Nitrogen Nutrition of Southern Seaoats (*Uniola paniculata*) Grown in the Float System©

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Southern seaoats (*Uniola paniculata* L.), a major coastal dune species, was grown by seed in a greenhouse using the tobacco float system with nitrogen (N) in the nutrient solution at 10, 60, 120, 180, or 240 mg·L^{-1} (ppm). Transplants were produced successfully using this means of culture and N at 135 to 150 mg·L^{-1} (ppm) maximized vegetative growth.

INTRODUCTION

Southern seaoats is a perennial dune grass that in most of its natural range is the dominant sand-binding plant species (Ricciuti, 1984). The plant is generally subtropical, and its native range is determined by climate because it is intolerant of extremely hot summers or cold winters (Ricciuti, 1984). In Virginia and North Carolina, southern seaoats is at the northern limit of its range, and the plants usually die back to ground level and resprout from rhizomes in the spring. Seed germination occurs in the late spring, and little growth takes place until adequate sand surrounds the culms, usually by the end of the second year (Woodhouse and Hanes, 1966). Seaoats has the ability to resist erosion upon establishment by utilizing culms to trap sand, which in turn helps improve plant growth (Latham, 2001). Thus, it has been planted extensively to build and stabilize coastal sand dunes (Woodhouse and Hanes, 1966).

Limited research has examined the fertility needs of southern seaoats. Due to the infertility of seaoats native environment, Broome et al. (1982) recommended macronutrient fertilization (10N–10 P_2O_5–10 K_2O) in the spring at a rate of 732 kg·ha^{-1} (653 lb/acre). Hester and Mendelssohn (1990) reported fertilization with nitrogen (N), phosphorous (P), and potassium (K) resulted in significant increases in aboveground biomass in seaoats with a maximum foliar N concentration of 2.1%.

Currently, former tobacco farmers are seeking alternative crops that can be grown similarly to production of tobacco (*Nicotiana tabacum* L.) transplants (Latham, 2001). Frantz and Wellbaum (1998) reported most tobacco farmers grow tobacco transplants in a vermiculite-based soilless medium using Styrofoam plug flats that float in a nutrient solution. These float-bed irrigation systems are used by tobacco growers to produce transplants in early spring, but the float beds are not utilized the rest of the year. Frantz and Wellbaum (1998) also noted if other crops could be produced successfully using the tobacco float system, float systems could potentially produce high-value horticultural crops to supplement farm incomes. David Nash, an Agricultural Extension Agent in New Hanover County, North Carolina, has been growing seaoats successfully utilizing the tobacco float system (Latham, 2001). Initially, he attempted to grow southern seaoats in containers utilizing an organic substrate. However, he encountered many problems, particularly with foliar fungal pathogens due to irrigating over the tops of the plants. He switched to using the float system, which dramatically reduced foliar infestations. However, despite successful culture of southern seaoats using the float system little, if any, quantitative information has been published on various aspects of this method of culture. Therefore, the following research was conducted to study the influence of N nutrition on vegetative growth of southern seaoats when grown in the float system.

MATERIALS AND METHODS

Standard Carolina Greenhouse 288 cell float trays (Carolina Greenhouse Co., Kinston, NC) [42 × 34 × 6.5 cm (17 × 13 × 3 inches)], with each cell having a volume of 14 cm^3 (0.9 in^3), were cut (reduced) on 9 July 2004 from 24 × 12 cells to 15 × 12 cells. These modified trays were filled with Carolina's Choice Tobacco Mix (Carolina Soil Co., Kinston, North Carolina), a vermiculite-based hydroponic mix. The medium-filled trays were then floated in gray plastic tubs [50 × 36 × 12 cm (20 × 14 × 5 inches)] filled with 10 L (3 gal) of tap water. On 12 July 2004, seeds of a North Carolina provenance of southern seaoats were removed from storage at 4 °C (39 °F) and surface disinfested with a solution of 2.6% sodium hypochlorite for 15 min. Following treatment, seeds were sown in the float trays at three seeds per cell in a 6 × 6 cell cube in the center of the trays [center was determined from the top (shorter dimension side) of tray counting five cells right and four cells down]. After seeding, each seed-filled tray was refloated in 10 L (3 gal) of tap water with a particular N treatment and were maintained in the Department of Horticultural Science Greenhouses at North Carolina State University under natural photoperiod and irradiance. Treatments included five rates of N [10, 60, 120, 180, or 240 $mg \cdot liter^{-1}$ (ppm)] from an $8N–32P_2O_5–5K_2O$ liquid slow-release fertilizer (Growth Products, Ltd., White Plains, New York). The nutrient solution was replaced weekly. Nutrient sources were urea, methylene urea, potassium carbonate, and diammonium phosphate. The experiment was conducted in a randomized complete block design with four replications. A tub was considered a single experimental unit. Tubs were oriented on a greenhouse bench parallel to the cooling pads to direct even airflow across all treatments. As seeds germinated, they were thinned to one seedling per cell. During the study, daily day/night air temperatures averaged 27/21 °C (81/70 °F), respectively, whereas daily nutrient solution temperatures averaged 26 °C (79 °F).

