SOIL FERTILITY RESEARCH-MISSOURI

Soil Fertility Workgroup
J.R. Brown, Spokesman

ABSTRACT

Rather than focus on one item for this years' report I thought an overview of some of the Missouri soil fertility work would be of interest. Our workgroup, though informal and scattered over campus, tries to meet weekly to provide some continuity. Much of the work is driven by grants with specific foci. For example, Newell Kitchen has reported to this group on MSEA a joint agency project to study pesticide and N movement into ground and surface water in a central Missouri watershed.

FERTILIZER NITROGEN MANAGEMENT FOR NO-TILL WHEAT

John Stecker

Nitrogen (N) sources and application methods for no-till wheat were studied at sites near Columbia and Novelty, Missouri during 1993 and 1994. All N sources were split applied between the fall and spring. Each N source was applied at amounts of 80 and 120 lb N/acre. At Columbia, average treatment yields were almost identical for 1993 and 1994, varying at most by only 3 bu/acre. In both years grain yields were similar between anhydrous ammonia, ammonium nitrate and urea. Knife injected UAN yields averaged 10 bu/acre less and surface broadcast UAN 13 bu/acre less than anhydrous ammonia. At Novelty, the N sources performed similarly each year (same treatment order), but yields were slightly higher in 1994. Grain yields were not affected by N source in 1993, and in 1994 only ammonium nitrate (50 bu/acre) and surface broadcast UAN (42 bu/acre) resulted in different yields.

Table 1. Average no-till yields for as affected by N source and placement. Columbia and Novelty, Missouri. 1993-1994.

N Source	Columbia	Novelty	Two Year Avg.
	--------------------	bu/acre	--------------------
Anhydrous ammonia	70	38	54
Ammonium Nitrate	69	42	56
UAN-knife	60	37	51
Urea	64	39	52
UAN broadcast	57	36	46

NITROGEN SOURCES AND PLACEMENT METHOD FOR NO-TILL CORN

John Stecker

This study investigated the performance of fertilizer N sources and placement methods for no-till corn production. Seven site-years of data for corn following soybean are reported from field studies conducted at three sites in Missouri during 1991-93. Treatments were anhydrous ammonia, broadcast ammonium nitrate, knife injected urea ammonium nitrate solution (UAN-knife), broadcast urea, and spilt placed urea ammonium (1/3 to 1/2 of N was surface broadcast and the remainder was knife injected). Nitrogen rates used were 100 or 120 and 150 or 180 lb N/acre. For corn following soybean yields averaged across site-years, the order of N source performance was anhydrous ammonia = ammonium nitrate > UAN-knife > urea > UAN-split. However, results varied considerably with site-year, as there was an N source by site-year interaction. At two sites which had somewhat poorly and poorly drained soils, anhydrous ammonia performed best in three site-years which had much above normal precipitation in the 60 days following N application. Ammonium nitrate performed best in 1992 in which yields were much above normal. Averaged across site-years, the UAN-knife yield was 8% less than ammonium nitrate and anhydrous ammonia, but in three of seven site-years UAN-knife yields were statistically equal to either of these N sources. The UAN-split treatment consistently yielded the least, ranging from 8 to 47% less than the highest yielding N source.

Table 2. Corn grain yield following soybean as affected by N source and placement. Columbia, Novelty, and Corning Missouri. 1991-1993.

	Columbia			Novelty		Coming		Seven Site-year
	1991	1992	1993	1991	1993	1991	1992	Average
N Source				Grain Yield (bu/acre)				
Ammonium Nitrate	142	194	121	86	77	177	189	141
Anhydrous Ammonia	131	178	138	104	96	172	175	142
UAN-knife	142	173	133	72	64	169	162	132
Urea broadcast	132	166	119	82	47	168	168	126
UAN-split	109	155	109	66	51	163	160	116
LSD_{05}	18	13	13	12	13	NS	20	5

SOIL ACIDITY

J.R. Brown, Syed-Omar Syed-Rastan and R.J. Miles

We've been trying to unravel some aspects of the acidity of the acid soils of southern Missouri. The soils are a mix of alfisols and ultisols in very dissected landscapes. There has been increased interest in alfalfa in the area but the extremely acid (pHs 3.8-4.5) and high KCL extractable. Al in the subsoils and unlimed surface soils creates problems.

Mr. Syed-Rastan is in the midst of a Ph.D. problem to document the pattern of Al activity resulting from of liming these acid soils. While we have known that these acid soils must be limed 6 to 12 months or more before seeding alfalfa we have never fully documented the Al in the soils and soil solution at different times after lining. We feel that while the initial benefit of fine limestone in reducing Al activity is there it is the longer term effect upon "reserve active Al" that is the key. Figure 1 is an illustration of the results we have repeated on two soils at different times. These greenhouse results parallel observation reported by growers who seeded soon after lining. The pH of the extracted soil solution parallels these growth curves.

