Role of Pensacola Bahiagrass Stolon-Root Systems in Fertilizer Nitrogen Utilization on Leon Fine Sand

W. G. Blue

ABSTRACT

An experiment was conducted with Pensacola bahiagrass (Paspalum notatum Flugge) on Leon fine sand near Gainesville, Fla. for 6 years to determine residual effects of applied N on forage N uptake, and changes in stolons, roots, and soil N. Nitrogen was applied at 0, 112, 224, and 448 kg/ha/year. Except for the control, paired plots were used at each N rate. Nitrogen fertilization was discontinued on one of each treatment pairs in 1969 and 1970 to determine the residual effect of N. These treatments were resumed in 1971. The residual effect of N was small for all treatments, amounting to 8, 41, and 95 kg/ha total N in harvested forage above the control for the 2-year period for the 112, 224, and 448 kg N rates, respectively. Unrecovered N through 1968 was approximately 206, 350, and 770 kg/ha for the three treatments, respectively. Nitrogen lost from the stolon-root systems during 1969 and 1970 through decrease in mass and N concentrations was 60, 100, and 190 kg/ha for the three N treatments, respectively. Little of the unrecovered N could be accounted for by analysis of the surface soil. Lack of residual effect on plant growth confirmed that little available N was in the soil profile to rooting depth. Based on previous studies, teaching appears to have limited importance when N is applied to well-established perennial grass pastures during the growing season. Conditions imposed in this soil by high water table, large amounts of plant residues, and rapid decomposition during the summer season could make denitrification a significant factor.

Additional key words: Forage N, N recovery.

NITROGEN is probably the most deficient nutrient in Florida's mineral soils. Its accumulation in soils occurs slowly and its rate of availability is inadequate for optimum crop production. Nitrogen uptake in perennial grass forage from Leon fine sand without N applied ranged from about 30 to 50 kg/ha in contrast to quantities in excess of 200 kg/ha, where high rates of N were used. Oven-dry forage yields were 3 to 4 tons/ha without applied N and 12 tons/ha or more for high rates of N (4). Residual effects of N applied to harvested plots beyond the season of application have been small (4).

It was demonstrated recently (3) that over a relatively long period, apparent recovery of currently applied N in harvested Pensacola bahiagrass (Paspalum notatum Flugge) forage gradually increased. During the 7th year it exceeded 70% of the annual application. The stolon-root mass and N concentrations were increased by fertilization. Total N in the stolon-root systems was 105, 182, and 245 kg/ha for N rates of 0, 112, and 224 kg/ha, respectively. There is obviously the potential for a large amount of N to be utilized and immobilized in the development and maintenance of the stolon-root systems. The high recovery efficiency of applied N in the latter years of this study was attributed to development of a static condition in stolon-root system development. Beaty, Brown, and Morris (1) in Georgia have also shown the effect of fertilization on stolon-root weights. They emphasized the importance of this large reservoir for storage materials.

Because of the large quantity of N necessary for intensive production and its relatively high cost, the potential utilization of N immobilized in the stolon-root system in the production of forage and recycling of N in soil-plant-animal systems is of interest. Mott, Quinn, and Bisschoff (6) showed substantial residual N effect for grazed Panicum maximum in Brazil. The grass had been fertilized with 200 kg N/ha annually for 8 years. Estimated total digestible nutrient production gradually declined when N fertilization was discontinued. Four years after fertilization was discontinued, however, production was calculated to be approximately 50% above the control. Nitrogen utilized after discontinuance of fertilization undoubtedly came from the soil and stolon-root system as well as recycling from animal excretions.

MATERIALS AND METHODS

The experiment was initiated in 1966 with a Pensacola bahiagrass sod established in 1962 on Leon fine sand, a spodosol, at the Beef Research Unit near Gainesville. A randomized block design with four N rates and four replications was used. Rates were 0, 112, 224, and 448 kg N/ha from ammonium nitrate. Except for the control (no N), paired plots were established for each N rate to permit later measurement of applied N residuals. Phosphorus and K were applied to all plots as ordinary superphosphate and KCl to give an N-P-K ratio of approximately 9-1-4 (N-P2O5-K2O ratio of 4-1-2). The control treatment received the same P-K fertilizer as the 112 kg/ha N treatment. Soil pH was maintained between 6.0 and 6.5 by combined use of high calcic and dolomitic limestones. Forage harvests were made on approximately May 15, July 1, August 10, and October 4 of each year. The complete fertilizer was applied four times per year in equal increments. Applications were made the last week of March and immediately after each of the first three harvests. However, N fertilization was discontinued on one of each of the treatment pairs during 1969 and 1970. All plots were fertilized with N in 1971 according to the treatments originally established. Plot size was 2 by 5 m and the area harvested was 1 by 5 m.

Forage was cut at a height of 2.5 cm. Stolon-root samples were collected immediately after the last forage harvest in October by taking 30 cm square blocks to a depth of 15 cm in 1967 and 1968 from the edge of each plot. In subsequent years two cores from randomly distributed parts of each plot were taken at the

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2Professor (Soil Chemist), Florida Agricultural Experiment Station, University of Florida, Gainesville 32601.
vested forage (Table 2) were similar to values previously reported (3). Recovery by duplicate treatments through the first 3 years was similar. Most efficient recovery occurred during the 4th year of fertilization, with recovery percentages declining thereafter. For the 112-kg N rate, it was not significant whether fertilizer N was applied on one of the duplicate treatments.

