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Growth of Southern Naiad (*Najas guadalupensis*) and Hydrilla (*Hydrilla verticillata*) using Controlled-release Fertilizer

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The native aquatic plant southern naiad (*Najas guadalupensis*) is often mistaken for the invasive weed hydrilla (*Hydrilla verticillata*). Much information has been published on the growth of hydrilla but few studies have investigated the growth of naiad. We compared the growth of naiad and hydrilla plants fertilized with 0, 1, 2, or 4 g of controlled release fertilizer (CRF) (Osmocote 15N–4.05P–9.96K) per kg of sand, with the fertilizer layered into the sand prior to planting. We prepared three mesocosms per fertilizer rate, with 3 containers of naiad or hydrilla in each mesocosm. Mesocosms were randomly arranged in a greenhouse and filled with water to create a submersed growing environment. Growth was monitored for 8 weeks in Spring 2014 and was repeated in Summer 2014. Naiad shoot and root dry weights were greatest in containers fertilized with 2 g of CRF per kg of sand, while hydrilla shoot and root dry weight were greatest in containers fertilized with 4 g of CRF per kg of sand. Although these species may look similar, it is clear from this study that their nutritional requirements are different.

The Florida Fish and Wildlife Conservation Commission (FWC) reported that Florida has 2.5 million acres of aquatic freshwater resources (FWC, 2015). Conservation of these areas is crucial to our state because they promote a balanced ecosystem in the form of food and habitats for fish and birds. A nuisance in these waters is the invasive plant species hydrilla (*Hydrilla verticillata*). Hydrilla is an invasive aquatic weed introduced into the state in the 1950s that hinders navigation and drainage of canals, rivers, lakes, and waterways in Florida (Gordon and Thomas, 1997). Hydrilla has substantially increased its invaded range since its introduction (Schmitz et al., 1991; Schardt and Nall, 1983).

Hydrilla is a submersed perennial aquatic plant with thin green stems that can grow up to 25 ft long, small leaves that grow in whorls of four to eight around the stem, and branching that occurs near the water surface (UF/IFAS CAIP, 2015a). Hydrilla can be found in a variety of water body types and easily spreads by fragmentation (UF/IFAS CAIP, 2015a). The invasion of hydrilla has decreased biodiversity and threatens to push out native species.

Naiad (*Najas guadalupensis*) is a desirable Florida native aquatic plant that is fondly referred to as "Southern naiad". In Florida, naiad is often mistaken for the invasive weed hydrilla. Naiad is a submersed perennial aquatic plant with dark green leaves and shoots that grow long and thin, like a ribbon. It reproduces by seeds and fragmentation and provides a habitat for invertebrates, food for fish and wildlife and helps to remove nutrients from the water (UF/IFAS CAIP, 2015b).

There has been much research on hydrilla growth in relation to differing fertilizer levels (Barko, 1982; Sutton, 1985; Sutton, 1990; Moeller; 1983). However, little research has been conducted on the growth of southern naiad with different fertilizer rates. The objective of this experiment was to compare hydrilla and naiad growth when both species were fertilized with three rates of controlled release fertilizer (CRF).

Materials and Methods

Apical cuttings that were approximately 4 to 6 inches long were obtained from stock cultures of both species maintained in the aquatic tanks located at the University of Florida Fort Lauderdale Research and Education Center (FLREC). Eight-inch diameter azalea pots were lined with plastic bags and filled with coarse masonry sand, then ten cuttings of a single species were planted in each pot. Prior to transplanting the cuttings, a CRF (Osmocote 15N–4.05P–9.96K, Everris, Dublin, OH) was layered under the surface of the sand at 0, 1, 2, or 4 g of fertilizer per kg of sand.

