MUNICIPAL SOLID WASTE COMPOST USE ON IRRIGATED COARSE TEXTURED SOILS[1]

M. MAMO, C.J. ROSEN, T.R. HALBACH, AND J.F. MONCRIEF[2]

ABSTRACT

Field experiments were conducted at Staples and Becker to assess corn yield and nitrate leaching on soils amended with municipal solid waste (MSW) compost. The MSW composts (Truman, Swift, and St. Cloud) were applied in the spring of 1992. The Becker location received Truman and Swift composts, while Staples received Truman and St. Cloud. The compost rates were 0, 20,40, and 80 dry T/A with either 0, 220, or 440 lbsN/A split applied as urea. In 1993 at Becker, MSW compost was also applied on new plots to evaluate the effect of split vs one time application. The compost rate was 40 T/A (yearly application) and 120 T/A (one time application) with either 0, 110, or 220 lbs N/A split applied as urea. In 1994, nitrate leaching was high on compost amended soils compared to unamended soils. Nitrogen application on all compost types and rates increased NO_3-N leaching. In 1993, yield was relatively high on residual plots compared to the control. The 1993 established plot gave a reasonable yield at all compost rates with N application in 1994. Yield was lower at all compost rates when N was not applied.

INTRODUCTION

Increasing costs and environmental concerns associated with landfills and incineration have prompted interest in developing alternative methods for managing municipal wastes. Viable waste management alternatives should ideally be environmentally sound and should emphasize recycling of resources. Composting of municipal solid waste (MSW) has been given consideration during recent years as it becomes a practical alternative to landfilling. The number of composting facilities in the U.S. has consistently increased in number since 1988. This increase is due to limited storage capacity of landfills and their failure to meet regulatory guidelines and increasing costs. Minnesota leads the nation in MSW composting facilities with eight currently in operation. Thus, there is a need to determine environmentally safe and beneficial uses as well as establish potential markets for the compost.

The compost utilization project (CUP) was initiated in 1992 to evaluate the use of municipal solid waste (MSW) compost on crop production. Three compost studies were established in 1992 and 1993 at Becker and Staples, MN. Two of the experiments were established in 1992 at Becker and Staples to compare the effects of MSW compost and nitrogen (N) application rates on field corn production. A third experiment was established in 1993 to compare a one time compost application (120 T/A) with three annual compost application (40 T/A). The overall goals of the 1994 CUP project were 1) to determine residual effects of MSW compost on corn production, and soil chemical and physical properties 2) to compare annual split with one time MSW compost application and 3) to monitor levels of nitrate in soil water 4) to assess if any water stress is induced by compost amendments on plants.

MATERIALS AND METHODS

1994 Becker Compost Utilization Project
(established in 1992)

- The treatments for the 1992 established experiment are listed in Table 1. MSW compost was applied only in the first year. Nitrogen fertilizer was applied every year. In 1994, the 440 lbs/A N rate was omitted.
- Corn variety 3921 Pioneer (85 day) was planted May 6, 1994 at a planting rate of 30,700 kernels per acre in 30" rows with starter fertilizer banded at 160 lbs/A (8-10-30).

[1]Support for this project was provided by the Minnesota Pollution Control Agency (MPCA) and Prairieland Composting Facility. Their support is greatly appreciated.
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- Granular fertilizer urea 46-0-0 was split applied: one-half on 5/26/94 and the other half on 6/16/94. The urea was sidedressed with a Gandy on both sides of each row and irrigated in with 0.5-1" of water for incorporation.
- Four whole plant samples were taken from each plot for chemical analysis on 6/24/94.
- Two 20' rows of corn were harvested for grain and stover between 9/29/94 and 10/6/94.

1994 Staples Compost Utilization Project
(established in 1992)

- The treatments for the 1992 established experiment are listed in Table 2. MSW compost was applied only in the first year. Nitrogen fertilizer was applied every year. In 1994, the 440 lbs/A N rate was omitted.
- Corn variety 3921 Pioneer (85 day) was planted May 3, 1994 at a planting rate of 32,200 kernels per acre in 30" rows with starter fertilizer banded at 175 lbs/A (25-5-10-20).
- Granular fertilizer urea 46-0-0 was split: applied one-half on 5/31/94 and the other half on 6/13/94. The urea was sidedressed with a Gandy on both sides of each row and incorporated by cultivation.
- Four whole plant samples were taken from each plot for chemical analysis on 6/23/94.
- Two 20' rows of corn were harvested for grain and stover on 10/14/94.

1994 Becker Compost Utilization Project
(established in 1993)

- The treatments for the 1993 established experiment are listed in Table 3. MSW compost was applied either annually for two years or at one cumulative rate the first year. Nitrogen fertilizer was applied every year.
- Corn variety 3921 Pioneer (85 day) was planted May 6, 1994 at a planting rate of 32,200 kernels per acre in 30" rows with starter fertilizer banded at 160 lbs/A (8-10-30).
- Granular fertilizer urea 46-0-0 was split applied: one-half on 5/26/94 and the other half on 6/16/94. The urea was sidedressed with a Gandy on both sides of each row and irrigated with 0.5-1" of water for incorporation.
- Four whole plant samples were taken from each plot for chemical analysis on 6/24/94.
- Two 15' rows of corn were harvested for grain and stover between 9/30/94 and 10/17/94.

Table 1. Residual effect of compost type, compost rate, and nitrogen rate on grain yield, stover yield, and plant population, Becker, MN. 1994.

Compost type	N rate LBS/A- 1994	Compost rate T/A 1992	Grain Yield BU/A	Stover Yield T/A	Plant/A Population x 1000
Control	0	0	49.3	1.46	24.8
Control	220	0	153.9	2.88	26.0
Control§	440	0	68.5	1.76	24.7
Truman	0	20	84.3	2.04	27.2
Truman	220	20	155.0	3.05	26.2
Truman	0	40	98.4	2.17	24.5
Truman	220	40	162.7	3.04	25.7
Truman§	440	40	94.6	2.44	25.5
Truman	0	80	110.0	2.44	26.2
Truman	220	80	175.3	3.55	27.8
Swift	0	40	118.1	2.37	25.7
Swift	220	40	163.1	2.90	25.0
Significance			**	**	**
BLSD			12.9	0.72	1.8

§ The N rate at 440 lbs/A was applied only in 1992 and 1993. * Significant at 5% **Significant at 1% NS= Not significant

Table 2. Residual effect of compost type, compost rate, and nitrogen rate on grain yield, stover yield, and plant population, Staples, MN. 1994.

Compost type	N rate LBS/A 1994	Compost rate T/A 1992	Grain Yield BU/A	Stover Yield T/A	Plant/A Population x 1000
Control	0	0	84.3	1.61	28.5
Control	220	0	141.1	2.73	28.6
Truman	0	20	95.5	1.76	28.5
Truman	220	20	140.6	3.00	26.8
Truman	0	40	108.0	2.02	27.7
Truman	220	40	151.0	2.17	28.0
Truman§	440	40	104.3	1.63	28.6
Truman	0	80	112.5	1.56	28.4
Truman	220	80	140.5	2.73	28.4
St. Cloud	0	40	118.8	2.04	28.1
St. Cloud	220	40	142.1	2.43	27.4
St. Cloud§	440	40	110.7	1.85	29.8
Significance			**	**	NS
BLSD			19.9	0.47	---

§ The N rate at 440 lbs/A was applied only in 1992 and 1993.
* Significant at 5% **Significant at 1% NS= Not significant

Table 3. Effect of compost type, compost rate, and nitrogen rate on grain yield, stover yield, and plant population, Becker, MN. 1994.

Compost type	N rate LBS/A 1994	Compost rate T/A 1993-94	Grain Yield BU/A	Stover Yield T/A	Plant/A Population x 1000
Control	0	0	75.2	1.53	25.4
Control	110	0	160.1	2.53	26.4
Control	220	0	176.6	3.17	27.6
Truman	0	40+40†	119.0	1.80	24.8
Truman	110	40+40	166.9	1.85	26.4
Truman	220	40+40	185.9	3.24	27.4
Truman	0	120	153.6	2.65	25.0
Truman	110	120	175.8	3.47	26.0
Truman	220	120	190.1	3.55	27.6
Wright	0	40+40	145.2	2.55	26.4
Wright	110	40+40	184.2	3.22	26.6
Wright	220	40+40	182.7	3.25	27.2
Wright	0	120	121.8	2.20	25.0
Wright	110	120	178.6	3.21	25.7
Wright	220	120	192.0	4.17	27.3
Compost type			NS	*	NS
N rate			**	**	**
Compost rate			**	**	NS
Compost rate*N rate			**	NS	NS
Compost type*Compost rate			**	**	NS
N rate* Compost type			NS	NS	NS
Compost type*Compost rate*N rate			**	**	NS

* Significant at 5% **Significant at 1% NS= Not significant. †40 T/A applied in 1993, and second 40 T/A applied in 1994.

Table 4.Plant moisture stress measured during the 1994 growing season on the 1992 established experiment, Becker, MN.

Compost type	N rate LBS/A 1994	Compost rate T/A 1992	Leaf Water Potential† MPa Dates:7/29/94 and 7/1/94 Time 9:15-10:10 A.M.	1:30-2:30 P.M.
Control	220	0	0.49(0.28)	1.01(0.22)
Truman	220	40	0.56(0.46)	1.49(0.10)
Truman	220	80	0.53(0.23)	1.13(0.37)
Swift	220	40	0.52(0.31)	1.09(0.28)
Time			**	
Time*Compost			NS	
Date			**	
Time*Date			NS	
Compost*Date			NS	
Time*Compost*date			NS	

†Number in parentheses is standard deviation.
‡Measurements made on clear days void of irrigation and precipitation.

Table 5.Plant moisture stress measured during the 1994 growing season on the 1993 established experiment, Becker, MN.

Compost type	N rate LBS/A 1994	Compost rate T/A 1993-94	Leaf Water Potential† MPa Dates:7/29/94 and 7/1/94‡ Time 8:15-10:10 A.M.	12:30-1:30 P.M.
Control	220	0	0.34(0.13)	0.91(0.30)
Truman	220	40+40	0.32(0.17)	1.04(0.36)
Truman	220	120	0.30(0.16)	0.89(0.23)
Wright	220	40+40	0.31(0.15)	0.97(0.24)
Wright	220	120	0.30(0.12)	0.67(0.25)
Time			**	
Time*Compost			NS	
Date			**	
Time*Date			NS	
Compost*Date			NS	
Time*Compost*date			NS	

†Number in parentheses is standard deviation.
‡Measurements made on clear days void of irrigation and precipitation.

SUMMARY OF RESULTS

1992 established experiment-residual effect (Becker and Staples, MN):

YIELD

Compared to the control, grain yield was high at all compost rates with no N application (Tables 1 and 2). Yields at both sites were generally lower than 1993 when N was not applied. Nevertheless, trend of MSW compost residual effect still remains in 1994. Grain yield of residual compost with optimum N rate was generally higher than the control at the same N rate (Becker site).

SOIL WATER NITRATE

Becker (Figs. 1a, b, c, and d)- Soil water NO_3-N was generally high for the 20 T/A Truman compost with no N application. As expected, all compost rate at the 220 lbs N/A resulted in higher NO_3-N loss than the 0 lbs N/A. Compared to the control with N, the compost rates at 20, 40, and 80 T/A gave higher nitrate leaching losses.

Staples (Figs. 1a, b, c, and d)- Soil water NO_3-N was lower for no N compost rates compared to the 220 lbs N/A treatment. The Truman compost at 80 T/A and 220 lbs N/A resulted in much higher NO_3-N loss throughout the growing season compared to all other compost rates at the same N rate.

PLANT MOISTURE STRESS

Water stress measurements were made on two clear and warm days (air temperature: mid 80's). Unless of rain events, irrigation was not made before stress maesurements. The last irrigation event of one inch was made on 7/15/94 before leaf water potential measurements on 7/29/94 and 8/1/94. Morning leaf water potential were highly significantly lower than the afternoon. In the 1992 established experiment at Becker, compost treatment on plant moisture stress was not significant (Table 4).

1993 established experiment-residual effect and annual application (Becker, MN)

