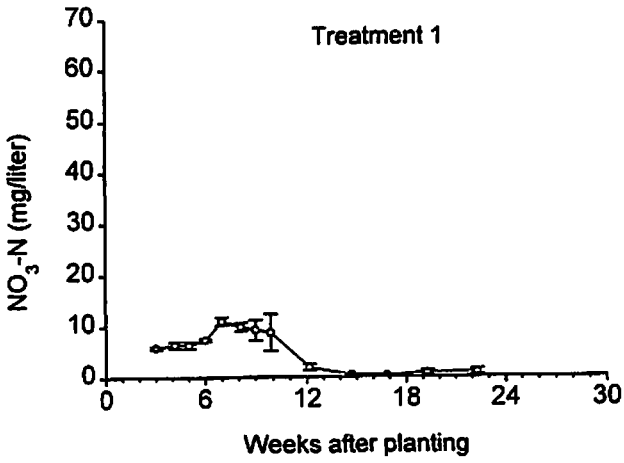

Figure 2. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 1: no leaves, no nitrogen applied. Error bars represent SE of the mean.

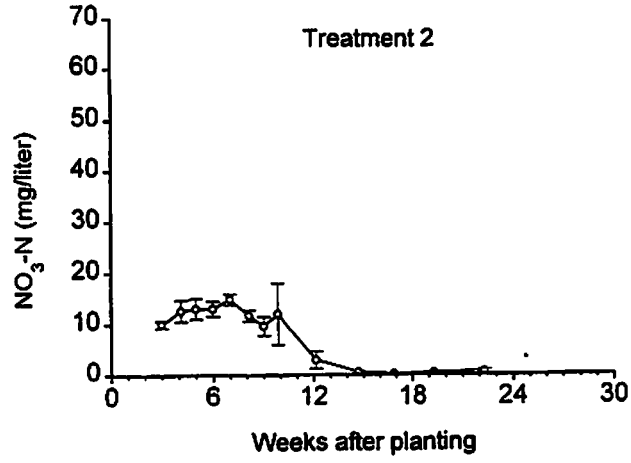

Figure 3. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 2: 20 tons/A leaves, no nitrogen applied. Error bars represent SE of the mean.

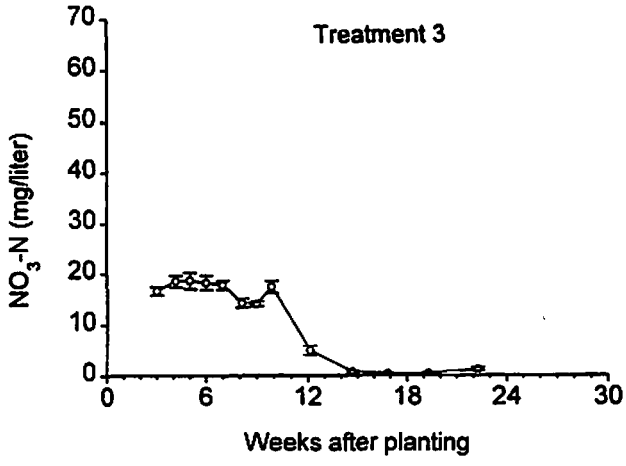

Figure 4. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 3: 40 tons/A leaves, no nitrogen applied. Error bars represent SE of the mean.

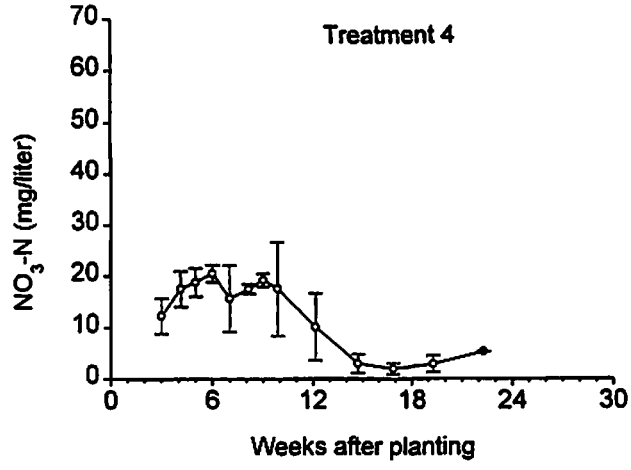

Figure 5. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 4: 80 tons/A leaves, no nitrogen applied. Error bars represent SE of the mean.

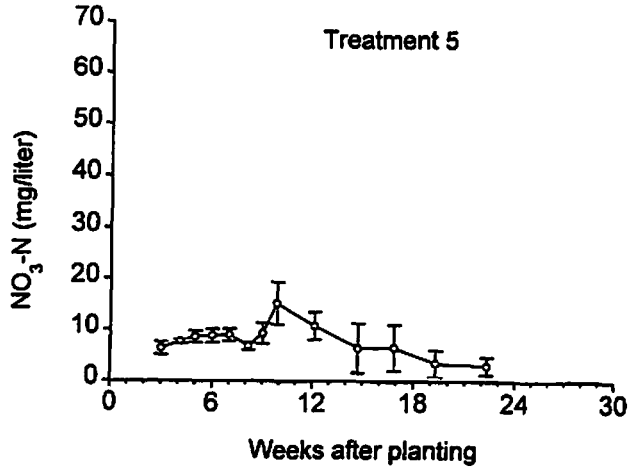

Figure 6. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 5: no leaves, 100 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

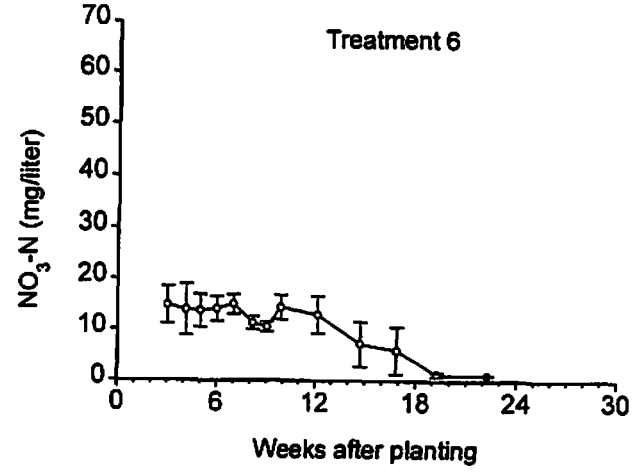

Figure 7. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 6: 20 tons/A leaves, 100 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

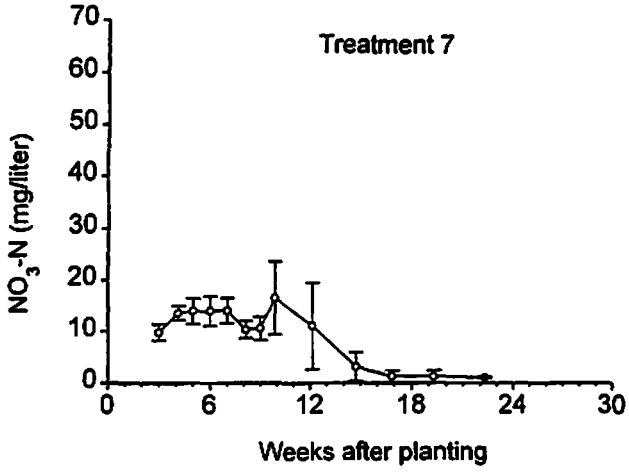

Figure 8. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 7: 40 tons/A leaves, 100 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

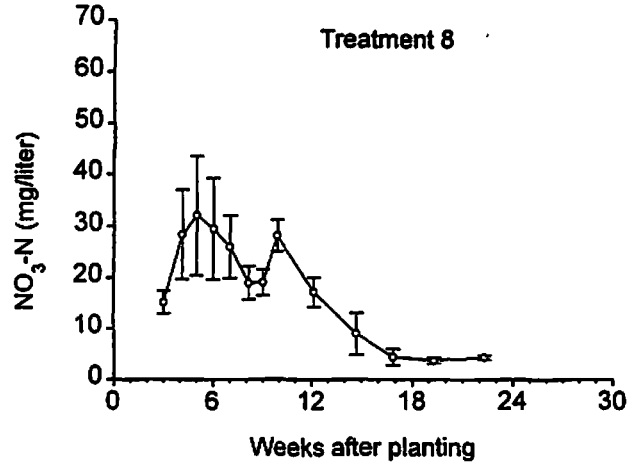

Figure 9. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 8: 80 tons/A leaves, 100 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

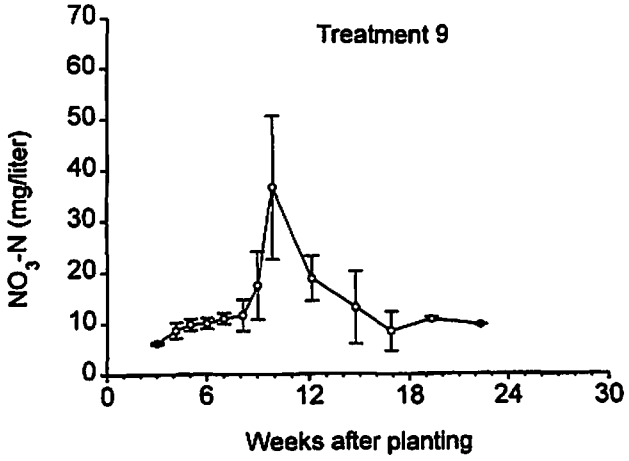

Figure 10. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 9: no leaves, 200 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

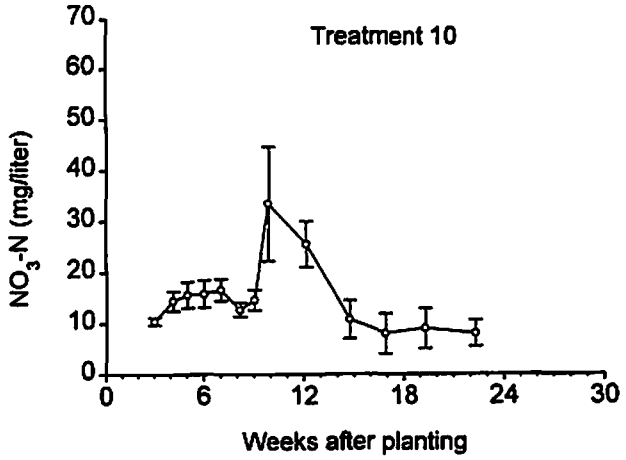

Figure 11. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 10: 20 tons/A leaves, 200 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

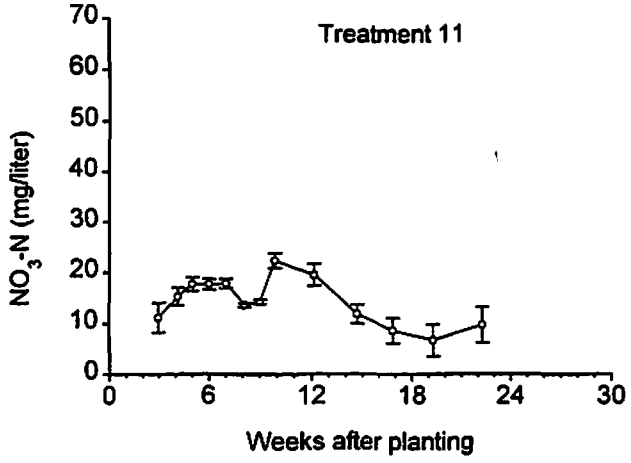

Figure 12. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 11: 40 tons/A leaves, 200 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

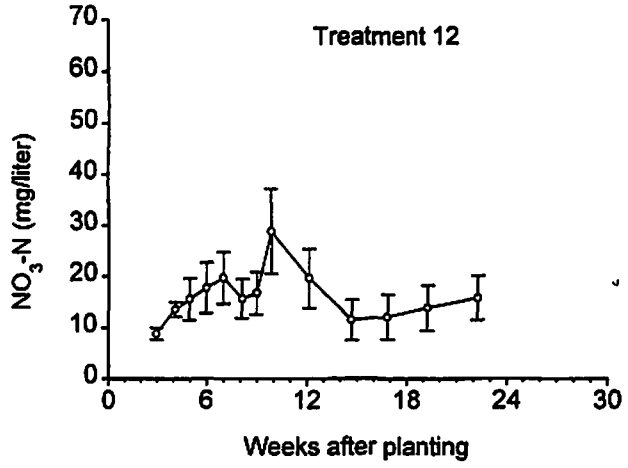

Figure 13. Nitrate-N concentration in soil water sampled at the 4 ft. depth over the 1995 growing season. Treatment 12: 80 tons/A leaves, 200 lbs/A nitrogen applied during the growing season. Error bars represent SE of the mean.

EVALUATION OF MUNICIPAL SEWAGE/PAPER MILL SLUDGE AS A SOIL AMENDMENT IN CROPPING SYSTEMS

Russell D. Mathison[1]

Abstract

Research was conducted at Grand Rapids, MN to evaluate the agronomic benefits and environmental impact of applying municipal sludge (in this case essentially paper mill sludge) to cropping systems. Sludge appears to reduce oat, alfalfa and weed seedling germination and seeding year plant growth if the material is applied immediately prior to seeding. However, sludge applied one year ahead of seeding did not adversely affect seedling performance. Municipal sludge seems to benefit crop production on coarse-textured soils during dry periods by increasing moisture holding capacity via the addition of organic matter. Municipal sludge also elevates soil pH which is especially useful in the production of pH sensitive crops, such as alfalfa. This study did not appear to identify any adverse environmental impacts associated with applying municipal sludge to cropping systems.

Introduction

Grand Rapids municipal sludge, a mixture of approximately 90 percent paper mill sludge from Blandin Paper Company and 10 percent municipal sludge from the city of Grand Rapids is currently being landfilled. This disposal method may not be the best use of a potentially beneficial organic product or a sound disposal method from an environmental or economic perspective. Sludge may benefit cropping systems because it contains a high percentage of organic matter that could benefit crop production, especially on coarse textured soils such as found in northeast Minnesota, by increasing soil tilth and nutrient and water holding capacity. Sludge also contains some plant nutrients, primarily nitrogen, phosphorous and potassium.

This research study was initiated at the North Central Experiment Station in 1994 to evaluate the agronomic benefits and environmental impacts of applying Grand Rapids municipal sludge to agricultural cropping systems. Funding for this project was provided by the city of Grand Rapids. Establishment of the study, data collection and analysis of results were a joint effort between Environmental Land Management, Eagan, MN and the North Central Experiment Station, University of MN, Grand Rapids, MN.

Materials and Methods

A randomized complete block experiment with four replications was established 24 May, 1994 at the North Central Experiment Station, University of Minnesota, Grand Rapids. Sludge application rates were determined by calculating available N using formulas developed by the Minnesota Pollution Control Agency (MPCA). Sludge application rates based on available N were used because the nitrogen economy of soils to which sludge has been added will likely affect crop production the most for two reasons: N is needed to fuel the decomposition of organic compounds in the sludge and is also a nutrient frequently added to nonleguminous cropping systems to achieve maximum yield. The sludge application rates used should add approximately 27, 53 and 106 lb/a of N to the soil with the 53 lb/a rate being a common amount in normal small grain production systems. The lower and higher sludge rates were included to develop a response curve. Also included was a treatment containing ash from Blandin's Co-Generation facility because it is currently being successfully used in alfalfa cropping systems and the mixture of sludge and ash may be superior to either component alone.

Treatment materials were hand-applied to 10 x 20 ft plots, then incorporated with a field cultivator and spike-toothed harrow. Valley oats @2.5 bushels per acre and Oneida alfalfa @ 20 lb/acre were seeded 26 May. Prior to seeding, check plots in the oat area received 300 lb/a of 11-5-40 and 100 lb/a of 46-0-0. Check plots in the alfalfa area received 300 lb/a of sul-po-mag (22-18-22). All commercial fertilizer was applied using a 10 ft Gandy broadcast fertilizer spreader. Eptam pre-emergence herbicide was applied at 3 lb/a to the alfalfa area on 25 May. The alfalfa seeding was not uniform due to an equipment malfunction, so the area was reseeded 10 June. Data collected on oats included: percent stand, percent weeds and plant height. Alfalfa data included: percent stand, percent weeds, dry matter yield, soil and plant tissue analysis. In 1995, the plot area containing oats in 1994 was reseeded to an oat/alfalfa mixture to investigate the effects of applying sludge one year prior to planting. Troy oat and Oneida alfalfa were seeded 18 May at 2 bu/a and 15 lb/a, respectively. Plant height and forage dry matter yield data was taken 18 July when oat was in the boot stage. No alfalfa forage dry matter yield data from the new seeding was collected in 1995, however forage yield and plant tissue elemental analysis data was collected from the 1994 alfalfa seeding. Statistical analysis of data was performed using MSTAT statistical software. Statistical differences, when detected, were separated using Fisher's LSD and Duncan's multiple range test.

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[1]Agronomist, North Central Experiment Station, Grand Rapids, MN.

