Nitrogen Response of Arrowleaf Clover Seedlings Grown on Field Soils

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Introduction

Prior to the development of an efficient nitrogen-fixing symbiosis, legumes rely on nitrogen from seed reserves and the soil. Studies have shown that growth can be N limited in both grain and forage legume seedlings dependent on *Rhizobium* (Cooper, 1979; Fishbeck and Phillips, 1981; Silsbury, 1984). Early growth of white clover and subterranean clover is faster when plants are supplied with some mineral N (Ryle et al., 1979; Silsbury, 1984). Arrowleaf clover seedling growth and dinitrogen fixation was stimulated by the addition of 14 mg N pot^{-1} when the plants are grown in N free sand (Schomberg and Weaver, 1986). Establishment of arrowleaf clover in the field may be poor due to its small seed size and low N reserves (Evers, 1982). We conducted an experiment to

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evaluate the response of arrowleaf clover, to starter levels of N when grown on soil.

Procedure

Cores of soil were collected from four sites in Robertson County, Texas by pressing metal cans of 7.6 cm in diameter 11.4 cm in height into the soil. Soils at sites 1 and 2 are Padina sands (loamy, siliceous, thermic Grossarenic Paleustalf) having a soil pH of 6.4. Native grass and briar were growing on site 1 and Coastal bermudagrass (*Cynodon dactylon* L.) was established at site 2. The soil at site 3 is a Benchley clay (fine, montmorillonitic, thermic Vertic Argiustoll) having a soil pH of 5.5. A mixture of bermudagrass and arrowleaf clover (*Trifolium vesiculosum* Savi) was growing at this site. The soil at site 4 was a Houston clay (fine, montmorillonitic, thermic Udic Pellusterts) having a soil pH of 5.5. A mixture of native grasses was growing at this site. Twenty soil cores were collected from each site during March. The top of each core of soil was fertilized with 191 mg K, 116 mg P, and 73 mg Mg which was added as a solution prior to planting. Micronutrients were added according to a nutrient solution composition of Silsbury (1984) . The solution provided 1.75 mg B, 1.75 mg Mn, 0.17 mg Zn, 0.08 mg Cu, 0.04 mg Mo, and 4.0 mg Fe to each core. Nitrogen was also added in solution to provide rates of 0, 14, and 28 mg N core^{-1}. The N source was KNO_3 and rates corresponded to 0, 30.7, and 61.4 kg N ha^{-1} on an area[3] basis. The cores were seeded with Yuchi arrowleaf clover on March 16, 1987 and inoculated with *Rhizobium leguminosarum* biovar *trifolii* strain RP115-2. Ryegrass (*Lolium multiflorum* Lam.) was also planted and fertilized with 0 and 14 mg N core^{-1} to evaluate the available nitrogen from each soil and to determine if nitrogen was the most limiting nutrient for plant growth. The seeds were covered with a 2 mm layer of sand and kept moist until emergence. Plants were grown in a greenhouse and thinned to seven core^{-1} after emergence. The bottom of each core was set in a plastic dish (15 mm diameter) that served as a water reservoir. Visual observation of the soils was used to determine when water was needed. Twenty-eight days after planting, and again 28 days later the plant shoots were clipped and dried at 65°C for 48 hours for dry weight determination. Analysis of variance was used to determine differences in dry weights of shoots due to nitrogen levels within a soil.

Results and Discussion

The influence of N on arrowleaf clover dry weight grown on soils from four field sites is shown in Table 1. Addition of N to the soils from sites 1 and 2 resulted in increased growth of ryegrass, but did not result in a significant increase in the shoot dry weight of arrowleaf clover. Addition of 14 mg of N to soils from sites 3 and 4, promoted the early growth of both arrowleaf clover and ryegrass. Addition of 14 mg N to cores of soil from site 3 doubled the dry weight of arrowleaf clover. For the same treatment soil from site 4, plant dry weight was increased by 1.7 times. The dry weight of arrowleaf clover did not show an additional increase by addition of 28 mg N to soils from either of these two sites. Plants clipped after regrowth of 28 days showed similar dry weight trends for the soils from the four sites (data not shown).

TABLE 1. EFFECT OF NITRATE NITROGEN ON SHOOT DRY WEIGHTS OF ARROWLEAF CLOVER AND RYEGRASS GROWN IN SOIL CORES IN A GREENHOUSE

		Dry Weight			
Species	Nitrogen Rate	Soil 1	Soil 2	Soil 3	Soil 4
		mg core^{-1}			
Arrowleaf	0	124.7	152.3	145.0	236.0
	14	183.0	186.0	310.0	393.8
	28	162.7	211.7	406.0	451.5
LSD (.05)		NS	NS	158.9	125.3
Ryegrass	0	136.8	184.3	129.5	201.5
	14	476.8	411.5	516.2	462.8
LSD (.05)		51.7	195.8	61.1	49.1

NS - Not significant.

The results from this study indicate that early growth of arrowleaf clover is enhanced by the addition of starter N, and though not shown here, it may increase early nitrogen fixation. In a previous study, additions of some mineral N to sand increased both dry weight of arrowleaf clover and nitrogen fixation (Schomberg and Weaver, 1986). Kunelius (1974a,b) observed better establishment of alfalfa (*Medicago sativa* L.) and birdsfoot trefoil (*Lotus corniculatus* L.) in low N soils when 25 kg N ha^{-1} was added at planting and weeds were controlled.

Soil pH was low in soils from sites 3 and 4, and the additional growth when N was added may have been related to an amelioration of a pH effect. Weaver et al. (1987) found that growth of arrowleaf clover in an acidic soil was nearly equal to growth in the same soil when the pH was neutralized if supplemental mineral N was provided.

Arrowleaf clover establishment in soils with low N availability may be enhanced by the addition of starter N. The role of mineral N during early growth of arrowleaf clover needs further evaluation in both the greenhouse and field to determine soil conditions that result in beneficial plant responses. An additional complexity from application of mineral N is enhanced competition from weeds and grasses.

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