YIELD

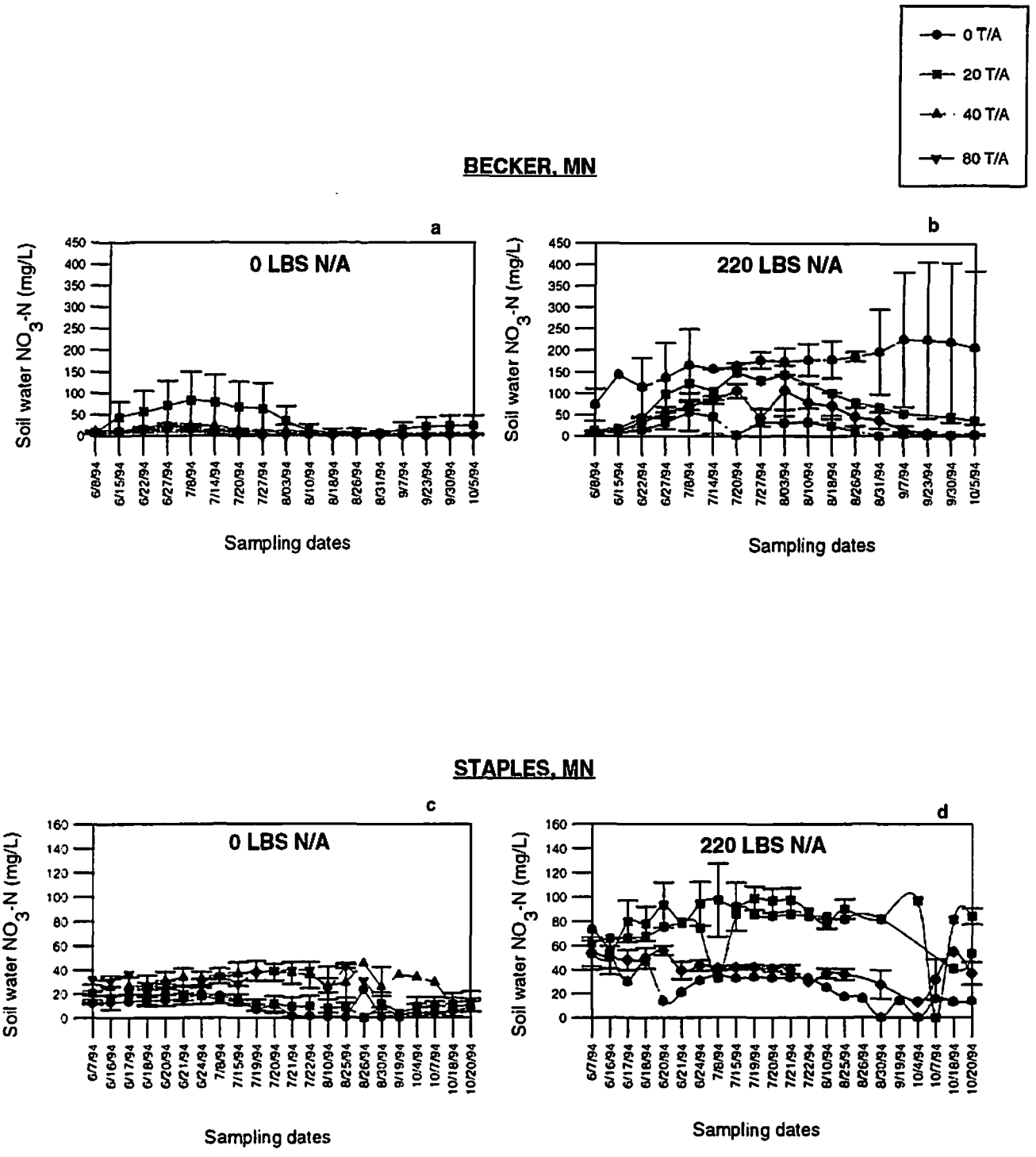
Grain and stover yields were much higher for all compost rates with no N application (Table 3). The higher grain and stover yield of the compost with no N suggests residual compost effect. Grain yield at a rate of 120 T/A compost with no N was higher for the Truman compost compared to the Swift compost, in which the latter gave much higher yield in 1993. In the year of application (1993), the Truman compost had a high C:N ratio (30:1). This high C:N of Truman in 1993 resulted in lower yield due to immobilization of applied N. The split application of MSW compost improved yield for both compost sources when N is added. The split application (40 T/A in 1993, and additional 40 T/A in 1994) of Truman compost with no Napplied resulted in lower grain yield compared to the 120 T/A one time application of Truman compost with no N application. This is suggestive of N immobilization by 40 T/A Truman compost (C:N> 20:1) applied in the second year (1994) and N mineralization one year after application of 120 T/A Truman compost (1993). The Wright compost split application (40 T/A in 1993, and additional 40 T/A in 1994) with no applied N gave higher yield compared to the Truman compost at the same compost and N rates as well as the 120 T/A Wright compost with no N (Table 3). Overall, The Wright compost had lower C:N ratio compared to the Truman compost both in 1993 and 1994. Thus, in the second year split application of Wright compost (40 T/A in 1993, and additional 40 T/A in 1994), there was less immobilization of the applied N, and hence resulted in higher yield compared to the Truman compost. Generally, the cumulative 80 T/A (40+40 T/A) rate still gave much higher grain yield for both sources compared to the control.

SOIL WATER NITRATE

All rates of Truman and Wright composts at 0 lbs N/A had lower leaching losses compared to the 110 and 220 lbs N/A treatments (Figs. 2a, b, c, d, e, and f). Truman compost amended at 120 T/A in 1993 generally gave higher NO_3-N losses compared to the annual rate of 40 T/A. This may be indicative of N mineralization from Truman compost a year after application, resulting in more N available for leaching. On the contrary, Wright compost amended in split at 40 T/A gave higher NO_3-N losses throughout most of the growing season compared to the Truman compost at the same rate. This is again associated with the low C:N of Wright compost All Wright compost rates at 220 lbs N/A had much higher NO_3-N loss compared to the control.

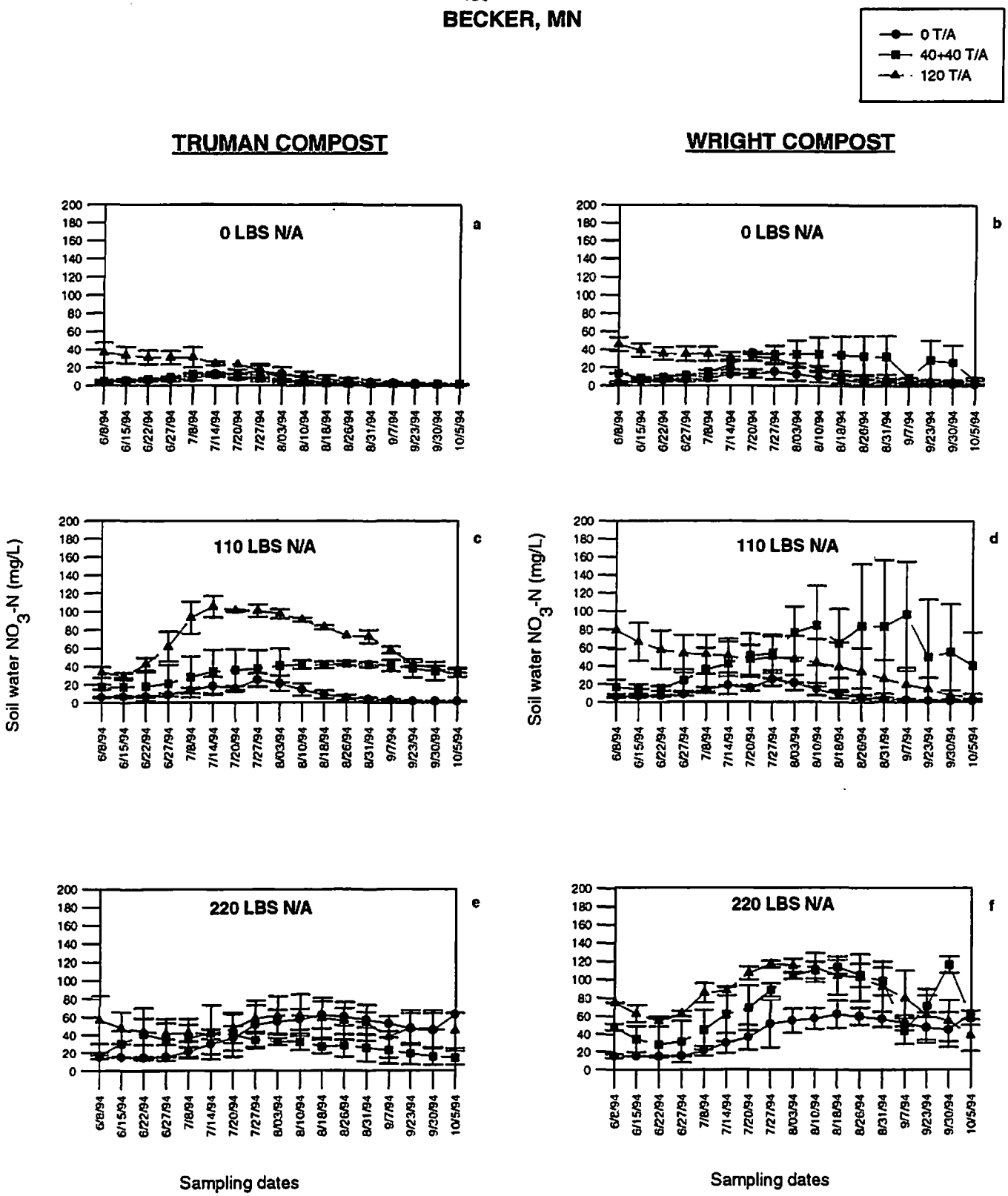
PLANT MOISTURE STRESS

Water stress measurements were made on two clear and warm days (air temperature: mid 80's). Unless of rain events, irrigation was not made before stress maesurements. The last irrigation event of one inch was made on 7/15/94 before leaf water potential measurements on 7/29/94 and 8/1/94.
In the 1993 established experiment, compost amendment, time, and date of measurement were significant. There were no treatment interactions. The mean comparison with compost as the main effect is presented in Table 5. Plants did not experience moisture stress in the early mornings. However, leaf water potential was highly significantly increased by the early afternoon compared to the morning. Afternoon plant moisture stress for the Wright compost at 120 T/A was significantly lower from the plots that received additional compost of 40 T/A in 1994. None of the compost treatments were significantly different from the control.



Figs. 1- SOIL WATER NITRATE-1994 GROWING SEASON
Compost utilization plots established in 1992

BECKER, MN



Figs. 2- SOIL WATER NITRATE- 1994 GROWING SEASON
Compost utilization plots established in 1993

TILLAGE COMPARISON AT ROSEMOUNT, 1994

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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 plots planted to corn with no nitrogen applied to plots in soybeans. The objective of the study are to determine the long term effects of various cropping systems on herbicide movement, earthworm activity, grain yield, nutrient availability and nutrient uptake. Though it is too early in the study to examine the differences in many of the objectives, enough information has been gathered to study grain yield, surface residue, simple economic analysis, and earthworm populations.

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), corn/soybean (CS) [soybean 1994] and soybean/corn (SC) [corn 1994] rotations were planted into four tillage systems in a randomized complete block design with three replicates. 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 soybean. Corn is no-tilled 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 preformed only when soil or weed conditions require attention. Cultivation performed only when determined necessary.

EXPERIMENTAL PROCEDURE: Prepared seedbed by discing all Conventional and Conservation tillage which were to be planted to corn. Corn (Pioneer 3751) was planted in the CC and SC plots across all tillage systems on May 5. The seeds were planted at a population of 26,100 seeds/acre. Force insecticide was banded over the row at the rate of 8oz/1000 feet of row. Corn emergence was counted from two 20' sections of row in each plot periodically throughout the first five weeks of growth. Lasso (Alachlor) was broadcast at the rate of 2qt product/acre May 7 on all CC and SC treatments under Conservation and Minimized tillage and the SC treatment under Conventional tillage. Broadcast Roundup (glyphosate) at the rate of 6pt product/acre product on all the CS treatments under Minimized tillage. May 17. Applied Bladex (Cyanazine) on May 17 at the rate of 2 pounds product/acre on all plots planted to corn under all tillage systems. Planted soybean on all CS plots at the rate of 60 lbs/acre. Broadcast Pursuit (imazethapyr) on all CS plots at the rate of 4 oz product/acre, June 1. Broadcast Buctril (bromoxynil) on June 2 at the rate of 1 1/2 pt product/acre on both the CC and SC treatments under Conservation and Ridge till. The same was also applied to the SC treatments of Conventional and Minimum tillage. Cultivated all CC and SC plots to a depth of 3 inches applying 150 lbs N/acre during the cultivation. Broadcast Fusilade (Fluazifop) on June 21 to all CS plots at the rate of 20 oz product/acre. Accent (Nicosulfuron) was applied on June 21 at the rate of 2/3 oz product/acre. Ridged all CC, CS and SC treatments under the ridge tillage system. Harvested all soybean and corn plots under all tillage systems. Sampled earthworm populations in each plot under all tillage systems. Performed tillage as to tillage systems.

RESULTS

YIELD: Grain yields and moistures from all tillages and rotations are given in figures 1-3 and table 1.

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Within the continuous corn system, grain yields from the conventional till plots out-yielded all other tillages followed by conservation, ridge and minimized in that order. Statistically, conventional and conservation had significantly greater yields than minimized tillage (fig. 1). The Continuous corn yields averaged over the past three years rank the tillage systems differently. The three year average places conventional in front followed by ridge, conservation and minimized respectively. I will note that the combined year ranking has changed this year placing conventional ahead of ridge-till.

The 1994 corn yields in the soybean/corn rotation created the same yield rank as continuous corn when comparing the 4 tillage systems. Conventional tillage yielded the highest followed by conservation, ridge and minimized. Statistically, corn grain yields for the conventional system were significantly greater than the corn grain yield under minimized tillage (fig. 2). The 1994 soybean yields in the corn/soybean rotation were greatest under the ridge tillage system followed by minimized, conventional and conservation respectively. No statistical yield difference occurred between tillage systems (fig. 3). The three year average soybean yield ranked conventional first followed by conservation, minimized and ridge respectively. The complete difference in rank between the 1994 and three year average soybean yields points to unpredictability. Soybean yield changes more radically from year to year under the various tillage systems than do corn yields. One explanation is that the soybean yields are all within 2.2 bushels of each other enabling the tillage systems to change rank more easily.

The mean yield (which includes both crops) for each tillage system indicates that conventional tillage produced the highest yield followed by conservation, ridge and minimized respectively. The yield from the conventional system is significantly greater than both the ridge and minimized tillage systems. The conservation tillage system is significantly greater than the yield produced by the minimized tillage system. The only significant difference not yet described occurs between the ridge and minimized tillage systems. The mean corn grain yields in 1994 indicate the soybean/corn rotation outyielding the continuous corn rotation by 16.4 bushels/acre. The same rotation outyielded continuous corn in 1993, but only by 10 bushels/acre. It is uncertain whether the yield differences will become more pronounced in future years.

RESIDUE: Residue cover after planting is shown in table 2 . As expected both conservation and minimized tillage provide sufficient corn and soybean residue to qualify for the erosion control requirements, where residue must provide at least 30% surface coverage 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. Ridge-till provided sufficient residue to qualify under the continuous corn and corn/soybean systems. Ridge-till buried a majority of the soybean residue under the soybean/corn rotation leaving only 27% surface residue. A conventional tillage system did not provide enough surface residue to qualify for the residue requirements. Since the soybean plots in conventional tillage are chisel plowed in the fall, on might expect at least 30% residue cover. However, the fall chisel plowed soybean plots only produced 9% residue cover.

EMERGENCE: Corn seedling emergence varied in the cropping systems presumably due spring soil moistures and temperatures. Figure 5 depicts 4 types of corn emergence trends. Conventional (CC) and conventional (SC) sprouted quickly with 75-85% corn emergence 13 days after planting. Conservation (SC) and ridge (SC) tillage systems had about 55% emergence after 13 days. The third trend includes conservation (CC), ridge (CC) and minimized (SC) with 32-42% emergence after 13 days. The last trend was created by the minimized (CC) cropping system with 15% emergence after 13 days. The advantage of ridge-till was minimized during the 1994 growing season due to the warmer soil temperatures. During the 1993 growing season, ridge-till cropping systems were grouped in the first two trends. The same cropping systems dropped to the 2nd and 3rd trends during 1994. This could be connected to the advance of the conservation tillage corn yields over ridge-till corn yields which occurred in 1994. All cropping system corn seedling emergence began to merge at day 19 after planting (fig. 4).

