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NITROGEN AND PHOSPHORUS RESPONSES OF SWITCHGRASS GROWN FOR BIOMASS

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Summary

Field trials in Texas with switchgrass (Panicum virgatum L.) were initiated in 1992 as part of the Biofuels Feedstock Development Program sponsored by the U.S. Department of Energy. Fertility responses of 'Alamo' switchgrass are being evaluated at two locations. Biomass yields of Alamo were maximized at the highest N rate of 200 lb/acre at Beeville and Stephenville and decreased as row spacing increased at Beeville. There was little response to phosphate fertilization at either location.

Introduction

In response to growing concerns over consumption of nonrenewable fuel sources, the U.S. Department of Energy, through the Biofuels Feedstock Development Program, has initiated biomass technology research. The biofuels program includes investigations into biomass production, conversion into fuel, economics and environmental impacts. Switchgrass was selected for biomass research because of its high yield potential, adaptation to marginal sites, and tolerance to water and nutrient limitations. Switchgrass like other grasses has a requirement for N and phosphorus (P) on deficient soils. Nitrogen requirement for maximum yields of switchgrass has been reported to range from 60 lb/acre for 'Pathfinder' (Anderson and Matches, 1983) to 150 lb/acre for 'Cave-in-Rock' in Iowa (George and Oberman, 1989). However, these varieties were managed as forages and not as biomass crops. Because there are few data on fertility responses of switchgrass grown as a biomass crop in Texas our objective was to determine the N and P responses of switchgrass grown at various row spacings.

Materials and Methods

Nitrogen and (P) responses of Alamo switchgrass are being evaluated at Beeville on a Parrita clay loam and at Stephenville on a Windthorst fine sandy loam. Field plots were established in 1992 and primary data collection initiated in 1993. Fertilizer rates were 0, 50, 100,

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150 and 200 lb N/acre and 0, 20, 40, 60, and 80 lb P_2O_5/acre. Treatments (N and P_2O_5 combinations) were applied in an incomplete factorial arrangement in spring to three different switchgrass row spacings. Row spacings were 10, 20, and 40-in. at Beeville and 7, 14, and 28-in. at Stephenville. Biomass yield, herbage nutrient concentration, canopy height, lodging, plant and tiller counts, and plant developmental stage at harvest are being evaluated.

Results and Discussion

The data presented are for one year at Beeville and two years at Stephenville from an ongoing project. Alamo switchgrass differed in response to fertility at Beeville and Stephenville. Yields were higher at Stephenville even though rainfall was higher at Beeville (Table 1). This may be due to differences in plant age because Stephenville was planted in spring and Beeville in autumn of 1992. Other factors contributing to lower yields at Beeville may be a more erratic distribution of rainfall, especially during the latter portion of the growing season, or loss of N at Beeville due to leaching. At Beeville, switchgrass yields increased linearly ($P<0.05$) as N rates increased from 0 to 200 lb/acre. Maximum yield of Alamo at Beeville was 6,450 lb/acre at 200 lb N/acre when averaged across P rates. There was a significant N x row spacing interaction at Beeville. At the widest row spacing, yield response to N was lower than at narrower row spacings (Fig. 1).

At Stephenville, switchgrass yields increased linearly in 1992 and linearly and quadratically in 1993 as N levels increased. Average biomass yields were higher in 1993 than in 1992 (11,000 vs. 8,100) probably because 1992 was an establishment year (Fig. 2). There was a N x P interaction in 1993. Maximum yields at Stephenville were 10,090 and 16,890 lb/acre at 200 lb N/acre when averaged across P rates in 1992 and 1993, respectively. Hall et al. (1982) reported both linear and quadratic relationships for switchgrass in response to applied N at rates up to 135 lb/acre.

Alamo switchgrass did not respond ($P>0.54$) to P at either location. Yields averaged 5,300, 8,100, and 11,000 lb/acre at Beeville in 1992, Stephenville in 1992, and Stephenville in 1993, respectively. This response may be due to adequate levels of P in the soil or to colonization of switchgrass roots by vesicular-arbuscular mycorrhizae (Brejda et al., 1993). These mycorrhizae increase plant uptake of P from the rhizosphere at low soil P levels. In agreement with our findings, P fertilizer did not increase the yields of 'Shelter' switchgrass grown in Pennsylvania on a soil with low P (Jung et al., 1988).

Row spacing affected biomass yields at Beeville but not at Stephenville (Fig. 3). Biomass yields at Beeville averaged 6,700, 5,380, and 3,930 lb DM/acre at row spacings of 10, 20, and 40-in. At Stephenville, row spacings did not affect (P>0.40) yields which averaged 8,100 lb/acre in 1992 and 11,000 lb/acre in 1993.

Conclusions

Limited field evaluations suggest that Alamo switchgrass responds well to added N at the two locations tested and may respond to N rates greater than 200 lb/acre. Alamo switchgrass yields at Beeville were less than half that of yields at Stephenville. Optimum management and yields appear to be dependent on local climate and soil conditions.

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Table 1. Monthly precipitation at Beeville and Stephenville.

	Beeville	Stephenville	
	1993	1992	1993
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January	1.61	2.27	2.19
February	2.26	4.79	4.04
March	4.98	1.74	2.47
April	2.00	1.72	3.96
May	8.16	4.99	1.57
June	7.84	4.87	2.24
July	0.07	2.99	0.00
August	1.25	2.29	1.94
September	0.92	2.98	5.20
October	2.03	1.74	4.58
November	0.59	3.48	1.09
December	5.78	3.54	1.36
Total	37.49	37.40	30.64
Long-term Average	31	29	29