The Effects of Hog Manure and Elemental Sulfur on a Solonetzic soil

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Introduction

When hog manure is added to a soil, it affects the chemical and physical conditions of that soil. This paper describes a study examining how adding hog manure, by itself and in combination with elemental sulfur, affects the availability of nutrients in the soil and how this impacts on yield. The effect that these treatments have on soil structure and possible remediation effects in Solonetzic soils will also be discussed briefly.

Study Site

The study took place in southern Saskatchewan in the Brown Soil zone near the town of Central Butte. The soil at the site is classified as belonging to the Rosemae Association, with soils in the surrounding area predominantly classified in the Ardill-Kettlehut Association. The Rosemae association primarily consists of Dark Brown Solonetzic soils that have developed from unsorted glacial till. The parent material is moderately to strongly calcareous and weakly to moderately saline. The texture at the site is a loam. The site is extremely variable in terms of horizon depths and depth to carbonates. The site occurs on a gently undulating plain, and the soil profile characteristics vary with the landscape position. The upper slope positions are Solonetz or Solonetzic Chemozems and the lower slope positions are mainly Solodized Solonetz.

Experimental Design

Four different treatments were applied: ripped, hog manure, hog manure + sulfur, and a control. The treatments were replicated three times. The ripped plots were worked using 3-6" depth and 30" shank spacing. The manure was injected using a deep ripper hooked up to a flexible hose system connected to a pump and holding tank containing liquid hog manure. The sulfur was applied by adding it to the hog manure in the tank and agitating the mixture to keep the sulfur from settling out. The hog manure and hog manure + sulfur treatments were applied at a rate of 8000 gallons/acre. Equivalent rates of nutrients added are shown in table 1.

Table 1: Nutrient addition rates and composition of the hog manure

Treatment	NO3- N (lbs/ac)	NH4+-N (lbs/ac)	Organic N (lbs/ac)	SAR	S (lbs/ac)	E (dS/m)
HM	<2.67	120	1735	14.4	0	16.1
HM+S	<2.67	80	1199	9.9	1000	14.0

In the liquid hog manure in this study, most of the nitrogen is in the organic form, and must be mineralized to ammonium and/or nitrate through a microbially mediated process before it becomes plant-available. Elemental sulfur is an inexpensive source of sulfur that is produced as a by-product of natural gas production. It is a yellow powder that is difficult to handle, especially when finely ground. Elemental sulfur must be oxidized to sulfate before it becomes plant-available. The latter process is performed by heterotrophs, organisms that require an organic carbon source for growth. Therefore, the addition of the hog manure and the sulfur in concert should stimulate the process of sulfur oxidation and increase the rate of this reaction. This synergistic effect, as well as the effect that the process of sulfur oxidation has on the physical properties of the Solonetzic soil by enhancing the leaching of sodium are a further focus of this study, but will not be discussed in this paper.

Results and Discussion

Table 2: Crop yields for 1995

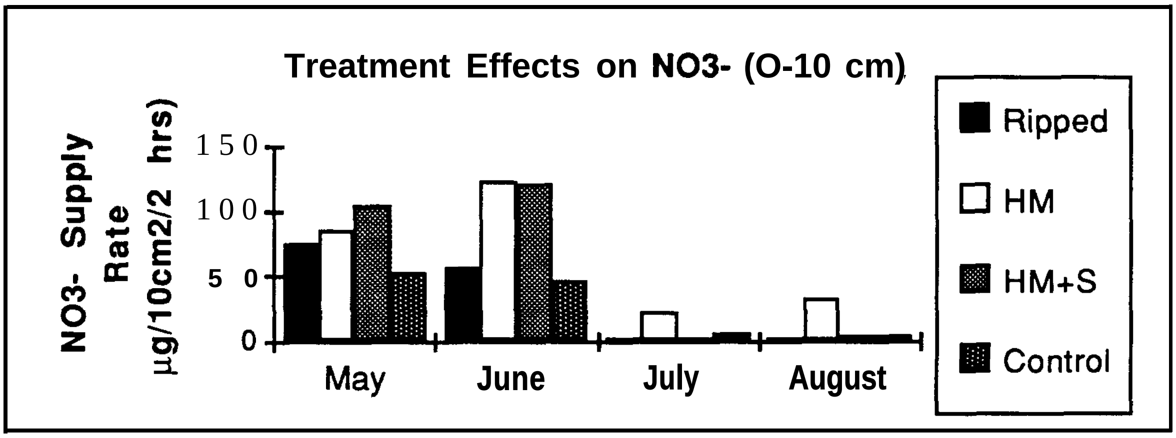
Treatments	Total yield (t/ha)		Grain yield (bushels/ac	
	upslope	low slope	up slope	low slope
Control	3.67a	5.27a	22.3	30.9a
HM	5.00b	9.55b	26.0	49.0b
HM+S	4.49ab	8.87b	24.2	49.9b
Ripped	4.09ab	6.00a	23.0	34.9a