ECONOMIC ANALYSIS: Table 3 presents a comparison in time (hrs) and costs ($). The information was gathered during the 1994 growing season. The corn crop comparison gives evidence that' conventional is the most time and cost intensive cropping system. All corn systems are compared to the conventional (CC) system. Values greater than 1.00 indicates a system is more time or cost intensive than conventional (CC), whereas a value less than 1 indicates that the system in question is less intensive in time or costs. The soybean cropping system comparison is more varied. Ridge-till, overall, is the most time and cost intensive system.

EARTHWORM POPULATIONS: When comparing earthworms populations between the tillages, conventional tillage has the highest population at 50 earthworms/m^2. This was followed by the conservation tillage system with a population of 48/m^2, minimized tillage at 33/m^2 and ridge-till at 27/m^2. No statistical difference was found between the tillage systems. One might have expected the no-till and ridge-till systems to support a higher population of earthworms. An explanation for the low population in the ridge-till system might be that more earthworms might reside in the ridge, whereas the samples were taken from the inter-row. The cropping rotation CS (soybean 94) maintained the highest earthworm population with 56 earthworms/m^2 followed by SC (corn 94) and CC both with 32/m^2. Again, no statistical difference was found between rotations. The earthworm population consisted almost entirely of Apporectodea tuberculata and Aporectodea trapazoides.

Fig. 1

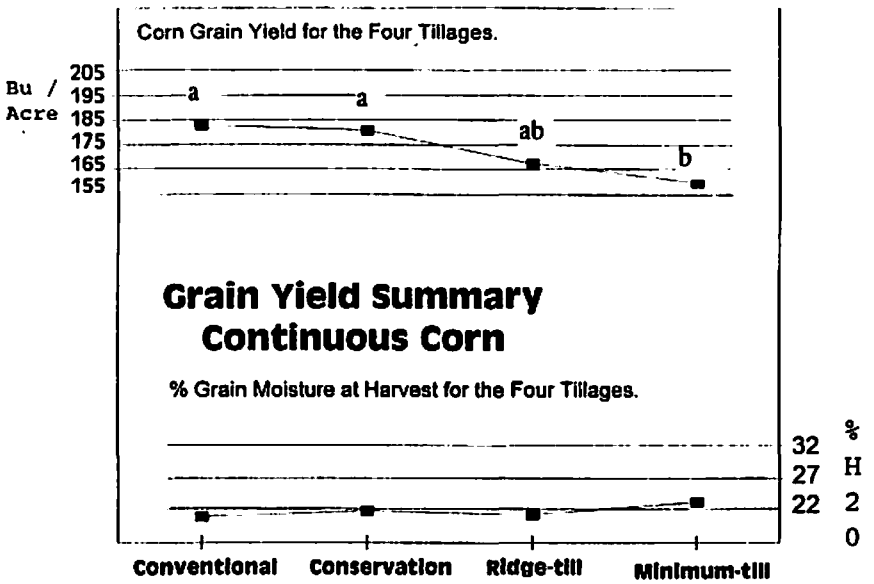

Fig. 2

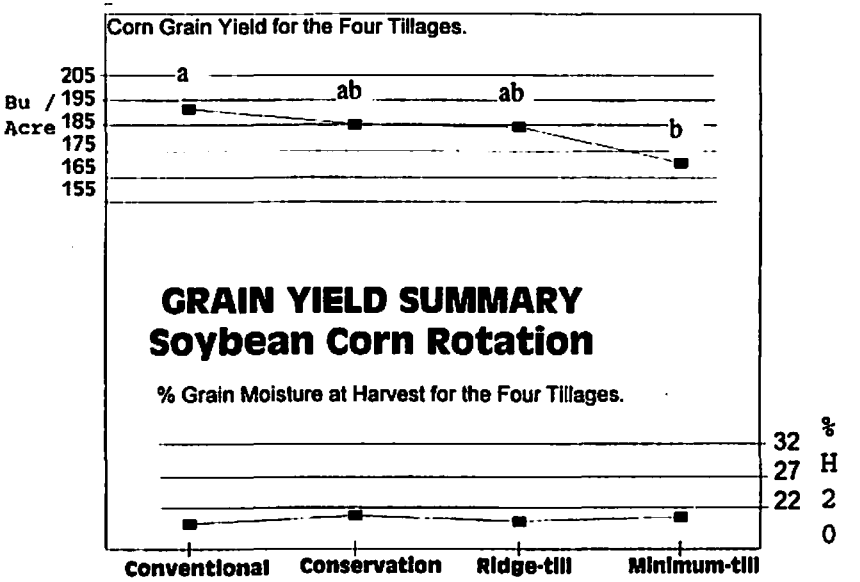

Fig. 3

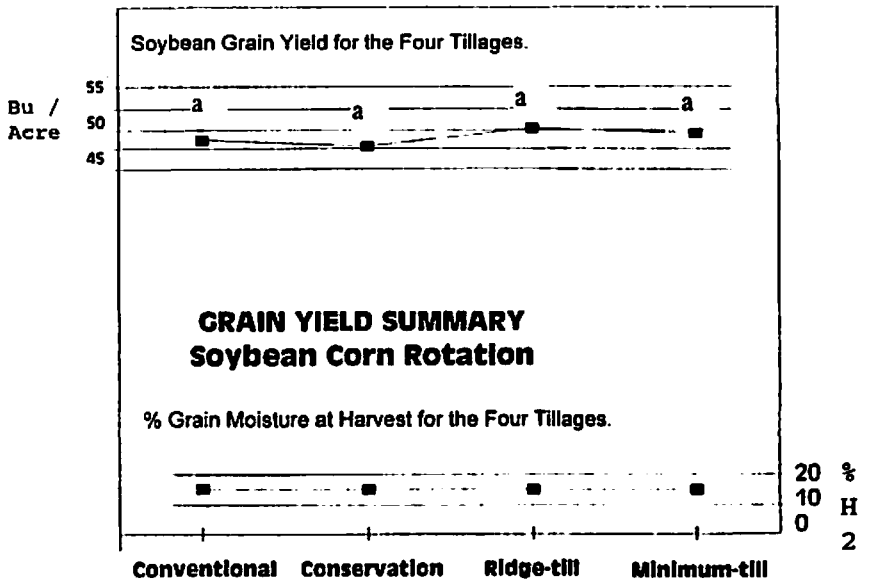

Fig. 4

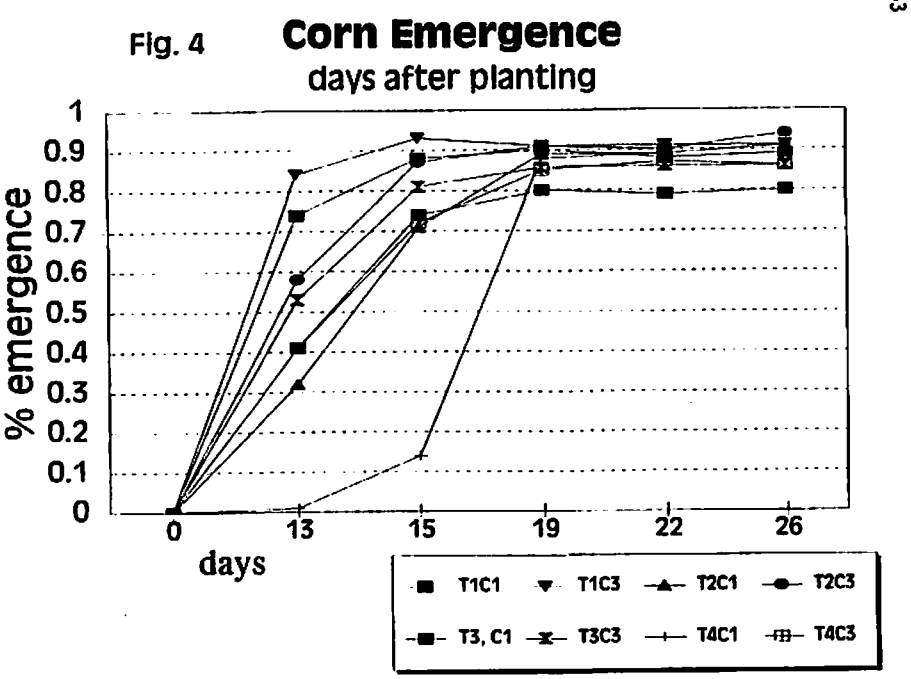

Table 1 Grain yields for the tillage study at Rosemount Study, 1994.

Treatment		Grain Yield			
Tillage	Rotation	1994		92-94 avg.	
		bu/ac	mt/ha	bu/ac	mt/ha
Conventional (T1)	Cont.Corn	182.9	9.7	139.7	7.4
	Corn/Soy	48.6	2.8	43.2	2.5
	Soy/Corn	197.9	10.5	157.9	8.4
Conservation (T2)	Cont.Corn	181.0	9.6	128.7	6.8
	Corn/Soy	47.8	2.8	42.9	2.5
	Soy/Corn	191.8	10.2	145.9	7.7
Ridge-Till (T3)	Cont.Corn	167.9	8.9	136.6	7.2
	Corn/Soy	50.0	2.9	41.5	2.4
	Soy/Corn	190.8	10.1	155.2	8.2
Minimum-Till (T4)	Cont.Corn	159.9	8.5	115.3	6.1
	Corn/Soy	49.4	2.9	42.3	2.5
	Soy/Corn	176.8	9.4	138.3	7.6

Table 2

Treatment			% residue cover
Tillage	Rotation		
Conventional (T1)	Cont.Corn	(CC)	5.0
	Soy 94	(CS)	4.0
	Corn 94	(SC)	9.0
Conservation (T2)	Cont.Corn	(CC)	39.0
	Soy 94	(CS)	35.0
	Corn 94	(SC)	67.0
Ridge-Till (T3)	Cont.Corn	(CC)	36.0
	Soy 94	(CS)	64.0
	Corn 94	(SC)	27.0
Minimum-Till (T4)	Cont.Corn	(CC)	89.0
	Soy 94	(CS)	88.0
	Corn 94	(SC)	81.0

Table 3

Production time and cost comparisons for all cropping systems.

all systems use conventional tillage as the standard

Crop	Time only	Costs* without Pesticide	Costs* with Pesticide
(corn)			
Conventional (CC)	1.00	1.00	1.00
Conventional (SC)	1.00	1.00	1.00
Conservation (CC)	0.87	0.87	0.92
Conservation (SC)	0.78	0.80	0.85
Ridge-till (CC)	0.88	0.92	0.93
Ridge-till (SC)	0.88	0.92	0.85
Minimized (CC)	0.69	0.69	0.93
Minimized (SC)	0.69	0.70	0.93
Crop (soybean)			
Conventional (CS)	1.00	1.00	1.00
Conservation (CS)	0.82	0.79	0.88
Ridge-till (CS)	1.14	1.22	1.13
Minimized (CS)	0.80	0.75	1.14

Costs include machinery costs only (no labor included)

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EVALUATION OF RESIDUE MANAGEMENT SYSTEMS IN WEST CENTRAL MN FOR CORN, SOYBEANS, AND WHEAT, 1994[1]

H.J. Stanislowski, J.F. Moncrief, B.P. Peterson, P.M. Bongard, and B.J. Johnson[2]

Abstract Crop residue cropping-systems were evaluated on five farms for soybeans, corn, and wheat. Yields were not influenced at one soybean, corn, and barley site. Yields were reduced at one soybean and wheat site with no till or paraplowing systems. The yield reduction with wheat appeared to be related to stand loss.

Introduction

This is the third and final year of a study evaluating residue management systems for corn, soybeans, and wheat. The crop sequence at all sites is corn-soybeans-wheat and back to corn. At each site there is only one crop each year. Treatments have varied somewhat in some respects over the course of the study but have consistency in others. Generally effectiveness of planter mounted tillage tools for planting corn in high residue environments has been looked at every year. Drill performance for soybean and small grain stand establishment in high residue environments has been a common treatment. In the fall of 1993 deep tillage treatments were established for evaluation in 1994 in response to the wet conditions and very dense soils that were encountered.

Results and Discussion

Tom Jennen Farm

At the Tom Jennen farm corn response following wheat to fall chisel and para plowing compared to no tillage was evaluated. A paraplow is a unique type of deep tillage tool. It has a vertical shank with a 45 degree bend. On the lower shank leg a small shatter plate is mounted. The angle of the plate can be changed with a cam located beneath it. This tool is specifically designed to maximize soil shattering while minimizing incorporation of surface residue. This treatment was used at the Tom and Dan Jennen farms in the fall of 1993.

Soil cover with residue is shown in table 1b. The "in row" (6" centered over the row) cover was higher than desired for corn in all the tillage systems evaluated (should be less than 10-15%). Cover was similar between the no till and paraplowing systems both in and between the row. Clearing tools were equally effective with these systems but did not reduce "in row" cover when chisel plowed followed by spring field cultivation.

The plant stand, early growth, grain moisture and yield are shown in table 1c. Stands were not affected by the tillage. Early growth and test weight were reduced with the paraplowing system. The absence of delayed early growth with the no till system is curious considering the 47 percent soil cover in the row with this system. Grain moisture trends followed early growth measurements (slowed early growth-higher grain moisture). Grain yields were not affected by tillage. This is curious since the soil was obviously very dense in the fall and tillage resulted in high draft. The lack of a response to fall 1993 tillage may have been due to a dry spring and timely rains in 1994.

There are no consistent trends in plant tissue levels due to tillage. Potassium levels are extremely low for all systems however.

Everett Gilbertson Farm

At this site fall chisel plowing was compared to a no till system using a Hiniker sweep type planter. A conventional planter (30" rows) was used on the chisel plowed plots. Soil cover was reduced from 95 to 60% with the Hiniker sweep seeder. There was no effect of the planter on soil cover with corn residue with the soybean planter on the chisel plowed plots.

Stands were good with both systems although much higher with the Hiniker unit. There was no statistical difference in yields due

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[2] H.J. Stanislowski and B.P. Peterson are Extension Educator and Plot Coordinator, Ottertail County, MN; J.F. Moncrief and B.J. Johnson are Extension Soil Specialist and Assistant Scientist in the Soil, Water, and Climate Department, U of M; P.M. Bongard is an independent data analysis specialist, Faribault, MN.

to tillage although the trend was for slightly lower yields with the no till system. This is surprising since a narrow row response (broadcast vs. 30" rows) often occurs with soybeans in MN.

There was no consistent trend in tissue levels of nutrients due to tillage (table 2c).