The mesocosms used in these experiments were 18-gallon HDPE rectangular tubs maintained in an open-sided greenhouse at the University of Florida FLREC and exposed to ambient conditions. Each mesocosm was filled with ca. 16 gallons of tap water and three planted containers of a single species were placed in each mesocosm. Twenty-four mesocosms (12 with naiad and 12 with hydrilla) were arranged in a randomized block design

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for this experiment, with mesocosms divided into 3 blocks (reps) of 4 groups (0, 1, 2, and 4 g of CRF per kg of sand) for each species. The experiment ran for 8 weeks in Spring 2014 and was repeated in Summer 2014. After 8 weeks of culture, shoots and roots were harvested from each container. All plant tissue was washed clean of debris and placed in a forced-air oven set at 90 °C until a constant weight was achieved. Dry weights were subjected to analysis of variance and least significant difference separation of means to identify treatment differences (R statistical program, version 3.2.0).

Results and Discussion

There were no significant differences between the two runs of this experiment, so data from both runs were pooled for analysis. There was no difference between naiad and hydrilla shoot and root dry weight when plants were fertilized with 0 or 1 g CRF/kg sand, but hydrilla shoot dry weight was greater than naiad shoot dry weight in containers fertilized with 2 or 4 g CRF/kg sand (Fig. 1 and Fig. 2). Hydrilla shoot weight was greatest in containers with 2 or 4 g CRF/kg sand, while naiad shoot dry

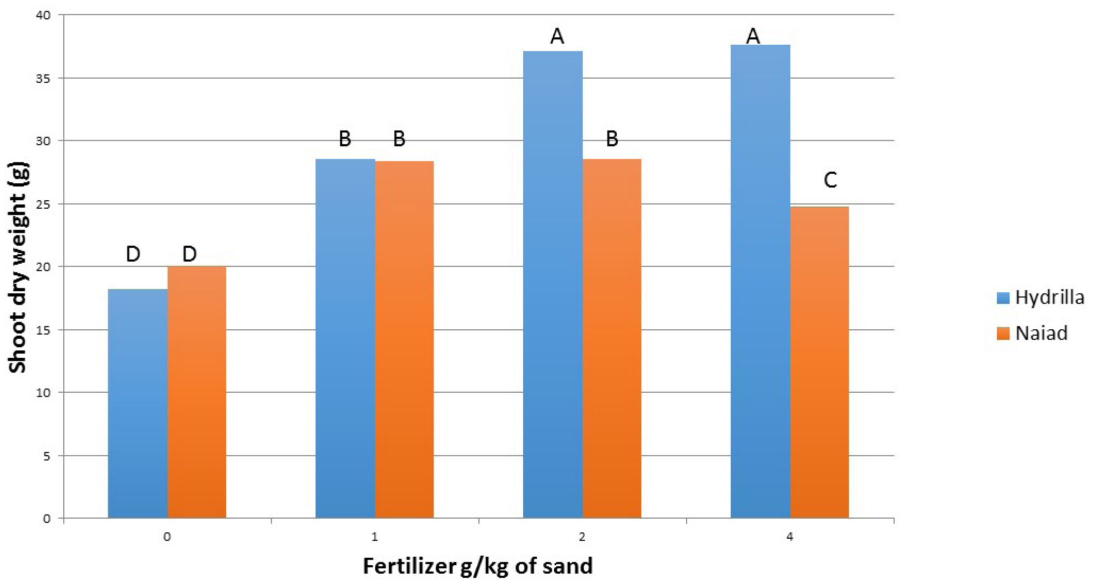

Fig. 1. Shoot dry weight (g) of hydrilla (*Hydrilla verticillata*) and naiad (*Najas guadalupensis*) grown in submersed containers fertilized with 0, 1, 2, or 4 g of controlled-release fertilizer (Osmocote 15N–4.05P–9.96K) per kg of sand. Values are means of nine replicates per treatment. Means followed by different letters are significantly different at $P = 0.05$.