1994 Results

Oats

Plant response Oat plant height (Table 1) and general plant vigor were adversely affected by the presence of sludge, but only the highest sludge rate negatively affected final percent stand. Environmental conditions for oat growth were less than optimum during seedling germination, emergence and early growth stages, as evidenced by the poor performance of the check treatment. Sludge apparently magnified the adverse effects of weather on oat growth. The addition of ash from Blandin's co-generating plant increased oat height compared to sludge treatments containing no ash. All sludge treatments significantly reduced percent weeds compared to the check.

Alfalfa

Plant response Alfalfa seedling emergence and early growth were reduced by the presence of sludge. Consequently, seasonal forage dry matter yield was significantly less for all sludge only treatments compared to the check (Table 1). Blandin ash increased alfalfa dry matter yield. Treatment five, containing Blandin ash and sludge, yielded significantly more dry matter than treatment four, which contained the same amount of sludge but no ash. Sludge did not affect final alfalfa percent stand, and the two highest sludge rates significantly reduced the percentage of weeds present in the final alfalfa stands compared to the control.

Plant tissue response Major plant nutrients necessary for alfalfa production were at sufficient levels in alfalfa plant tissue from all treatments and the check except boron (Table 2), which was only at the sufficient level in the ash/sludge treatment. Levels of heavy metals (Pb, Ni, Cr, and Cd) in alfalfa plant tissue were not affected by any of the treatments.

Soil response Soil pH is a critical factor in alfalfa production with a pH level of 6.5 considered the minimum level necessary for successful production. Soil pH of this research site was initially 6.6 (Table 3). Soil pH in the fall following spring treatment application was highest for the sludge/ash treatment. The 20 and 30 ton/acre sludge rates also raised soil pH to higher levels than the control, but the increase was not statistically significant.

Soil levels of the plant nutrients phosphorous (P) and boron (B) were similar for all treatments and the check. Soil levels of potassium (K) and magnesium (Mg) in the ash/sludge treatment were higher than the other treatments and the check. Soil levels of sulfur (S) in the check and ash/sludge treatments were higher than for all sludge-alone treatments. Soil levels of zinc(Z) were higher in the ash/sludge and 20 and 30 ton/acre sludge treatments than in the check and 5 ton/acre sludge treatment. Soil levels of iron (Fe), manganese (Mg) and the heavy metals were similar for all treatments and the check.

1995 Results

Oat/Alfalfa Mixture (Seeded in 1995)

Unlike 1994, oat or alfalfa seedling emergence in 1995 was not inhibited nor was early seedling growth reduced in treatments containing municipal sludge compared to plants in the control. Oat plant height (Table 4) at harvest was greater for all treatments which contained municipal sludge. Oat forage dry matter yield was greater for treatments containing sludge at application rates of 20 or 30 ton/acre, compared to the control. The sludge/ash combination did not affect either oat plant height or dry matter yield differently than sludge-alone treatments. The weed control benefit of sludge in the application year was not as readily apparent in 1995, one year after sludge application. Weed species invasion was of primarily grass species rather than broad leaves, which may or may not be a direct effect of the presence of sludge. Growth of alfalfa was not visibly inhibited by municipal sludge, as visual stand ratings of all treatments and the control were not different.

Alfalfa (Seeded in 1994)

Treatments containing sludge at application rates of 20 or 30 ton/acre had significantly higher alfalfa forage dry matter yields (Table 4) at cut one, whereas only the treatment containing a sludge/ash combination had higher total season forage dry matter yield.

Plant tissue elemental analysis

Plant tissue (Table 5) from treatments containing sludge alone consistently differed from the control only by containing higher concentrations of zinc (Zn). Plant tissue from the treatment containing a sludge/ash mixture had lower concentrations of phosphorous (P), calcium (Ca), magnesium (Mg) and sodium (Na) and higher concentrations of potassium (K), zinc and boron (B). No differences in sulfur (S), aluminum (Al), iron (Fe), copper (Cu) or heavy metal [lead (Pb), nickel (Ni), chromium (Cr) or cadmium (Cd)] concentrations were measured between any treatments and the control.

Soil elemental analysis

Soil from treatments containing sludge alone consistently differed from the control only in having lower concentrations of magnesium (Table 6). Treatments containing the sludge/ash mixture had higher soil pH and higher potassium, sulfur, boron, calcium and magnesium concentrations than the control and sludge/alone treatments. Treatments containing sludge at application rates of 20 and 30 ton/acre had higher zinc concentrations than the control and the 5 ton/acre sludge treatment. Heavy metal (lead, nickel, chromium and cadmium) concentrations of treatments did not consistently differ from the control. The sole exception was the control had a higher nickel concentration than the treatment containing the sludge/ash mixture.

Discussion

1994 data indicated municipal sludge may inhibit seedling emergence and reduce vigor resulting in reduced plant performance. The precise mechanism of this inhibitory factor is beyond the scope of this study, however, it could involve a significant alteration in the nutrient status of soil resulting from sludge application, and/or the sludge may present some type of physical barrier. 1995 data seem to show reduced seedling emergence and vigor as a result of municipal sludge application occurs only in the year of sludge application. Oat and alfalfa seeded in 1995 were not affected by the presence of municipal sludge applied in 1994.

Oat plant height and forage DM yield in 1995 were higher for all treatments containing sludge compared to the control. Growing conditions during May and early June 1995 were drier than optimum for seedling emergence and growth. It seems likely this increased plant growth response during dry conditions was due to an increase in the water holding capacity of the soil resulting from addition of organic matter via the sludge. It is also possible the same phenomenon was partially responsible for the greater alfalfa forage dry matter yield at cut one of the alfalfa established in 1994.

Plant tissue and soil elemental analysis data from established alfalfa indicate forage dry matter yield differences were probably related to available potassium (P) and boron (B) because concentrations of these elements in alfalfa tissue were generally sufficient (potassium and boron are 20,000 and 30 ppm, respectively) for only the treatment containing ash, even though fertilizer was applied at recommended rates.

Municipal sludge appears to have a generally beneficial effect on soil chemistry if applied and incorporated well in advance of seeding, although the benefit is not always statistically measurable. Specifically, the soil pH increase observed with the addition of sludge could be more beneficial than observed in this study to pH sensitive crops, such as alfalfa, in situations where the existing soil pH is well below the required minimum of 6.5. Other crops potentially could benefit from increases in soil pH as well because many plant nutrients become generally more available as soil pH becomes closer to neutral (pH of 7). Additionally, zinc (Zn) concentrations in both soil and plant tissue, appears to be elevated to favorable levels by the addition of municipal sludge.

Conclusions

Results thus far do not appear to indicate any adverse environmental effects of municipal sludge application to cropping systems. Municipal sludge application appears to have both beneficial and detrimental effects on plant growth. Detrimental effects associated with sludge application are reduced seedling germination and early plant vigor, both of which likely can be avoided by applying the sludge well ahead of seeding, i.e., in the fall previous to a spring seeding. Beneficial effects of sludge application on plant growth are associated with an increase in soil pH, especially for pH sensitive crops, and an increase in the moisture holding capacity of coarse-textured soils during periods of reduced soil moisture.

Table 1. Plant responses to sludge applications.

	Oat			Alfalfa		
Treatment	Stand	Weeds	Height	Stand	Weeds	Yield
	----------%----------		in.	----------%----------		T/A
1. Check	94 a*	24 a	35 a	94 a	6 a	1.02 a
2. Sludge, 5 tons/A	88 a	2 b	15 b	80 a	4 ab	0.53 c
3. Sludge, 20 tons/A	86 a	2 b	13 b	88 a	2 bc	0.58 c
4. Sludge, 30 tons/A	73 b	1 b	13 b	78 a	1 c	0.46 c
5. Sludge, 30 tons/A + Blandin ash, 10 tons/A	85 a	2 b	14 b	92 a	1 c	0.82 b

* Means within the same column followed by the same letter do not differ statistically at the 0.05 level of significance.

Table 2. Effect of sludge application on alfalfa plant tissue.

Treatment	S	P	K	Ca	Mg	Na	Al	Fe
	%	ppm						
1. Check	0.35 b*	3090 c	26870 b	18540 a	2021 a	94.5 c	16.63 a	63.8 a
2. Sludge, 5 tons/A	0.30 c	3431 bc	26580 b	17840 a	1948 a	155.3 bc	19.92 a	87.6 a
3. Sludge, 20 tons/A	0.36 b	3620 ab	28580 b	16170 a	1987 a	330.5 ab	16.35 a	88.4 a
4. Sludge, 30 tons/A	0.37 b	3892 ab	27740 b	17140 a	2125 a	518.3 a	17.45 a	95.6 a
5. Sludge, 30 tons/A + Blandin ash, 10 tons/A	0.45 a	4037 a	39980 a	13340 a	2047 a	209.8 bc	13.38 a	100.1 a
Alfalfa sufficient nutrient level	30	2500	24000		300-1000			

Treatment	Zn	Cu	B	Pb	Ni	Cr	Cd
	ppm						
1. Check	22.1 c	7.63 a	15.40 c	1.96 ab	1.39 ab	0.40 ab	0.38 a
2. Sludge, 5 tons/A	33.6 b	7.52 a	22.53 b	1.68 b	1.66 a	0.36 b	0.14 a
3. Sludge, 20 tons/A	33.0 b	7.96 a	16.73 bc	1.88 b	1.18 bc	0.41 ab	0.18 a
4. Sludge, 30 tons/A	35.1 ab	8.33 a	16.33 c	1.95 ab	1.17 bc	0.43 a	0.18 a
5. Sludge, 30 tons/A + Blandin ash, 10 tons/A	39.0 a	9.92 a	40.01 a	2.22 a	0.98 c	0.43 a	0.30 a
Alfalfa sufficient nutrient level	20-50		31-80				

*Means within the same column followed by the same letter do not differ statistically at the 0.05 level of significance.

Table 3. Effect of sludge application on soil nutrient and heavy metal concentrations.

Treatment	pH	P	K	S	B	Ca	Mg	Fe
	ppm							
1. Check	6.63 bc*	73 a	71 b	18.8 a	0.15 a	1072 b	32.0 b	52.0 a
2. Sludge, 5 tons/A	6.55 c	77 a	68 b	4.8 b	0.35 a	827 c	24.0 c	59.8 a
3. Sludge, 20 tons/A	6.90 b	72 a	67 b	5.3 b	0.18 a	980 bc	27.5 bc	50.3 a
4. Sludge, 30 tons/A	6.90 b	78 a	68 b	6.0 b	0.18 a	1009 bc	28.3 bc	53.3 a
5. Sludge, 30 tons/A + Blandin ash, 10 tons/A	7.25 a	77 a	281 a	29.0 a	0.73 a	1492 a	57.8 a	48.8 a

Treatment	Mn	Zn	Cu	Pb	Ni	Cd	Cr
	ppm						
1. Check	5.25 a	0.93 c	0.48 b	0.58 a	0.52 ab	0.049 a	0.028 a
2. Sludge, 5 tons/A	8.70 a	2.55 c	0.56 a	0.81 a	0.61 a	0.055 a	0.028 a
3. Sludge, 20 tons/A	7.03 a	5.40 b	0.54 ab	0.61 a	0.44 b	0.052 a	0.028 a
4. Sludge, 30 tons/A	7.84 a	7.48 a	0.55 a	0.67 a	0.44 b	0.053 a	0.028 a
5. Sludge, 30 tons/A + Blandin ash, 10 tons/A	7.15 a	8.43 a	0.59 a	0.60 a	0.42 b	0.082 a	0.028 a

*Means within the same column followed by the same letter are not statistically different at the 0.05 level of significance.

Table 4. Oat plant height and forage dry matter yield for oats and alfalfa seeded in 1995 and forage dry matter yield for alfalfa seeded in 1994.

	Oats/Alfalfa		Alfalfa		
Treatment	Plant Ht	Forage DM Yld	Cut 1	Cut 2	Total
	--in--	TDM/A			
Check	22 d*	0.64 c	1.76 bc	1.02 a	2.78 a
5	26 c	0.98 b	1.66 c	0.95 a	2.61 a
20	29 ab	1.23 a	1.90 bc	1.05 a	2.95 a
30	29 a	1.20 a	2.03 b	1.05 a	3.07 a
20 + 10	27 bc	1.26 a	2.37 a	0.98 a	3.35 a

*Means within the same column followed by the same letter are not statistically different at the 0.05 level of significance.

Table 5. Grand Rapids Municipal Sludge Study - 1995 Plant tissue elemental analysis. Alfalfa seeded in 1994.

Treatment	S	P	K	Ca	Mg	Na	Al	Fe
	%	ppm						
1. Control	0.29 a*	2844 a	19060 b	15850 a	2341 a	535 a	17.0 a	61 a
2. Sludge, 5 tons/A	0.25 a	2639 bc	19910 b	15600 a	2048 ab	436 ab	21.0 a	63 a
3. Sludge, 20 tons/A	0.26 a	2780 ab	20230 b	15900 a	2002 b	511 a	18.1 a	63 a
4. Sludge, 30 tons/A	0.28 a	2783 ab	18850 b	16720 a	2127 ab	666 a	18.4 a	66 a
5. Sludge, 30 tons/A + Ash, 10 tons/A	0.26 a	2476 c	26840 a	12140 b	1518 c	205 b	25.3 a	63 a

Treatment	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd
	ppm							
1. Control	39.5 ab	20.2 d	5.47 a	19.6 b	<1.68 a	3.27 a	0.41 a	<1.20 a
2. Sludge, 5 tons/A	43.0 a	24.0 c	5.47 a	21.5 b	<1.68 a	3.00 a	0.42 a	<1.20 a
3. Sludge, 20 tons/A	35.4 abc	26.7 b	5.12 a	20.5 b	<1.68 a	2.89 a	0.37 a	<1.20 a
4. Sludge, 30 tons/A	34.7 bc	29.0 a	5.49 a	20.8 b	<1.68 a	2.93 a	0.38 a	<1.20 a
5. Sludge, 30 tons/A + Ash, 10 tons/A	28.1 c	25.7 bc	4.77 a	31.8 a	<1.68 a	2.08 a	0.37 a	<1.20 a

*Means within the same column followed by the same letter are not statistically different at the 0.05 level of significance.

Table 6. Grand Rapids Municipal Sludge Study - 1995 Soil elemental analysis of treatments established in 1994.

Treatment	pH	P	K	S	B	Ca	Mg	Fe
	ppm							
1. Control	6.5 bc*	71 a	69 b	4.25 bc	0.10 b	849 bc	34 b	45 ab
2. Sludge, 5 tons/A	6.3 c	71 a	66 b	1.75 c	0.10 b	777 c	23 c	50 a
3. Sludge, 20 tons/A	6.7 b	69 a	62 b	7.75 b	0.10 b	958 b	24 c	40 bc
4. Sludge, 30 tons/A	6.8 b	74 a	68 b	5.25 bc	0.13 b	978 b	24 c	40 bc
5. Sludge, 30 tons/A + Ash, 10 tons/A	7.3 a	75 a	149 a	14.8 a	0.35 a	1262 a	42 a	34 c

	Mn	Zn	Cu	Pb	Ni	Cd	Cr
	ppm						
1. Control	4.6 a	0.99 b	0.48 a	0.57 a	0.52 ab	0.05 a	<0.03 a
2. Sludge, 5 tons/A	5.8 a	3.38 b	0.56 a	0.75 a	0.62 a	0.06 a	<0.03 a
3. Sludge, 20 tons/A	3.8 a	6.71 a	0.55 a	0.55 a	0.44 bc	0.05 a	<0.03 a
4. Sludge, 30 tons/A	4.3 a	8.23 a	0.54 a	0.60 a	0.40 bc	0.05 a	<0.03 a
5. Sludge, 30 tons/A + Ash, 10 tons/A	4.0 a	7.81 a	0.53 a	0.56 a	0.30 c	0.07 a	<0.03 a

*Means within the same column followed by the same letter are not statistically different at the 0.05 level of significance.

SEED-PLACED FLUID FERTILIZER FOR CORN PRODUCTION

George Rehm, Gyles Randall, Dave Huggins, Thor Sellie, Andy Scobbie, and Jeff Vetsch[1/]

Abstract

Banded fertilizer becomes an important placement option for immobile nutrients as soil test levels increase. Seed-placed (pop-up) fertilizer is one option. This study evaluated the effect of three fluid fertilizers applied in contact with the seed at three rates on emergence, early growth, and yield of corn grown at two locations. This placement method had no effect on emergence, increased early growth, and had mixed effects on corn yield.

Introduction

The placement of fertilizer with the seed (pop-up) has been used by some corn producers for several years. Limits for use have not been well defined. This practice may become a more important option as soil test levels for P and K continue to increase. Therefore, the impact of this fertilizer management practice needs to be studied in more detail.

Experimental Procedure

This study was conducted at the Waseca and Lamberton Experiment Stations. Three fluid fertilizers (7-21-7, 4-10-10, 10-34-0) were applied at rates of 5, 10, and 15 gallons per acre in contact with the seed (pop-up). A control (no fertilizer with the seed) was also used. Corn was planted in both early and mid-May at the Waseca location. The corn was planted in mid-May at the Lamberton site. The soil to a depth of 6 inches was wet at both locations.