David Holt Farm

At this site a chisel plowing system was compared to a no till approach for soybeans following corn. The stands were adequate with both tillage systems. Residue levels were marginal with the chisel system. There was no difference in test weight but about an eight bushel per acre reduction in yield with the no till system. Differences in growth were apparent from early in the season. It may be possible that "in seed furrow" corn residue with the no till system delayed growth due to poor seed-soil contact and phytotoxicity. There is no consistent trend of tillage on tissue levels of trifoliate samples at 10% bloom.

Orland Ohe Farm

At this site a chisel plowing system was evaluated against a no till approach for barley production following wheat. The drill was equipped with smooth coulters to cut the wheat straw. Soil cover levels were relatively high with the chisel plowing system. There was no statistical difference in stand, test weight, protein, or yield due to tillage.

Dan Jennen Farm

Tillage influences on wheat following soybeans were evaluated at this site. The treatments were fall chisel or paraplowing compared to no tillage. Soil cover with soybean residue (table 6b) was similar for the chisel and paraplowing systems (53%) and much reduced with the chisel treatment (12%). Stands were reduced with the high residue systems.

Wheat yields were about 6 bushels per acre lower with the two high residue systems compared to the chisel plowing approach. The yield difference may have in part been due to the stand differences.

Table 1a. Cultural practices used at the corn tillage demonstration on the Tom Jennen farm, 1994.

Tillage Treatments

1. Chisel plow- 3" twisted shovels at 12" spacing going about 8-10" deep in the fall followed by a field cultivator in the spring (42'wide with 9" sweeps at 6" spacing)
2. Paraplow-in the fall with a five shank unit going about 14-16" deep. See text for description. No secondary tillage in the spring.
3. No tillage-planted with rolling finger clearing units.

Planting and harvest information

Crop	Hybrid	Planted	Seeding	Harvested
Corn	NK3907	5/7	29,500s/A	10/10

John Deere 7200 8-row planter

Crop history

1990-Wheat
1991-Corn
1992-Soybean
1993-Wheat
1994-Corn

Nutrients applied

		Actual applied lb//A		
Date	Analysis	N	P_2O_5	K_2O
5/7	24-60-40	24	60	40
6/10	82-0-0	120	0	0

Weed control

Date	Control	Rate lb ai/A
6/17	Primisulfuron (Beacon) +	0.02
	Nicosulfuron (Accent)	0.016
6/18	Dicamba (Banvel) (spot spray on thistle)	

Soil

Langhei loam (40%) (Typic Eutrochrept)
Fordum fine sandy loam (30%) (Mollic Fluvaquent)
Sandberg loamy sand (30%) (Udorthentic Haplobroll)

Table 1b. Effect of tillage on wheat residue in, between and across the rows at the Tom Jennen farm, May 17, 1994.

Tillage	Residue In	Between	Across
	----------%cover----------		
Chisel plow	24.3cd[1]	26.0cd	21.7d
No-till	46.7bc	72.0a	62.0ab
Paraplow	44.0bcd	62.7ab	46.7bc
Chisel plow[2]	24.0b		
No-till	60.2a		
Paraplow	51.4a		
Row position	38.3b	53.9a	43.4b
Pr>F			
Tillage	0.063		
Row position	0.002		
Till.x Row pos.	0.086		

1. Data followed by the same letter in the same group are not significantly different at the 0.10 level, n=27.
2. Means averaged over row position.

Table 1c. Effect of tillage on corn population (5/17), leaf numbers (5/17), and harvest data at the Tom Jennen farm, 1994.

Tillage	Corn Population	Leaf Nos.	Test Weight	Grain Moisture	Corn Yield
	#/Ax1000	#/plant	lb/bu	%	bu/A
Chisel plow	24.5a[1]	6.8a	53.5a	24.1a	117a
No-till	25.0a	6.6a	53.3a	25.8a	105a
Paraplow	26.6a	6.2b	52.2b	25.2a	116a
Pr>F					
Tillage	0.535	0.026	0.023	0.290	0.336

1. Data followed by the same letter in the same column group are not significantly different at the 0.10 level, n=9.

Table 1d. Effect of tillage on ear leaf concentrations at the Tom Jennen site, 1994.

Tillage	P	K	Ca	Mg	Na	Al	Fe	Mn
	----------%----------		----------ppm----------					
Chisel	0.238a[1]	0.662a	8620a	6080a	4.05a	22.2a	89.8a	98.2a
No-till	0.280a	0.682a	9670a	7440a	3.66a	22.3a	115.9a	100.7a
Paraplow	0.235a	0.669a	9070a	6120a	4.44a	21.7a	88.8a	93.7a
Pr>F								
Tillage	0.693	0.988	0.509	0.540	0.616	0.982	0.108	0.849

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=9.

Table 1d. continued. Effect of tillage on ear leaf concentrations at the Jennen site, 1994.

Tillage	Zn	Cu	B	Pb	Ni	Cr	Cd
	----------ppm----------						
Chisel	11.9a	3.22a	5.80a	1.70a	0.483a	0.649a	0.121a
No-till	9.4a	5.07a	4.99b	1.68a	0.440b	0.520b	0.120a
Paraplow	12.3a	3.75a	5.35b	1.68a	0.459ab	0.512b	0.120a
Pr>F							
Tillage	0.654	0.280	0.044	0.444	0.074	0.056	0.444

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=9.

Table 2a. Cultural practices used at the soybean tillage demonstration on the Everett Gilbertson farm, 1994.

Tillage

1. Chisel plowed in the fall of 1993 followed by discing (4/30/94) 18.5' with 22" blades at 9" spacing and a field cultivator 22' with 7" sweeps at 6" spacing on May 23, 1994
2. No till (planted with a Hiniker sweep unit)

Planting and harvest information

Crop	Variety	Plant	Pop.	Harvest
Soybean	P9091	5/26	200,000s/A	10/14
No-till plots	"		240,000s/A	"

IH CycloAir (8-30" rows) in chisel plots
Hiniker Air Seeder in no-till plots

Crop history 1991-Soybeans, 1992-Wheat, 1993-Corn, 1994-Soybeans

Soil Chappett loam 4% slope (Udic Agriboroll)

Nutrients applied

		Actual applied lb/A				
Date	Analysis	N	P_2O_5	K_2O	Fe	Mn
6/29	8-8-8-3-3	0.3	0.3	0.3	0.1	0.1
(1.5 qt/A)						

Weed control

Date	Control	Rate
No-till		lb ai/A
Pre-plant	Glyphosate (Roundup) +	0.38
"	2,4-D ester	0.25
5/20	Flumetsulam (Broadstrike)	
Chisel		
5/20	Flumetsulam (Broadstrike) & 2,4-D ester	0.25 lb ai/A

Spot spray of Bentazon (Basagran)

Statistical Design

Randomized complete block with four replications.

Table 2b. Effect of tillage on corn residue before and after planting (5/26), soybean population (6/27), and harvest data (10/14) at the Gilbertson farm, 1994.

Tillage	Planting Before	Planting After	Soybean Population	Test Weight	Harvest Moisture	Soybean Yield
	------% cover-----		plts/Ax1000	lb/bu	%	bu/A
Chisel plow	15.9b[1]	15.9b	193b	54.0a	12.0a	41.0a
No-till	95.0a	60.1a	291a	54.0a	12.0a	38.0a
Pr>F						
Tillage	<0.001	0.001	<0.001	1.00	0.789	0.121

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=8.

Table 2c. Effect of tillage on soybean trifoliate concentrations contents at the Gilbertson site, 1994.

Tillage	P	K	Ca	Mg	Na	Al	Fe	Mn
	----------%	--------	----------	----------	ppm	----------	----------	----------
Chisel	0.652a	2.58a	10,200a	3780a	7.06a	11.6a	72.8a	63.4a
No-till	0.655a	2.53a	9,860a	3830a	5.11a	8.7a	68.2a	49.9b
Pr>F								
Tillage	0.892	0.154	0.197	0.665	0.314	0.439	0.331	0.034

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=8.

Table 2c. continued. Effect of tillage on trifoliate concentrations at the Gilbertson site, 1994.

Tillage	Zn	Cu	B	Pb	Ni	Cr	Cd
	----------	----------	----------	ppm	----------	----------	----------
Chisel	45.5a[1]	9.6a	34.3a	1.77a	8.49a	0.700a	0.221a
No-till	43.1a	9.0a	35.0a	1.68b	7.22b	0.550b	0.142a
Pr>F							
Tillage	0.198	0.127	0.608	0.070	0.023	0.070	0.368

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=8.

Table 3a. Cultural practices used at the soybean tillage demonstration on the David Holt farm, 1994.

Tillage

1. Disced and Chisel plowed (10/25/93) equipped with 4" twisted shovels at 1' spacing. Spring field cultivated (5/11/94) 7"-sweeps at 7" spacing.
2. No till planted with 750 no till drill.

Planting and harvest information

Crop	Variety	Plant	Pop.	Harvest
Soybean	P9091	5/17	200,000s/A	9/26

John Deere 7000 planter in chisel plots
John Deere 750 drill in no-till plots

Crop history

1991-Soybean
1992-Wheat
1993-Corn
1994-Soybean

Nutrients applied

None

Weed control

Date	Control	Rate (lb ai/A)
6/1	Fluazifop (Fusilade) +	0.14
	Imazethapyr (Pursuit)	0.047

Soil

Sandberg loam 4-9% slope
(Udorthentic Haploboroll)

Table 3b. Effect of tillage on soybean population (6/2), residue (5/17), test weight, harvest moisture content and yield (9/26) at the Holt farm, 1994.

Tillage	Soybean Population	Corn Residue	Test Weight	Harvest Moisture	Soybean Yield[1]
	plt/Ax1000	%cover	lb/bu	--%--	bu/A
Chisel plow	347a[2]	21.2b	56.7a	14.0a	32.3a
No-till	220b	84.7a	56.3a	12.7a	23.8b
Pr>F					
Tillage	0.005	0.004	0.423	0.424	0.027

1. Soybeans in the no-till plots were approx. 12" tall vs. 24" in the chisel plots; no-till plots also had significant ragweed and Canada thistle problems.
2. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=6.

Table 3c. Effect of tillage on soybean trifoliate concentrations at the Holt site, 1994.

Tillage	P	K	Ca	Mg	Na	Al	Fe	Mn
	----------%---------		----------ppm----------					
Chisel	0.604a[1]	2.16b	11,900a	4760a	7.12a	10.8b	74.4a	56.5a
No-till	0.578a	2.37a	13,100a	4740a	9.18a	12.9a	70.2a	60.8a
Pr>F								
Tillage	0.606	0.090	0.590	0.956	0.286	0.043	0.207	0.434

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=6.

Table 3c. continued. Effect of tillage on trifoliate concentrations at the Holt Farm.

Tillage	Zn	Cu	B	Pb	Ni	Cr	Cd
	----------ppm----------						
Chisel	41.2a[1]	8.74a	45.4a	1.71a	6.40a	0.679a	0.266a
No-till	39.0a	8.01a	44.8a	1.68a	4.40b	0.661a	0.209a
Pr>F							
Tillage	0.249	0.283	0.896	0.423	0.047	0.719	0.342

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=6.

Table 4a. Cultural practices used in the barley tillage demonstration on the Orland Ohe farm, 1994.

Tillage

1. Fall chisel plowing followed by field cultivation in the spring (4" sweep/harrow).
2. No tillage (Haybuster Drill with smooth coulters and double disc openers.

Planting and harvest information

Crop	Variety	Plant	Rate	Harvest
Barley	Robust	4/23	2 bu/A	8/19

Haybuster drill (7" rows)

Crop history 1991-Wheat, 1992-Soybeans, 1993-Wheat, 1994-Barley

Nutrients applied

		applied lb/A		
Date	Analysis	N	P_2O_5	K_2O
4/23	15-38-10	22	57	15
4/19	46-0-0	69	0	0

Weed control

Date	Control	Rate
		lb ai/A
	Preplant Glyphosate (Roundup)	0.75
6/5	Clopyralid (Stinger) + 2,4-D ester	0.59

Soil

Formdale-Buse clay loam complex 2-6% slope (60%)
(Udic Haploboroll & Typic Calciboroll)
Formdale-Langhei clay loam 6-12% slope (20%)
(Udic Haploboroll & Typic Eutrochrept)
Aazdahl clay loam 0-3% slope (20%)
(Aquic Haploboroll)

Table 4b. Effect of tillage on barley population (5/24), crop residue (5/10), and harvest data at the Ohe farm, 1994.

Tillage	Barley Population	Wheat Residue	Test Wt.	Protein	Plump Kernels	Grain Moisture	Barley Yield
	plt/Ax1000	%cover	lb/bu	%	%	%	bu/A
Chisel plow	641a[1]	40.4b	48.4a	13.9a	88.7a	14.1a	54.4a
No-till	572a	66.9a	47.8	13.3a	87.3a	14.1a	58.2a
Pr>F							
Tillage	0.157	0.029	0.122	0.230	0.529	0.940	0.227

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=6.

Table 5a. Effect of tillage on barley population (5/18/94) and residue (4/22/94) on the Sjostrom farm, 1994[1].

Tillage	Barley Population	Residue
	#/Ax1000	%cover
Chisel plow	732a[2]	16.0b
No-till	662a	45.2a
Pr>F		
Tillage	0.105	0.017

1. The barley crop was lost at this site and therefore are no yields to report.
2. Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 6a. Cultural practices used in the wheat demonstration on the Dan Jennen farm, 1994.

Tillage Treatments

1. Chisel plow (11/3/93) 17' wide with 7" twisted shovels at 12" spacing; field cultivated (4/15/94) 27'wide with 7"sweeps at 7" spacing
2. No till
3. Paraplowed in the fall with no spring tillage.

Planting and harvest information

Crop	Variety	Plant	Rate	Harvest
Wheat	2375	4/22	2 bu/A	8/10

John Deere 9350 (6" row spacing, 30' width)

Crop history 1991-Wheat, 1992-Corn, 1993-Soybean, 1994-Wheat

Soil

Barnes-Langhi loam complex 6-12% slope (Udic Haploboroll & Typic Eutrochrept)

Nutrients applied

		Actual applied lb/A		
Date	Analysis	N	P_2O_5	K_2O
No-till				
4/22	9-23-30	9	23	30
4/20	82-0-0	100	0	0
Chisel				
11/1	28-20-9	81	60	26

Weed control

Date	Herbicide	Rate
		lb ai/A
5/26	Fenoxaprop + 2,4-D + MCPA (Tiller)	0.42
	Bromoxynil (Buctril)	0.25

Table 6b. Effect of tillage on wheat population (5/19), residue (5/11), and harvest data (8/10) on the Dan Jennen farm, 1994.

