# Growth Responses of Bermudagrass to Different Levels of Nutrients in the Culture Medium

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## *Abstract*

*Bermudagrass (Cynodon dactylon L.), cv. Arizona Common was studied in a greenhouse to evaluate its growth responses in terms of shoot and root lengths and shoot and root dry weights under different levels of nutrients. Plants were grown hydroponically under five levels of nutrients in the growth medium [Full Nutrients (FN), Half Nutrients (½N), Quarter Nutrients (1/4N), One Eighth Nutrients (1/8N), and One Sixteenth Nutrient (1/16N)], using Hoagland solution No. 1. Plant shoots (clippings) were harvested weekly, oven dried at 60 °C, and dry weights recorded. At each harvest, both shoot and root lengths were measured and recorded. At the last harvest, plant roots were also harvested, oven dried, and dry weights were determined and recorded. The results show that shoot length, shoot and root dry weights,* shoot total-N contents and concentrations*, and the % of canopy green cover significantly decreased at lower (1/8 & 1/16) nutrient levels. This reduction was more pronounced as growth period progressed. Root length was stimulated at lower (1/4, 1/8, and 1/16) nutrient levels of the culture solutions. The differences in shoot lengths and shoot and root dry weights were not significant among the Full,1/2, and 1/4 nutrient levels of the culture solutions. The differences in shoot total-N content and concentrations were not significant among the Full, !/2, and 1/4 nutrient levels. There was no difference in either shoot total-N contents or concentrations among the respective nutrient treatments at different harvests. The above results were observed for both cumulative as well as the weekly growth responses.*


## Introduction

Bermudagrass (*Cynodon dactylon* L.), a common warm season turf species, grows worldwide as a turfgrass species in a wide range of climates, soils, and environmental conditions. The grass can be manipulated to produce dwarf varieties which require less mowing as well as more stress (i.e., salinity and drought) tolerant cultivars which require less maintenance (i.e., fertigation, fertilization and irrigation), and grow in poor soil conditions. These characteristics can be very beneficial for turfgrass growth in arid and semi-arid regions where the soils are usually saline/sodic and water is limited for irrigation and other agricultural uses.

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## Objectives

The objectives of this study were to compare growth responses of bermudagrass in terms of shoot and root lengths and dry weights (shoot clippings weight) grown under different levels of the nutrients in the culture medium. In addition, to gather more information on the growth and to find an optimum nutrient requirement of this common turfgrass species.

## Materials and Methods

Bermudagrass (*Cynodon dactylon* L.), cv. Arizona common, was used in a greenhouse experiment to evaluate its growth in terms of shoot and root lengths and dry weights (shoot clippings weight) grown under different levels of nutrients in the culture medium, using a hydroponic technique.

The plants were vegetatively grown in cups, 9 cm diameter and 7 cm height. Silica sand was used as the plant anchor medium. Each cup was fitted into one of the 9 cm diameter holes cut in a rectangular plywood sheet 46 cm X 37 cm X 2 cm. The plywood sheets served as lids for the hydroponic tubs and supported the cups above the solution to allow for root growth, and were placed on 42 cm X 34 cm X 12 cm Carb-X polyethelene tubs containing half strength Hoagland solution No. 1 (Hoagland and Arnon, 1950, Pessarakli and Tucker, 1988, Pessarakli et al., 2001). Eight replications of each treatment were used in a Randomized Complete Block design (RCB) in this investigation.

Plants were allowed to grow in this nutrient solution for 42 days. During this period, the plant shoots (clippings) were harvested weekly in order to allow the grass to reach full maturity and develop uniform and equal size plants. The harvested plant materials (clippings) were discarded. The culture solutions were changed biweekly to ensure adequate amount of plant essential nutrient elements for normal growth and development. On day 42, roots were also cut to have plants with uniform roots and shoots prior to the initiation of the desired various nutrient treatments.

The various nutrient levels consisted of Full Nutrients (FN), Half Nutrients (½N), Quarter Nutrients (1/4N), One Eighth Nutrients (1/8N), and One Sixteenth Nutrient (1/16N)]. The culture solution levels in the tubs were marked at the 10 liter volume level and maintained at this level by adding the respective nutrient solutions as needed. Culture solutions were changed twice per week to maintain the desired nutrient concentration levels. The plant shoots (clippings) were harvested weekly for the evaluation of the dry matter production. At each weekly harvest, both shoot and root lengths were measured and recorded. The percent of the visual green cover was also estimated and recorded.

The harvested plant materials were oven dried at 60$^{o}$C and dry weights were measured and recorded. The recorded data were considered the weekly plant dry-matter production. At the termination of the experiment, the last harvest, plant roots were also harvested, oven dried at 60 $^{o}$C, and dry weights were determined and recorded.

## Statistical Analysis

The data were subjected to Analysis of Variance, using SAS statistical package (SAS Institute, 1991). The means were separated, using Duncan Multiple Range test.

