Acclimatization and Growth of Dwarf Pampas Grass in Response to Fertilizer Application Following *In Vitro* Culture[1]

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Abstract

Dwarf pampas grass (*Cortaderia selloana* Schult. 'Pumila') plantlets produced *in vitro* were subjected to one of seven fertilization treatments during acclimatization to greenhouse conditions. Though all plantlets survived acclimatization, level of fertilizer significantly affected growth rate. Increase in fresh weight, leaf number and tillering during the first 6 weeks of acclimatization was greater when Osmocote micro-fertilizer at 2 kg/m^3 (oz/ft^3) was incorporated into the growing mix (Pro-Gro 200 with starter nutrients) as compared to 4 kg/m^3 (oz/ft^3) of Osmocote or addition of liquid fertilizer. The slowest growth was obtained from plants growing without Osmocote or liquid fertilizer. Once adapted to the greenhouse, plants fertilized with 400 mg/l (ppm) N from 17N-4P-11K (17-9-13) soluble fertilizer twice per week had the most rapid growth.

Index words: greenhouse production, micropropagation, ornamental grass, tissue culture

Species used in this study: Dwarf pampas grass (*Cortaderia selloana* Schult. 'Pumila').

Significance to the Nursery Industry

Successful acclimatization and rapid growth of plantlets from *in vitro* culture is an essential component of micropropagation techniques. However, relatively little has been published on the effect of fertilization on growth rate during acclimatization. Micropropagation of pampas grass has been highly successful in increasing the rate of propagation, and plants produced through *in vitro* culture readily adapt to greenhouse conditions. However, rapid growth of these plants is required to achieve a saleable plant in a reasonable period of time. This study demonstrated that the early growth rate of pampas grass plantlets can be greatly increased by incorporation of low levels of Osmocote microfertilizer into growing medium containing starter fertilizer. Fertilization with high levels of Osmocote or with liquid fertilizer during the early weeks of acclimatization yielded a slow rate of growth.

Introduction

Ornamental or landscape grasses, such as pampas grass (*Cortaderia selloana* Schult.), are becoming increasingly popular as landscape plants. Pampas grass is especially prized for its stately appearance and large, showy plumes in late summer and fall (4). 'Pumila' is a dwarf cultivar that is in short supply due to its popularity. To maintain cultivar identity, pampas grass must be clonally propagated. Propagation through division yields a 4-fold plant increase per year, while *in vitro* propagation yields thousands of plantlets (9).

Reports of the effect of fertilization on survival and growth rate during acclimatization of *in vitro* propagated plants has often been lacking. Though many laboratories incorporate fertilizer into the transplanting medium in a slow-release form and/or fertilize the transplanted plantlets with a dilute soluble complete fertilizer (1, 7), species differ in response to both type and level of fertilizer. Superior growth of grape microcuttings during acclimatization was achieved with transplant media that contained starter nutrient charge (2). Similarly, *Populus alba* plantlets had the best survival and growth in prefertilized medium without additional liquid fertilizer (5). In contrast, *Artocarpus heterophyllus* had significantly more growth and better survival with low or no fertilization in the first few weeks of acclimatization (8). Also, potato plantlets transplanted into pre-fertilized medium had weak, elongated stems and poorer root development than plantlets fertilized after root development (3).

In a previous studies with pampas grass from *in vitro* culture, plantlets were transplanted into Pro Gro 200 (Gro-Bark, McCormick, SC.), a peat moss and vermiculite mix containing starter fertilizer with trace elements. Though nearly all of the plantlets survived acclimatization, growth rate was slow (9). A fast rate of growth is desired, since customers prefer large plants. To determine whether growth rate could be increased during acclimatization to greenhouse conditions, I investigated the effect of seven fertilizer treatments on several growth parameters.

Materials and Methods

The procedure described by Robacker and Corley (9) was used for explant establishment and shoot production. Immature inflorescences about 300 mm (12 in) long, enclosed within the terminal leaves, were collected from field-grown 'Pumila' pampas grass. Following disinfestation in 95% (v/v) ethanol for 1 min, 1% NaClO for 20 min, and three sterile water rinses, the leaves surrounding the inflorescence were removed, and the inflorescence was cut into segments 20 mm (0.8 in) long. Three to five inflorescence segments were positioned horizontally in each 25 × 150 mm (1.0 × 6.0 in) culture tube. The culture medium consisted of MS salts and vitamins (6), 1.0 mg/l (ppm) 2,4-dichlorophenoxyacetic acid (2,4-D), 2.0 mg/l 6-benzyladenine, 750 mg/

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l $MgCl_2$, 20,000 mg/l sucrose, and 2,000 mg/l Gelrite. Following adjustment of the pH to 5.5, the medium was dispensed in 16 ml (0.6 oz) aliquots into culture tubes capped with clear Magenta caps (Magenta, Chicago), and autoclaved for 20 min at 121°C (250°F).

