Production of Wetland Plants in Constructed Wetland Cells Designed to Treat Nursery Runoff

Thomas Holt, Brian Maynard, and William Johnson
Department of Plant Sciences, University of Rhode Island, Kingston, Rhode Island 02881 U.S.A.

INTRODUCTION

Containerized nurseries and greenhouses produce nutrient-laden runoff which may contribute to the nutrient loading of surface waters (HWQA, 1992; Alexander, 1993). This occurs when liquid fertilizer is applied through irrigation systems, or when nutrients are leached from fertilized fields or containers. In some operations it is estimated that up to 78% of applied irrigation water ends up as runoff (Furuta, 1978).

Constructed wetlands have emerged as effective, low-cost methods of water treatment which have the potential to reduce agricultural nonpoint source pollution. The role of wetlands in pollution and flood control has been recognized since the 1960s (Young, 1996). Beginning in the 1970s Congress adopted a wetland policy of "no net loss" and mitigation, which required that new wetlands be created or restored as natural wetlands were lost to development (Young, 1996). However, the costs of implementing treatment wetlands are relatively high, with little opportunity for cost recovery.

With few wetland plant nurseries operating in the Northeast, demand often greatly exceeds supply. Given the demand and increasing popularity of the commodity, wetland plant production could represent a profitable niche. At one time wetland plants had been collected from the wild for mitigation projects, but public policy has moved toward reducing or prohibiting such practices (Harbaugh et al., 1992). At the same time, water gardening has become one of the fastest growing specialties in landscape design and home gardening (Altekruse, 1997). Ornamental emergent and floating aquatic plants represent some of the greatest demand and commercial value in the gardening industry today.

Our objectives are: (1) to demonstrate an economical solution to treating nursery runoff by growing, harvesting, and selling wetland plants produced in a constructed wetland, and (2) to research nutrient removal potentials of several different plant species.

METHODS

Four vegetative propagules (75 to 100 g FW) of *Iris pseudacorus* (yellow flag), *Sagittaria latifolia* (arrowhead), *Phalaris arundinacea* 'Picta' (variegated ribbongrass), *Colocasia esculenta* (taro), and *Canna flaccida* hybrid were planted individually in 120-liter cylindrical wetland cells ($0.3\ m^2 \times 0.4$ m). Each cell was equipped with a drain plug and filled with 4- to 6-mm gravel. The water level was maintained at the gravel surface. A gravel medium was chosen to prevent ponding and establish good contact between water and plant roots. Unplanted wetland cells served as controls.

Experiments were carried out at the Rhode Island Agricultural Experimental Station (Lat. $42^{\circ} 29'$ N). Wetland cells were established outdoors from 15 July 98 to

21 Sept 98 with N-P-K fertilizer solution, then moved into a greenhouse (mean temp. 23±7C) to protect plants from rain during the nutrient removal experiment.

Wetland cells were drained and filled with 100 ppm N 20N-20P-20K Peters fertilizer on 23 Sept 98. During the week tap water was added to the cells to replace water lost by evapotranspiration. On 29 Sept 98 the cells were drained and the effluent water was analyzed (Eaton, et al.,1995) for nitrogen (ammonia and nitrate) and phosphate reduction (Table 1). The number of divisions in each of the wetland cells were determined and expressed as divisions per m^2.

Table 1. Nutrient removal[1] and plant increase[2] of several species of ornamental and native wetland plants.

	Nutrient removal (%)		Average division estimates	
Plant species	N	P	No. m^{-2}	Wse. Value
Canna flaccida	81	59	100	\$1.00-\$3.00
Colocasia esculenta	72	35	70	\$0.75-\$2.50
Iris pseudoacorus	69	48	66	\$0.50-\$0.75
Phalaris arundinacea 'Picta'	51	34	60	\$1.00-\$2.00
Sagittaria latifolia	80	52	126	\$0.50-\$1.00
Typha latifolia	79	40	74	\$0.50-\$0.75
Control (no plant)	24	28	-	-

[1] Wetlands cells were fertilized with 100 ppm N 20N-20P-20K Peters fertilizer with a retention time of 7 days.

[2] Each treatment cell was established with four propagules of 75 to 100 g FW on 15 July 1998. Cells were harvested on 29 Sept. 1998.

RESULTS AND DISCUSSION

Results of this experiment show that all the wetland plants in this study were able to remove nutrients from fertilizer better than the no plant control, with canna > arrowhead > cattail > taro > iris > ribbon grass > no plant control in N removal and canna > arrowhead > iris > cattail > taro > ribbon grass > no plant control in P removal. The different plants species produced between 66 to 120 divisions m^{-2}, representing an earnings potential of up to \$300 per m^2. Our experience growing different plant species in constructed wetland filters shows a trend towards the plants with the greatest biomass removing the most nutrients. For example, canna removed more nutrients than ribbon grass primarily because of biomass. In our wetland cells canna grew up to 2 m and had stems up to 2.5 cm in diameter, while ribbon grass grew to only 0.5 m and had stem diameters of only a few millimeters. Most wetland plants have plant tissue nutrient contents of approximately 2% N and 0.5% P (Debusk et al., 1995).

This study serves as an example of how constructed wetlands can be designed to remove nutrients from fertilizer runoff while producing a marketable crop. If these wetland cells had been established in the spring as opposed to mid July there would most likely have been a larger number of divisions per square meter. It might also have been possible to achieve multiple harvests in a single season if the wetland was established early. Wetland plant production cycles can be started with the propagation of plants from existing stock and growth of the propagules for appropriate lengths of time ranging from 3 months to 1 year before sale. Appropriately sized stock can then be harvested bareroot and sold to wetland construction and landscaping firms, or established for a short time in containers for sale to garden centers. Some plants are replanted to initiate a new production cycle. Partial harvests help maintain the nutrient removal efficiency of the treatment system. This self perpetuating system derives nutrition from the treated effluent and requires only the labor of harvesting and replanting.

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