Stand counts were taken at approximately four weeks after emergence at both sites. Whole plants were harvested at this time, dried, and weighed. These plant samples were ground and analyzed for P and K. Grain yields were measured in October.

Summary of Results

Fertilizer applied in contact with corn seed had no negative effect on emergence at all sites. The soil moisture in the seed zone was high and this may have eliminated any negative effects caused by this practice.

This placement practice increased the early growth of corn at both locations. Even though soil test values for P and K were in the high range at all sites, this practice was positive because of the cold, wet conditions at planting.

The effect of "pop-up" fertilization on yield was mixed. For the early planting at Waseca, yields were reduced slightly when this practice was compared to the control. This effect was not observed for the mid-May planting at both the Waseca and Lamberton locations.

This study will be repeated in 1996.

[1/] Professor, Department of Soil, Water, and Climate; Soil Scientist, Southern Experiment Station; Soil Scientist, Southwest Experiment Station; Junior Scientist and Assistant Scientist, Department of Soil, Water, and Climate; Assistant Scientist, Southern Experiment Station, respectively.

EFFECT OF ANHYDROUS AMMONIA APPLICATION PATTERNS AND TIMING ON CORN STAND AND YIELDS

M.A. Schmitt, and D.R. Hicks[1/]

Abstract

Earlier corn planting could occur in many farming operations if it wasn't for delays due to nitrogen fertilizer applications. This study was designed to evaluate the effects of applying anhydrous ammonia after corn planting--yet before emergence--using various application patterns. Applying anhydrous ammonia parallel to and in-between corn rows resulted in no stand loss and optimum yields. Other application patterns resulted in varying degrees of stand loss that was correlated with grain yield loss.

Introduction

In the northern Corn Belt, corn producers are annually challenged with completing all the necessary field work to ensure planting by the optimum dates. Factors such as seedbed tillage operations, wet soil conditions due to soil frost and/or rainfall, and chemical and fertilizer applications all contribute to delay in planting. One management strategy that may allow for earlier corn seeding is to apply anhydrous ammonia (AA), which is the most popular nitrogen (N) form used, after planting yet before emergence. The objectives of this study were to determine the feasibility of this practice by evaluating corn stands and yield as affected by AA application patterns, N rate, and time of application.

Experimental Procedure

This study was conducted for four site-years in eastern Minnesota. An AA application rig was used to apply the treatments in four configurations: 1) with the knives centered down the middle of the corn rows; 2) the rig driving at an angle through the plots; 3) the rig driving at the same angle through the plots twice; and 4) with the knives centered on the seeded rows of corn. The application treatments were applied either within 24 hr of corn planting or a week after planting. Nitrogen was applied at rates of 0 or 150 lb N per acre, with the 0 N rate still having the application rig and knives going through the plots. Corn stands in the plots were measured approximately 3, 4, 5, and 6 wk after planting, with stand quality parameters, such as gaps and delayed plants, quantified at 6 wk after planting. Grain yields were measured at physiological maturity.

Summary of Results

Corn stands were reduced when both angled treatments or the in-row treatments were applied, regardless of whether AA was being applied or not. Compared to the between row treatment, stands were reduced 6, 14, and 31% with the angle, angle-twice, and in-row treatments, respectively. The reduction in stand was highly correlated to gaps (>12 in.) in the rows. Yields were 96, 92, and 81% of the between row treatment, which had an average yield of 176 bu/acre for the four site-years. The N rate (0 or 150 lb N/acre) did not have a significant effect on stand, except with the in-row treatment, which indicates that seed displacement from the knives is just as important as AA injury. There were minor negative effects on stand and injury with treatment applications one week after planting.

Status

This project consisted of two site-years in 1994 and two site-years in 1995.

[1/] Associate Professor, Department of Soil, Water, and Climate; Professor, Department of Agronomy and Plant Genetics, respectively.

ANNUAL MEDICS AS A SOURCE OF NITROGEN AND MEANS OF WEED CONTROL IN CORN

C.C. Sheaffer, M.A. Schmitt, and G.W. Randall[1/]

Abstract

Annual medics, which are legumes that provide rapid ground cover early in the season and then senesce by the middle of the season, may be grown with corn in an effort to reduce herbicide and nitrogen inputs. This study was designed to evaluate the weed control and nitrogen sufficiency of this dual-crop system. Research results indicated that the weed control properties were questionable and that nitrogen contributions were not realized by the corn. In summary, medic was a significant competitor with the corn.

Introduction

Annual medics establish and grow quite rapidly in the spring of the year, and by mid-summer they have completed their vegetative growth cycle. Previous research has shown that medics can fix significant quantities of nitrogen (N) in their growth cycle. Also, due to their growth habit, they can have a weed suppression effect. The objective of this study was to evaluate medics grown with corn as contributors to weed suppression and N sufficiency for corn.

Experimental Procedure

This study was conducted in Waseca and Olmsted counties in 1995. Three different medic/N main effect treatments were established. One treatment consisted of broadcast application of N and broadcast seeding of medic immediately preceding corn planting. The second treatment consisted of band application of N directly in-between the corn rows and band seeding of medic directly over the corn rows. The third treatment used banded N (in-between corn rows) with no medic being grown. Each of these main effect treatments were established using N rates of 0, 50, 100, and 150 lb N/acre. In addition, a preplant herbicide treatment was used with each of the main effect treatments at the 100 lb N/acre rate. Soil N and plant (corn, medic, weed) N were measured in June and July and grain yield was measured at maturity.

Summary of Results

Results between the two locations were similar. There was a significant effect of N rate for each of the medic/N application methods. Averaged across N rates, the broadcast medic/N treatments provided the lowest corn biomass during the season and lowest grain yield at the end of the season. The banded medic/N treatments provided intermediate results between the broadcast treatments and the no medic treatments. The greatest yields were observed when a preplant herbicide was used. These results indicate the need for effective weed control strategies and an understanding of the competitive nature of plants, even a legume, for inorganic N.

Status

This project was started in 1993 and was conducted at two sites in 1994 and again in 1995.

[1/] Professor, Department of Agronomy and Plant Genetics; Associate Professor, Department of Soil, Water, and Climate; Soil Scientist, Southern Experiment Station, respectively.

EFFECT OF ALFALFA STAND AGE ON N CREDITS FOR SUBSEQUENT CORN N RECOMMENDATIONS

M.A. Schmitt, C.C. Sheaffer, G.W. Randall, and D.R. Huggins[1/]

Abstract

Age of alfalfa stand is not considered in providing N credits for a subsequent non-legume crop. This study was designed to evaluate the effect of alfalfa stand age on corn's N responsiveness. One-, two-, and three-year old stands of alfalfa were killed and seeded to corn. Nitrogen fertilizer rates ranging from 0 to 150 lb/acre were applied. In 1995, grain yield responsed up to 50 lb N/acre with the 1-year old stands. No corn response to N was measured when grown on 2- or 3-year old stands of alfalfa.

Introduction

It is not unusual for alfalfa producers to be forced into plowing-up a stand of alfalfa much earlier than expected. Winterkill, changes in the government program, or poor stands all provide opportunities for producers to rotate out of alfalfa early. This study was designed to evaluate the effect of stand ages on corn response to fertilizer N.

Experimental Procedure

This study was located at three locations in Minnesota--Rosemount, Waseca, and Lamberton. Alfalfa was established in 1992, 1993, and 1994 so that in 1995, when corn was to be grown, there were 1-, 2-, and 3-yr old stands of alfalfa. The alfalfa was chemically killed in the fall of 1994. On each of these plots, N rates of 0, 25, 50, 75, 100, and 150 lb/A were applied shortly before corn seeding, which was accomplished without any tillage. Plant and soil samples were collected regularly throughout the growing season in the control plots to monitor soil N and, hence, N uptake. At harvest, grain and stover yields were measured.

Summary of Results

At the Rosemount site, corn grain yields were reduced throughout the entire study; possibly due to a combination of poor stands, poor weed control, and/or compacted soils. As a result, there were no treatment responses caused by the applied N rates or the age of alfalfa stand. Waseca and Lamberton data were quite similar. The 1-year old stand of alfalfa resulted in a yield response with the 25 and 50 lb N/A treatments. There was no yield response to fertilizer N with the 2- or 3-yr old stands.

Status

Identical protocols were used for the 1994 and 1995 corn crops and will continue with the 1996 crop.

[1/] Associate Professor, Department of Soil, Water, and Climate; Professor, Department of Agronomy and Plant Genetics; Soil Scientist, Southern Experiment Station, Assistant professor, Department of Soil, Water, and Climate, respectively.

THE IMPACT OF STARTER FERTILIZERS ON ROOT ACTIVITY AND PRODUCTION OF POPULAR BUT DIFFERENT CORN HYBRIDS

George Rehm, Deborah Allan, Diane Knight, Andy Scobbie, and Thor Sellie[1/]

Abstract

Previous studies in recent years had shown that various corn hybrids show differences in root architecture. Little is known about the impact of fertilizer use on distribution and activity of corn roots. This study evaluated the impact of various rates of K_2O and placement on root activity of three popular, but different, corn hybrids. The study was conducted at two sites. One had a high soil test value for potassium. The other had a medium soil test value for potassium. Neither hybrid nor potash fertilization affected yield at the site with the medium soil test. Hybrid, but not potash fertilization, affected yield at the site having the high soil test for potassium.

Introduction

Root growth and root activity is not the same for all hybrids. Past research has shown that corn hybrids respond differently to potash use and placement. These differences have been attributed to differences in the way that roots grow with root development being different among hybrids. In addition, very little is known about differences in root activity among hybrids. Therefore, this study was conducted to measure the effect of potash fertilizer on the distribution and activity of roots of three popular corn hybrids.

Experimental Procedure

This study was conducted in fields of cooperating farmers in Goodhue County. Selection was based on soil test values for potassium. One site had a very high soil test for potassium. The potassium level at the second site was in the medium range. Three popular, but different, hybrids were grown at each site. Three rates of potash (20, 40, 60 lb. K_2O per acre) were applied in a starter fertilizer with 100 lb. 18-46-0 per acre. Other treatments were: 1) no starter, 2) 100 lb. 18-46-0 per acre in a starter (no potash), and 3) 200 lb. K_2O per acre broadcast with 100 lb. 18-46-0 per acre in a starter.

Three non-essential cations (strontium, rubidium, lithium) were injected to various depths at two distances (4 and 8 inches) from the row at both 30 and 40 days after planting. Injections were made perpendicular to corn plants. Whole plant samples were taken ten days after each injection. These plant samples were analyzed for potassium, rubidium, and strontium in an effort to measure root growth and activity.

Grain yields were measured in October and corrected to 14.5% moisture.

Summary of Results

Results recorded in 1995 were inconsistent. Neither hybrid nor use of potash fertilizer had a significant effect on yield at the site with a medium soil test for potassium. An early growth response to potash use was clearly visible at this site. These differences in early growth, however, were not reflected in yield.

Yield was affected by hybrid, but not potash use, at the site where the soil test for potassium was in the high to very high range. The lack of response to potash would be expected at this site.

Uptake of non-essential cations was quite variable in 1995. Therefore, definite comments about root geometry and root activity cannot be made at this time.

[1/] Professor, Associate Professor, Research Associate, Assistant Scientist, and Junior Scientist, Department of Soil, Water, and Climate, respectively.

FIELD SCALE USE OF A CHLOROPHYLL METER FOR NITROGEN FERTILIZER APPLICATION

J.A. Lamb, D.S. Onken, and K.I. Ault[1/]

Abstract

A chlorophyll meter was used to schedule nitrogen fertilizer applications for irrigated corn grown on a Zimmerman fine sand. After three years results have been mixed. Grain yields reductions from scheduled applications compared to sufficiently fertilized corn ranged from 0 to 11 percent. The N fertilizer reductions were 30 % of the sufficiently fertilized corn. Use of this technique on sandy soils in Minnesota will require top management.

Introduction

Chlorophyll meters have been developed to schedule in-season nitrogen applications for corn under irrigated conditions. Nebraska researchers found that using a relative nitrogen status (RNS) of 95 % (comparing an adequately fertilized area to a scheduled area) on silt loam soils would result in a 6 % reduction in corn grain yield while reducing fertilizer N inputs. This reduction has implications for reduced nitrate-N losses into the ground water. The objective of this study was to use a chlorophyll meter to schedule in-season N applications for irrigated corn in Minnesota.

Materials and Methods

This study was conducted as part of the Northern Cornbelt Sand Plains Management Systems Evaluation Area (MSEA) project from 1993 to 1995. A ridge-till corn-soybean rotation was used with each crop present in each year. The cropping areas are 4.4 acres in size with the predominant soil being a Zimmerman fine sand. Nitrogen was applied as 20 pound N per acre in the starter at planting and 60 to 70 pounds N per acre at the V4 corn growth stage. The rest of the fertilizer N (about half) was applied according to the chlorophyll meter scheduling. To schedule N applications, well fertilized reference strips consisting of the outside 8 rows on each side of the cropping area were established each year. The reference strips received an additional 50 to 70 pounds N per acre at corn growth stage V8. This operation occurred before the ridging operation. Relative nitrogen status (RNS) was calculated by comparing the chlorophyll meter readings from the scheduled area with the reference strip chlorophyll readings. RNS is expressed as follows: (Chlorophyll number scheduled/ Chlorophyll reference strip) X 100. The chlorophyll numbers were determined by a Minolta SPAD meter periodically after the V8 corn growth stage. When the RNS went below 95 %, 20 to 30 pounds N per acre was applied as Urea Ammonium Nitrate solution (28-0-0) injected into the irrigation system. Hand harvested grain yields were determined from both the reference and scheduled areas each year.

Results and Discussion

The use of the chlorophyll meter for N fertilizer scheduling requires a considerable amount of management. Sampling must be done on at least a weekly basis. There was a grain yield reduction between the reference and scheduled areas in 1993 and 1995 of 10 and 11 percent, respectively. In 1994, no grain yield reduction occurred. The N inputs were approximately 70 % for the scheduled area compared to the reference strips. In 1993, some of the grain yield reduction was caused by the newness of the technique to the researchers. In 1995, we were unable to make up the loss after the 95 % threshold was reached. Future use will require the RNS threshold to be increased to 97 % on sandy low organic matter soils.

This is the third year of an on-going study.

[1/] Associate Professor, and Assistant Scientist, Department of Soil, Water, and Climate; Support Scientist, USDA-ARS, respectively.

PRECISION SOIL SAMPLING FOR IMMOBILE NUTRIENTS

J.A. Lamb, G.W. Rehm, G.L. Malzer, and J.G. Davis[1/]

Abstract

A study to evaluate the best grid cell size and best soil sample system for immobile nutrients was conducted in South-Central Minnesota from 1993 to 1995. A corn-soybean cropping system was used. The soils at the research sites were formed in glacial till. Three grid cell sizes, 60 X 60 ft., 180 X 180 ft., and 300 X 300 ft. were evaluated. The sampling patterns included a mid-plot sample, a 60 X 60 ft. grid all-point pattern, and five to nine sample pattern. The smaller the grid cell the better the characterization of the soil for P and K. Economics of the cropping system will dictate the grid cell size used in most situations. The sampling pattern results indicate that a single mid-point soil sample is not a good characterization of soil P and K in a grid cell. The use of any pattern with at least five sample locations in the cell is as good as using soil from 25 locations. To get the most out of grid soil sampling, the person taking the sample should use their knowledge of soil science and of the field being sampled to get a sample which "best" reflects the grid cell.

Introduction

Precision soil sampling has become an issue in Minnesota. Many fertilizer dealers and consultants have invested in the variable rate technology (VRT) for application of phosphorus (P) and potassium (K) fertilizer. The variable rate application equipment require a condition map of the field to provide information on how much and where to apply fertilizer. As the use of VRT grows more questions arise about how to develop the condition map. Most consultants have adopted a grid system of soil sampling a field to meet this need.

As more grid soil sampling is done the following questions have been asked: 1. What is the best grid cell size for P and K soil testing? 2. What is the best soil sampling pattern within a grid cell? and 3. How does the time of the year affect the soil test results?

Materials and Methods

A study was started with three locations in Southern Minnesota to answer questions about using grid soil sampling. These locations were established in farmer's fields in the soybean year of a corn-soybean rotation. One location (SB) was started in June 1993 and the others (RA and RM) in June 1994. For this report only SB and RA locations will be discussed. Soil samples to a six inch depth were taken on a 60 X 60 ft. grid and analyzed for pH, organic matter, Bray-P, sodium bicarbonate-P (Olsen-P), and potassium. The SB location was 360 feet wide and 1320 feet long accounting for an area of 10.9 acres which forms 132 - 60 X 60 ft. grid cells. The RA site was 360 feet wide and 1140 feet long which is 9.4 acres in area and has 114 - 60 X 60 ft. grid cells. Soybean and corn were grown by the farmer cooperators as part of their bigger fields. At the end of the second year corn grain yields were determined in 60 foot segments by a plot combine.