## Results and Discussion

The results for both cumulative as well as the average weekly growth responses were essentially the same and are presented in Tables 1-3.

### Root Length

Root length was stimulated at lower (1/4, 1/8, and 1/16 N) nutrient levels of the culture medium. This is in agreement with Sagi et al. (1997) and Pessarakli (1994 and 2001) reports as well as the common knowledge in plant physiology that under stress conditions (nutrient deficiency stress in the present study), the roots grow more in search of water and/or nutrients. There was not any significant difference detected among the root lengths at these levels of nutrients (Tables 1 and 2). Also, as shown in these Tables, statistically, there was no difference in the root lengths at the full nutrient (FN) and the half strength nutrient (1/2 N) levels.

### Shoot Length

In contrast to the root length, shoot length significantly decreased at lower (1/8 and 1/16 N) levels of the nutrient in the culture medium (Tables 1 and 2). This reduction was more pronounced at the lowest (1/16 N) level of the nutrients. The values for the shoot lengths were statistically the same for the full nutrient (FN), half strength (1/2 N), and the quarter strength (1/4 N) nutrient levels of the culture medium.

### Root Dry Weight

Root dry weights responses followed the same pattern as shoot length, significantly decreased at lower (1/8 and 1/16 N) nutrient levels of the culture medium (Tables 1and 2). However, statistically, there was no difference detected in the root dry weights at these two nutrient levels. Also, the differences in root dry weights were not significant among the full nutrient (FN), 1/2 strength (1/2 N), and quarter strength (1/4 N) nutrient levels of the culture solutions.

### Shoot Dry Weight

Shoot dry weights responses followed exactly the same pattern as shoot length. The values significantly decreased at lower (1/8 and 1/16 N) nutrient levels of the culture medium (Tables 1 and 2). The differences in shoot dry weights were not significant among the full strength (FN), 1/2 strength (1/2 N), and quarter strength (1/4 N) nutrient levels of the culture medium. However, reduction in shoot dry weights was more pronounced at the lowest (1/16 N) level of the nutrients in the culture medium.

#### Percent Canopy Green Cover

The percent of canopy green cover decreased only at the lower (1/8 and 1/16 N) nutrient levels (Table 3). This reduction was more pronounced as growth period progressed.

## Conclusions

Shoot length significantly decreased at lower (1/8 and 1/16 N) nutrient levels. Root length was stimulated at lower (1/4, 1/8, and 1/16 N) nutrient levels. Both shoot and root dry weights responses followed the same pattern as shoot length. Both significantly decreased at lower (1/8 and 1/16 N) nutrient levels of the culture medium. The differences in shoot lengths and shoot and root dry weights were not significant among the Full, 1/2, and 1/4N nutrient levels of the culture solutions. The above observations are true for both cumulative as well as the weekly growth responses. The percent of canopy green cover decreased only at the lower (1/8 and 1/16 N) nutrient levels. This reduction was more pronounced as growth period progressed.

## References


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Table 1. Bermudagrass growth responses (cum.) to various nutrient levels of the culture medium.

| Nutrient levels | Length (cm) | | Dry Wt. (g) | |
|---|---|---|---|---|
| | Root | Shoot | Root | Shoot |
| Full Nutrient (FN) | 41.4b | 39.1a | 1.06a | 3.09a |
| 1/2 N | 35.5b | 42.2a | 1.14a | 3.35a |
| 1/4 N | 54.9a | 38.8a | 1.28a | 3.07a |
| 1/8 N | 50.8a | 32.3b | 0.75b | 2.50b |
| 1/16 N | 54.0a | 25.6c | 0.68b | 2.07c |

The values are means of eight replications.
All the values followed by the same letter in each column are not statistically different at the 0.05 probability level.

Table 2. Bermudagrass growth responses (average weekly growth) to various nutrient levels.

| Nutrient levels | Length (cm) | | Dry Wt. (g) | |
|---|---|---|---|---|
| | Root | Shoot | Root | Shoot |
| Full Nutrient (FN) | 5.2b | 4.9a | 0.13a | 0.39a |
| 1/2 N | 4.4b | 5.3a | 0.14a | 0.42a |
| 1/4 N | 6.9a | 4.8a | 0.16a | 0.38a |
| 1/8 N | 6.4a | 4.0b | 0.09b | 0.31b |
| 1/16 N | | 6.8a | 3.2c | 0.08b 0.26c |

The values are means of eight replications.
All the values followed by the same letter in each column are not statistically different at the 0.05 probability level.

Table 3. Bermudagrass percent of canopy green cover responses to various nutrient levels.

| Nutrient levels | Harvests | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 |
| Full Ntrient (FN) 100 | 100 | 100 | 100 | 100 | 100 | |
| 1/2 N | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/4 N | 100 | 100 | 100 | 100 | 95 | 90 |
| 1/8 N | 100 | 95 | 90 | 85 | 80 | 75 |
| 1/16 N | 95 | 90 | 85 | 80 | 70 | 65 |