Tillage	Wheat Population	Residue	Test Weight	Protein	Grain Moisture	Wheat Yield
	#/Ax1000	%cover	lb/bu	%	%	bu/A
Chisel plow	963a[1]	11.8b	60.6a	13.6a	13.9a	51.4a
No-till	815b	52.3a	59.4b	13.8a	14.3a	44.5b
Paraplow	728c	53.6a	60.0ab	14.2a	14.0a	46.3b
Pr>F						
Tillage	0.007	<0.001	0.052	0.218	0.804	0.018

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=9.

EVALUATION OF TILLAGE AND NO TILL DRILLS FOR SOYBEANS IN NOBLES CO., MN 1994[1]

John F. Moncrief, Tom L. Ahlberg, Art R. Frame,
Jim B. Nesseth, Phyllis M. Bongard, and Brian J. Johnson [2]

Abstract: Evaluation of fall moldboard plowing, fall deep chiseling, and no till systems on soybean stand establishment, weeds present, and yields resulted in higher yields with a no till approach. Lower yields with moldboard and chisel plowing were correlated with increases in weeds present. Evaluation of no till drills for soybean production resulted in higher yields with single disc openers compared to sweep type units. Differences were not related to differences in stands or weeds present.

Introduction

There are two studies. One is designed to evaluate tillage systems and the other no till drills under no till conditions. The cultural practices are shown in table 1a. The soil is naturally poorly drained but well tiled. The seeds planted per acre (shown in table 1a) were determined by knowing the weight of seed in each drill before planting and weighing the residual after planting. Seeds per acre was determined by difference. The three drills planted slightly over 200,000 seeds per acre.

Results of Spring Tillage/Drill Study

Soil cover with corn residue after planting, stands, and yield for the tillage study are shown in table 1b. The three tillage treatments were planted with the John Deere no till drill. There was no difference in stand due to tillage and stands were adequate. Soil cover with corn residue was measured before and after spring discing, as well as after planting. There was very little soil cover with the fall deep tillage treatments. Yields were highest with the no till system and lowest with the DMI 530 subsoiler. Moldboard plowing resulted in intermediate yields.

The weeds were tallied at physiological maturity and are shown in table 1c. These data are visual estimates of the percent soil cover by weed species in each plot. The dominant weeds were cocklebur, pigweed, and smart weed. Full width, deep fall tillage increased these three weed species and may explain some of the yield reduction with these systems.

Results of No Till Drill Study

The results of study 2 looking at no till drills are summarized in tables 2a and 2b. The only weed species affected by drill type was thistle which was higher with the JD750 drill compared to the sweep type units. As expected the sweep type units resulted in lower levels of soil cover by corn residue. Both reduced soil cover by about 10% compared to no reduction with the JD750. Soybean stands were higher with the JD750 and DMI/Concord units compared to the Hiniker but stands were adequate with all drills. The sweep type units resulted in about a 6 bushel per acre lower yield than the single disc opener unit (JD750). This yield difference does not appear to be related to differences in weeds present or stand.

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[2] John F. Moncrief is an Extension Soil Scientist, Soil Science Department, U of M; Tom Ahlberg is an independent crop consultant with Southwest Agronomics at Worthington, MN; Art R. Frame and Jim B. Nesseth are Extension Educators in Nobles and Jackson Counties respectively; Phyllis M. Bongard is an independent data analysis specialist, Faribault, MN; and Brian J. Johnson is an Assistant Scientist, Soil Science Department, U of MN, St. Paul.

Table 1a. Cultural practices used in the soybean tillage study on the Daryle Albersman farm at Worthington, Minnesota, 1994.

Tillage systems evaluated (study 1)

1. Fall DMI 530 Ecolo Tiger (parabolic shank subsoiler with wings, preceded by a gang of chisel shanks, preceded by a gang of discs) + spring disc
2. Fall Moldboard plow + spring disc
3. No-till

Drills Evaluated (study 2)

1. 15' John Deere 750 (7" rows)
2. Hiniker sweep 27" sweeps on 30" centers behind a coulter-gauge wheel
3. DMI/Concord 1100 sweep seeder 35' DMI (field cultivator) with 7" shovels at 6"spacing

Planting and harvest information

Soybean

Planter	Variety	Planted	seeds/a	Harvested
JD750	P9171	5/13	206,000s/A	9/30
DMI/Concord	"	5/15	226,000s/A	"
Hiniker	"	5/16	232,000s/A	"

Crop history

1993 - Corn

Nutrients applied none

Weed control

Date	Product	Rate
5/11	Roundup	.25 qt/a
	surfactant	2 qt/a
	ammonium sulfate	.7 lbs/a
	Dual+Broadstrike	2.75 pt/a

Soils Webster/Clarion/Nicollet 0-2% slope

Treatment	pH	O.M.	Olsen-P	Bray-P	K
No-till		%	-------ppm----------		
JD750	7.8	4.3	65	74	132
Concord	7.8	4.2	65	82	118
Hiniker	7.8	4.1	60	78	121
DMI 530	7.9	4.1	60	76	137
Moldboard	7.7	4.0	65	80	123
Average	**7.8**	**4.1**	**63**	**78**	**126**

Statistical Design

Study 1. Randomized complete block with 5 replications.
Study 2. Split plot with 5 replications

Table 1b. Effect of tillage on soybean stand (6/10), corn residue before and after spring tillage and after planting, and yield and moisture (9/30) at Worthington, 1994.

Tillage	Soybean Population	Corn Residue 5/12[1]	5/13[2]	5/16?[3]	Harvest Moisture	Soybean Yield
	plt/Ax1000	--------%cover----------			--%--	bu/A
No-till	184a[4]	52.0a	- 51.4a1		2.5a	61.7a
DMI Ecolo	162a	14.8b	12.6a	12.6b	13.3a	51.4b
Moldboard	184a	6.6b	2.6b	4.4c	12.8a	55.3c
Pr>F						
Tillage	0.289	<0.001	0.002	0.001	0.356	0.001

1 Residue measured before spring discing.
2 Residue measured after spring discing.
3 Residue measured after planting.
4 Data followed by the same letter in the same column are not significantly different at the 0.10 level. n=15.

Table 1c. Effect of tillage on weed cover at Worthington, September 9, 1994.

Tillage	Total cover	Weeds present[1] Ccklbur.	Pig-weed	Smart-weed	Com. lmsqtr.	Thistle	Foxtail sp.
	----------% cover----------						
No-till	8.7b[2]	0.6a	2.3b	2.9b	1.7a	1.2a	0.0a
DMI Ecolo	32.1a	6.7a	9.9a	10.0a	3.1a	2.4a	0.0a
Moldboard	26.6a	8.2a	9.2a	5.1b	2.0a	1.6a	0.5a
Pr>F							
Tillage	0.023	0.168	0.084	0.007	0.264	0.181	0.143

1. Ccklbur=Cocklebur; Com. lmsqtr=Common lambsquarters.
2. Data followed by the same letter in the same column are not significantly different at the 0.10 level. n=15.

Table 2a. Effect of drill type on soil cover by weed species (no-till plots only) at Worthington, MN, September 9, 1994.

Seeder	Total cover	Weeds present[1] Ccklbur.	Pig-weed	Smart-weed	Com. lmsqtr.	Thistle	Foxtail sp.
	% cover						
DMI/Concord	8.7a[2]	0.6a	4.0a	1.8a	1.7a	0.2b	0.4a
JD750	8.7a	0.6a	2.3a	2.9a	1.7a	1.2a	0.0a
Hiniker	6.5a	0.9a	2.5a	2.2a	0.4a	0.5b	0.0a
Pr>F							
Seeder	0.512	0.781	0.175	0.329	0.154	0.029	0.410

1. Ccklbur=Cocklebur; Com. lmsqtr=Common lambsquarters.
2. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=15.

Table 2b. Effect of seeder on soybean stand (6/10), stand establishment, corn residue before and after planting, and yield and moisture (9/30) in the no-till plots at the Worthington site, 1994.

Seeder	Seeding Pop.	Soybean Pop.	Stand Estab.	Corn Residue 5/12[1]	Corn Residue 5/16?[2]	Harvest Moisture	Soybean Yield
	plt/Ax1000		--%--	---%cover---		--%--	bu/A
Concord	226	167a[3]	74.1b	45.6a	33.8b	12.2a	54.7b
JD750	206	184a	89.6a	52.0a	51.4a	12.5a	61.7a
Hiniker	232	114b	49.2c	47.0a	37.6b	12.3a	55.4b
Pr>F							
Seeder		<0.001	<0.001	0.354	0.002	0.590	<0.001

1. Residue measured before planting.
2. Residue measured after planting.
3. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=15

EVALUATION OF TILLAGE AND NO TILL DRILLS FOR SOYBEANS IN YELLOW MEDICINE CO., MN, 1994[1]

Richard P. Kvols, Steve D. Lutes, John F. Moncrief
Phyllis M. Bongard, and Brian J. Johnson[2]

Abstract: Spring tillage and drill types were evaluated for soybeans following corn on a loam textured soil. Drill types that result in more tillage (sweep seeders and fluted coulters compared to single disc openers) reduced soil cover with corn residue and soybean stands (likely due to crusting from an intense rainfall shortly after planting). A yield reduction was associated with stand loss. Spring tillage approaches did not affect stands or yields.

Introduction

Two studies were initiated in the spring of 1994 in southwestern Minnesota, one to evaluate three spring tillage options and the other to evaluate three no till drills for soybeans following corn. The designs were a randomized complete block with split plots and split plot design for spring tillage and no till drill studies respecitively. The soil is a Ves loam (Udic Haplustol) with 0-2% slope. The cultural practices and treatment definitions are shown in table 1.

Results of Spring Tillage/Drill Study

The results of the spring tillage/drill comparison is shown in table 2. Spring tillage with discing or mulchmaster reduced soil cover with corn residue from 52 to about 36%. When averaged over tillage the John Deere 750 (JD750) drill reduced soil cover with corn residue from 45 to 39% compared to the Case-IH (CIH) drill equipped with a Yetter coulter cart. Although all the seeding equipment was set to deliver 200,000 seeds per acre stands were different between the two drills. The CIH drill resulted in about one half the stand of the JD750 (127 vs. 61 thousand plants per acre). The drill differences in stand were consistant across spring tillage treatments. There was a very intense rainfall following planting that had more of an effect on soil crusting over the row with the CIH compared to the JD750 unit due to lower soil cover in the row. This was the likely reason for stand differences. Spring tillage did not affect stands however and averaged about 100 thousand plants per acre.

The primary weeds were pig weed, yellow and giant foxtail, and lambsquarters. A visual estimate of broadleaves vs grass was made before post emergent herbicides were applied. There were no significant effects of drill type or tillage on weed type. Late season weed control was excellant although pressure was high before applying post emergent herbicides.

The grain yields varied from 45 to 52 bushels per acre over the three spring tillage treatments but was due to field variability and not tillage. There was a four bushel per acre reduction in yield with the CHI drill which was likely due to stand loss from the crusting rain discussed earlier. This is also supported by the trend for a tillage by drill interaction. The spring discing and mulch master tillage treatments resulted in a larger stand and yield reduction with the CHI drill than the no till system.

Results of Drill Study (no till only)

The comparision of the three no till drills evalauted (only under no till conditions) is shown in table 3. The DMI/Concord sweep seeder compared to the JD750 and CIH drills reduced soil cover by corn residue from 53 to 38%. Stands were reduced with the sweep and coulter cart units compared to the JD750. Grain yields were correlated with stands but not significantly different due to drill type.

Table 1. Cultural practices at Yellow Medicine County, 1994.

Spring Tillage Treatments

1. Spring discing-IH 470 with 16" discs at 9" spacing
2. Sweep seeder DMI/Concorde 1100-35' DMI (fld. cult) with 7" shovels at 6"spacing
3. John Deere Mulchmaster-24' wide with 24" low crown sweeps at 24" spacing followed by 1" heavey rotary hoe angled gangs on 18" diameter

Crop history

1993 - Corn

Nutrients applied

None

[1] This project was supported by the Midwest Soybean Growers Association, Deere and Co., the Minnesota Extension Service, and the Natural Resource Conservation Service. Their support is greatly appreciated.

[2] Richard P. Kvols and Steve D. Lutes are Extension Educator and District Conservationist respectivley in Yellow Medicine County, MN; John F. Moncrief and Brian J. Johnson are Extension Soil Scientist and Assisstant Scientist in the Soil, Water, and Climate Department, U of M, St. Paul, MN; and Phyllis M. Bongard is an independent data analysis specialist, Faribault, MN.

Drills Evaluated

1. 15' John Deere 750 (7" rows)
2. 20' Case IH (10" rows) with Yetter coulter cart (1" fluted) & 2-bar tine drag
3. DMI/Concord 1100 sweep seeder 35' DMI (fld. cult) with 7" shovels at 6" spacing

Planting and harvest information

Crop	Variety Planted	Seeding	Harvested
Soybean	DK532	5/22	200,000s/A 10/24

Rainfall

Date	Amt.(inches)	
5/23	.9	
5/24	1.1	Hard downpour.
5/26		A hot dry wind crusted topsoil.

Weed control

Date	Herbicide	Rate
5/12	Glyphosate +	0.2 lb ai/A
	2,4-D	0.25 lb ai/A
6/26	Bentazon + Acifluorfen+	0.7 lb ai/A
	Sethoxydim +	0.18 lb ai/A
	Thifensulfuron	0.002 lb ai/A

Soil	Soil Test O.M.	P	K
Ves loam (Udic Haplustoll)	3.4%	152 ppm	410 ppm

Experimental Design

1. Randomized Complete Block with split plots (tillage main plots and drill type subplots) and four replications (table 2).
2. Split plot with four replications (drill types with no tillage, table 3).

Table 2. Effect of tillage and drill type on corn residue, soybean population, stand establishment, weed composition, and yield at the Yellow Medicine County demonstration, 1994.

