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NITROGEN UPTAKE AND DISTRIBUTION IN ANNUAL RYEGRASS

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Background. Nitrogen (N) is the most limiting of the three major plant nutrients for annual ryegrass growth. Nitrogen level in leaves has a direct effect on the photosynthetic rate which is responsible for the synthesis of carbohydrates that drives plant growth. Because of the low fertility, sandy soils in East Texas, from 100 to 250 lb N/acre are necessary for good ryegrass growth. Because N is rapidly solubilized in water, it can be lost by leaching through the soil past the plant root zone or in runoff during heavy rainfall. Nitrogen loss by leaching results in low utilization of the applied N and possible nitrate contamination of groundwater. For these reasons it is important to know how N rate and time of application influence N uptake and its distribution in the plant. TAM 90 annual ryegrass was seeded at 25 lb/acre in a prepared seedbed in October 2001 and 2002. Fall growth was measured on plots fertilized with 0, 50, 100, or 150 lb N/acre at ryegrass emergence. Winter growth was measured on plots fertilized with 50 lb N/acre at emergence to provide moderate fall growth and then mowed to a 2-in. height in late December and fertilized with 0, 50, 100, or 150 lb N/acre. Spring growth plots were treated the same as the winter plots except they were fertilized with 50 lb N/acre in late December, mowed to a 2-in. height in late February, and fertilized with 0, 50, 100, or 150 lb N/acre. Plots were sampled at 2, 4, 6, and 8 weeks after the N fertilizer treatments were applied. Plants were separated into roots, stems, and leaves and analyzed for N.

Research Findings. Nitrogen concentration increased in root, stems, and leaves as N fertilizer rate increased both years (data not shown). Nitrogen concentration in all plant components decreased from fall to winter to spring (Table 1). Leaves always had the highest N concentration followed by stems and then roots. The higher N level (directly related to protein level) in the leaves is one of the reasons they have a higher nutritive value than stems. The percentage of total plant N in the roots, stems, and leaves differed between the 2 years. The first year only 10% of the N was found in the roots during the fall and then increased to about 20% in winter and spring (Table 2). The second year, when fall growth was about 50% less, almost 40% of the plant N was in the roots and then decreased through winter and spring. Percentage of total plant N in the stems increased with succeeding seasons which coincides with increasing stem weight. Percent N efficiency (percent of the N applied that was taken up by the plant) was calculated at 6 weeks of growth (Table 3). Comparing N efficiency during the fall for both years demonstrates what an impact growing conditions can have on N efficiency. With yields over 2000 lb/acre at 6 weeks in 2001-2002, N efficiencies were from 44 to 54 %. In 2002-2003 when

yields were less than 1000 lb/acre at 6 weeks, N efficiencies were only 8 to 14%. Although maximum winter yields occurred at 100 lb N/acre the first year and 50 lb N/acre the second year, N efficiency was similar or increased slightly from 50 to 150 lb N/acre. Ryegrass continued to take up N without an increase in plant growth.

Application. Nitrogen concentration was highest in the leaves followed by stems and roots. Most of the plant N was in the leaves in the fall but shifted to the stems with succeeding seasons. Annual ryegrass can take up additional N without an increase in growth.

Table 1. Average nitrogen concentration of roots, stems, and leaves by season.

Season	2001-2002			2002-2003		
	Roots	Stems	Leaves	Roots	Stems	Leaves
	-----N (%)-----					
Fall	1.23 a†	2.24 a	3.60 a	1.59 a	3.13 a	3.62 a
Winter	1.23 a	1.83 b	3.34 b	1.28 b	1.96 b	3.51 b
Spring	0.93 b	1.38 c	2.89 c	0.98 c	1.46 c	2.64 c

†Values in a column followed by the same letter are not significantly different at the 0.05 level, Fishers Protected LSD.

Table 2. Average nitrogen distribution among roots, stems, and leaves by season.

Season	2001-2002			2002-2003		
	Roots	Stems	Leaves	Roots	Stems	Leaves
	-----N (%)-----					
Fall	10.0 c†	22.1 c	67.9 a	38.8 a	30.3 c	30.9 b
Winter	21.6 a	35.9 b	42.8 b	25.9 b	34.6 b	39.5 a
Spring	18.0 b	42.6 a	39.4 c	15.9 c	51.6 a	32.5 b

†Values in a column followed by the same letter are not significantly different at the 0.05 level, Fishers Protected LSD.

Table 3. Percent of nitrogen applied that was taken up by plants 6 weeks after nitrogen application by season.

N rate lb/acre	2001-2002			2002-2003		
	Fall	Winter	Spring	Fall	Winter	Spring
	-----Nitrogen efficiency (%)-----					
50	54	47	73	14	29	58
100	54	53	64	8	30	65
150	44	50	39	10	35	60