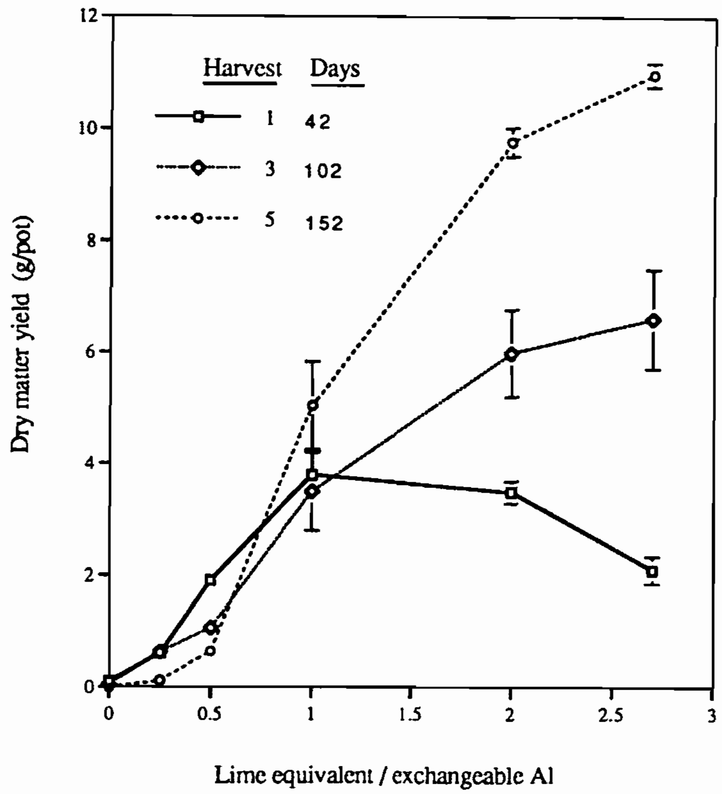

Figure 1. Dry matter yield of alfalfa response to liming at different harvest on Captina soil. (Vertical bar = 1 SE; 28 days between harvests)

SANBORN FIELD

J.R. Brown and T. Lorenz

This long-term soil management study was revised in 1990 to focus on legume nitrogen from cover crop and full season clover and soybean. While 4 crop years are inadequate to measure the N effects in a 4 course rotation (corn-soybean-wheat-clover with every crop every year) the benefits of added N on corn and wheat are starting to separate from the NO_3N result. This project is used in teaching as well as for documentation of the long term effects.

Table 3. Crop yields of a 4 course rotation with and without added N on the grown crops (corn, wheat). 1991-1994.

Nitrogen	Corn	Soybean+	Wheat	Clover+
	bu/A		T/A	
NO	114	49	45	4.0
YES*	118	45	56	4.0

*Ammonium nitrate N for yield goals of 180 bu/A corn and 70 bu/A wheat.
+Does not include 1994 results

A SENSOR METHOD FOR VARIABLE RATE NITROGEN RECOMMENDATION ON CLAYPAN SOILS

N.R. Kitchen, K.A. Sudduth, D.F. Hughes, S. Drummond and S.J. Birrell

Concepts of variability management rest on the premise that production and the factor(s) that limit crop production within a field are both variable and measurable. In the Midwestern United States there are about 10 million tilled acres on soils with a clay-rich subsoil called a "claypan". The claypan soil contains 45 to 60% montmorillonitic clay at the upper boundary of the claypan, making it restrictive to water infiltration and crop rooting. Additionally, natural fertility of the upper claypan horizon is typically low because of extensive mineral weathering. Thus, plant available water and nutrients are mediated by claypan features, like depth to the claypan.

The depth to the claypan is highly variable within fields. Variability management of N fertilizer on claypan-soil fields requires a technique that will allow for rapid cost-effective determination of claypan features. A noninvasive technique has been developed and is being evaluated using electromagnetic induction (EM) sensing to measure variable claypan features and provide a basis for variable N fertilizer recommendations. EM can accurately estimate depth of topsoil to the claypan horizon. Linked with a Global Positioning System (GPS), mobile EM sensing equipment can obtain detailed spatial information at the rate of 20 acres/hr. Field-scale studies are being conducted to evaluate variable N fertilizer inputs based on EM measurement compared to conventional single-rate fertilizer inputs.

YIELD MAPPING FOR PRECISION INPUT OF FERTILIZER NUTRIENTS

N.R. Kitchen, K.A. Sudduth, S.J. Birrell and S. Drummond

Yield mapping since 1991 has been used to establish soil productivity patterns within claypan and alluvial soil fields within Missouri. Yield variation typically ranges 1:2 or more with major grain crops. Studies have been initiated to evaluate variable applications of N and P fertilization based on spatially variable expected yield as determined from yield mapping and compared along side to conventional application rate methods. Corn yield with variable N applications have generally been equal to singe rate applications. Crop-use efficiency of fertilizer N has been found to improve with variable N-inputs. Our intuition is that a minimum of

4-5 years of yield mapping is at least needed to establish long-term yield patterns within fields before establishing variable expected-yield plans.