Soil data from one sampling time at each location was evaluated at three different grid cell sizes; 60 X 60 ft., 180 X 180 ft., and 300 X 300 ft. To compare grid cell sizes, similar areas of the sites were used. At the RA location 12 - 180 X 180 ft. grid cells and 3 - 300 X 300 ft. grid cells were used for acres of 360 X 1080 ft. and 300 X 900 ft., respectively. At the SB site, 21 - 180 X 180 ft. grid cells were used making the site size 360 ft. X 1260 ft. Four 300 X 300 ft. grid cells were used or an area 300 ft. X 1200 ft. Fertilizer recommendations for P and K were derived from University of Minnesota recommendation for a 150 bushel per acre corn yield goal.

Results and Discussion

Optimum Grid Cell Size

From an academic prospective, the smaller the grid cell sizes will provide a better documentation of the variation in a field. Current University of Minnesota research at two sites has looked at three grid cell sizes: 60 X 60 ft. (0.1 acre), 180 X 180 ft. (0.75 acre), and 300 X 300 ft. (2 acre). For the actual soil test values, there are some differences in average values with changing grid cell sizes. At the RA location, when using a standard single mid-point sample, the Bray-P test was affected by

[1/] Associate Professor, Professor, Professor, and Research Associate, Department of Soil, Water, and Climate, respectively.

cell size (16.4 ppm for 60 X 60 ft., 20.1 ppm for 180 X 180 ft., and 9.7 ppm for 300 X 300 ft.). The 300 X 300 foot soil test was less than the smaller two grid sizes. At the SB location, Bray-P soil test values decreased with increasing grid cell size (27.7 ppm for 60 X 60 ft., 26.9 ppm for 180 X 180 ft., and 21.0 ppm for 300 X 300 ft.). The phosphate fertilizer recommendations for a 150 bushel per acre corn crop based on the Bray-P soil test are quite different when comparing a 60 X 60 foot grid cell to a 300 X 300 foot grid cell (23.3 vs 30.0 pounds phosphate per acre). At both locations, the average recommended rate for all cells increased with increased cell size: (35 pounds phosphate per acre at RA and 7.9 pounds phosphate per acre at SB). For recommendation purposes, we suggest using the smallest grid cell size that is economically practical. Large cells should be used where there is a small amount of variability in a field. If substantial variability is expected, use smaller grid cells.

Sampling Pattern Within a Grid Cell

The sampling pattern used within the cell seems to make a substantial difference in the fertilizer recommendations. The use of a mid-point location produced different fertilization recommendations that if multi-point (5 to 9 sampling locations in the grid cell) were used. In this study, the multi-point and all points sampling systems produced the same Bray-P test. The all point system required collection from within the 300 X 300 ft. grid on 60 X 60 ft. intervals for at total of 25 soil samples. If possible a sampling pattern which would include at least five separate location in the grid cell, should be used. Again this would increase the number of soil samples taken but the increased precision in the fertilizer recommendations may be worth it. The mid-point sampling system allows an individual to return to a specific location each time a cell is sampled. With the improvement of global positioning system technology (GPS), the ability to return to the same place using 5 to 9 sampling areas should also be possible.

The RA location had three 300 X 300 ft. cells while SB was larger with four cells. The comparison of sampling patterns at RA indicates that in two of the three cells the single mid-point soil test Bray-P value was less than the all points value which utilized 25 individual soil samples taken in the 300 X 300 ft. cell. Because of this the phosphate recommendations are different between the two sampling systems at the RA site. At the SB site in three of four cells the mid-point Bray-P value was less than the all point value. Again the phosphate recommendations reflect these differences. In both locations, the Bray-P soil test value derived from a multi-point sampling pattern which involved five to nine soil samples was similar at the all point value. In this study multi-point patterns involved separate soil samples which were mathematically averaged and not composited.

Effect of Time of Sampling of pH, Bray-P, Olsen-P, and Potassium

The increase use of grid sampling has caused some concern about the increased amount of time involved in taking and analyzing the added soil samples. For immobile nutrients and pH, the "window" for soil sampling could be longer than the current practice. Part of this study was to determine soil test variability over time. Soil samples were taken at the RA site June 1994, October 1994, June 1995, and October 1995. The samples were taken at the SB site June 1993, October 1993, June 1994, and October 1994. At the RA site, phosphorus measurements were relatively similar during the sampling dates. The pH mean values were similar between sampling dates but the minimum value increased in the October 1994 sampling. The potassium soil test means increased with time. At the SB site the mean and minimum values for Bray-P and Olsen-P remained similar between sampling dates. The Bray-P and Olsen-P maximum values were decreased in 1995 from the 1994 values. All pH values decreased in 1995 compared to 1994. Again potassium soil test values changed more erratically between sampling times.

In general the phosphorus soil tests and pH are stable over time if they are taken from the same location in the field. In most cases, the differences between sampling times are within the accuracy of the analytical lab. Potassium is erratic. This is a concern. This variability can be from several different factors. First the soil moisture status at sampling time can cause variability. At lower soil test values, soil test K will increase when soils are dry causing release of fixed K from the clays in the soil. At high soil test values, the analytical methods do not allow enough time to extract the K released by the clays. The way the sample is handled in terms of drying temperature and the length of time it is dried at the soil testing laboratory can also cause considerable variability. Our recommendation to minimize the variability of K soil test is to sample a field in the same place during the same time of the year and use the same laboratory. At this time we believe that the "window" of time when soil sampling for immobile nutrients can be increased to make it a more manageable activity.

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EFFECT OF TIME OF APPLICATION ON MINERALIZATION OF MANURE N, CORN YIELD, AND SOIL NITRATE CONCENTRATIONS

G.W. Randall, M.A. Schmitt, and B. Montgomery[1/]

Abstract

There is often more available labor and time in the fall of the year for manure applications. However, there are several concerns associated with early manure applications. This study was designed to evaluate the agronomic and environmental aspects of various times of manure applications. In 1995, the time (and rate) of application had important effects on yield.

Introduction

The issue of when to apply manure can be a controversial issue. While producers realize that earlier applications are most convenient and labor efficient, environmental and agronomic concerns need answers. The objectives of this project are twofold. First is the determination of N mineralization rates of manure as affected by time of manure application and nitrification inhibitors. Second, the effects of these factors will be evaluated on crop N uptake, grain yield, and leaching potential.

Experimental Procedure

Studies were established at two sites in 1995 in south central Minnesota. At each site, three fall manure applications were scheduled (September, October, and November) along with a spring, preplant application. At each application date, two rates (3,000 and 6,000 gal./acre) of manure were applied, with each rate being applied with and without nitrapyrin (N-Serve). Commercial fertilizer N rates were used as reference treatments. Soil samples were collected in approximately two week intervals from the date of manure application through June of the crop year, excluding winter. These samples were analyzed for nitrate and ammonium. Soil water samples were collected from selected treatments and analyzed for nitrate. Grain and stover yields along with plant N concentrations were measured at maturity.

Summary of Results

Results indicate that spring soil nitrate-N and grain yields are strongly related to the fall application date–the earlier the manure was applied, the less available N and yield were measured the following season. For the two sites in 1995, there were no differences measured among the fall application dates. However, grain yields from all fall-applied treatments was slightly less than from spring-applied treatments. The higher rate of manure for all treatments resulted in higher soil N concentrations at all sampling times, and resulted in greater yields at the 1995 sites. Inclusion of nitrapyrin had the greatest effect in slowing nitrification with the September/October applications, and resulted in yield increases at one site when averaged across all treatments.

Status

This project was started in 1993 at two sites. Three sites were used for the study in 1994. Only residual yield affects will be measured in 1996 at the 1995 sites.

[1/] Soil Scientist, Southern Experiment Station; Associate Professor, Department of Soil, Water, and Climate; Soil Scientist, Minnesota Department of Agriculture, respectively.

MANAGEMENT TO IMPROVE ROOT HEALTH OF SOYBEANS GROWN IN NO-TILL PLANTING SYSTEMS

George Rehm, Ward Stienstra, Andy Scobbie, Thor Sellie, and Sandra Gould[1/]

Abstract

Root diseases are a concern when soybeans are planted in no-till systems. The effects of tillage system, variety, Ridomil use, and either potash or phosphate fertilization practices on soybean root health and subsequent yield were evaluated in this study. Experimental sites were selected in Dakota, Olmsted, and Swift Counties. The sites selected had been planted to soybeans in 1994 using no-till planting techniques. Results were varied. The effects of treatments on root health and yield were not consistent across all sites. In general, yields were lower where no-till was used. Incidence of Phytophthora Root Rot was more evident where the susceptible variety was planted with no-till techniques without the use of Ridomil.

Introduction

There is a substantial interest in no-till soybean production in Minnesota. Yet, root diseases are a common concern when soybeans are planted with no-till techniques. Management practices that might affect root health in this planting system have not been fully investigated. This study was conducted to evaluate the effect of tillage system, variety, Ridomil use, and management of either phosphate or potash fertilizers on the root health and subsequent yield of soybeans.

Experimental Procedure

This study was conducted in fields of cooperating farmers in Dakota, Olmsted, and Swift Counties. All sites selected were well drained and had been planted to soybeans in 1994 using no-till planting systems. The management practices studied were: 1) tillage system (no-till, either disk or field cultivation before planting, 2) variety (Pioneer 9071, Pioneer 9091), 3) Ridomil use (none, full rate), and phosphate or potash fertilizer management. The Pioneer 9071 variety is resistant to Phytophthora Root Rot. The Pioneer 9091 variety is susceptible to this pathogen. The Ridomil, when used, was placed in a band over the row at planting. Potash management (none, 40 lb. K_2O per acre in a band, 80 lb. K_2O per acre broadcast) was evaluated at the Dakota and Olmsted County sites. Phosphate management (none, 35 lb P_2O_5 per acre in a band, 70 lb. P_2O_5 per acre broadcast) was evaluated at the Swift County site. All fertilizer treatments were applied before tillage operations were completed in the spring.

Whole plant samples were dug from each plot at approximately 30 and again at 70 days after planting. Top growth was separated from the roots. The majority of the soil was removed from the root system and the root systems were transported to the laboratory. The root systems of six plants collected from each plot were scored for lesions, nodules, and tested with ELISA for Phytophthora Root Rot. Root sections were plated on water and Acid Potato Dextrose agar to determine fungal colonization of the root tissue.

Leaf samples from each plot were collected at early to mid-bloom. These samples were analyzed for potassium (Dakota and Olmsted County sites), or phosphorus (Swift County site). Yields were measured in October with a plot combine.

Summary of Results

Results were quite varied. At the Swift County site, tillage system, variety, and Ridomil use had no significant effect on yield. The broadcast application of phosphate improved yields in the conventional tillage planting system. Yields were in the range of 50 to 55 bushels per acre.

Soybean yield at the Dakota County site was not affected by the tillage system. Considering variety, the yield of Pioneer 9071 was higher than the yield of 9091. The use of Ridomil also increased yields at this site. Yields ranged from 45 to 50 bushels per acre.

No-till reduced the soybean yield at the Olmsted County site. Banded K_2O increased yield in the no-till planting system. The yield of Pioneer 9071 was slightly higher than the yield of 9091. Use of Ridomil had no effect on yield at this site. Yields ranged from 35 to 45 bushels per acre.

In general, incidence of Phytophthora Root Rot was lower when Pioneer 9071 was planted in the conventional planting system with the use of Ridomil. The effect of treatment on other disease development and nodulation was inconsistent.

[1/] Professor, Department of Soil, Water, and Climate; Professor, Department of Plant Pathology; Assistant Scientist, Junior Scientist, Department of Soil, Water, and Climate; Assistant Scientist, Department of Plant Pathology, respectively.

SOYBEAN YIELD IN SOUTHEASTERN MINNESOTA AS AFFECTED BY INOCULATION AND NITROGEN FERTILIZATION

Fritz Breitenbach and George Rehm[1/]

Abstract

The soybean crop with adequate nodulation is capable of manufacturing needed nitrogen from the atmosphere. In the past, use of nitrogen fertilizers has reduced nodulation. For this study, three rates of nitrogen fertilizer (0, 50, 100 lb. per acre) were broadcast and incorporated before planting. Both inoculated and non-inoculated soybeans were planted with each nitrogen rate. Nitrogen fertilizer use reduced nodulation, but had no significant effect on the yield of soybeans.

Introduction

There is general agreement that soybeans which are adequately nodulated will not need a nitrogen fertilization program. Excessive nitrate-nitrogen in the root zone has been known to reduce the amount of nodules present on soybean root systems. Yet, there were reports that nitrogen fertilizers would increase the yield of inoculated soybeans. Therefore, this study was conducted to monitor the effect of inoculation and nitrogen fertilization on early growth, nodulation, and yield of soybeans grown in southeastern Minnesota.

Experimental Procedure

This study was conducted in the field of a cooperating farmer in Olmsted County. Two rates of nitrogen (50, 100 lb. per acre), supplied as urea, were broadcast and incorporated before planting. An appropriate non-fertilized control was also used. Inoculated as well as non-inoculated soybeans were planted at each rate of fertilizer nitrogen.

Soybean plants were dug in early August. Whole plants were dried and weighed. Soil was carefully removed from the root system in the field. After washing, nodules were removed from the roots and fresh weights were measured. Soybean yields were measured in October.

Summary of Results

Nitrogen fertilization increased plant growth of both inoculated and non-inoculated soybeans. This increased plant weight, however, was not reflected in increased yields. With yields of approximately 45 bu. per acre, neither inoculation nor nitrogen fertilization had a significant effect on yield. The use of nitrogen fertilizer decreased nodule weight on both inoculated and non-inoculated soybeans.

Current plans call for repeating this study in 1996.

[1/] IPM Specialist, Southeast Minnesota, and Professor, Department of Soil, Water, and Climate, respectively.

SEED-PLACED FLUID FERTILIZER FOR SOYBEAN PRODUCTION

George Rehm, Dave Huggins, Gyles Randall, Andy Scobbie, Thor Sellie, and Jeff Vetsch[1/]

Abstract

Fertilization is important for soybean production. Yet, correct placement of immobile nutrients is difficult when soybeans are planted with no-till techniques. In this study, three fertilizer materials were applied at two rates in contact with the soybean seed. Seed placement reduced emergence. When planted in 8-inch rows, the reduced emergence was not reflected in yields.

Introduction

Soybeans will respond to fertilization with phosphate and potash at low soil test levels. The immobile nutrients should be broadcast and incorporated before planting for best results. This is not possible with no-till planting procedures. Seed placement is one option for fertilizer use. This study was conducted to measure the effect of seed-placed fertilizer on emergence, early growth, and yield of soybeans.

Experimental Procedure

This study was conducted at the Waseca and Lamberton Experiment Stations. Using a Tye Drill, soybeans were planted in a tilled seedbed in late May. The row spacing was 8 inches. The soil test levels for P and K were high at both sites. Three materials (7-21-7, 4-10-10, 10-34-0) were applied in contact with the seed (pop-up) at two rates at each site. A non-fertilized control was used as a basis for comparison. Stand counts were taken. Early growth and nutrient uptake were measured. Yields were measured in October.

Summary of Results

All fluid materials applied in contact with the seed caused a substantial reduction in emergence. Stand reduction at each site increased as rate of fertilizer applied increased. The fertilizer applied did improve the early growth of soybeans and uptake of P and K increased with the application of the fluid fertilizer. This method of fertilization, however, did not produce a significant reduction in yield. Apparently, soybeans seeded in narrow rows can compensate for some reduction in stand. Nevertheless, seed-placed fertilizer caused a substantial reduction in emergence and should not be used as a method of placement for soybean production.

[1/] Professor, Department of Soil, Water, and Climate; Soil Scientist, Southwest Experiment Station; Soil Scientist, Southern Experiment Station; Assistant Scientist and Junior Scientist, Department of Soil, Water, and Climate; Assistant Scientist, Southern Experiment Station, respectively.

SWINE MANURE APPLICATIONS FOR SOYBEAN

M.A. Schmitt, G.W. Randall, J.A. Lamb, J.H. Orf, and J.P. Schmidt[1/]

Abstract

Soybean may be a feasible alternative crop for manure applications. This study was designed to evaluate the agronomic and environmental effects of applying manure for soybean. A series of manure and commercial N application rates was applied for soybean at two sites. Preliminary, first-year results indicate that soybean respond in a visual manner to added N.

Introduction

Pork producers commonly use a crop rotation of corn-soybean. In this rotation, the majority of the manure is applied for corn. However, soybean may be a feasible crop for manure applications as well, even though the benefit of the N in manure may not be fully utilized. There may be several environmental benefits of applying manure for soybean, involving issues such as residue, immobilization, erosion, nutrient uptake potential, and risk. The objectives of this project are to study the production and environmental aspects of manure applied for soybean in a corn-soybean rotation. Emphasis will be placed on N cycling and transformations in the soil as well as varietal effects on N uptake and use efficiency.

Experimental Procedure

This study was initiated in 1995 at two locations--Morris and Waseca. Treatments consisted of several sweep-injected manure rates from 1,500 gal./acre to almost 10,000 gal./acre. A couple of these rates were also applied broadcast. A series of commercial fertilizer N rates were also applied to span the range of N from the manure rates. Soil N and plant uptake N were measured throughout the growing season and at harvest. Nodulating and non-nodulating soybean isolines were planted within each treatment and evaluated in terms of N uptake efficiency and recycling potential.

