Wheat Forage Response to Tillage and Sulfur Applications

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Introduction

Crop responses to applied sulfur are expected on deep sandy soils such as those found in the coastal plain region of the southeastern United States. Surface horizons of sandy coastal plain soils have low adsorption capacities for sulfate-sulfur and typically have low levels of extractable sulfate-sulfur (Mitchell and Blue, 1981; Neller, 1959; Rabufetti and Kamprath, 1977; Reneau and Hawkins, 1980; Rhue and Kamprath, 1973). A small adsorption capacity for sulfate-sulfur will result in limited residual effects of applied sulfur if leaching is occurring (Rhue and Kamprath, 1973).

Yield responses to applied sulfur have been reported for row and forage crops grown in the Southeast (Jordan, 1964; Rabuffetti and Kamprath, 1977; Reneau and Hawkins, 1980; Jones et al., 1982; Mitchell and Blue, 1989; Suarez and Jones, 1982; Oates and Kamprath, 1985; Thompson and Neller, 1963; Woodhouse, 1969). Sulfur fertilization has been shown to increase forage yields by as much as 50% under sulfur limiting conditions (Walker et al., 1956; Rees et al., 1974; Jones et al., 1982). In New Zealand, an annual application of 20 pounds of sulfur per acre is needed for adequate pasture growth (Adams, 1973). The current recommendation for sulfur on all crops in Alabama is 10 pounds per acre per year (Cope et al., 1983).

Research in the southeastern United States has shown that deep tillage is necessary to optimize wheat yields (Hargrove and Hardcastle, 1984, Karlen and Gooden, 1987; Sharpe et al., 1988; Touchton and Johnson, 1982). Root growth and distribution in many of these soils is restricted by traffic pans. Oates and Kamprath (1985) concluded that sulfur deficiency on wheat is likely to occur in soils that have a sandy surface layer and a tillage pan that restricts root growth into the subsoil. The objectives of this study were to determine the effects of tillage on wheat forage yields and evaluate wheat forage response to nitrogen and sulfur under conventional and reduced tillage systems.

Materials and Methods

Field studies were initiated in the fall of 1986 on Benndale (coarse-loamy, siliceous, thermic, Typic Paleudult) and Dothan (fine-loamy, siliceous, thermic, Plinthic Paleudult) soils and this report includes initial yield data from the first two years of this three year study. Both soils have sandy textures and are located in the coastal plain region of Alabama (Table I).

Treatments included two methods of tillage, two nitrogen rates. five rates of sulfur and two times of sulfur application. Tillage treatments were I) turn-disk prior to planting and 2) disk only prior to planting. The soil was turned with a moldboard plow at a depth of 8 to 10 inches. On the Dothan soil the entire experimental area received one pass with a field cultivator just prior to planting. Nitrogen rates were 120 and I80 pounds per acre. Sulfur rates were 0, 10, 20, 40, and 80 pounds per acre. Times of sulfurapplication were; I) prior to planting (fall) and 2) top dressing in early February (spring). The experiment was a split plot design with 4 replications. Tillage methods were the whole plots. Nitrogen rates, sulfur rates and time of sulfur application were the split-plots.

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Table 1. Initial chemical properties of the Dothan fine sandy loam and Benndale fine sandy loam soils receiving annual rates of phosphogypsum.

Location	Soil Series	Soil Depth	SO_4-S[#]	pH	Ca	K_20	Mg	P_20_5
					Extractable Nutrients[&]			
		inches	pm		---pounds/acre---			
Brewton	Benndale	0 to 10	6.1	6.2	637	58	72	60
Brewton	Benndale	10 to 20	16.3	5.2	250	46	56	4
Headland	Dothan	0 to 10	9.6	6.5	690	87	136	59
Headland	Dothan	10 to 20	14.5	5.8	290	40	57	3

[#]Extracted with a calcium phosphate solution.
[&]Extracted with Mehlick I (dilute double acid) extractant

Experimental areas were treated with limestone, potassium and phosphorus according to soil test. Wheat was planted in October or November each year. The fall applications of sulfur and half of the nitrogen were broadcast prior to planting. Spring applications of sulfur and the remaining nitrogen were broadcast in February. Sulfur was applied as phosphogypsum (15.3% sulfur) which is a by-product of the phosphate fertilizer industry. Wheat forage yields were determined by harvesting a strip in each plot as needed.

