 4-

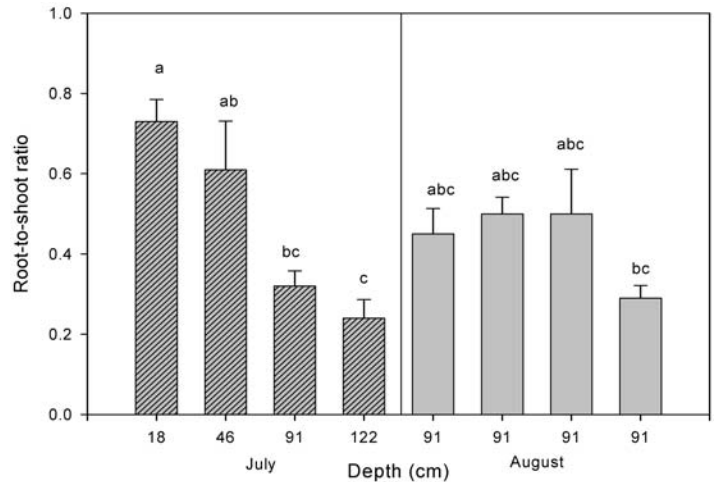


Figure 2. Effects of depth change on root-to-shoot ratio in wild celery.

fold to reach the water surface and widened (Owens, pers. observ.), becoming more similar to those grown in deeper water. Although leaf length remained significantly shorter than that of the greatest depth (122 cm), this difference was likely attributable to leaves produced by the deeper plants before being moved to 91 cm depths. Rosette numbers increased (30%) in plants moved from 122 cm to 91 cm depths. After the transfer to the same depth (91 cm), biomasses of all treatments became similar in August, although significant differences were still found between plants grown at the previously more shallow depths (18 and 46 cm) when compared to plants grown at deeper depths (122 cm). Leaf size, shape, and area are strongly influenced by depth and shading (Spence et al. 1973, Titus and Stephens 1983, Madsen 1991).

Although this study did not evaluate light availability at each depth, visibility was generally clear to the bottom of the pond. Effects of depth on resource allocation and resultant change in growth patterns were likely due to differing light availability at each depth. Significant differences were detected for aboveground biomass in August (Figure 1), although no differences were detected for belowground biomass.

Although water levels may impact establishment and growth of wild celery, this study indicates that plants can respond to changes in depth (or light penetration) by potentially altering rosette production (122 cm depth) or leaf length (18 and 46 cm). While we had only one treatment (122 cm) that decreased in water level, Titus and Adams (1979) found that wild celery could respond to light change within 24 h, supporting the findings in this study that found wild celery acclimating rapidly to changing light. This information might be useful in ascertaining best planting depths for wild celery colonies during restoration projects, especially where water level fluctuations are predictable. The ability of wild celery to tolerate water level fluctuations and different water depths indicates the importance of wild celery for restoration efforts.

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