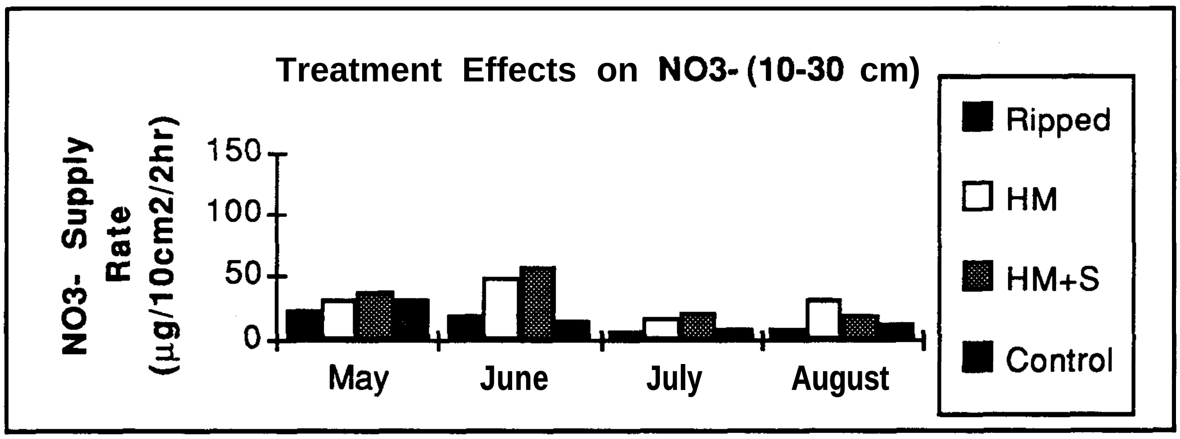
The crop yields determined in the plots at harvest (Table 2) showed a significant increase with the addition of the hog manure and hog manure + sulfur treatments. This is most likely due to the increased availability of nitrogen in these plots. The yields for the ripped plots were slightly higher than for the control plots, although this difference is not statistically significant. This increase could be due to the increased leaching in these plots and the concurrent decrease in sodium.

Since most of the nitrogen added in the amendments is organic and must be mineralized and was not immediately available, changes in the relative availability of the nitrogen (as measured by the nitrate supply rate) were measured over the course of the growing season. The supply rates were measured using anion and cation exchange membrane probes. A number of factors must be considered when interpreting this data, including the effects of: plant uptake, the leaching potential of the soil, and the rates of the different microbial processes occurring in the soil.