Summary of Results

Two trial sites were established in 1995 and all of the soil, plant, and seed data have not been completely analyzed and summarized. Preliminary observations indicate that added N, either from manure or commercial fertilizer, resulted in darker green plant color, taller plants, and quicker canopy closure. Although there appears to be some treatment effects on seed yield, additional data and analysis will be required to answer the research questions.

Status

This study was started in 1995 and is scheduled to continue through 1998.

[1/] Associate Professor, Department of Soil, Water, and Climate; Soil Scientist, Southern Experiment Station; Associate Professor, Department of Soil, Water, and Climate; Professor, Department of Agronomy and Plant Genetics; Postdoctoral Research Associate, Department of Soil, Water, and Climate, respectively.

SULFUR AND FOLIAR FERTILIZATION OF HARD RED SPRING WHEAT

George Rehm, Albert Sims, and Russell Severson[1/]

Abstract

The effect of sulfur fertilization combined with foliar fertilization on the yield of hard red spring wheat was not known. This study was conducted on a sandy soil in East Polk County to measure the effects of these fertilization practices. Use of sulfur broadcast and incorporated before planting produced substantial increases in yield with the application of sulfate-sulfur producing the highest yield. Foliar fertilization had no consistent effect on yield.

Introduction

Sulfur is recognized as an important part of the total fertilizer program for both corn and alfalfa grown on sandy soils in Minnesota. Response of small grains (especially hard red spring wheat) to this nutrient is not known. There is also a possibility that foliar fertilizer use, when combined with sulfur applications, might be beneficial for production of hard red spring wheat grown on sandy soils.

Experimental Procedure

This study was conducted in a field of a cooperating farmer in East Polk County. The soil had a loamy sand texture with an organic matter content of 1.7%. Two sulfur sources (sulfate-sulfur, elemental sulfur/clay mixture) applied at rates to supply 25 lb. sulfur per acre were broadcast and incorporated before planting. A no sulfur control was also used. All treatments received the same rate of nitrogen, phosphate, and potash broadcast and incorporated before planting.

Two fertilizers (28-0-0, 20-0-0-3) were applied to plots receiving the various sulfur fertilizers at either tillering or just after flowering. These fluid materials were applied at rates to supply 30 lb. nitrogen per acre. Yields and protein concentration in the grain were measured.

Summary of Results

Use of sulfur broadcast and incorporated before planting produced a substantial increase in yield. Yields were relatively good for a sandy soil (37-47 bu./acre). The sulfate sulfur source produced the highest yield which averaged approximately 3 bushels per acre higher than the yields produced by the elemental sulfur/clay mixture. A response to sulfur would be expected when crops are grown on a loamy sand with a soil organic matter content of 1.7%.

Use of foliar fertilizers at both growth stages produced inconsistent effects on yield. There was no obvious damage or burn from the foliar application.

The concentration of protein in the grain was not affected by either sulfur use or foliar fertilization. In general, grain protein decreased as grain yields increased.

[1/] Professor, Department of Soil, Water, and Climate; Soil Scientist, Northwest Experiment Station; Extension Educator, West Polk County, respectively.

AMMONIUM-NITRATE NUTRITION OF HARD RED SPRING WHEAT

George Rehm, Albert Sims, and Russell Severson[1/]

Abstract

Based on previous research with corn, there was some thought that yields of hard red spring wheat might be improved if nitrogen was supplied in the ammonium form. In this study, nitrogen was supplied as ammonium, nitrate, or a combination of both forms. Sulfur was supplied as either sulfate-sulfur or the elemental sulfur/clay mixture in combination with each nitrogen form. A control (no sulfur used) was also included in the study. The form of nitrogen used had no significant effect on grain yield and grain protein.

Introduction

Recently, various researchers have studied the effects of ammonium and nitrate nutrition on corn production. Results have generally shown that a mixture of ammonium and nitrate produces optimum yields. The effect of ammonium and nitrate nutrition on wheat yield has not been clearly defined. This is especially true for sandy soils.

Experimental Procedure

This study was conducted in the field of a cooperating farmer in East Polk County. The soil texture was a loamy sand and the soil organic matter content was 2.4%. Sources of sulfur (none, sulfate-sulfur, elemental sulfur/clay mixture) were combined with nitrogen forms (ammonium, nitrate, mixture of ammonium and nitrate). Adequate rates of phosphate and potash were applied. The sulfur sources were applied to supply 25 lb. sulfur per acre. The forms of nitrogen were applied to supply 125 lb. nitrogen per acre. All fertilizer materials were broadcast and incorporated just before planting in late April. Grain yields and protein concentrations were measured.

Summary of Results

Sulfur fertilization had no effect on yield at this site. Yields were quite good and ranged from 55 to 61 bushels per acre. The organic matter content of the soil (2.4%) and low sulfur demand by wheat can explain the lack of response. At this site, the form of nitrogen used had no significant effect on yield. Considering the rapid rate of nitrification in sandy soils, a significant effect of form of nitrogen applied on yield was not expected.

Neither sulfur fertilization nor form of nitrogen used had a significant effect on the grain protein percentage of hard red spring wheat.

[1/] Professor, Department of Soil, Water, and Climate; Soil Scientist, Northwest Experiment Station; Extension Educator, West Polk County, respectively.

PHOSPHORUS MANAGEMENT FOR SPRING WHEAT UNDER INCREASED RESIDUE SYSTEMS

J.A. Lamb, G.W. Rehm, A. Sims, and B.J. Holder[1/]

Abstract

The second year of a three year study on hard red spring wheat was conducted at the Northwest Experiment Station in 1995. The objective of the study was to characterize the effects of increased residue production systems on soil phosphorus. Treatments included three residue levels, four phosphorus fertilizer rates, and three application methods. Wheat grain yield was greatest with row application, followed by broadcast applications, and the least with a knife application. In 1994, sodium bicarbonate extractable P was greatest with band applications and decrease with time in all application methods.

Introduction

With conservation compliance many spring grain producers have had to alter their tillage systems to increase the amount of residue present to reduce erosion. Little research has been done on the effect of residue on phosphorus fertilizer rate and application method on spring wheat grown in the Northern Great Plains. The advent of increased residue farming systems has caused changes in soil chemical, biological, and physical properties. These changes can affect the availability of nutrients to wheat plants. Can soil or fertilizer phosphorus availability be affected by crop residue management and does the placement of phosphorus fertilizer need to be different in situations where large amounts of residue are present as compared to lesser amounts of residue? Research on winter wheat has shown a $5 to $10 per acre increase in profitability from use of an efficient row placement of phosphorus over a broadcast placement. The objectives of this study were to characterize the effects of phosphorus fertilizer management under increase residue production systems on the soil phosphorus chemistry in Northwest Minnesota.

Materials and Methods

A field and laboratory study was conducted at the University of Minnesota's Northwest Experiment Station. In the fall after small grain harvest, three residue treatments of no tillage, chisel plow, and moldboard plow (approximately 0, 50, and 100 percent reduction of initial residue) were established. Four rates of phosphorus fertilizer (0, 40, 80, and 120 pounds phosphate per acre) were applied with three different placements (broadcast, knife, and row). Triple super phosphate (0-44-0) fertilizer material was used. The broadcast and knife treatments were applied in the fall similar to what producers do. A spring broadcast treatment of 40 pounds phosphate per acre was applied as a comparison between fall and spring applications and how that effects soil phosphorus dynamics. The row application occurred at planting and the comparison between knife and row treatments will provide the fall versus spring comparison for banded treatments.

The bands were marked and sampled four times following application to determine the effect of soil on the availability of the fertilizer material and the amount of labile phosphorus present at these times. The soil samples are being analyzed for the following fractions: water soluble phosphorus, iron and aluminum phosphates, calcium phosphates, organic phosphorus, and labile phosphorus, The labile phosphorus is being determined by two different procedures: resin extraction and iron and aluminum oxide extraction.

Results and Discussion

This is the second field season for this study. Three factors were studied; residue level (plow, chisel, and nobill), phosphorus placement method (fall knife, fall broadcast, spring broadcast, and row), and phosphorus fertilizer rate (0, 40, 80, and 120 pounds phosphate per acre). The average spring grain yield was 45 bushels per acre. Grain yield was significantly affected by P rate and method of application. The P fertilizer response of 3.3 bushels per acre occurred with the first 40 pounds per acre of phosphate applied. The row placement produced the best grain yield (47.2 bushels per acre) then broadcast (46.1 bushels per acre), and the poorest grain yields were from the knife treatments (44.9 bushels per acre). The residue level had an effect at the 0.12 significance level. No-till treatments yield 40.3 bushels per acre, chisel yielded 44.6 bushels per acre, and plow 50.3 bushels per acre. There were no interactions between the three factors.

The phosphorus bands from the knife and row treatments and the soil treated with broadcast applications were sampled to a depth of six inches at three different times during 1994. In general the Olsen-P soil test values increased with increasing P application rates. The banded applications (knife and row) had greater soil test values than broadcast and the effect of the P application on soil test values decreased later in the growing season. The analyses of the 1994 soil samples for organic P, calcium phosphate, iron and aluminum phosphates and all analyses for 1995 are still in process.

This is a report on the second year of a three-year project and is partially funded by the Minnesota Wheat Council.

[1/] Associate Professor, and Professor, Department of Soil, Water, and Climate; Assistant Professor, Northwest Experiment Station; Associate Professor, University of Minnesota, Crookston, MN, respectively.

RESPONSE OF "GRANDIN" WHEAT TO POTASH, SULFUR, AND COPPER IN NORTHWESTERN MINNESOTA

George Rehm, Carlyle Holen, Bobby Holder, and Albert Sims[1/]

Abstract

In recent years, the "Grandin" variety of hard red spring wheat has appeared to be light green on large areas of several fields in northwestern Minnesota. Potash, sulfur, and copper were applied in various combinations to determine if a deficiency in one or more of these nutrients was responsible for the light green color. The yield data in combination with results of soil tests indicate that the light green color, early in the growing season, was caused by a shortage of potassium.

Introduction

In recent years, the "Grandin" variety of hard red spring wheat has appeared to be light green on large areas of several fields in northwestern Minnesota. Comparative soil tests in combination with plant analysis indicated that this problem, which was most prevalent early in the growing season, could be caused by a shortage of potassium, sulfur, or copper.

Experimental Procedure

This study was conducted in the field of a cooperating farmer in East Polk County. A site was selected where wheat yields in 1994 had been reduced by the light green color which affects early growth. Various combinations of potash, sulfur, and copper fertilizers were broadcast and incorporated before planting. The rates of potash, sulfur, and copper were 120, 25, and 10 lb. per acre, respectively. All treatments received a uniform application of nitrogen (100 lbs. per acre) and phosphate (80 lbs. per acre).

Summary of Results

Wheat yields ranged from 38 to 44 bu. per acre. Lowest yields were measured when potash was omitted from the fertilizer program. These results, when combined with the results of a soil test, indicate that the stunting of this variety (Grandin) early in the growing season could be caused by a shortage of potassium.

[1/] Professor, Department of Soil, Water, and Climate; IPM Specialist, Northwest Minnesota; Associate Professor, University of Minnesota at Crookston; Soil Scientist, Northwest Experiment Station, respectively.

EVALUATION OF VARIABLE RATE PHOSPHATE APPLICATION FOR SPRING WHEAT

George Rehm, and Harold Stanislawski[1/]

Abstract

Variable rate fertilizer application is one example of new technology being used in agriculture. For this study, variable rate phosphate application was compared with a uniform rate used for the production of hard red spring wheat. In 1995, both approaches to broadcast fertilization produced equal yields. The variable rate phosphate application was at an economical disadvantage because of the added cost of sampling and fertilizer application.

Introduction

The concept of variable rate fertilizer application is new to Minnesota farmers. The capability of apply various rates of fertilizer across the landscape offers opportunities for economic and environmental benefits. This management option, however, has not been evaluated in detail in farmers' fields.

Experimental Procedure

This study was conducted in the field of a cooperating farmer in West Ottertail County. A portion of a field to be planted to hard red spring wheat was marked off into grid cells in the fall of 1994. Following harvest of the soybeans, soil samples (0-6 inches) were collected from each grid cell. The cooperating farmer was asked to assign a yield goal to each grid cell. Phosphate application (broadcast) was based on the combination of the yield goal and soil test values for phosphorus. Using variable rate application equipment, phosphate was broadcast to one strip. The same amount of phosphate fertilizer used in this strip was applied at a uniform rate to a second strip.

Adequate nitrogen was applied at a uniform rate to both strips. Wheat was planted in late April and harvested in August. A weigh wagon was used for measuring yields. Grain samples were analyzed for protein.

Summary of Results

Grain yields were higher than expected. The yield from the strip, which received a variable rate of phosphate, was 63.7 bu. per acre. The wheat , which received a uniform rate of phosphate, produced a yield of 63.5 bu. per acre. Method of fertilization had no significant effect on the protein content of the grain. In this study, the variable rate treatment was at a disadvantage because of the added cost of soil sampling and variable rate fertilizer application.

[1/] Professor, Department of Soil, Water, and Climate; Extension Educator, West Ottertail County, respectively.

EFFECT OF SULFUR SOURCE AND FREQUENCY OF APPLICATION ON THE PRODUCTIVITY OF IRRIGATED ALFALFA

George Rehm, Thor Sellie, Andy Scobbie, and Mel Wiens[1/]

Abstract

The importance of sulfur for alfalfa production on sandy soils in Minnesota is well documented. This study was conducted to study the effect of split applications of this nutrient on production. Sulfur supplied as either SO_4 or an elemental S/clay mixture was supplied at two rates (25, 50 lb. sulfur per acre.) in either single or split applications. In the seeding year (1995), none of the treatments had a significant effect on yield. The use of fertilizer did increase the concentration of sulfur in alfalfa tissue.

Introduction

Sulfur in a fertilization program is essential for optimum production of alfalfa on the sandy soils of Minnesota. Most of the previous research with this nutrient has involved single applications. This study was conducted to evaluate the effect of split applications when compared to a single application in early spring.

Experimental Procedure

This study was conducted under irrigated conditions at the Irrigation Center at Staples. Two forms of sulfur (sulfate-sulfur, elemental sulfur/clay mixture) were broadcast at rates to supply either 25 or 50 lb. sulfur per acre in either single or split applications. When split, ½ of the sulfur was applied before planting and the remaining ½ was applied after the first cutting. Adequate phosphate, potash, and boron fertilizers were also broadcast and incorporated before seeding. Alfalfa was seeded on May 10 and two cuttings were harvested. Whole plant samples from each plot were collected at each cutting. These samples were analyzed for sulfur.

Summary of Results

In 1995, the seeding year, the application of sulfur had no significant effect on alfalfa yield. First cutting yields were reduced by weed competition. Total yield for the two cuttings was in the range of two tons of dry matter per acre.

The sulfur concentration in the alfalfa tissue was increased by sulfur fertilization. Sulfur contraction in alfalfa not fertilized with sulfur was higher than .200%. This is considered to be the "critical" value in separating sulfur deficient from sulfur sufficient alfalfa. The plant analysis and the yield information indicate that the sandy soil provided adequate sulfur for alfalfa production in 1995.

Current plans call for this study to be continued in 1996.

[1/] Professor, Junior Scientist, Assistant Scientist, Department of Soil, Water, and Climate; Research Plot Coordinator, Central Lakes Center, respectively.

EVALUATION OF POTASSIUM SULFATE FOR ALFALFA PRODUCTION IN MINNESOTA

George Rehm, Thor Sellie, Andy Scobbie, and Mel Wiens[1/]

Abstract

The importance of sulfur for alfalfa production on sandy soils is widely recognized. Less is known about the effect of sulfur and chloride on forage quality. This study was conducted to measure the effect of sulfate and chloride on the quality of alfalfa forage. Treatments were topdressed to an established stand at the Irrigation Center at Staples. In Goodhue County, the treatments were broadcast and incorporated before planting. Compared to the appropriate controls, use of sulfate and chloride had no significant effect on forage quality. Use of potash increased yield at the Goodhue County location. Use of sulfur increased yield at the Staples location.

Introduction

There's ample evidence to demonstrate that potassium and sulfur will increase alfalfa production when these two nutrients are needed in a fertilizer program. Potassium chloride (0-0-60) is the most widely used source of potash. The impact of either chloride or sulfate supplied with the potash on the quality of alfalfa produced is, however, not known. This study was designed to measure the effect of sulfate-sulfur and chloride on production and quality of alfalfa.

Experimental Procedure

There are two parts to this study. At the Irrigation Center at Staples, treatments were topdressed to an established stand of alfalfa seeded in the spring of 1994. In Goodhue County, the treatments were broadcast and incorporated before alfalfa was seeded in the spring of 1995.