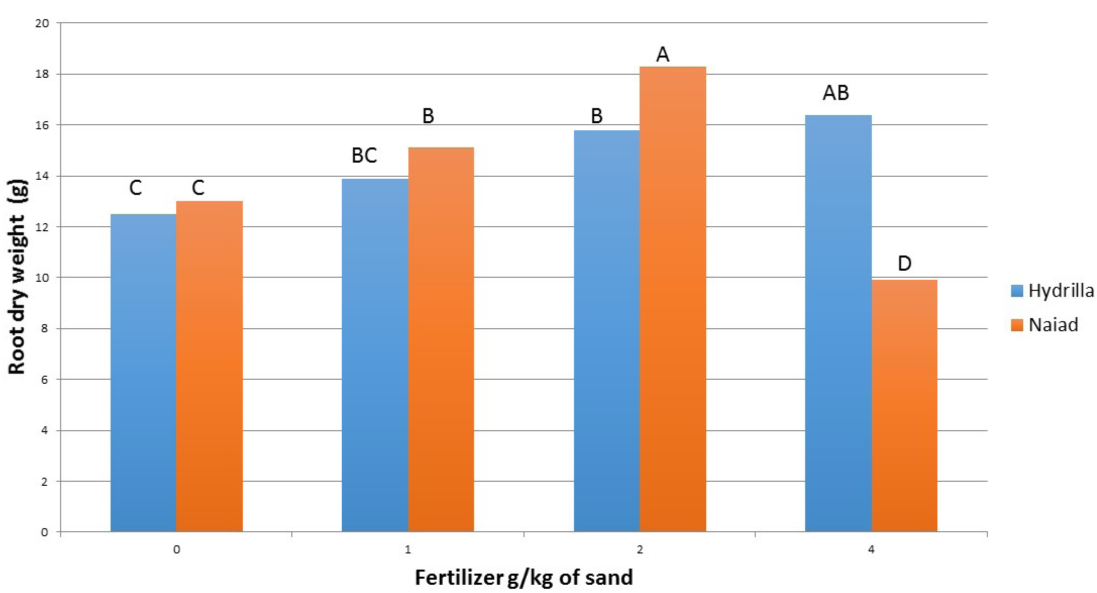

Fig. 2. Root dry weight of hydrilla (*Hydrilla verticillata*) and naiad (*Najas guadalupensis*) grown in submersed containers fertilized 0, 1, 2, or 4 g of controlled-release fertilizer (Osmocote 15N–4.05P–9.96K) per kg of sand. Values are means of nine replicates per treatment. Means followed by a different letter are significantly different at the $P = 0.05$.

weight was highest in containers with 1 or 2 g CRF/kg sand. Naiad root dry weight was greater than hydrilla root dry weight in containers fertilized with 2 g CRF/kg sand, but hydrilla root dry weight was greater than naiad root dry weight in containers with 4 g CRF/kg sand (Fig. 2).

Non-native plants like hydrilla and Eurasian watermilfoil (*Myriophyllum spicatum*) alter the natural interactions in an aquatic habitat and force out native species (Madsen, 1998). For example, southern naiad was displaced by non-native plant Eurasian water milfoil in two lakes in New York and was forced to grow in shallower areas than usual (Madsen et al, 2008). Also, non-native plants are often responsible for reduction in oxygen exchange, depletion of dissolved oxygen, increases in water temperatures, and internal nutrient loading (Madsen, 1998).

Although hydrilla and naiad appear similar, it is clear from this study that their nutritional preferences are different. Previous research on hydrilla yielded results similar to those reported in our study. Barko (1982) found that higher nutrient levels in sediments resulted in greater growth of hydrilla, and Sutton (1985) reported greater growth of hydrilla in containers with higher fertilizer rates. Naiad has been reported in several counties in central and southern Florida where soils are mostly nutrient-poor sandy loams (USDA Plants Database, 2015). This might explain why naiad grew better at lower fertilization rates compared to hydrilla, but more research is needed.

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