Nitrate Supply Rate

Figure 1: Effects of treatments on nitrate supply rates in plots

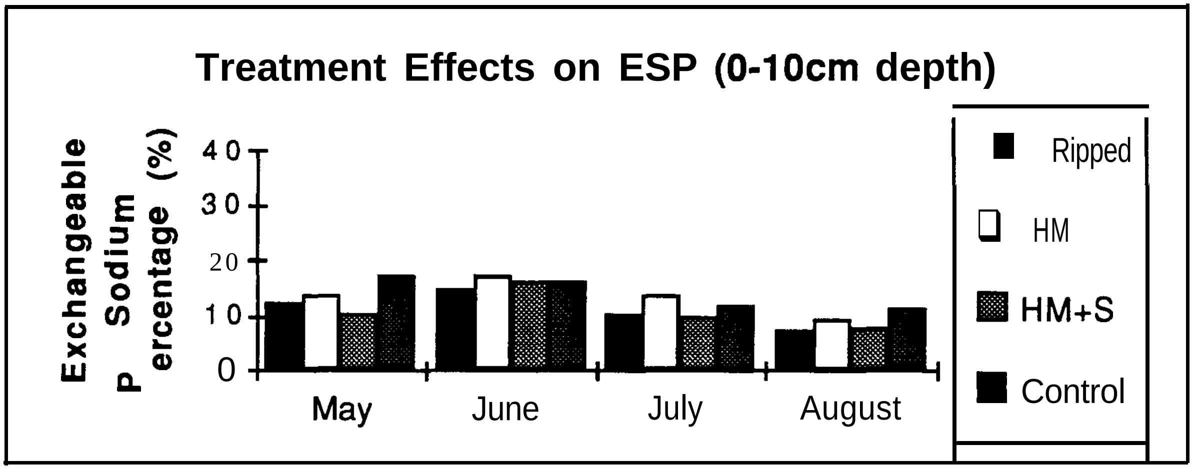


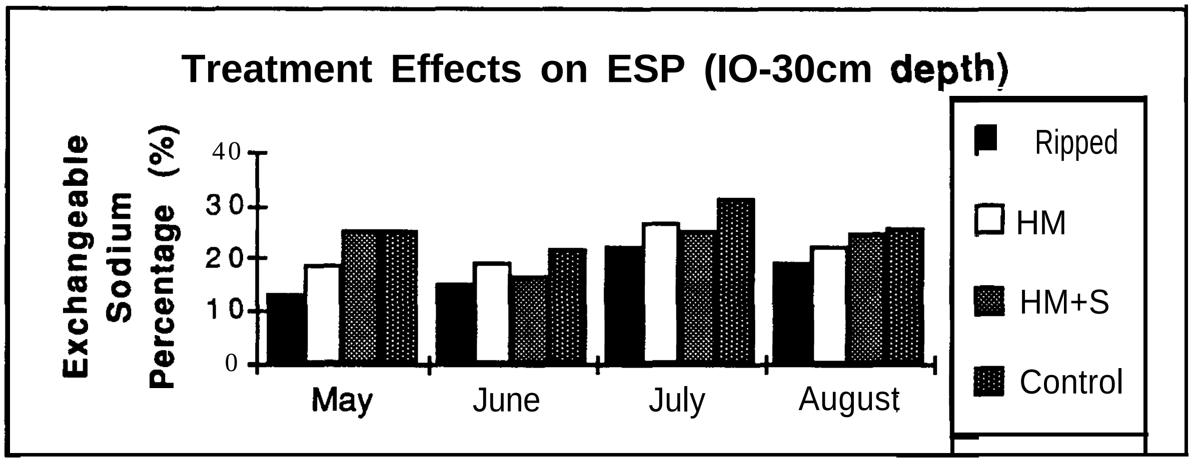


Nitrate supply rates are highest for the hog manure and the hog manure + sulfur plots, except for July and August at the O-10 cm depth where the hog manure + sulfur treatment decreases to very low levels. Mineralization of organic N from the hog manure treated plots results in a sustained high nitrate supply rate throughout June compared to the other treatments. In the 10-30 cm layer of the soil, the nitrate levels rise slightly in August because the plants take up most of their nitrogen requirements early in the growing season, and increased rainfall in August would contribute to mineralization and leaching.