Two sources of K_2O were used (0-0-60, potassium sulfate). Appropriate controls were used to evaluate the effect of sulfate-sulfur and chloride on yield and quality. In addition, the impact of various rates of potassium was evaluated by adding various rates of potassium sulfate to supply 60, 120, and 180 lb. K_2O per acre.

Three cuttings were harvested at the Staples site. One cutting was harvested in the seeding year from the Goodhue County site. Whole plant samples were collected from each plot at each cutting. These samples were analyzed for protein content and percentages of ADF and NDF.

Summary of Results

Alfalfa production at the Staples site was affected by sulfur use, but not by the application of potash and chloride. Considering total yields, use of sulfur increased yields by approximately .5 ton per acre.

Use of sulfur and chloride had no significant effect on alfalfa production at the Goodhue County site. Yields were improved by the application of potash at this site.

The measures of forage quality (protein, ADF, NDF) were not affected by the application of potash, sulfur, and chloride. This observation was true for both sites.

This project will be continued at the Staples site in 1996.

[1/] Professor, Junior Scientist, Assistant Scientist, Department of Soil, Water, and Climate; Research Plot Coordinator, Central Lakes Center, respectively.

LIME SOURCE AND RATE FOR ALFALFA PRODUCTION

George Rehm, Mel Wiens, Thor Sellie, and Andy Scobbie[1/]

Abstract

There are several liming materials that can be used for alfalfa production in Minnesota. This study was conducted to evaluate the impact of sources and rate of application on production of alfalfa grown under irrigated conditions. Lime use increased yield, but lime source had no effect on production. When applied to supply the same rate of ENP, all liming materials had the same effect on yield.

Introduction

The importance of lime, where needed, for alfalfa production has been recognized for some time. There are several materials that can be used to increase soil pH. There was a need to evaluate the effectiveness of these materials when applied at equivalent rates.

Experimental Procedure

This study was initiated in 1993 in an irrigated field of a cooperating farmer in Wadena County. The soil had a sandy loam texture and the initial pH was approximately 6.0.

Four liming materials (aglime, sugarbeet lime, Cutler Magner lime, Pel Lime) were broadcast at rates of supply 4,000, 8,000, and 12,000 lb. ENP per acre and incorporated in 1993. Two varieties of alfalfa were seeded in each lime treatment in the spring of 1994. The MN GRN 8020 variety is tolerant of nematode damage. The Wrangler 9369 variety is susceptible to nematode damage. Alfalfa was harvested three times in 1995.

Summary of Results

In 1995, total dry matter production was in the range of 4.0 tons per acre. Compared to the control (no lime applied), liming increased total production by approximately .3 ton per acre. A rate of 4,000 lb. ENP per acre was adequate for optimum production. All sources had an equal effect on yield and there was no significant rate by source interaction.

Considering varieties, higher yields were produced by MNGRN 8020. When averaged over all lime treatments, the yield advantage was approximately .4 ton of dry matter per acre.

[1/] Professor, Department of Soil, Water, and Climate; Research Plot Coordinator, Central Lakes Center; Junior Scientist, and Assistant Scientist, Department of Soil, Water, and Climate, respectively.

NITROGEN FERTILIZATION OF GRASS-LEGUME MIXTURES IN NORTH-CENTRAL MINNESOTA

George Rehm, Thor Sellie, Andy Scobbie, and Mel Wiens[1/]

Abstract

Grass-legume mixtures could play an important role in the diverse farm enterprises of North-Central Minnesota. For this study, four rates of fertilizer nitrogen (0, 40, 80, 120 lb. nitrogen per acre) were topdressed to established stands of four forages (kura clover, kura clover plus orchardgrass, kura clover plus reed canarygrass, kura clover plus birdsfoot trefoil plus orchardgrass) in early spring. Forage yields were measured twice during the growing season and botanical composition was measured after the second cutting. The rate of nitrogen applied increased the yield of kura clover as well as the forage mixtures. The use of 80 lb. nitrogen per acre produced optimum yield. The highest yields were produced by the mixture of kura clover plus reed canarygrass, and kura clover plus birdsfoot trefoil plus reed canarygrass.

Introduction

Forage crops are important to the diverse farm enterprises of North-Central Minnesota. Fertilization is one management practice that can be used to improve the various forages grown in the region. Grass-legume mixtures are popular. Yet, response of these mixtures to nitrogen fertilization is not well known. In addition, there was a need to evaluate the use of kura clover as a potential forage crop for the region.

Experimental Procedure

This study was conducted at the Irrigation Center at Staples. The forages (kura clover, kura clover plus orchardgrass, kura clover plus reed canarygrass, kura clover plus birdsfoot trefoil plus orchardgrass) were seeded in May of 1994. No yields were harvested in 1994.

In April of 1995, four rates of nitrogen (0, 40, 80, 120 lb. per acre) were topdressed to the established stand of kura clover and the mixtures. The forages were harvested twice. Whole plant samples were collected at the time that the second cutting was harvested. Grasses were separated from legumes and the percentage of each in the mixture was determined on a dry matter basis.

Summary of Results

Total forage production in 1995 was significantly affected by both nitrogen rate and the forage crop that was seeded. When averaged over all crops, the optimum rate of nitrogen was 80 lb. per acre. When averaged over all nitrogen rates, highest yields were produced by the mixture of kura clover and reed canarygrass and the mixture of kura clover plus birdsfoot trefoil plus orchardgrass. The pure stand of kura clover produced the lowest yield. Nitrogen fertilization increased the percentage of grass in all forage mixtures.

[1/] Professor, Junior Scientist, Associate Scientist, Department of Soil, Water, and Climate; Research Plot coordinator, Central Lakes Center, respectively.

RECYCLING DAIRY MANURE NUTRIENTS USING REED CANARYGRASS

M. Schmitt, G. Randall, C. Sheaffer, M. Russelle, D. Ivers, R. Beck, W. Wedin, L. Greub, and P. Clayton[1/]

Abstract

An alternative crop for in-season manure applications is reed canarygrass. This study was conducted to evaluate how manure management strategies can affect agronomic and environmental factors associated with growing this forage. Data collected in 1995, which in part, are affected by 1994 treatments, indicate that reed canarygrass is responsive to increasing N rates from manure or fertilizer sources. There have not been any significant differences between broadcast and surface band methods of manure application. Split applications that included one application in early spring appear to be superior to any other application timing scheme.

Introduction

Many producers are forced into summer-time manure applications onto alfalfa. Because topdress applications often result in higher-than-desired risks of crop injury, reed canarygrass was selected as an alternative. Reed canarygrass removes several hundred pounds of N on an annual basis, is tolerant to manure application burn, is a perennial, and can provide somewhat high-quality feed. This study is being conducted to evaluate several manure application strategies (including rate, timing, and application method) for reed canarygrass.

Experimental Procedure

Manure rates ranging from 0 to 40,000 gal./acre/year were applied onto established reed canarygrass plots in Waseca, MN, Fort Dodge, IA, and River Falls, WI. The basic set of application rates were broadcast applied after the second and third cuttings. In addition, selected rates were also surface banded. Some manure rates were also applied in a single application, or split between after the second cutting and after the third cutting or early spring. Commercial N fertilizer treatments were applied at rates of 100, 200, 300 and 400 lb. N/acre/year. Forage yields and quality parameters and N removal were measured with each cutting. Soil N concentrations, stand density, and soil water nitrate-N content were also measured during the year.

Results:

Some preliminary observations and data trends are apparent after one full application/harvest cycle at River Falls and Fort Dodge and two cycles at Waseca. Yields increased with each increasing rate of manure or N fertilizer. Thus, significant N loss to the atmosphere or immobilization/tie-up may be occurring at the very high manure application rates. There have been essentially no differences in forage yield between treatments when the broadcast and surface band application methods were compared. While there were no differences between single and split applications delivered after the 2nd and 3rd cuttings, the split application that included the April application date consistently provided higher yields.

Status

Project was started in 1993 and will continue through the 1996 growing season, after which a residual phase of this study is planned.

[1/] Associate Professor, Department of Soil, Water, and Climate; Soil Scientist, Southern Experiment Station; Professor, Department of Agronomy and Plant Genetics; Soil Scientist, USDA-ARS-MWA-PSRU; Soil Scientist, and Agronomist, Cenex/Land O'Lakes; Agronomist, Land O'Lakes Answer Farm; Professor, University of Wisconsin-River Falls; Agronomist, Land O'Lakes Answer Farm, respectively.

USING WATER AND NITROGEN MANAGEMENT TO REDUCE LOSSES CAUSED BY WHITE MOLD

George Rehm, Jerry Wright, Richard Meronuck, Mel Wiens, Andy Scobbie, and Thor Sellie[1/]

Abstract

White mold is a serious disease affecting the production of dry edible beans in Minnesota. This study was designed to measure the effect of fungicide use, water management, and nitrogen management on the incidence and severity of white mold. In 1995, none of the three factors studied had a significant effect on incidence of white mold and subsequent yield of light red kidney beans. These three factors also had no significant effect on plant height and canopy closure.

Introduction

Failure to control white mold can have serious negative effects on the yield of dry edible beans. Fungicides provide some control. If canopy closure can be delayed, wind will penetrate the canopy, thereby reducing the severity of the white mold growth. Irrigation management and timing fertilizer application should affect the degree of canopy closure. Therefore, this study was conducted to measure the effect of nitrogen management, water management, and fungicide use on the incidence and severity of white mold growth and yield of edible dry beans.

Experimental Procedure

This study was conducted at the Irrigation Center at Staples. The site selected had a history of white mold infestation. The three factors of irrigation management, nitrogen management, and fungicide use were evaluated in all possible combinations.

For fungicide use, Benlate was applied at two times with 2 lb. per acre applied each time. Two soil moisture deficits were used. For the low deficit, .5 to .6 inches of water was applied when the soil moisture deficit reached .35 to .4 inches. For the high deficit, .8 to 1.0 inches of irrigation water were applied when the soil moisture deficit reached .7 to .8 inches.

Three management options for nitrogen fertilizer were used. The nitrogen rate was constant at 120 lb. per acre. One-half was applied two weeks after emergence. Then, 3 options were used. These were: 1) the remaining ½ applied four weeks after emergence, 2) the remaining ½ applied at bloom, and 3) the remaining ½ applied two weeks after bloom.

Plant heights and canopy width measurements were taken in late July and early August. Yields of edible beans were recorded in September.

Summary of Results

Yield of edible beans was not significantly affected by any of the factors studied. With the light red kidney beans, there was not enough vegetative growth to provide canopy closure. Therefore, white mold was not a serious problem in 1995. The factors included did not have a significant effect on plant height or canopy closure.

This study will be repeated in 1996.

[1/] Professor, Department of Soil, Water, and Climate; Extension Agricultural Engineer; Professor, Department of Plant Pathology; Research Plot Coordinator, Central Lakes Center; Assistant Scientist, and Junior Scientist, Department of Soil, Water, and Climate, respectively.

RATE AND PLACEMENT OF ZINC FERTILIZER FOR EDIBLE BEAN PRODUCTION

George Rehm, Thor Sellie, and Andy Scobbie[1/]

Abstract

The response of edible beans to zinc fertilization has been recognized for some time. There are, however, several sources of zinc that can be used. In addition, the effect of rate and placement of zinc had not been well defined. For this study, four zinc sources were either broadcast at a rate to supply 10 lb. zinc per acre or applied in a band at planting to supply both 1 and 5 lb. zinc per acre. When compared to the control, the use of zinc fertilizer did not increase the yield of navy beans at this experimental site.

Introduction

In Minnesota, zinc is usually applied in a fertilizer program for edible bean production if soil test levels for zinc are in the low or very low range. The evaluation of various fertilizers that supply zinc, their placement, and rate of application, however, was not extensive. Therefore, this study was conducted in West-Central Minnesota in 1995.

Experimental Procedure

This study was conducted in the field of a cooperating farmer in Lac Qui Parle County. The previous crop was wheat. The soil test for zinc, measured by the DTPA procedure, was .5 ppm. Four granular sources of zinc were applied to supply 10 lb. zinc per acre (broadcast) or both 5 and 1 lb. zinc per acre in a band at planting. An appropriate control (no zinc applied) was also used. All treatments were fertilized with 120 lb. nitrogen per acre (supplied as 46-0-0) and 100 lb. 18-46-0 applied in a starter band at planting.

The navy beans were planted in late May at a seeding rate of seven seeds per foot of row. Recently matured trifoliate leaves were sampled at mid-bloom, dried, ground, and analyzed for zinc. Yields were measured in September.

Summary of Results

In 1995, source, placement, and rate of zinc had no significant effect on yield. Even though the soil test for zinc was low (.5 ppm), the navy beans did not respond to the use of this nutrient. These results are not consistent with results measured in previous years.

The broadcast application of zinc fertilizers increased the concentration of zinc in plant tissue. When placed in a band, use of lower rates did not increase the concentration. The yields were in the range of 3300 lb. per acre. Yet, the soil was apparently capable of supplying the needed zinc.

[1/] Professor, Junior Scientist, and Assistant Scientist, Department of Soil, Water, and Climate, respectively.

TILLAGE COMPARISON AT ROSEMOUNT, 1995[1]

L. M. Wallach, T. L. Hansmeyer, D.R. Linden, K.L. Walters, R.H. Dowdy, R.R. Allmaras, and C.E. Clapp[2]

ABSTRACT: A long term tillage system study was initiated at Rosemount in 1991. Four tillage systems including Conventional Tillage, Conservation Tillage, Ridge Tillage, and Minimum Tillage are used with continuous corn and corn/soybean rotations. Nitrogen inputs remained constant across all treatments planted to corn with no nitrogen applied to treatments in soybeans. The objective of the study is to determine the long term effects of various cropping systems on herbicide movement, earthworm activity, grain yield, nutrient availability, nutrient uptake, root distribution, and soil quality. Though only preliminary results are available for many of the objectives, enough information has been gathered to study grain yield, corn emergence, and surface residue.

SITE: An 18 acre site at the Rosemount Agricultural Experiment Station was chosen for study. The dominant soil type is a Waukegon Silt Loam (Typic Hapludoll) which has 20 to 32 inches of silt loam overlying calcareous sand and gravel with a slope of less than 2%. The site was grid sampled for elevation and depth to gravel prior to plot layout.

EXPERIMENTAL DESIGN: The site was separated into 36 plots of 0.4 acres each. A continuous corn (CC or C1), corn/soybean (CS or C2) [corn 1995], and soybean/corn (SC or C3) [soybean 1995] rotations were planted into four tillage systems in a randomized complete block design with three replications. The four tillage systems are described as follows:

Conventional (T1): Stalks are chopped in the fall. Plots are then moldboard plowed following corn and fall chisel plowed following soybeans. Disk to prepare seedbed. One or two cultivations after planting as needed.

Conservation (T2): Stalks are chopped in the fall. Plots are then chisel plowed following corn with no fall tillage following soybeans. Disk and/or field cultivate to prepare seedbed for soybeans. Corn is no-till seeded into soybean stubble. One or two cultivations after planting as needed.

Ridge-till (T3): No fall tillage following corn or soybeans (stalks chopped in the fall following corn harvest). Planting done in ridges formed by previous cultivation. Two cultivations following planting to control weeds and reestablish ridges.

Minimized Tillage (T4): Generally, no primary or secondary tillage is prescheduled. Tillage will be performed only when soil or weed conditions require attention. Cultivation performed only when determined necessary.

EXPERIMENTAL PROCEDURE: All of the T1 plots and all of the T2 plots that were in corn in 1994 were field cultivated prior to planting. Corn (Pioneer 3751) was planted in the CC and CS plots across all tillage systems on May 11. The seeds were planted at a population of 26,100 seeds/acre. Force insecticide was banded over the row on all continuous corn plots at a rate of 8 oz./acre. Corn emergence was counted from two 20' sections of row in each plot periodically for the first four weeks of growth. Round-up was broadcast on all no-till plots planted to soybeans at a rate of 6 pt. Round-up/acre on May 17. Soybeans were planted on May 18 at a rate of 60 lbs/acre to a depth of 2". The Hodgson variety was used which contains 2900 seeds/lb. All tilled corn and soybean plots were rotary hoed to a depth of 2" on May 18 to eliminate small emerging weeds. Lasso was broadcast on May 19 to all plots at a rate of 4 pt. Lasso/acre. Basagran was broadcast on June 2 to all plots at a rate of 4 pt. Basagran/acre. On June 3, all CC and CS plots received 205 lbs. N/acre and were cultivated with a Hinnicker Sweep. On June 12, all T3C3 plots were cultivated with a 6 row shovel cultivator. Accent was broadcast sprayed at the rate of 4 oz./acre on plots T4C1 and T2C1 on June 13. All T3C3 plots were hand-weeded on June 14. Fusilade was broadcast on T2C3 and T4C3 plots at the rate of 24 oz./acre on June 19. All T3C1 plots were cultivated with a 6 row shovel cultivator on June 19. Plots T3C1, T3C3, T4C2, and T2C3 were cultivated with a 6 row cultivator to a depth of 3" on June 28. All T3C1 and T3C3 plots, as well as T3C2 (#23), were ridged on July 11. All plots were harvested on October 30. Tillages were not performed in the fall as laid out in the experimental procedure due to the lack of time. Corn stands were observed and recorded during the season and the final plant population count was recorded on October 16.