Results and Discussion

Total wheat forage yield data from the Benndale soil are summarized in Tables 2 and 3. During the two years of the study the conventional tillage system averaged 13.8% higher yields than the reduced tillage system when yields were averaged over all sulfur and nitrogen rates. However, differences due to tillage were not statistically significant. As expected, forage yields increased as the nitrogen rate was increased from 120 to 180 pounds per acre. Forage yields were also affected by the rate of sulfur and the time of sulfur application during both years of the study. In 1986-1987 (Table 2) yields were increased by as much as 13% by the application of sulfur. Applying sulfur in the spring increased forage yields by an average of 8% over the fall application. Similar trends were observed in 1987-1988 (Table 3).

Table 2. Total wheat forage yields (lbs/acre) during the 1986-1987 growing season on a Benndale soil.

Time[#]	S rate (lbs/acre) 0	10	20	40	80	x
			120 lbs N/acre			
Fall	2030	2226	2143	2424	2296	2224
Spring	2030	2604	2416	2691	2761	2500
			180 lbs N/acre			
Fall	2378	2488	2639	2651	2496	2530
Spring	2378	2787	2568	2833	2737	2660

Test of significant effects

Tillage	NS
Nitrogen Rate	$P < 0.01$
Sulfur Rate	$P < 0.01$
Time	$P < 0.01$

[#]Time of sulfur application.

Table 3. Total wheat forage yields (Ibdacre) during the 1987-1988 growing season on a Benndale soil.

Time[#]	S rate (Ibdacre) 0	10	20	40	80	x
			120 lbs N/acre			
Fall	3975	4046	3777	4179	4347	*4065*
Spring	3975	4301	4555	4372	4232	4287
			180 lbs N/acre			
Fall	4295	4604	4940	4711	4592	4628
Spring	4295	4694	4702	*5064*	4820	4715

Test of significant effects

Tillage	NS
Nitrogen Rate	$P < 0.01$
Sulfur Rate	$P < 0.05$
Time	$P < 0.10$

[#]Time of sulfur application

Forage yields on the Dothan soil are presented in Table 4 and Table 5. In both years higher yields were obtained under conventional tillage ($P < 0.10$). The conventional tillage system produced an average of 27.5% more forage as compared to the reduced tillage system. Yield responses were obtained to added nitrogen and sulfur under both tillage systems. Forage yields were increased by as much as 16% by the addition of sulfur. Tillage effects were not eliminated by applying higher rates of sulfur and nitrogen. Forage yields on the Dothan soil were not affected by the time of sulfur application in 1986-1987 (Table 4). In 1987-1988 (Table 5) higher yields were obtained when sulfur was applied in the fall.

Table 4. Total wheat forage yields (lbs/acre) during the 1987-1988 growing season on a Dothan soil.

N Rate (lbs/acre)	Conventional Tillage S rate (lbs/acre) 0	10	20	40	80	x
			Conventional Tillage			
120	2386	2829	2614	2961	2837	2725
180	3702	3538	3054	3671	3767	3546
			Reduced Tillage			
120	2132	2103	2129	2474	2446	2257
180	2521	2921	2938	3030	3003	2883

Test of significant effects

Tillage	$P < 0.01$
Nitrogen Rate	$P < 0.01$
Sulfur Rate	$P < 0.01$
Time	NS

Table 5. Total wheat forage yields (lbs/acre) during the 1987-1988 growing season on a Dothan soil.

N Rate		S rate (lbs/acre)					
(lbs/acre)	Time#	0	10	20	40	80	
		Conventional Tillage					x
120	Fall	2473	2550	2703	2838	2710	2655
120	Spring	2473	2416	2638	2838	2629	2599
180	Fall	2713	3655	3096	3174	3543	3236
I80	Spring	2713	2868	3096	2965	3073	2943
		Reduced Tillage					
I20	Fall	1651	2052	2073	2064	1860	1940
120	Spring	1651	2081	2098	1988	1884	1940
180	Fall	2162	2546	2468	2461	2514	2431
180	Spring	2162	2321	2229	2520	2225	2291

Test of significant effects

Tillage	$p < 0.10$
Nitrogen	$P < 0.01$
Sulfur Rates	$P < 0.01$
Time	$p < 0.01$

#Time of sulfur application.