Before recording data, the seedlings in the outermost row of each float tray were discarded to remove edge effects, which left a 4 × 4 square consisting of 16 plants. Three plants were randomly chosen from the 4 × 4 square. On 9 Sept. 2004, the study was terminated and various data recorded including leaf, stem, and root dry weights following drying at 60 °C (140 °F) for 48 h. Total plant dry weight was calculated as leaf + stem + root dry weight. Root to top ratio was calculated as root dry weight ÷ top dry weight (stems + leaves). Tops (stems and leaves) were also analyzed for mineral nutrient concentrations. All data were subjected to analysis of variance procedures and regression analysis. When significant, simple linear and polynomial curves were fitted to data. The maximum of the polynomial curve was calculated as a first order derivative of the independent variable where the dependent variable equaled zero.

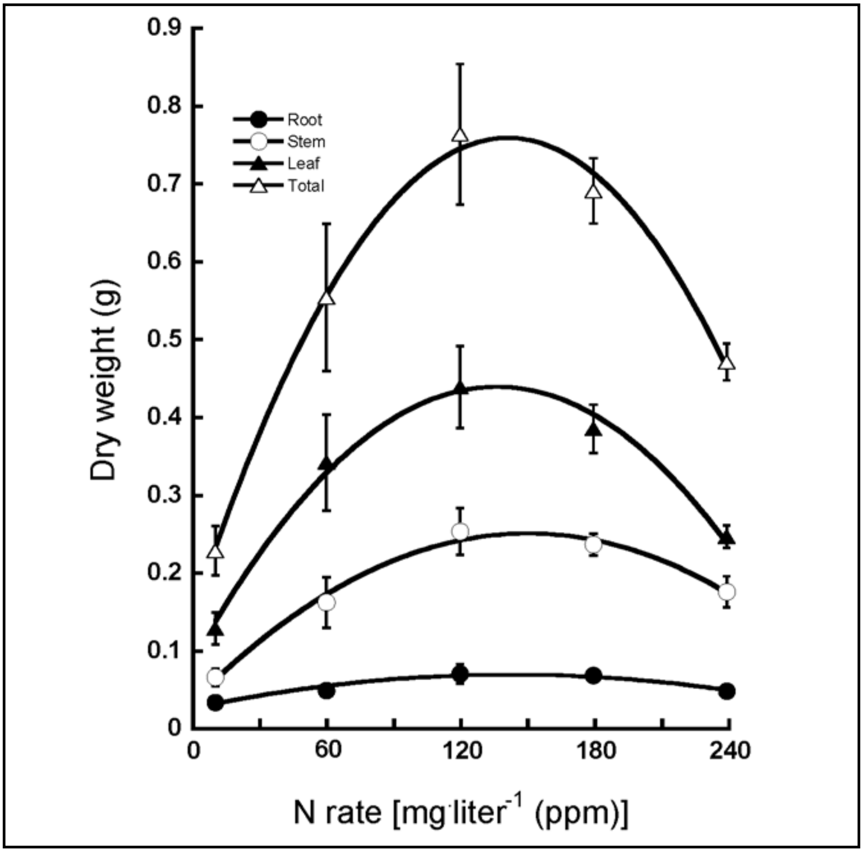

Figure 1. Influence of N rate on root, stem, leaf, and total plant dry weights of southern seaoats grown in the float system. Data points are means of 12 observations, and vertical bars = ± 1 SE. Regression equations are: root dry weight $y = 0.03 + 0.0006x - 0.000002x^2$, $R^2 = 0.98$; stem dry weight $y = 0.04 + 0.003x - 0.0000095x^2$, $R^2 = 0.99$; leaf dry weight $y = 0.09 + 0.005x - 0.00002x^2$, $R^2 = 0.99$; total plant dry weight $y = 0.15 + 0.009x - 0.00003x^2$, $R^2 = 0.99$.

RESULTS AND DISCUSSION

Root, stem, leaf, and total plant dry weights of southern seaoats responded quadratically to increasing N rate with maximum root, stem, leaf, and total plant dry weights calculated to occur at 143, 151, 137, and 141 mg·liter^{-1} (ppm), respectively (Fig. 1). Root to top ratio was unaffected by N rate (data not presented).

Foliar mineral N and P concentrations increased quadratically with increasing N rates, whereas foliar K increased linearly (data not presented). The predicted N rate for maximum foliar N (3.2%) was calculated to be 180 mg·L^{-1} (ppm). Maximum top dry weight also occurred at 3.2% N, which is considerably higher than the 2.1% reported by Hester and Mendelssohn (1990). Thus, foliar N concentration ≥ 3.2% should be considered adequate for maximum plant growth.

In summary, southern seaoats can be produced successfully using the float system with optimum N rates of 135 to 150 $mg \cdot L^{-1}$ (ppm). Due to the relative nutrient sterility of the dune environment, Broome et al. (1982) noted that dune grasses, such as seaoats, respond positively to fertilization, even though their extensive fibrous root system allows them to exploit the low nutrient conditions in their natural habitat. Culture of the species using the flat system may allow tobacco farmers to utilize their float beds at times of the year when the beds are not in use. Also, seaoats may serve as a possible alternative crop to tobacco or an additional crop to supplement farm incomes.

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