The cultures were incubated at 27° to 30°C (80° to 86°F) with 16 hr of light provided by 110-W wide-spectrum fluorescent tubes (70 $\mu mol \cdot m^{-2} \cdot s^{-1}$; approx. 350 ft-c). After one month, the cultures were transferred to MS medium as described above, except that the growth regulators were reduced to 0.1 mg/l 2, 4-D and 1.0 mg/l BA. Following two culture cycles on this medium, shoots that had formed were transferred to MS medium without growth regulators, where they rooted spontaneously.

Plantlets were rinsed to remove culture medium from the roots, and potted in Pro-Gro 200 medium in 6 × 6 × 5.5 cm deep (2.3 × 2.3 × 2.1 in) plastic pots, one plantlet per pot. The plantlets were placed under 65% shadecloth (40 to 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$, 200 to 300 ft-c) and intermittent mist (mist "on" 8 sec every 16 min) for 36 hours. The frequency of mist application was gradually decreased, and at the end of one week, the plantlets were removed from the mist. Shadecloth was continued for one additional week. The plantlets were then grown under ambient greenhouse conditions. This study was conducted in Griffin, Georgia during the months January through March. Mean temperature was 19°C (67°F) night, 24°C (75°F) day, and light levels ranged from 100 to 800 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (500 to 4000 ft-c.).

Seven fertilization treatments were applied. The control treatment had only the starter fertilizer with trace elements that is part of the Pro-Gro 200 mix. In three treatments, Osmocote (Grace-Sierra Horticultural Products) microfertilizer 17N-4P-11K (17-9-13) was incorporated into the Pro-Gro 200 medium at 2, 3, or 4 kg/m^3 (2, 3 or 4 oz/ft^3). Liquid fertilizer, made up of fertilizer salts in the ratio of 17N-4P-11K, was applied to the pots at the rate of 100, 200 or 400 mg/l (ppm) N in the other three treatments. The liquid fertilizer was applied twice per week beginning 2 weeks after planting.

Forty potted plants were randomly selected for each treatment; within each treatment, the plants were randomly numbered from 1 to 40. The number of leaves per plant was determined. After 5 weeks in the greenhouse, plants numbered 1 through 20 were selected from each treatment. Fresh weight of the tops, number of new leaves and number of tillers per pot were determined for each pot. Fertilizer treatments continued for the remaining plants, and after another 4 weeks, the plants were harvested and data were collected as above. For statistical analysis, leaf number and plant number per pot were transformed to square-root values. The data were analyzed using a general linear models procedure (10). When treatment effects were significant, individual treatment differences were tested with the LSD (Least Significant Difference).

Results and Discussion

All plantlets in this study successfully acclimatized to the greenhouse. However, fertilizer treatment significantly affected growth rate of the plants. Six weeks after transfer to the greenhouse, plants fertilized with Osmocote at 2 kg/m^3 (oz/ft^3) had significantly more new leaves and more tillers per pot than did the control plants and those fertilized with liquid fertilizer (Table 1). Furthermore, plants fertilized at the lowest rate of Osmocote (2 kg/m^3) grew faster in all measured parameters than those fertilized at the highest rate (4 kg/m^3). Among the liquid fertilizer treatments, tillering was greater at the lowest rate (100 mg/l N) than at the highest rate (400 mg/l N), though fresh weight and leaf number were not significantly affected by fertilizer rate.