Exchangeable Sodium Percentage

Figure 2: Effects of the treatments on exchangeable sodium percentage

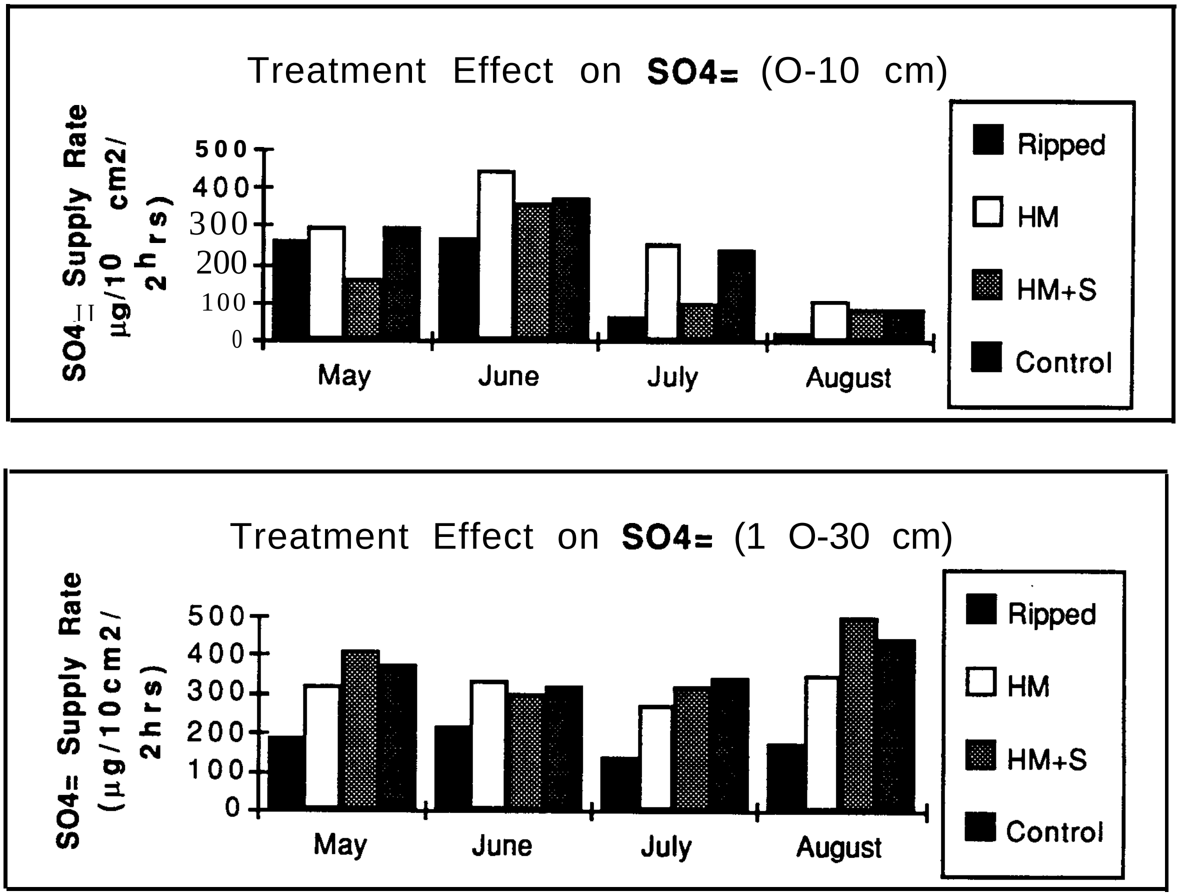




The exchangeable sodium percentage (ESP) was determined using the procedure of Greer and Schoenau (1994). The ESP was higher in the 10-30 cm depth than the O-10 cm depth, reflecting the occurrence of the Bnt horizon at the 10-30 cm depth. There were no significant differences among the treatments, but there was a trend towards lower ESPs in the ripped and the hog manure treatments compared to the control plots.

Sulfate **Supply** Rate

Figure 3: Effects of the treatments on sulfate supply rate



It was found to be impractical to attempt to correlate the sulfate supply rate in the soil with a single process because there were three sources of sulfate: the calcium and sodium salts in the soil, the sulfate and in and released from the manure, and the sulfate that was oxidized from the elemental sulfur. The changes in the sulfate supply rate are likely most influenced by fluctuations in the water table. This is because the high solubility of sulfate salts results in movement up and down with the water. The hog manure + sulfur and the ripped treatments show consistently lower supply rates than the hog manure and control treatments, perhaps reflecting better drainage.

Conclusion

Overall, the effects of applying hog manure, alone and in combination with elemental sulfur, were to increase the yields of the spring wheat mainly reflecting the effect of the hog manure in increasing the mineralizable nitrogen supply.

References:

Greer, K.J. and J.J. Schoenau. 1994. A rapid method for assessing sodicity hazard using a cation exchange membrane. Soil Technology.