Tillage	Drill	Corn Residue	Soybean Population	Stand Estab.	Weed composition Grass	Weed composition Broadleaves	Soybean Yield
		%cover	plt/Ax1000	%	--------%--------		bu/A
No-till	CIH[1]	52.7a[2]	72bc	45.8ab	68.8a	31.2a	48.7ab
	JD 750	52.2a	137a	57.4a	53.0a	47.0a	50.3ab
Spring disc	CIH	45.7b	45c	28.8b	43.3a	56.7a	48.7ab
	JD 750	34.0cd	135a	56.5ab	50.0a	50.0a	56.2a
Mulchmaster	CIH	37.0c	65bc	41.4ab	68.3a	31.7a	43.7b
	JD 750	30.7d	108ab	45.2ab	73.3a	26.7a	46.3b
No-till		52.4a	105a	51.6a	61.0a	39.1a	49.5a
Spring disc		39.8b	90a	42.6a	46.7a	53.3a	52.4a
Mulchmaster		33.8b	86a	43.3a	70.8a	29.2a	45.0a
	CIH	45.1a	61b	38.7b	60.2a	39.8a	47.0b
	JD 750	38.9b	127a	53.0a	58.8a	41.2a	51.0a
Pr>F							
Tillage		0.010	0.741	0.723	0.392	0.392	0.337
Drill type		0.053	0.001	0.038	0.876	0.876	0.013
Tillage*Drill		0.280	0.280	0.262	0.524	0.524	0.152

1. Case International Harvester drill with yetter coulter cart and tine drag (10" rows).
2. Data followed by the same letter in the same column group are not significantly different at the 0.10 level. n=18.

Table 2a. Effect of drill type on soil cover by weed speccies (no-till plots only) at Worthington, MN., September 9, 1994.

Seeder	Total cover	Weeds present[1] Cocklebur	Pigweed	Smart weed	Common Lambsqrtr	Thistle	Foxtail sp.
	%						
DMI/Concord	8.7a[2]	0.6a	4.0a	1.8a	1.7a	0.2b	0.4a
JD750	8.7a	0.6a	2.3a	2.9a	1.7a	1.2a	0.0a
Hiniker	6.5a	0.9a	2.5a	2.2a	0.4a	0.5b	0.0a
Pr>F							
Seeder	0.512	0.781	0.175	0.329	0.154	0.029	0.410

1. Data followed by the same column are not significantly different at the 0.10 level, n= 15.

Table 2b. Effect of seeder on soybean stand (6/10), stand establishment, corn residue before and after planting, and yield and moisture (9/30) in the no-till plots at the Worhtington site, 1994.

Seeder	Seeding Population	Soybean Population	Stand Estab.	Corn Residue 5/12[1]	5/16[2]	Harvest Moisture	Soybean yield
	Plants/acre x 1000		--%--	%		---%---	bu/A
Concord	226	167a[3]	74.1b	45.6a	33.8b	12.2a	54.7b
JD750	206	184a	89.6a	52.0a	51.4a	12.5a	61.7a
Hiniker	232	114a	49.2c	47.0a	37.6b	12.3a	55.4b
Pr>r							
Seeder		<0.001	<0.001	0.354	0.002	0.590	<0.001

1. Residue measured before planting.
2. Residue measured after planting.
3 Data followed by the same letter in the same column are not significantly different at the 0.01 level, n=15.

Table 3. Effect of seeder type on corn residue, soybean population, stand establishment and weed composition and yield in the no-till plots only at the Yellow Medicine County tillage study, 1994.

Seeder	Corn Residue	Soybean Stand	Stand Estab.	Weed Composition Grass	Broad	Soybean Yield
	%cover	#/Ax1000		-------%--------		bu/A
Sweep	37.7b[1]	55b	27.8b	68.3a	31.7a	46.1a
Case Int	52.7a	72b	45.8ab	68.8a	31.2a	48.7a
JD 750	52.2a	137a	57.3a	53.0a	47.0a	50.3a
Pr>F						
drill	0.028	0.037	0.086	0.708	0.708	0.760

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=9.

SOYBEAN STAND ESTABLISHMENT UNDER NO TILL CONDITIONS FOLLOWING CORN IN SOUTHWESTERN MN, 1994[1]

William E. Lueschen, Jim B. Nesseth, Wayne W. Schoper, Bob J. Byrnes, Steve R. Quiring, John F. Moncrief, Phyllis M. Bongard, and Brian J. Johnson[2]

Abstract: Stand establishment, height, lodging, and yield of soybeans were evaluated over a range in seeding rates under no till conditions following corn at five sites in southwestern MN. Stands ranged from 61 to 251 thousand plants per acre. When stands were over about 200 thousand plants per acre plants were slightly shorter but there was no effect of stand density on lodging. There was no affect of stand density on soybean yield at any site.

Introduction

This study was designed to assess the effect of no till soybeans following corn on stand loss and yield. Sites were established at the Lamberton Experiment Station and on four farms with assistance from cooperating farmers. Drills were set using manufacturer's recommendations to get a range in seeding rate from 125 to 250,000 seeds per acre in 25 thousand seeds per acre increments. Stands were measured at least once during the season. In some cases height and lodging observations were made.

Results

The only site that had appreciable stand loss was at Lamberton. The other four sites had stands close to the seeding rate. Height differences were related to seeding density were statistically significant where the measurements were made. Generally after about 200 thousand plants per acre heights were slightly lower. Lodging was not related to stand densities however. Final stands ranged from about 120 to 240 thousand plants per acre at the four "on farm" sites. At the Lamberton site the range was from 60 to 150 thousand plants per acre. There was no affect of stand density on soybean yield at any site.

Table 1a. Cultural practices used in the soybean seeding rate trial at the Lamberton Experiment Station, 1994.

Tillage system No-till

Planting and harvest information

Variety	Planting date	Harvest
Parker	5/17/94	10/14/94

(no inoculant or fungicide)
Planted with a John Deere 750 no-till (7")
Stands estimated by counts on $1m^2$/plot

Crop history 1993-Corn

Fertilizer applied

	Soil Test		Applied		
Date	P	K	N	P_2O_5	K_2O
	---ppm--		-----lb/A-----		
1992	15	110			
10/93			0	100	100

Soils
Ves loam (Udic Haplustoll)

Weed control

Date	Product	Rate
		lb ai/A
5/12	Glyphosate (Roundup)	0.75
5/20	Metolachlor (Dual) +	2.5
	Metribuzan (Sencor)	0.25

Experimental Design
Randomized Complete Block with 3 replications

[1] This project was supported by the Midwest Soybean Grower Association, the MN Extension Service, and The MN Agricultural Experiment Station. Their support is greatly appreciated. Special thanks to Willis Wendland, Gary Veenstra, Dennis Whinsey, and Dave Knutson for allowing this study on their farms and providing assistance in treatment establishment and measurements of crop response.

[2] William E. Lueschen and Steve R. Quiring are Head and Senior Plot Technician respectively at the Southwest Agricultural Experiment Station, Lamberton, MN; Jim B. Nesseth, Wayne W. Schoper, and Bob J. Byrnes are Extension Educators in Jackson, Brown, and Lyon Counties respectively; John F. Moncrief and Brian J. Johnson are Extension Soil Scientist and Assistant Scientist in the Soil, Water, and Climate Department, St. Paul, MN; Phyllis M. Bongard is an independent data analysis specialist, Faribault, MN.

Table 1b. Effect of seeding rate on soybean height, lodging, harvest population, and yield, October 14, 1994.

Seeding Rate	Height	Harvest Lodging	Soybean Population[2]	Yield
seeds/A	inches	score	plants/Ax1000	bu/A
125,000	24.0bc[1]	2.0a	97.2bc	42.8a
150,000	15.0c	2.3a	60.7c	41.2a
175,000	22.3bc	2.0a	90.4bc	40.7a
200,000	32.3ab	2.7a	130.9ab	42.5a
225,000	25.3bc	2.3a	102.6bc	43.8a
250,000	36.3a	2.7a	147.1a	43.1a
Pr>F				
Seeding rate	0.064	0.574	0.064	0.739

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=18.
2. Stand was measured by 1 meter square/plot.

Table 2a. Cultural practices used in the soybean seeding rate trial at the Willis Wendland farm in Lyon County, Minnesota, 1994.

Tillage system
No-till

Planting and harvest information

Variety	Planting date	Harvest
Parker	5/16/94	10/12/94

Planted with a John Deere 750 no-till drill (7" rows)

Crop history
1993 Corn

Fertilizer applied
none

Soil
Barnes loam (Udic Haploboroll)

Weed control

Date	Product	Rate
		lb ai/A
5/12 PPI	(Treflan)	1.0
6/8 Post	Imazethapyr (Pursuit)	0.032

Experimental Design
Randomized Complete Block with 3 replications. Stands were estimated by counting 10feet of row three places in each plot.

Table 2b. Effect of seeding rate on soybean harvest population, moisture content and yield at the Wendland farm, October 12, 1994.

Seeding Rate	Harvest Population[2]	Moisture Content	Soybean Yield
seeds/A	plt/Ax1000	--%--	bu/A
125,000	162.9c[1]	10.8a	47.2a
150,000	153.6c	10.7a	49.0a
175,000	165.3c	10.6a	50.2a
200,000	202.5b	11.1a	49.8a
225,000	207.2b	11.0a	48.8a
250,000	251.4a	10.9a	48.0a
Pr>F			
Seeding rate	<0.001	0.124	0.279

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=18.
2. Stand was measured by 10 ft. Counted, 3 places/plot.

Table 3a. Cultural practices used in the soybean seeding rate trial at the Gary Veenstra farm in Brown County, Minnesota, 1994.

Tillage system
No-till

Planting and harvest information

Variety	Planting date	Harvest
ICI 213	5/4/94	10/13/94

treated with fungicide
Planted with John Deere 750 no-till drill (10" rows)

Crop history
1993 - Corn (C-S rotation)

Fertilizer applied
None (fertilizer applied in corn years)

Soil
Ves and Storden loams 2-6% slope
(Udic Haplustoll & Typic Eutrochrept)

Weed control

Date	Product	Rate lb ai/A
6/7	Imazethapyr (Pursuit)	0.047

Observed weed pressure: light to moderate
Weeds present: Foxtail sp., Quackgrass, Dandelion, Thistles, Mares tail, slight volunteer corn

Experimental Design
Randomized Complete Block with 3 replications

Estimated crop residue cover
Before planting 77%
After planting 69%
(Estimates by G. Tennant of Brown Co. SCS)

Table 3b. Effect of seeding rate on soybean population (7/13), harvest moisture content and yield (10/13) at the Veenstra farm, 1994.

Seeding Rate	Soybean Population[2]	Moisture Content	Soybean Yield
seeds/A	plant/Ax1000	--%--	bu/A
125,000	130.7[1]	10.2a	45.5a
150,000	167.5	10.6a	48.4a
175,000	183.2	10.4a	52.4a
200,000	209.4	10.4a	48.2a
225,000	225.1	10.5a	49.1a
250,000	246.0	10.3a	46.2a
Pr>F			
Seeding rate		0.138	0.732

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=18.

Table 4a. Cultural practices used in the soybean seeding rate trial at the Dennis Whinsey farm in Jackson County, Minnesota, 1994.

Tillage system No-till
John Deere 750 no till drill (7.5" rows)

Planting and harvest information

Variety	Planting date	Harvest
Stine 2245	5/12/94	10/12/94

no inoculant or fungicide

Crop history 1993 - Corn (C-S normal rotation)

Soil
Canisteo-Glencoe clay loam 1% slope
(Typic Endoaquoll & Cumulic Endoaquoll)

Soil test (1990)	O.M.	pH	P	K
no fertilizer '94	6.5%	6.9	70 ppm	500 ppm

Weed control

Date	Product	Rate lb ai/A
5/4	Glyphosate (Roundup) +	0.38
	2,4-D	0.5
6/4	Bentazon + Aciflourfen (Galaxy) &	0.69
	Imazethapyr (Pursuit)	0.032
6/20	Clethodim (Select)	0.125

Experimental Design
Randomized Complete Block with 3 replications. Stands were estimated by counting plants in 10 feet of row in 3 places in each plot.

Estimated crop residue cover
Before planting 75%
After planting 80%

Table 4b. Effect of seeding rate on soybean populations at stages V2 and physiological maturity (PM), soybean height, and yield at the Whinsey farm, 1994.

Seeding Rate	V2[2] Population	PM Population	Soybean Height	Soybean Yield
seeds/A	plants/A x 1000		inches	bu/A
125,000	124.7f[1]	124.0f	41.0a	48.4a
150,000	138.7e	138.2e	41.0a	50.0a
175,000	167.3d	166.2d	41.0a	51.3a
200,000	209.3c	210.8c	40.0b	49.3a
225,000	224.3b	221.3b	40.0b	50.0a
250,000	243.3a	238.7a	39.0c	48.4a
Pr>F				
Seeding rate	<0.001	<0.001	<0.001	0.685

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=18.
2. Stand was measured by 10 ft. Count, 3 places/plot.

Table 5a. Cultural practices used in the soybean seeding rate trial at the Dave Knutson farm in Jackson County, Minnesota, 1994.

Tillage system No-till

Planting and harvest information

Variety	Planting date	Harvest
DeKalb 232	5/15/94	10/9/94

no inoculant or fungicide (10" rows)

Crop history 1993-Corn (C-S rotation)

Fertilizer applied none

Soil Clarion loam 2-6% slope (Typic Hapludoll)

Soil test (1992)

O.M.	pH	P	K
3.7%	6.1	47 ppm	203 ppm

Weed control

Date	Product	Rate
		lb ai/A
5/8	Glyphosate (Roundup) +	0.75
	2,4-D	0.5
6/4	Bentazon + Aciflourfen	
	(Galaxy) &	0.69
	Imazethapyr (Pursuit)	0.032

Experimental Design

Randomized Complete Block with 3 replications. Stands were estimated by counting plants in 10 feet of row in 3 places in each plot.

Estimated crop residue cover

Before planting 70%
After planting 60%

Table 5b. Effect of seeding rate on soybean population at stages V2 and physiological maturity (PM), soybean height, moisture content, and yield (10/9) at the Knutson farm, 1994.

Seeding Rate	V2 Population	PM Population	Soybean Height	Moisture Content	Soybean Yield
seeds/A	plants/A x 1000[2]		inches	--%--	bu/A
125,000	122.8d[1]	121.7e	40.7a	13.2a	48.4a
150,000	143.8c	140.3d	40.0a	13.3a	49.5a
175,000	154.5c	154.7cd	40.0a	13.3a	53.0a
200,000	158.8c	158.7bc	40.0a	13.0a	55.2a
225,000	177.4b	176.7b	40.0a	12.3a	48.8a
250,000	241.4a	237.3a	38.0b	13.3a	54.2a
Pr>F					
Seeding rate	<0.001	<0.001	0.001	0.708	0.312

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=18.
2. Stand was measured by 10 ft. Count, 3 places/plot.

INTEGRATION OF MANURE AND ALFALFA N SOURCES INTO RESIDUE MANAGEMENT SYSTEMS FOR KARST AREAS OF MN, 1994[1]

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Abstract Tillage and N source were evaluated for corn and soybean production on four farms in southeastern MN. Generally "in row" cover with corn or soybean residue reduced corn development. Soybean growth was slowed in some instances but no yields. Tillage had variable effects on grain yields. Manure generally resulted in increased early growth and development compared to commercial fertilizer.