RESULTS

YIELD: Grain yields and moisture percentages from all tillages and rotations are given in figures 1-3 and table 1. Within the continuous corn system, the grain yields from the conventional till plots out-yielded all other tillages, followed by the yields from the conservation, ridge, and minimized tillages, respectively (fig. 1). The continuous corn yields averaged over the past four years rank the tillage systems differently. The four year average places conventional in front followed by ridge, conservation, and minimized tillage.

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[1]This project was supported by the University of Minnesota Agricultural Experiment Station at Rosemount and the USDA-ARS Soil and Water Unit in St. Paul.

[2]L. M. Wallach, T. L. Hansmeyer, D.R. Linden, R.H. Dowdy, R.R. Allmaras, and C.E. Clapp are Ag. Research Technician, Ag. Research Technician, Soil Scientist, Soil Scientist, Soil Scientist, and Research Chemist of the USDA-ARS, St. Paul, MN. K.L. Walters is Director of the Agricultural Experiment Station at Rosemount.

The 1995 corn yields in the corn/soybean rotation created a different yield rank than the 1995 continuous corn yields and the 1994 soybean/corn rotation yields, when comparing the 4 tillage systems. Conventional tillage yielded the highest, followed by ridge, minimized, and conservation tillages (fig. 2). The four year average for the corn/soybean rotation ranked conventional first, followed by ridge, conservation, and minimized tillages.

The 1995 soybean yields in the soybean/corn rotation were greatest under the conventional tillage system, followed by ridge, conservation, and minimized tillage (fig 3). The 4 year average soybean yield ranked conventional first, followed by conservation, minimized, and ridge tillage. The complete difference in rank between the 1995 and four year average soybean yields points to unpredictability.

The mean yield (figure 5) for each tillage system (for the plots cropped in corn in 1995 only) shows that conventional tillage produced the highest yield followed by conservation, ridge, and minimized tillages, respectively. This ranking is the same as that in 1994. The mean yield across crop rotations (figure 5) shows that the corn/soybean rotation produced a higher yield compared to the continuous corn rotation. Statistically, this yield is highly significant at the 1% level when comparing the plots cropped to corn only and was the only statistically significant yield difference found between treatments during 1995.

RESIDUE: The residue cover comparison after planting is shown in table 2 and figure 6. The conservation and minimized tillage provide enough corn and soybean residues on the surface to meet the erosion control requirements, which stipulates that at least 30% of the surface must be covered at planting. It must be noted that in the conservation tillage plots, corn is no-tilled into the previous years soybean stubble leaving the soybean stubble on the surface. The ridge-till plots provided sufficient residue to meet conservation compliance under the continuous corn and the soybean/corn rotation. Ridge-tilling buried a majority of corn residue under the corn/soybean rotation leaving only 17.8% surface residue. The conventional tillage system did not provide enough surface residue to qualify for the residue requirements under either crop. It might be expected that the soybean plots in conventional tillage would contain at least 30% residue cover over the winter since they are chisel plowed in the fall, but the fall chisel plowed soybean plots (CS in 1995) only had 13.3% residue cover. This is consistent with the previous years residue data, where the fall chisel plowed soybeans only left 9% surface residue.

EMERGENCE: Corn seedling emergence was first recorded on May 23, 12 days after planting. Most plots had between 0-5% emergence at this time, except conventional tillage plots (CC and CS) which showed 12-20% emergence. Emergence had increased greatly by the 16th day after planting, but the percentages were highly variable between the cropping systems. This variability and slow start is presumably due to the spring soil moistures and temperatures. Figure 4 shows 3 different corn emergence trends. Conventional (CC and CS), ridge (CS), and minimized (CS) plots sprouted corn quickly with 76-84% emergence 16 days after planting. The second trend is within the conservation plots (both CC and CS) and the ridge (CC) plot where they had attained 49-60% corn emergence after 16 days. The last and slowest trend was seen in the minimized (CC) plot where only 14% emergence was seen after 16 days. The corn emergence trend in 1995 is fairly similar to the trend seen previously, except that in general the emergence numbers were somewhat lower in 1995 than in 1994. Corn seedling emergence exceeded 80% for all cropping systems 21 days after planting.

Table 1 Grain yields for the tillage study at Rosemount, 1995.

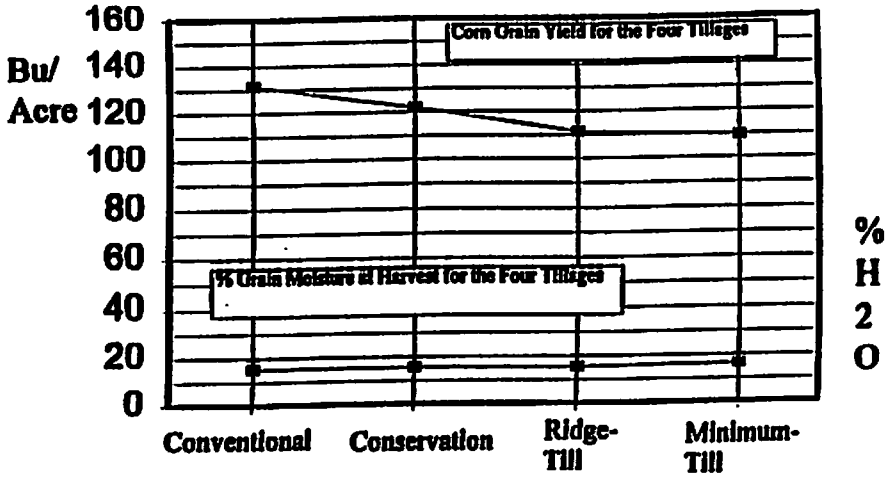
Treatment			Grain Yield			
Tillage	Rotation		1995 bu/ac	1995 mt/ha	92-95 avg. bu/ac	92-95 avg. mt/ha
Conventional (T1)	Cont.Corn	c1	131.4	6.97	137.7	7.3
	Corn/Soy	c2	143.5	7.61	154.4	8.2
	Soy/Corn	c3	34.8	1.85	41.0	2.4
Conservation (T2)	Cont.Corn	c1	121.9	6.46	127.0	6.7
	Corn/Soy	c2	128.3	6.8	141.5	7.5
	Soy/Corn	c3	33.2	1.76	40.5	2.3
Ridge-Till (T3)	Cont.Corn	c1	111.3	5.9	130.4	6.9
	Corn/Soy	c2	132.6	7.03	149.7	7.9
	Soy/Corn	c3	34.3	1.82	39.7	2.3
Minimum-Till (T4)	Cont.Corn	c1	109.5	5.8	113.9	6.0
	Corn/Soy	c2	129.5	6.86	136.2	7.4
	Soy/Corn	c3	32.8	1.74	40.0	2.3

Table 2 % Residue Cover for the Tillage Study at Rosemount, 1995

Treatment			Residue Cover
Tillage	Rotation		% residue
Conventional (T1)	Cont.Corn (CC)	c1	5.9
	Corn 95 (CS)	c2	13.3
	Soybean 95 (SC)	c3	21.5
Conservation (T2)	Cont.Corn (CC)	c1	37.8
	Corn 95 (CS)	c2	43.0
	Soybean 95 (SC)	c3	48.1
Ridge-Till (T3)	Cont.Corn (CC)	c1	48.1
	Corn 95 (CS)	c2	17.8
	Soybean 95 (SC)	c3	32.6
Minimum-Till (T4)	Cont.Corn (CC)	c1	79.3
	Corn 95 (CS)	c2	56.3
	Soybean 95 (SC)	c3	69.6

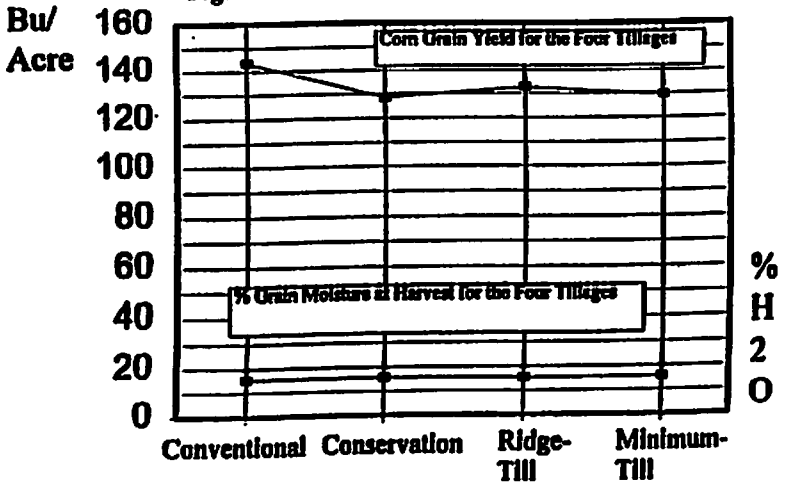
Grain Yield Summary
Continuous Corn

Fig. 1



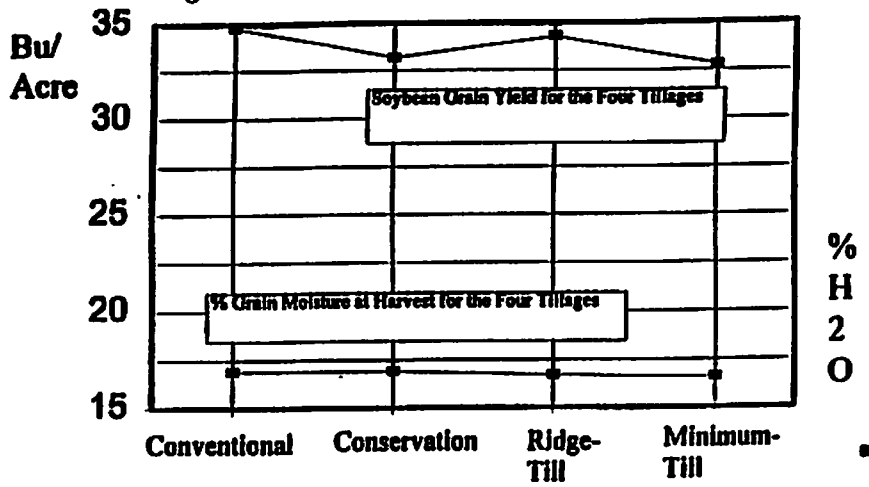
Grain Yield Summary
Corn in '95 after Soybean Rotation

Fig. 2



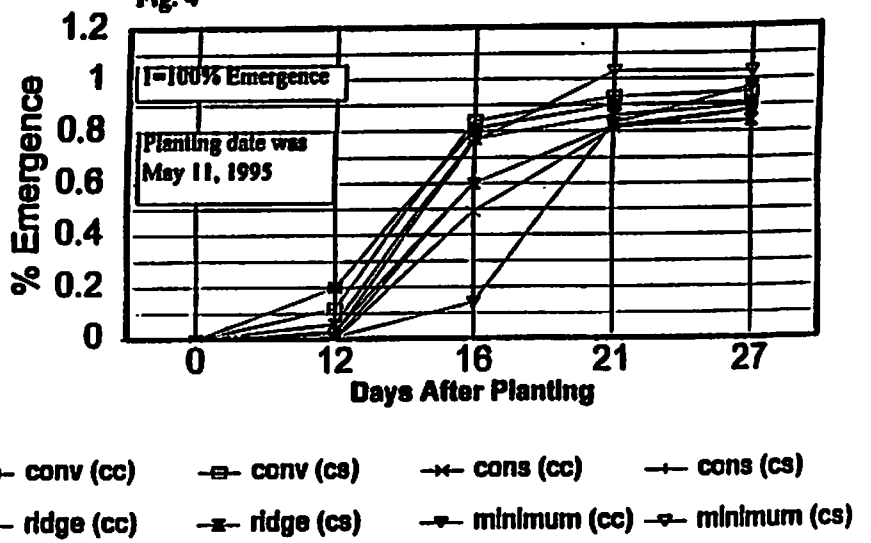
Grain Yield Summary
Soybean in '95 Following Corn

Fig. 3



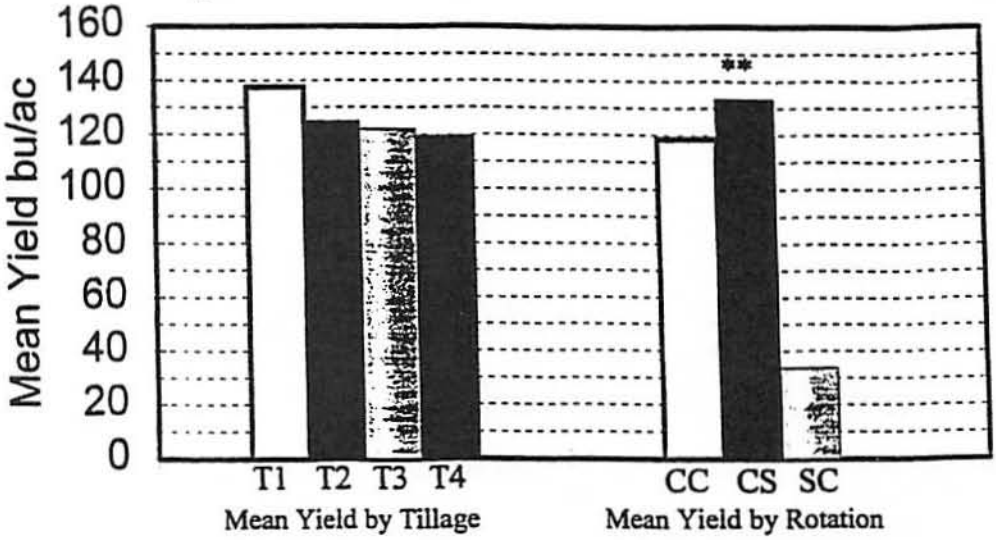
1995 Corn Emergence
Tillage and Rotation Comparison

Fig. 4



1995 Mean Yield Comparison
by Tillage and Rotation

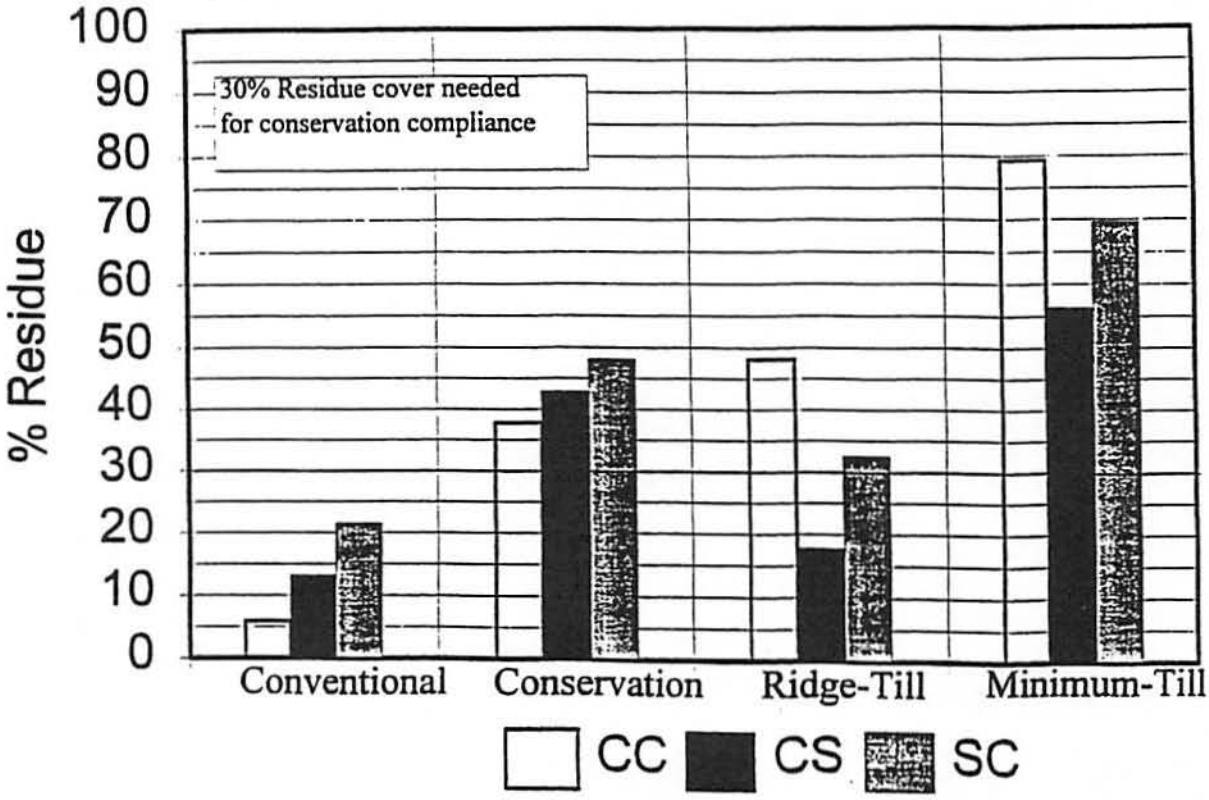
Fig. 5



*LSD at 5%=7.97;
**LSD at 1%=11.06;
Comparing plots in corn only

Residue Cover Comparison

Fig. 6



ASSESSMENT OF THE EFFECTS OF TILLAGE AND MANURE APPLICATION ON RUNOFF AND YIELD OF SOYBEAN AFTER CORN[1]

D. Ginting, J.F. Moncrief, S.C. Gupta, S.D. Evans, G.A. Nelson, A. Ranaivoson, and Andreas Naujoks[2]

ABSTRACT

Tillage and manure interactions on surface runoff are being evaluated at Morris, MN. This research is the continuation of erosion study for continuous corn during the 1992-1994 period which was then planted to soybean in 1995. Water equivalent of snowfall during 1994-1995 winter was 16.2 cm. Due to snow trapping by standing residue, the amount of snow water equivalent in the ridge till (RT) plots was 58 percent of the snow fall compared to 12 percent in the moldboard plow (MP) plots. This resulted in total snowmelt runoff 6.6 times greater in the RT (7.8 cm) compared to MP (1.2 cm) plots. Tillage, manure or manure by tillage interactions had no significant effects on rainfall runoff because rainfall was low intensity and occurred when the soil was covered by soybean residue after senescence. The annual runoff (November 1994-October 1995) was 6 times greater in the RT than MP plots. Soybean yield was 720 kg/ha higher in the MP (2.61 Mg/ha) than RT (1.89 Mg/ha) plots. The difference in yield was due to greater yield per plant or number of seed per plant in MP than RT plots. There was no significant effect of manure of manure by tillage interaction on soybean yield.