PHOSPHATE FERTILIZATION OF TALL FESCUE PASTURES IN SOUTHWEST MISSOURI INCREASED LEAF MAGNESIUM AND CALCIUM CONCENTRATION: IMPLICATION FOR THE GRASS TETANY PROBLEM

T. Reinbott and D.G. Blevins

Several years ago we began hydroponic studies in laboratory aimed at trying to increase leaf blade Mg and Ca concentration with the overall objective of trying to lessen the likelihood of grass tetany in tall fescue pastures. In the laboratory/growth chamber studies we found that phosphate nutrition of grasses regulated the uptake and translocation of magnesium and calcium. Based on our work, and the literature, we think that this involvement of phosphate with magnesium and calcium uptake and translocation is a basic principle of the nutrition of all plants, not just grasses.

More recently we have extended our work to tall fescue pastures in Southwest Missouri (Mt. Vernon). Initial soil samples indicated that Bray I phosphate was around 10 lbs/acre, so we began a series of phosphate fertilization experiments. Phosphate fertilization as low as 25 lb/acre caused an increase in leaf concentration of both Mg and Ca, above those threshold levels likely to cause grass tetany, and lowered the tetany ration. Interestingly over the past two years, the addition of Mg, as Kmag, actually lowered both Mg and Ca concentrations of leaves in plots not treated with P. We do not understand this result, but is repeated a second year and will require further work to sort out. Since most cases of grass tetany occur on low phosphate soils we believe that if farmers and ranchers simply followed University recommendation on soil testing and phosphorus fertilization of pastures that the likelihood of grass tetany would be reduced. This spring we began a study to determine the minimum level of Bray I phosphate in soils where there is no longer an increase in tall fescue leaf Mg and Ca concentrations with P fertilization. We are now looking at both forage and seed yield for tall fescue in response to phosphorus fertilization. This has been done many times by others, but we hope to remind people that a small investment in phosphorus will not only help in terms of grass tetany, but also will increase forage and seed yield on soils like those in Southwest Missouri.

FORAGE CROPS FERTILITY RESEARCH

R.E. Joost

Our soil fertility research effort is focused in two major areas. The first involves nitrogen management for forage grasses with an emphasis on evaluation of the effect of N source on N uptake efficiency. We have just completed a study comparing the effectiveness of urea or urea + NBPT with ammonium nitrate as N sources for Caucasian bluestem, a warm-season perennial grass. As a part of this trial we are also investigating the importance of split applications to improving N use efficiency by forage grasses. We are presently completing soil analyses from a corn silage trial designed to compare the impact of NH_4 vs NO_3 N-sources on corn yield and N uptake efficiency. The other focus of this effort is to determine potential NO_3 leaching in this continuous corn system. We are also investigating N availability from dry and composted poultry litter for fertilizing tall fescue and bermudagrass. We are presently in the third year of this long-term study and are monitoring soil build-up of N and P.

The second focus of our soil fertility research is the use of surface applied materials to ameliorate subsoil Al toxicity. We initiated this effort in 1991 to evaluate the potential of various sulfate salts for overcoming subsoil acidity to support alfalfa production. Last year we expanded this effort to include the use of organic amendments including poultry litter and the pre-coal mineral, humate. To date our efforts have indicated that langbeinite has the greatest potential of the sulfate salts evaluated and that poultry litter may have some benefit with respect to this problem. We hypothesize that the responses we are observing due to poultry litter are associated with slow-release P, since earlier studies that evaluated the use of N application gave a negative response in alfalfa. We plan to expand our evaluation of poultry litter as an amendment for soil exhibiting high subsoil Al.

PERSONNEL
(area code 314)

1	J. Stecker	Plant Science Unit	144 Mumford	882-6480
1	J.R. Brown	Dept. of SAS	144 Mumford	882-6302
1	Syed-Omar Syed Rastan	Dept. of SAS	144 Mumford	882-5757
2	R.J. Miles	SNR	1-30 Ag. Bldg.	882-6607
2	T. Lorenz	Dept. of SAS	144 Mumford	882-6480
3	N.R. Kitchen	Dept. of SAS	250 Ag. Engr.	882-1138
3	K.A. Sudduth	Dept. of SAS	245 Ag. Engr.	882-4090
3	D.F. Hughes	Dept. of SAS	250 Ag. Engr.	882-1420
3	S. Drummond	Dept. of Ag. Engr.	269 Ag. Engr.	882-1142
3	S.J. Birrell	Dept. of Ag. Engr.	241 Ag. Engr.	882-1135
4	T. Reinbott	Plant Science Unit	1-87 Ag. Bldg.	882-6320
4	D.G. Blevins	Plant Science Unit	1-87 Ag. Bldg.	882-4819
4	R. Joost	Plant Science Unit	210 Waters	882-2001

1 = FAX = 884-4960
2 = FAX = 882-1977
3 = FAX = 882-5650
4 = FAX = 882-0588

(SAS = Soil and Atmospheric Sciences)

PROCEEDINGS OF THE TWENTY-FOURTH
NORTH CENTRAL EXTENSION-INDUSTRY
SOIL FERTILITY CONFERENCE

October 26-27, 1994

Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 10

Program Chairman and Editor:

Dr. Maurice Vitosh
Michigan State University
Dept. of Crop and Soil Sciences
Plant and Soil Sciences Building
East Lansing, MI 48824-1325