Introduction

This study was initiated in the spring of 1993 to evaluate manure utilization strategies within residue management systems in southeastern MN. The same farmer cooperators agreed to another year in three counties in 1994. Each demonstration was tailored to fit within the project guidelines and also address particular farmer interests. Residue management systems are the convention in this part of the state due to the erosive nature of the soils. This is the second and final year of this study.

Tony and Walter Hammel Farm

This site had first year corn following alfalfa in 1993. Treatments in 1993 included aspect and timing of alfalfa killing as variables. For a detailed description of treatments see the 1994 copy of this publication. In 1994 in addition to these two variables planter applied fertilzier was evaluated on second year corn. The design is a randomized complete block with split, split plots. Time of alfalfa kill are main plots, the first subplot is aspect, and the second subplot is starter fertilizer. The planter used was equipped with a 2 inch fluted coulter.

Residue levels are shown in table 1b. Killing the alfalfa in the spring of 1993 compared to the fall of 1992 resulted in higher levels of residue in the row after planting in 1994 (72 compared to 65%). This is largely due to higher densities of weed and alfalfa residues. Fluted coulters reduced "in row" cover from 74 to 63%. This is much higher than optimum for corn growth and development.

Early growth, stand, and tasselling rate are shown in table 1c. Starter fertilizer increased corn stands by about 1,600 plants per acre. Starter also increased early growth by .5 leaves per plant. None of the treatments affected the tasselling rate, however. The silking data shows an effect of aspect (table 1d). Southern aspect had about 25% more plants with silk emerged on 7/18 and 7/22.

Inadvertently one replication was lost by harvest by the cooperating farmer. For this reason yield parameters do not have a statistical analysis. Means of the remaining two replications are presented to show trends. No conclusions can be drawn however.

Jim Holty Farm

At the Jim Holty farm two studies were conducted. The first evaluated tillage and nitrogen source on corn response followig corn. The second evaluated tillage effects on soybean production. The corn study is shown in tables 2b-2d. In this study the two N sources (manure and anhydrous) and two tillage systems were evelauted (chisel and no till). Soil cover with corn residue was influenced strongly by the rolling finger type row cleaners. After planting there was about the same "in row" cover for both the no till and chisel systems (about 37%) although there was large differences between the row. At the second residue measurement (6/27) the residue had blown back into the row with the no till treatment. The increase was more with the manure application than with the anhydrous N source (20 vs 10%). These values are much to high for effective early corn growth and

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development.

Tillage and N source did not affect stands (table 2c). Both did affect early growth. The no till system reduced early growth 1.3 leaves per plant compared to the chisel system. The manure N source increased early growth by .4 leaves. The growth advantage of the corn grown with chisel plowing also hastened tasselling. The manure N source showed a similar trend. Development trends also carried through silk emergence (table 2d).

Chisel plowing resulted in a 45 bushel per acre yield advantage over the no till system. This is a greater difference than other studies have shown considering the size of the early growth differnces. There was a small yield advantage of the manure N source (7 bushels per acre).

The soybean study compared no till and chisel tillage system effects on soybean response (tables 2e and 2f). Corn residue levels were about 20% higher with no tillage. Chisel plowing followed with secondary tillage left greater than 30% cover.

Soybean stands were similar and more than adequate. Although there was a slight early growth difference (.2 nodes per plant) grain yields were identical. This is typical on these soils when weeds are effectively controlled.

Dan Graskamp Farm

At this site two sources of N (liquid pig manure and anhydrous ammonia), two rates of manure (1,500 and 3,000 gallons per acre resulting in 80 and 160 pounds of estimated available N per acre), and row cultivation was evaluated on second year corn. Results are given in tables 3a-3c.

Corn residue levels were greater than 40% and slightly higher in the row (apparently the result of the planter mounted fluted coulters). It is also interesting that row cultivation tended to increase cover with corn residue. Soil cover in the row is much higher than recommended.

Stands, early growth and yield are shown in table 3c. The high rate of manure increased stands about 2,000 plants per acre. Cultivation reduced stands 1,000 plants per acre. Stand levels are high enough that it is unlikely that they affected yields. Cultivation decreased early growth by .4 leaves per plant. A similar trend was found in the rate of silk emergence and grain moisture.

Yields were not affected by N source, rate, or cultivation.

Daryl Highum Farm

Treatments at this site are tillage, corn hybrid, and N source. Tillage systems evaluated are chisel plowing followed by discing and a no till approach. Nitrogen sources are anhydrous ammonia and liquid hog manure. Manure application was made in the spring followed by tillage and planting. Anhydrous ammonia was applied side dress June 15. The results from this demonstration is presented in tables 4a-4d and figures 1-6. Back ground information for is shown in table 4a.

Soil cover with soybean residue was about 9% for both tillage systems after planting. The fluted coulters did an usually good job of removing residue from the row area with both tillage sytems. On the second date of residue measurment (only 9 days later) "in row" cover increased about 30% with the no till system. Manure increased soil cover slightly with the discing system but reduced it with no tillage.

The main effects of tillage, N source, and hybrid did not affect stands. There was a significant interaction between N source and tillage. Tillage surprisingly did not affect early growth. There was an effect of N source and corn hybrid. Manure and the Cargill hybrid increased early growth .3 leaves per plant. The manure N source and Cargill hybrid resulted in earlier tasselling and silk emergence. There were no significant main effects for grain moisture although there were several interactions. Grain yields were only affected by corn hybrid (P3578 was 10 bushels per acre higher than Cargill 4327).

Sigificant interactions are shown in figures 1-4. The Cargill hybrid tasselled much earlier than the Pioneer hybrid under the discing tillage system. Grain moisture showed an opposite trend which is expected. Grain yield differences between hybrids were greater under the discing tillage system.

The relationship between "in row" cover with corn residue and early growth for the two hybrids is shown in figures 5 and 6. Residue effects on early growth increased with time for the Cargill hybrid and decreased with time for the Pioneer hybrid.

Table 1a. Cultural practices used at the Hammel farm sodkill (1993), aspect (1993), and starter fertilizer (1994) corn study Houston County, MN, 1994.

Tillage system
No-till (not a variable)

Planting and harvest information

Crop	Hybrid	Planted	Seeds	Harvested
Corn (100 day)	DK 451	4/20	29,000s/A	9/15/94

New Idea planter with Kinsey planting units and 2" fluted coulters

Crop history
1993 - Corn; 1992 Alfalfa

Fertilizer nutrients applied

		applied (lb/A)		
Date	Analysis	N	P_2O_5	K_2O
4/20/94	9-23-30	9	23	30

Liquid dairy manure applied

Manure Analysis (lb/1000 gallons)				
Total N	NH_4^+	Org. N	P_2O_5	K_2O
48	24	24	19	31

		Nutrients applied			
Date	Rate	Total N	N_{avail}[1]	P_2O_5	K_2O
	gal/A	----------lb/A----------			
11/93	3000	145	94	56	93

1. Estimated available N from manure = 100% mineral N + 30% organic N (Assumes 50% org. and 50% inorg.)
Liquid dairy manure stored in earthen lagoon.

Soils
Black Hammer-Southridge silty clay loam
Nodine-Rollingstone silty clay loam
(Typic Hapludalfs & Typic Paleudalfs respectively)

Weed control

Date	Herbicide	Rate
		lb ai/A
5/9/94	Acetachlor (Harness)	1.75
"	Dicamba (Banvel)	0.25
"	Flumetsulam (Broadstrike)	0.04

Fall '92 or Spring '93 glyphosate (Roundup) for alfalfa sod kill

Weed (6/27)	Whole site % cover
Foxtail sp.	40
Quackgrass	15
Com. lambsquarters	10
Dandelion	1.5
Alfalfa	1
Common milkweed	1
Blackseed plantain	1
Hedge bindweed	0.5

Aspect		Mean
North slope	14-22%	17.8
South slope	16-21%	17.2

Table 1b. Effect of sodkill, aspect, and starter fertilizer on corn residue in and between the rows at the Hammel farm demonstration, June 1994.

			Corn Residue					
			6/9/94		6/27/94		Mean	
Sodkill	Aspect	Starter	In	Between	In	Between	In	Between
			----------% cover----------					
Fall	North	Yes	57.5a[1]	67.5a	67.5	72.5	62.5	70.0
		No	62.5a	75.0a	62.5	72.5	62.5	73.8
	South	Yes	62.5a	65.0a	55.0	67.5	58.8	66.2
		No	52.5a	77.5a	50.0	72.5	51.2	75.0
Spring	North	Yes	65.0a	70.0a	62.5	77.5	63.8	73.8
		No	70.0a	80.0a	70.0	70.0	70.0	75.0
	South	Yes	77.5a	82.5a	72.5	80.0	75.0	81.2
		No	62.5a	77.5a	60.0	77.5	61.2	77.5
Fall[2]			65.0a		65.0a		65.0a	
Spring			73.1a		71.2a		72.2b	
	North[2]		8.4a		69.4a		68.9a	
	South		69.7a		66.9a		68.3a	
		Starter[2]	68.4a		69.4a		68.9a	
		No starter	69.7a		66.9a		68.3a	
		Row pos.	63.8a	74.4a	62.5a	73.8b	63.1a	74.1a
Pr>F								
Sodkill			0.190		0.186		0.028	
Aspect			0.728		0.314		0.808	
Sodkill*Aspect			0.508		0.116		0.238	
Starter			0.811		0.732		0.920	
Starter*Sodkill			0.637		0.863		0.763	
Starter*Aspect			0.315		0.863		0.586	
Starter*Sodkill*Aspect			0.558		0.732		0.654	
Row Position			0.174		0.064		0.108	
Row position*sodkill			0.799		0.817		0.803	
Row position*aspect			0.865		0.494		0.690	
Row position*starter			0.502		0.817		0.620	
Row pos *sodkill*aspect			1.00		0.817		0.920	
Row pos *sodkill*starter			0.865		0.645		0.765	
Row pos.*aspect*starter			0.672		0.494		0.586	
RowP.*sodkill*aspect*starter			0.799		0.645		0.960	

1 Data followed by the same letter in the same group (by date) are not significantly different at the 0.10 level, n=32

2. Means are over row position.

Table 1c. Effect of sodkill, aspect and starter fertilizer on corn population, corn leaf numbers, and tasselling at the Hammel farm, 1994.

			Corn Population			Leaf Numbers			Corn Tasselling		
Sodkill	Aspect	Starter	6/9	6/27	Mean	6/9	6/27	Mean	7/18	7/22	Mean
			--plants/A x 1000----			----leaves/plant---			------% plants------		
Fall	North	Yes	18.6a[1]	19.2a	18.9ab	4.6a	7.2a	6.0a	55.8a	92.3a	74.0a
		No	19.9a	19.9a	19.9ab	4.2a	6.2a	5.2a	49.2a	81.2a	65.2a
	South	Yes	19.9a	21.3a	20.6ab	5.1a	8.4a	6.8a	88.3a	100.0a	94.2a
		No	17.9a	17.9a	17.9b	5.0a	8.0a	6.5a	95.4a	100.0a	97.8a
Spring	North	Yes	24.0a	24.7a	24.4a	5.0a	7.6a	6.4a	83.4a	100.0a	91.7a
		No	22.0a	22.0a	22.0ab	4.5a	8.4a	6.4a	85.0a	100.0a	92.5a
	South	Yes	20.6a	20.6a	20.6ab	5.5a	8.5a	7.0a	97.4a	100.0a	98.7a
		No	17.2a	19.2a	18.2b	4.9a	6.8a	5.8a	78.6a	85.7a	81.2a
Fall			19.1a	19.6a	19.3a	4.8a	7.4a	6.1a	72.2a	93.4a	82.8a
Spring			21.0a	21.6a	21.3a	5.0a	7.8a	6.4a	86.0a	96.4a	91.3a
	North		21.1a	21.5a	21.3a	4.6a	7.4a	6.0a	68.3a	93.4a	80.9a
	South		18.9a	19.8b	19.3a	5.1a	7.9a	6.5a	89.9a	96.4a	93.2a
		Starter	20.8a	21.5a	21.1a	5.1a	7.9a	6.5a	81.2a	98.1a	89.7a
		No Starter	19.2b	19.8a	19.5b	4.6a	7.3a	6.0a	77.0a	91.7a	84.4a
Pr>F											
Sodkill			0.500	0.442	0.471	0.153	0.667	0.549	0.228	0.775	0.429
Aspect			0.238	0.072	0.163	0.231	0.369	0.270	0.145	0.656	0.238
Sodkill*Aspect			0.294	0.072	0.187	0.793	0.193	0.322	0.194	0.226	0.199
Starter			0.027	0.142	0.069	0.143	0.155	0.113	0.639	0.159	0.400
Starter*Sodkill			0.057	0.734	0.306	0.522	0.794	0.856	0.614	0.841	0.663
Starter*Aspect			0.057	0.506	0.225	0.895	0.300	0.483	0.846	0.841	0.834
Starter*Sodkill*Aspect			0.320	0.218	0.225	0.696	0.089	0.176	0.356	0.159	0.254

1. Data followed by the same letter in the same column group are not significantly different at the 0.10 level, n=16.

Table 1d. Effect of sodkill, aspect, and starter fertilizer on corn silking, harvest population, grain moisture and corn yield at the Hammel farm, September 9, 1994.

			Corn silking			Harvest	Harvestable		
Sodkill	Aspect	Starter	7/18	7/22	Mean	Pop.	Ears	Moisture	Yield
			-------% plants--------			plts/Ax1000	%	%	bu/A
Fall	North	Yes	0.0a	42.0a	21.0a	17.9	100.0	30.8	76.1
		No	0.0a	31.9a	16.0a	16.5	100.0	30.4	75.2
	South	Yes	36.6a	96.2a	66.4a	19.2	78.6	47.4	54.2
		No	32.2a	90.9a	61.6a	16.5	100.0	29.4	73.6
Spring	North	Yes	20.1a	96.6a	58.4a	20.6	96.2	29.4	116.2
		No	24.6a	78.2a	51.4a	19.2	95.6	34.1	94.3
	South	Yes	37.3a	90.2a	63.8a	19.6	95.3	28.0	107.1
		No	35.7a	67.8a	51.8a	21.3	85.0	29.4	110.4
Fall			17.2a	65.2a	41.2a	17.5	94.6	34.5	69.8
Spring			29.4a	83.2a	56.4a	20.2	93.0	30.2	107.0
	North		11.2a	62.2b	36.7b	18.6	98.0	31.2	90.4
	South		35.5a	86.3a	60.9a	19.2	89.7	33.4	86.3
	Starter		23.5a	81.3a	52.4a	19.3	92.5	33.9	88.4
	No Starter		23.1a	67.2a	45.2a	18.4	95.2	30.8	88.4
Pr>F									
Sodkill			0.609	0.468	0.533				
Aspect			0.142	0.042	0.037				
Sodkill*Aspect			0.428	0.024	0.047				
Starter			0.955	0.225	0.399				
Starter*Sodkill			0.783	0.550	0.784				
Starter*Aspect			0.694	0.982	0.883				
Starter*Sodkill*Aspect			0.949	0.834	0.871				

1. Data followed by the same letter in the same column group are not significantly different at the 0.10 level, n=16.

Table 2a. Cultural practices used at the Holty farm corn and soybean tillage studies, Houston County, 1994.