INTRODUCTION

The importance of runoff as a driving force of non-point source pollutants lies in the significant association between runoff, sediment, sediment associated and soluble chemicals. Runoff is the main driving factor to carry the sediments, sediment associated P and the soluble chemicals to the edge of the plots once the soil particle or aggregates are detached by rain drops. In Minnesota hog, dairy and poultry farming is extensive, therefore, manure application to land is a regular management practice for crop production. However to get the nutrient benefits from manure, it needs to be incorporated in the soil. The dilemma is: to what degree of soil cultivation is necessary to incorporate manure while maintaining enough residue to prevent excessive runoff and the associated erosive losses of sediment and phosphorus.

This research is the continuation of erosion study started in 1992. During the 1992-1994 period, the crop was continuous corn. In 1995, it was cropped to soybean. During the winter, standing corn residue influenced the amount of snow trapped. In the summer, the corn residue and soybean canopy affected the rainfall runoff. The specific objectives of this study are:

1. To evaluate the effects of moldboard vs. ridge tillage in combination with and without manure application on surface runoff both from snowmelt and rainfall.

2. To evaluate the effects of tillage and manure on soybean yield.

MATERIALS AND METHODS

Tillage and manure interactions on sediment and phosphorus transport in surface runoff are being evaluated at Morris, MN. Soil at the experimental site is Barnes loam (fine-loamy mixed udic Haploborolls, 12 % slope with south-eastern aspect). The initial soil test in 1992 for pH, Olson-P, Bray-P and ammonium acetate extractable K were 8, 17 ppm, 23 ppm and 155 ppm respectively.

The experimental design is a randomized complete block with split plots and three replications (tillage main plots and manure the subplots). Twelve erosion plots, 22 m by 3 m (to accommodate four rows of soybean) were marked and isolated using corrugated steel plates. At the end of each plot the runoff was routed with a polyvinyl chloride (PVC) sheet (3 m by .3 m) and then channeled through a PVC pipe to a collecting system. Until August 1995, the collecting system consisted of three barrels of 210 L each. The first barrel collects very coarse sediments. The overflow from the first barrel was channelled to the second barrel. At the second barrel, 9 adjacent holes of 3.8 cm diameter were drilled near the rim of the barrel. One of the holes was connected to a PVC pipe of 3.8 cm diameter which channelled the excess runoff to the third barrel. This setup allowed 1/9 of the overflow from the second barrel to be collected in the third barrel. The collector was designed for a runoff depth of 3.5 cm (10 year 24-hour rainfall of 9.7 cm considering the curve number of 71). Corrugated roofing was placed over the PVC sheet at the end of the plots to avoid direct precipitation getting into the collecting system.

In September 1995, the barrel-collecting system was replaced with a tipping bucket system linked to an automated data logger. This new system provided more detailed runoff data. Each tipping bucket was made of PVC sheets and calibrated for 2.45 L for each tip. The tipping bucket was stationed on a platform also made of PVC sheeting. On both sides of the platform (the tipping sides of bucket) a 2.5-cm hole was drilled. Both holes were connected to a 25 L pale with 2.5-cm diameter PVC pipes. Therefore from each tipping, 100 mL runoff sample was collected for sediment and P analysis (sediment and P data are pending). This procedure resulted in a flow-weighted composite runoff sample which was collected for each

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[1] Support for this project was provided by the Legislature Commission on Minnesota Resources. The support is greatly appreciated.

[2] D. Ginting, J.F Moncrief, S.C. Gupta, and A. Ranaivoson are Postdoctoral Research Associates, Professors, and graduate student, respectively in the Soil, Water, and Climate Department at the University of Minnesota, St. Paul, MN, 55108. S.D. Evans and G.A. Nelson are professor and Assistant scientist, West Central Experiment Station, University of Minnesota, Morris, MN. Andreas Naujoks is a visiting scientist from Christian-Albrechts-Universitaet zu Kiel, Germany.

runoff event.

Tillage treatments include ridge tillage and moldboard plowing systems. In the moldboard system, primary tillage in fall was achieved with moldboard plowing and followed in the spring by a field cultivation prior to planting. Ridge tillage represents an intermediate level of soil incorporations. Plant residues were concentrated between plant rows during winter and spring. Ridging was done on 12 July 1995. Detailed cultural practices are presented in Table 1. Manure treatments are with and without. Solid beef manure was applied at the rate of 56 Mg/ha. The manure contained approximately 161 kg P/ha.

Before September 1995, the runoff volume in each barrel was measured using a calibrated dip stick. Starting in September 1995, runoff was measured with tipping buckets linked to an automated data logger. Logarithmic (base 10) transformation of runoff data was done prior to the analysis of variance using SAS, 1986. The central tendency of runoff data is reported as geometric means.

Soybean was planted on the twelve erosion plots at the seeding rate of 460,000 seeds/ha. Seeding was done up and down the slope. Herbicides used for weed control are listed in Table 1. Grain and stover yield, and the weight of 100 seeds were measured. Number of plants were tallied from two 3-m rows at the flowering stage (18 July, 1995). Yield data and the associated variables are presented.

Corn residue cover was measured using the line transect procedure, diagonally across the row and interrow area. The "row area" was defined as a 10-cm wide strip centered over the row and the "interrow area" was the remainder. Measurement were made in quadruplicate for each plot at various tillage operations i.e. before secondary tillage and before planting, after secondary tillage and after planting, and at ridging. The surface residue cover is presented in percent.

RESULTS AND DISCUSSIONS

Runoff

Ridge Till (RT) vs. Moldboard Plow (MP)

Corn residue cover in the interrow area was greater in the RT than the MP plots. In RT plots, over-winter surface residue was 76 percent and increased to 82 percent after soybean planting. A slight increase of residue was due to the removal of residue from the inrow to the interrow area at planting. The Hiniker planter was equipped with clearing disks that removes residue from in row area. The in row corn residue after planting in the RT plots was 24.6 percent. After ridging, corn residue in the interrow area decreased to 34 percent. At ridging, soil and residue were removed from interrow to in row area by the 40-cm sweep which was equipped with a lister. In the MP plots, corn residue over winter and after planting was 3.0 and 3.4 percent, respectively. The corn residue in row area after planting in the MP plots was 3.4 percent.

During the 1994-1995 winter, snowfall (water equivalent) was 16.2 cm. Snow depth (water equivalent) measured two days before snowmelt runoff occurred in RT and MP was 9.4 and 1.9 cm respectively. Greater amount of snow in RT plots was due to snow trapping by standing residue. In MP plots, due to lack of residue cover, snow drifted from the plots. The amount of snow in the RT plots was 58 percent of the snow fall compared to 12 percent in the MP plots. Greater snow depth resulted in greater snowmelt runoff from the RT plots compared to the MP plots (Table 2). There where only two snowmelt runoff events (March 11 and 12) during the 1994-1995 winter. Total snowmelt runoff was 6.6 times greater in the RT compared to MP plots. As expected, the main effects of manure (three years after application) or the interaction of manure and tillage on snowmelt runoff was not significant (Table 2).

During the rainfall period (April-October 1995) the total rainfall was 67.9 cm. In this period, four rainfall runoff events were recorded(September 29 and 30 and on October 2 and 4). There was no significant difference in total rainfall runoff between the RT and MP plots (Table 2). The runoff events occurred when soybean leaf were shed. Therefore soybean leaves (in addition to corn residue) were covering the ground and resulted in similar runoff, especially when the rainfall intensity was low. The main effects of manure or the interaction of manure by tillage was not significant (Table 2). During the growing season in 1992, 1993 and 1994 it has been observed that manure reduced rainfall runoff mostly in rain events with high intensity. Therefore, the absence of manure effects on reducing runoff was due to the low intensity of rainfall.

The annual runoff (November 1994-October 1995) was significantly different between the RT and MP plots (Table 2). Annual runoff was 6 times greater in the RT than MP plots. For both the RT and MP plots, snowmelt runoff was the major portion of the annual runoff. In the RT plots, the snowmelt runoff was 61 times greater than rainfall runoff. In the MP plots, the snowmelt runoff was 8.3 times greater than the rainfall runoff. The manure main effects or the interaction of manure by tillage were not significant (Table 2).

Soybean Yield

Soybean yield was significantly higher in the MP than RT plots (Table 3). Soybean yield in MP plots (2.61 Mg/ha) was 720 kg/ha higher than the RT plots (1.89 Mg/ha).The difference in yield apparently was not due to plant number or seed weight, but due to the yield per soybean plant or the number of seed per plant. Plant number and the weight of 100 seeds were similar between the RT and the MP plots (Table 3). However, the yield and number of seeds per plant were significantly greater in the MP than RT plots (Table 3). This was also shown by greater stover yield in the MP than RT plots. This indicates that soybean growth was better in the MP than the RT plots. The main effects of manure and the interaction of manure by tillage were not significant on grain and stover yield, number of plants, weight of 100 seeds, yield per plant, and number of seeds per plant (Table 3).

Table 1. Cultural practices at the West Central Agricultural Experimental Station, Morris, MN.

Tillage		Cropping History
1994	Fall Moldboard (Oct. 27, 1993)	1994-Corn Pioneer-3751
	Spring field cultivation (Apr. 28, 1994)	1995-Lambert Soybean
	Ridge tillage (June 24, 1994)	
1995	Fall Moldboard (Oct. 27, 1994)	
	Spring field cultivation (May 16, 1995)	
	Ridge tillage (July 12, 1995)	

Planting and Harvest Dates

Crop	Planting Date	Planting Rate	Harvested
Soybean	May 16, 1995	406,000 seeds/ha	Oct. 16, 1995 Two rows of 15 feet long each

1992 Manure Analysis

Manure source	Rate	Date Applied	NH4	NO3	Mineral	Organic	Total N	Total P	Total K	DMRP	Solids Total	Solids Volatile	Solids fixed
			%										
Beef	56Mg/ha	May 6/92	.215	.005	.220	.64	.860	.289	.668	0.114	29.12	84	16

Rate of applied and available N, P_2O_5 and K_2O and DMRP

Manure source	Rate	Date Applied	NH4	NO3	Mineral	Organic	Total N	P2O5	K2O	DMRP
			kg/ha							
Beef	56 Mg/ha	May 6/92	120	2.8	123	358	481	370	374	146

Soil

Barnes loam (fine-loamy mixed Udic Haploborolls, 12 % slope with southern aspect. Soil is high in organic matter, and pH is 8.0. Initial soil test on Olson-P, Bray-P and K are 17, 23 and 155 mg/kg respectively.

Weed Control

Lasso, 3.3 kg ai/ha + Glyphosate (1.7 kg ai/ha) as pre-emergent herbicide (May 18, 1995). Basagran (1.1 kg ai/ha) + Poast (0.31 kg ai/ha) were applied (June 23, 1995).

Table 2. The effects of tillage and manure application on the snowmelt runoff, rainfall runoff, and the annual runoff (November 1994-October 1995).

	RIDGE TILL			MOLDBOARD			Average		P>F Values		
	No Man	Man	Avg	No Man	Man	Avg	No Man	Man	Tillage (T)	Manure (M)	T by M
Snowmelt Runoff (mm)	88.7	69.2	**77.6**	11.2	12.3	**11.7**	30.9	29.5	.030	.828	.593
Rainfall Runoff (mm)	1.31	1.21	**1.25**	1.37	1.46	**1.41**	1.34	1.33	.264	.902	.405
Annual Runoff (mm)	89.1	69.2	**77.6**	11.5	12.9	**12.3**	38.0	30.3	.030	.836	.559

Table 3. The effects of tillage and manure application on the soybean and stover yield, number of plants, weight of 100 seeds, yield per plant, and number of seed per plant in 1995.

	RIDGE TILL			MOLDBOARD			Average		P>F Values		
	No Man	Man	Avg	No Man	Man	Avg	No Man	Man	Tillage (T)	Manure (M)	T by M
Yield (Mg/ha)	1.89	1.89	**1.89**	1.89	2.40	**2.82**	2.15	2.35	.009	.265	.250
Stover (Mg/ha)	1.41	1.46	**1.44**	2.25	2.30	**2.27**	1.83	1.88	.029	.718	.984
plants (1000/ha)	309	301	**305**	309	315	**312**	309	308	.768	.982	.668
100 seeds (g)	17.8	16.8	**17.3**	17.8	17.6	**17.7**	17.8	17.2	.248	.143	.268
Yield/plant (g)	6.22	6.32	**6.27**	7.84	9.01	**8.42**	7.04	7.66	.021	.508	.572
seeds/plant	35.0	37.7	**36.3**	44.1	50.9	**47.5**	39.5	44.3	.033	.036	.683

PHOSPHATE FERTILIZER MANAGEMENT FOR CORN AND SOYBEAN PRODUCTION IN TWO CONTRASTING TILLAGE SYSTEMS

George Rehm, George Nelson, Andy Scobbie, Thor Sellie, and Sam Evans[1/]

Abstract

Management of phosphate fertilizer for soybean production on calcareous soils that have very low or low soil test levels for P has not been fully researched. The possibility of applying phosphate fertilizer prior to the soybean crop instead of the corn crop may offer potential for added profit. This study was conducted to evaluate all possible combinations of 1) row spacing for soybeans, 2) tillage system, 3) frequency of phosphate application, 4) phosphate rate, and 5) phosphate placement on production of corn and soybeans grown in rotation. In 1995, all factors studied had a significant effect on soybean yield.

Introduction

Traditionally, major emphasis on fertilizer use is focused on corn in the corn/soybean rotation. The possibility of applying phosphate fertilizer prior to the soybean crop instead of the corn crop has not been fully researched and may offer potential for added profit. This is especially true where soybeans are grown on calcareous soils that have low to very low levels of soil test phosphorus. Placement options for phosphate fertilizer also needed further evaluation.

Experimental Procedure

This study was initiated in the fall of 1994 at the West-Central Experiment Station after corn harvest. The study involved all combinations of 1) row spacing (7, 30 inch), 2) tillage system (fall chisel, no-till), 3) frequency of phosphate application (annual, biennial), 4) phosphate rate (0, 23, 46, 69, 92 lb. P_2O_5 per acre), and 5) phosphate placement (band, broadcast). The phosphate was applied in the fall of 1994. The chisel tillage operation was completed after fertilizer application.

Soybeans were seeded in each tillage system in either 7 -inch or 30-inch rows. A John Deere drill was used for planting in narrow rows. A conventional planter was used for the 30-inch row spacing.

Recently, matured trifoliates were collected from each plot at mid-bloom. These samples were dried, ground, and analyzed for P to monitor P uptake. Grain yields were measured in October.

Summary of Results

In 1995, soybean yields were affected by all factors studied. When averaged over all other factors, yields were higher when the chisel plow system is compared to the no-till system (47.2 bu./acre vs. 44.2 bu./acre). Considering row spacing and averaging over all other factors, yields were higher when 7-inch rows are compared to 30-inch rows (53.4 bu./acre vs. 38.0 bu./acre).

Averaging over other factors, yields were higher when the P_2O_5 was broadcast rather than applied in a band (47.0 bu. per acre vs. 44.7 bu. per acre). Yields increased as the rate of applied phosphate increased. With the very low soil test for phosphorus, a response to phosphate fertilization would be expected.

This study will be continued in 1996.

[1/] Professor, Department of Soil, Water, and Climate; Assistant Scientist, West-Central Experiment Station; Assistant Scientist and Junior Scientist, Department of Soil, Water, and Climate: Soil Scientist, West-Central Experiment Station (retired), respectively.