The percentage of applied N recovered in the harvested forage are also recorded in Table 2. The values in-adequate for the continuous 448-kg rate than for the same discontinuous rate and the 224 kg rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous N treatment than from comparable continuous treatments. In 1970 the residual N effect was extremely small. None of the discontinued N treatments produced yields that differed from the control.

When N fertilization was discontinued on one each of the duplicate treatments, the N treatment showed lower forage yields than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment, probably because of differential recovery of N depending on the rate.

Nitrogen was applied N was increased (Table 1). Yields for the discontinuously N treatments did not differ between the two 112 kg N treatments but were higher from the continuously fertilized 224 kg treatment than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the same discontinuous rate and the 224 kg rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment. The 448 kg N rate was lower for the continuous 448-kg rate than for the 448 kg N rate. Yield was higher for the continuous 224 kg N rate than from its discontinuous treatment.

Organic matter in the surface soil (0 to 15 cm) was determined by a micro-Kjeldahl procedure. Sample weights were adjusted for acid-insoluble residue as a partial correction for soil contamination. Soil samples were obtained by taking 10 2.5-cm-diameter cores from each plot. These samples were air-dried, passed through a 2-mm sieve, subdivided with a sample splitter, and subsamples were ground to a powder. Organic matter, by the X.Valkley-Black wet digestion method (8), and total N, by micro-Kjeldahl procedure, were determined.
in 1969, total N contents declined markedly, when N fertilization was resumed, N concentrations increased but remained significantly different at the control and those that received N. When N fertilization was discontinued in 1969 for one treatment at each N rate, stolon-root weights declined. With reinstitution of N, since samples were collected near the plot edges to avoid interference with forage yield evaluation. Differences due to treatments were primarily between the control and those that received N. When N fertilization was discontinued on one each of the duplicate N treatments in 1969, stolon-root N concentrations at each N rate were not different. With the continuous at the 112 and 224 kg/ha N rates, they were not obtained prior to the experiment, the differences in stolon-root N contents in 1967 must have been very low for the 448 kg/ha N rate due to the detrimental effect of this rate on the Pensacola bahiagrass stand.

Part of the stolon-root N would have been immobilized and partial decomposition of some stolons and roots. The limited residual effect of applied N was lost. The limited residual effect of applied N was accounted for at the 112 kg/ha N rate. At the 112 kg/ha N rate it was little more than 10%. The decline in the stolon-root system was obviously the result of death count, for the 112-kg N rate it was little more than 10%. The decline in the stolon-root system was obviously the result of death count, for the 112-kg N rate it was little more than 10%. The decline in the stolon-root system was obviously the result of death count, for the 112-kg N rate it was little more than 10%.

According to the recovery of N from soil, forage, and soil, which increased by an average of 228 kg/ha during this period. The change in soil organic matter in these processes as shown by total N in the surface soils of the N treatments was 8, 19, and 41, and 95 kg/ha for the 112-, 224-, and 448-kg N rates. Nitrogen reductions in stolon-root systems during this 2-year period were approximately 60, 100, and 190 kg/ha for the 112-, 224-, and 448-kg N rates. The residual effect of N not removed in harvested forage was relatively small (Fig. 1). Total forage mass continued to decrease, resulting in little increase in total N.

Table 3. Pensacola bahiagrass stolon-root weights and nitrogen contents at several levels of applied nitrogen on Leon finesand.

<table>
<thead>
<tr>
<th>N Rate (kg/ha)</th>
<th>Stolon-root N, kg/ha</th>
<th>Stolon-root system%</th>
<th>Oven-dry stolon-root system%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14.9 a</td>
<td>13.4</td>
<td>9.4</td>
</tr>
<tr>
<td>0.47 a</td>
<td>10.3 a</td>
<td>10.0 ab</td>
<td>7.4 a</td>
</tr>
<tr>
<td>0.77 c</td>
<td>16.6 c</td>
<td>13.4 c</td>
<td>11.4 b</td>
</tr>
<tr>
<td>0.89 ab</td>
<td>19.5 b</td>
<td>18.1 b</td>
<td>17.1 b</td>
</tr>
<tr>
<td>1.03 b</td>
<td>23.1 b</td>
<td>22.1 c</td>
<td>22.1 c</td>
</tr>
<tr>
<td>1.54 d</td>
<td>27.1 d</td>
<td>24.3 d</td>
<td>24.3 d</td>
</tr>
</tbody>
</table>

** Nitrogen was not applied to these treatments in 1969 and 1970. Data for 1967 and 1968 were not significant. Lack of interaction was surprising particularly true for the control treatment and may have been due in part to border effect from plots treated with higher N rates. The data indicated that little available N was present in the surface soils of the N treatments; a large portion of the applied N was not recovered in the harvested forage. This was partly due to the large differential in quantities of applied N not recovered in the harvested forage.
previous studies with this soil. They showed that multiple applications of N during the growing season (as many as 16 totalling 224 kg N/ha) were not superior to two applications in terms of N uptake in forage (2). Moreover, Volk (7) showed N losses from leaching of less than 2% of a 400 kg/ha N rate applied in several increments to Lakeland fine sand planted to perennial, warm-season grasses in large lysimeters. Denitrification is suspected as a major mechanism of N loss from soils under conditions of this study. This process normally is not considered to be important in sandy soils, but in Leon fine sand the water table is high during the summer rainy season and plant residue decomposition is rapid. Anaerobic conditions that could enhance denitrification probably develop.