Data collected 10 weeks after potting revealed continued growth under all treatments, though the best growth was obtained with the liquid fertilizer at the higher rates (Table 2). Those plants that had exhibited slow growth in the first 6 weeks, i.e. those fertilized with Osmocote at 4 kg/m^3 or with liquid at any rate, recovered and attained or exceeded the size of plants from the low-fertilizer Osmocote treatments. Apparently, as the plants grew larger and became acclimatized to greenhouse conditions, their need for fertilizer increased. Plants on the no-fertilizer treatment and those on low levels of Osmocote appeared chlorotic. Though pampas grass readily acclimatized to greenhouse conditions, growth rate was clearly sensitive to rate of fertilizer. The level of starter fertilizer in Pro-Gro 200 mix was insufficient to yield rapid growth of pampas grass. Incorporation of Osmocote micro-fertilizer at low levels (2 or 3 kg/m^3) into the growing medium supported a high rate of leaf growth and tillering during acclimatization. However, after 4 to 6 weeks in the greenhouse, plants fertilized with high levels (400 mg/l N) of liquid fertilizer showed superior growth, indicating that following acclimatization, supplementation with liquid fertilizer is advisable to sustain rapid growth.

Table 1. Mean fresh weight, number of new leaves and number of tillers per pot[z] of pampas grass 6 weeks after potting.

Treatment	Fresh weight tops (g)	Number of new leaves	Number of tillers per pot
Control (no fertilizer)	0.98 d[y]	6.0 c	2.6 d
Osmocote—2 kg/m^3 (oz/ft^3)	1.69 a	12.8 a	4.1 a
Osmocote—3 kg/m^3 (oz/ft^3)	1.54 ab	11.4 a	3.7 ab
Osmocote—4 kg/m^3 (oz/ft^3)	1.40 bc	9.4 b	3.4 bc
Liquid—100 mg/l N (ppm)	1.14 cd	9.1 b	3.3 bc
Liquid—200 mg/l N (ppm)	0.95 d	7.9 b	3.0 cd
Liquid—400 mg/l N (ppm)	1.27 bc	7.8 b	2.6 d

[z]Initial number of plants (tillers) per pot was one.

[y]Mean separation within columns by the LSD; P = 0.05; n = 20. Analysis of leaf number and tillers per pot on square-root transformed data; nontransformed data are presented.

Table 2. Mean fresh weight, number of new leaves and number of tillers pot pot[z] of pampas grass 10 weeks after potting.

Treatment	Fresh weight tops (g)	Number of new leaves	Number of tillers per pot
Control (no fertilizer)	2.12 c[y]	12.0 c	2.9 c
Osmocote—2 kg/m^3 (oz/ft^3)	6.36 a	23.4 b	4.9 a
Osmocote—3 kg/m^3 (oz/ft^3)	4.62 b	22.4 b	4.3 ab
Osmocote—4 kg/m^3 (oz/ft^3)	5.14 b	22.6 b	4.6 ab
Liquid—100 mg/l N (ppm)	4.58 b	22.4 b	4.1 b
Liquid—200 mg/l N (ppm)	6.62 a	23.8 b	4.6 ab
Liquid—400 mg/l N (ppm)	6.88 a	28.3 a	4.8 a

[z]Initial number of plants (tillers) per pot was one.

[y]Mean separation within columns by the LSD; P = 0.05; n = 20. Analysis of leaf number and tillers per pot on square-root transformed data; nontransformed data are presented.

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Determination of Constant-Feed Liquid Fertilization Rates for *Spathiphyllum* 'Petite' and *Dieffenbachia* 'Camille'[1]

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Abstract

Spathiphyllum 'Petite' and *Dieffenbachia* 'Camille', two popular foliage plants sensitive to excess salts, were grown using 9 levels of water-soluble fertilizer in a 3-1-2 ratio of N-P_2O_5-K_2O. The range for maximum growth occurred at 100–200 ppm (mg/l) N for *Spathiphyllum* and 200–400 ppm (mg/l) N for *Dieffenbachia* on a constant-feed basis. *Spathiphyllum* showed more noticeable leaf burn symptoms compared to *Dieffenbachia* when the concentration of fertilizer in the irrigation water increased above the range that yielded maximum growth.

Index words: tropical foliage plants, salinity, fertilizer, peace lily, dumbcane

Species used in this study: peace lily (*Spathiphyllum* Schott. 'Petite'); dumbcane (*Dieffenbachia* Schott. 'Camille').

Significance in the Nursery Industry

Spathiphyllum and *Dieffenbachia* are two of the most popular tropical foliage plant species. Accumulation of soluble salts in the growing medium from water-soluble fertilizers and dissolved soluble salts in the irrigation water are limiting factors in plant growth and survival. The range for maximum growth was 100–400 ppm N from a 3-1-2 N-P_2O_5-K_2O fertilizer on a constant-feed basis. *Spathiphyllum* performed best at the lower end of this range, while *Dieffenbachia* performed best at the upper end. Our results show

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