Conclusions

Wheat forage yields were affected by tillage on one of two sandy coastal plain soils. On a Dothan soil wheat forage yields were higher under a conventional tillage system as compared to a reduced tillage system. Yield responses were obtained to nitrogen and sulfur at both locations. Responses were obtained to nitrogen and sulfur at both locations. Responses to fall versus spring applied sulfur were inconsistent and varied between locations. Initial results of this study suggest that where wheat yields are affected by tillage, higher rates of nitrogen and high rates of sulfur will not eliminate the effects of tillage.

Literature Cited

Adams, A.F.R.1973. Sulphur on NewZealand pastures-effect of rates and form. Sulphur Inst. J. 9:14-I6

Cope, J.T.. Jr. C.E. Evans, and H.C. Williams. 1983. Soil test fertilizer recommendations for Alabama crops.Auburn Univ. (Ala.) Agric.Exp. Stn. Bull. 561.

Hargrove, W.L.,and W.S.Hardcastle. 1984. Conservation tillage practices for winter wheat production in the Appalachian PiedmontJ. Soil Water Conserv. 39:324-326.

Jones, M.B., V.V. Rendig, D.T.Torell, and T.S. lnouye. 1982. Forage quality for sheep and chemical composition associated with sulfur fertilization on a sulfur deficient site. Agron. J. 74:775-780.

Jordan, H.V1964. Sulfur as a plant nutrient in the sobthern United States. USDA Tech. Bul. 1297.

Karlen, D.L.,and D.T. Gooden. 1987. Tillage systems for wheat production in the Southeastern Coastal Plains. Agron. J. 79:582-587.

Mitchell. C.C.. and W.G. Blue. 1981. The sulfur fertility status of Florida soils. 1. Sulfur distribution in Spodosols, Entisols. and Ultisols. Soil Crop Sci. Soc. Fla. Proc. 40:71-76.

Mitchell. C.C., and W.G. Blue. 1989. Bahiagrass response to sulfur on an Aeric Haplaquad. Agron. J. 81:53-57.

Oates, K.M. and E.J. Kamprath. 1985. Sulfur fertilization of winter wheat grown on deep sandy soils. Soil Sci. Soc. AM. J. 49:925-927.

Neller, J.R. 1959. Extractable sulfate-sulfur insoils of Floridainrelation to amount of clay in the profile. Soil Sci. Soc. Am. Proc. 23:346-348.

Rabuffetti, A., and E.J. Kamprath. 1977. Yield, N, and S content of corn as affected by Nand S fertilization on coastal plain soils. Agron. J. 69:785-788.

Rees. M.C., D.J. Minson, and F.W. Smith. 1974. The effect of supplementary and fertilizer sulphur on voluntary intake, digestibility, retention time inthe rumen and site of digestion ofpangolagrass in sheep. J. Agr. Sci. Camh. 82:419-422.

Reneau, R.B., Jr., and G.W. Hawkins. 1980. Corn and soybeans response to sulphur in Virginia. Sulphur in Agric. 4:7-11.

Rhue, R.D., and E.J. Kamprath. 1973. Leaching losses of sulfur during winter months when applied as gypsum. elemental S or prilled S. Agron. J. 65:603-605.

Sharpe, R.R., J.T. Touchton, and D.W. Reeves. 1988. Influence of tillage systems on wheat yields and the need for in-row subsoiling for double cropped soybeans. Proceedings of the 1988 Southern Region Conservation Tillage Conference. Tupelo, MS. pp. 76-78.

Suarez. E.L.. and U.S. Jones. 1982. Atmospheric sulphur as related to acid precipitation and soil fertility. Soil Sci. Soc. Am. J. 46:976-980.

Thompson. L.G., and J.R. Neller. 1963. Sulfur fertilization of winter clovers. coastal bermudagrass and corn on north and west Florida soils. Univ. of Florida Agric. Exp. Sta. Bull. 656.

Touchton. J.T. and J.W. Johnson. 1982. Soybean tillage and planting method effects of yield on double-cropped wheat and soybeans. Agron. J. 74:57-59

Walker. T.W., A.F.R. Adams. and H.D.Orchiston. 19.56. The effect of levels of calcium sulphate on the yield and composition of a grass and clover pasture. Plant and Soil. 7:290-300.

Woodhouse, W.W., Jr. 1969. Long-term fertility requirements of coastal bermudagrass. III. Sulphur. Agron. J. 61:705-708.