Tillage systems

1. No-till
2. Spring disced (4/20/94) 14' Case IH; chisel plowed (4/23/94) Case IH with 2" shovels;

Planting and harvest information

Crop	Hybrid/Var.	Plant	Population	Harvest
Corn	Keltgen 2550	4/23	29,000s/A	11/16
Sybn	Asgrow 2234	4/26	210,000s/A	11/16

Corn planted with Case IH 800 with Yetter rolling finger row cleaners.

Soybeans planted with Case IH grain drill equipped with a Yetter coulter cart.

Crop history

1993 - Corn at both demonstration sites

Fertilizer nutrients applied (corn only)

		applied (lb/A)		
Date	Analysis	N	P_2O_5	K_2O
4/18/94	82-0-0	131	0	0
4/20/94	9-23-30	12	30	39

Beef manure nutrients applied

Manure Analysis (lb/ton)				
Total N	NH_4^+	Org. N	P_2O_5	K_2O
16	3	13		

		Nutrients applied			
Date	Rate	Total N	N_{avail}[1]	P_2O_5	K_2O
	ton/A	----------lb/A----------			
4/12/94	21	336	158		

1. Estimated available N from manure =100% mineral N + 35% organic N Solid beef manure from cement lot.

Soils

Port Byron silt loam 3-6% slope (Typic Hapludoll)

Weed control

Date	Product	Rate
Corn		lb ai/A
5/15/94	Dicamba+Atrazine (Marksman)	1.0
	" Metolachlor (Dual)	1.3
	" Atrazine	0.6

6/3 & 6/16 Row cultivator- Case IH 4-38" rows & 5 Danish tines/row

Soybean

Rep 1		lb ai/A
5/3	Imazethapyr + Pendimethalin (Pursuit Plus)	0.9
"	Pendimethalin (Prowl)	0.5
Rep 2		
6/21/94	Imazethapyr (Pursuit)	0.063
"	Thifensulfuron (Pinnacle)	0.001

Weeds present	Whole site % cover
Corn	
Foxtail sp	4.0
Quackgrass	2.0
Horsetail	0.5
Velvetleaf	0.1
Dandelion	0.5
Soybean	
No-till plots	
Quackgrass	2.0
Horsetail	0.5
Red clover	0.05
Maple trees	0.05
Chisel plots	
Quackgrass	1.0
Velvetleaf	1.0

Table 2b. Effect of tillage and manure on corn residue (6/9 and 6/27) in the corn demonstration at the Holty farm, 1994.

Tillage	N Source	Corn Residue 6/9 Row Position In	Corn Residue 6/9 Row Position Between	Corn Residue 6/27 Row Position In	Corn Residue 6/27 Row Position Between	Corn Residue Mean In	Corn Residue Mean Between
		----------% cover----------					
No-till	Manure	38.2bc[1]	70.8a	63.2a	65.5a	51.0ab	68.2a
	An.NH_3	40.8bc	60.0ab	49.5a	60.5a	45.2ab	60.2ab
Chisel/disc	Manure	32.5c	40.8bc	43.8a	46.0a	38.2b	43.5ab
	An.NH_3	35.8bc	38.8bc	55.2a	55.0a	45.5ab	47.0ab
No-till[2]		52.4a		59.7a		56.2a	
Chisel/disc		36.9a		50.0a		43.6a	
	Manure[2]	45.6a		54.6a		50.2a	
	An.NH_3	43.8a		55.1a		49.5a	
	Row position	36.8b	52.6a	52.9b	56.8a	45.0b	54.8a
Pr>F							
Tillage		0.136		0.267		0.184	
N Source		0.619		0.941		0.776	
Tillage*N Source		0.512		0.203		0.118	
Row position		0.003		0.053		0.006	
Row position*tillage		0.013		0.115		0.025	
Row position*N Source		0.124		0.327		0.456	
Row pos*tillage* N Source		0.449		0.115		0.847	

1. Data followed by the same letter in the same column or row group (by date) are not significantly different at the 0.10 level, n=16.
2. Means within row position.

Significant interactions from Table 2b.

Tillage	Residue 6/9 Row position In	Residue 6/9 Row position Between	Residue 6/27 Row position In	Residue 6/27 Row position Between	Corn Residue means In	Corn Residue means Between
	----------%cover----------					
No-till	39.5b	65.4a	56.4	63.0	48.1	64.2
Chisel	34.2b	39.8b	49.5	50.5	41.9	45.2

Table 2c. Effect of tillage and N source on corn population, leaf numbers, tasselling, silking and harvest data in the corn demonstration at the Holty farm, 1994.

Tillage	N Source	Corn Population 6/9	Corn Population 6/27	Corn Population Mean	Leaf Numbers 6/9	Leaf Numbers 6/27	Leaf Numbers Mean	Tasselling 7/13	Tasselling 7/17	Tasselling Mean
		---plants/A x 1000---			------leaves/plant------			----------% plants--------		
No-till	Manure	21.2a[1]	20.4a	20.9a	4.9b	7.4bc	6.2b	16.6a	72.7a	44.6a
	An.NH_3	20.9a	20.3a	20.6a	4.9b	7.2c	6.1b	6.8a	69.6a	38.2a
Chisel/	Manure	23.3a	23.5a	23.4a	5.6a	9.8a	7.8a	50.4a	92.1a	71.2a
disc	An.NH_3	23.6a	24.2a	24.0a	5.2ab	9.2ab	7.2ab	32.8a	84.4a	58.6a
No-till		21.0a	20.4a	20.7a	4.9a	7.3b	6.2b	11.7b	71.1a	41.4a
Chisel/disc		23.5a	23.8a	23.4a	5.4a	9.5a	7.5a	41.6b	88.2b	65.0a
	Manure	22.2a	22.0a	22.1a	5.3a	8.6a	7.0a	33.4a	82.4a	58.0a
	An.NH_3	22.2a	22.3a	22.3a	5.1a	8.2a	6.6a	19.8a	77.0a	48.4a
Pr>F										
Tillage		0.451	0.407	0.426	0.114	0.080	0.084	0.291	0.073	0.168
N Source		1.00	0.795	0.916	0.057	0.226	0.137	0.113	0.586	0.245
Tillage*N		0.838	0.752	0.755	0.057	0.457	0.237	0.521	0.812	0.652

1. Data followed by the same letter in the same column group are not significantly different at the 0.10 level, n=8.

Table 2d. Effect of tillage and N source on corn silking, grain moisture, and corn yield in the demonstration at the Holty farm, 1994.

Tillage	Source	Corn Silking 7/13	Corn Silking 7/17	Mean	Grain Moisture	Corn Yield
		------% plants------			%	bu/A
No-till	Manure	0.0a	15.2a	7.6a	19.2a	117a
	An.NH_3	0.0a	22.4a	11.2a	19.4a	102a
Chisel	Manure	11.0a	79.0a	45.0a	19.8a	154a
	An.NH_3	4.8a	47.4a	26.1a	19.4a	153a
No-till		0.0a	18.8a	9.4a	19.3a	109a
Chisel		7.9a	63.2a	35.6a	19.6a	154a
	Manure	5.5a	47.0a	26.3a	19.6a	135a
	An.NH_3	2.4a	34.9a	18.7a	19.4a	127a
Pr>F						
Tillage		0.202	0.141	0.150	0.644	0.114
N Source		0.280	0.252	0.158	0.168	0.117
Tillage*N Source		0.280	0.126	0.082	0.038	0.135

1. Data followed by the same letter in the column group are not significantly different at the 0.10 level, n=8.

Table 2e. Effect of tillage on corn residue in and across the rows in the soybean study at the Holty farm, 1994.

Tillage	Residue (6/17) Row Position In	Residue (6/17) Row Position Across	Residue (6/24) Row Position In	Residue (6/24) Row Position Across	Residue means Row Position In	Residue means Row Position Across
	----------%cover----------					
No-till	52.5a[1]	54.3a	62.5a	52.2a	57.5a	53.2a
Chisel	30.0a	30.7a	33.3a	34.3a	31.7a	32.6a
No-till[2]	53.4a		57.3a		55.4a	
Chisel	30.4a		33.8a		32.1a	
RowPos.	41.2a	42.5a	47.9a	43.2a	44.6a	42.9a
Pr>F						
Tillage	0.146		0.160		0.153	
RowPos.	0.775		0.263		0.660	
Till*RPos.		0.899		0.202		0.523

1. Data followed by the same letter in the column group are not significantly different at the 0.10 level, n=8.
2. Means over row position.

Table 2f. Effect of tillage on soybean population, node numbers and harvest data in the soybean demonstration at the Holty farm, June 1994.

Tillage	Soybean Population 6/8	Soybean Population 6/24	Soybean Population Mean	Node Numbers 6/8	Node Numbers 6/24	Node Numbers Mean	Harvest Moisture	Soybean Yield
	plt/Ax1000			nodes/plant			--%--	bu/A
No-till	206a	192a	199a	3.1b	6.8a	5.0a	14.2a	57.4a
Chisel/Disc	227a	220a	224a	3.3a	7.0a	5.2a	14.6a	57.4a
Pr>F								
Tillage	0.747	0.683	0.713	0.052	0.205	0.126	0.395	1.00

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level, n=4.

Table 3a. Cultural practices used in the Graskamp farm nitrogen source and cultivation corn study near Fountain in Fillmore County, 1994.

Tillage systems

1. Coulter-Chisel plow (fall) 13' John Deere with straight discs at 7" spacing in front of 3" shanks at 18" spacing in back followed by a feld cultivator (5/2/94) 21' w/ 2" shanks at 6" spacings

2. No till

Planting and harvest information

Crop	Hybrid	Plant	Population	Harvest
Corn	Agrigene 3965	5/2	25,500s/A	11/9

Corn planted with John Deere 7000 with 2" fluted coulters

Crop history

1993 - Corn

Soil

Fayette silt loam 2-6% slope
(Typic Hapludalf)

Insect Control

5/2 Terbufos (Counter) 1.2 oz ai/1000' row (1.0 lb ai/A)

Nutrients applied (lb/A)

Date	Analysis	N	P_2O_5	K_2O
4/20/94	82-0-0	125	0	0
5/2/94	8-20-27	10	25	34

Liquid hog manure applied

Manure Analysis (lb/1000 gallons)

Total N	NH_4^+	Org. N	P_2O_5	K_2O
57.1	51.0	6.1		

Nutrients applied

Date	Rate	Total N	N_{avail}[1]	P_2O_5	K_2O
	gal/A	lb/A			
11/93	3000	171	160		
"	1500	86	80		

1. Estimated available N from manure = 100% mineral N + 35% organic N Liquid hog manure stored in a pit.

Weed control

Date	Control	Rate
		lb ai/A
5/12/94	Dicamba + Atrazine (Marksman)	1.0
	Pendimethalin (Prowl)	1.25
	Cyanizine (Bladex)	0.9
6/16/94	Row cultivator 13' John Deere (4-38"rows) w/ 4-2" sweeps between rows	

Weeds present	% cover
Foxtail sp	1.5
Quackgrass	1.0
Velvetleaf	1.0

Table 3b. Effect of nitrogen source and cultivation on corn residue in and between the rows at the Graskamp farm, 1994.

N Source	Cultivation	Corn residue 5/31/94 In	5/31/94 Between	6/21/94 In	6/21/94 Between	Means In	Means Between
		%cover					
Anhyd. NH_3	No	46.2a[1]	43.4ab	40.4a	39.2a	43.5a	39.8abc
	Yes			45.4a	44.2a		
Manure	No	43.9a	30.2c	45.8a	40.8a	44.8a	35.6c
1500g/A	Yes			52.0a	43.6a		
Manure	No	45.2a	33.8bc	39.1a	40.1a	42.2ab	37.0bc
3000g/A	Yes			42.2a	38.4a		
Anhyd. NH_3[2]		43.5a		42.3a		41.7a	
Manure (1500g/A)		37.1a		45.5a		40.2a	
Manure (3000g/A)		39.5a		40.0a		39.6a	
No Cultivation[2]				40.9a			
Cultivation				44.3a			
Row position		45.2a	34.8b	44.1a	41.1a	43.5a	37.4b
Pr>F							
N Source			0.296		0.166		0.674
Cultivation					0.141		
N Source*Cultivation				0.669			
Row Position		<0.001		0.118		0.004	
Row pos.*N Source		0.237		0.414		0.360	
Row pos.*Cultivation				0.473			
Row pos*N*Cultivation				0.864			

[1]Data followed by the same letter in the same group (by date) are not significantly different at the 0.10 level. n=24 (before cultivation); n=48 (after cultivation)
[2]Means over row position.

Table 3c. Effect of nitrogen source and cultivation on corn population, corn leaf numbers, silking score (7/25), and harvest data (11/9) at the Graskamp farm, 1994.

N Source	Cultivation	Corn Population[1] 5/31	6/21	Mean	Leaf Numbers 5/31	6/21	Mean	Silk Score[2]	Grain Moisture	Corn Yield
		----plants/Ax1000----			------leaves/plant------			score	%	bu/A
An. NH3	No		24.1bc[3]			6.9a		1.2a	13.7a	140a
	Yes		24.8abc			6.5abc		1.2a	13.2b	143a
Manure	No		22.9c			6.9a		1.2a	13.6a	148a
1500g/A	Yes		25.4ab			6.4bc		1.0a	13.4a	146a
Manure	No		26.4a			6.8ab		1.4a	13.3ab	150a
3000g/A	Yes		26.5a			6.2c		1.1a	13.1b	152a
An. NH_3		23.8b	24.4b	24.1b	2.4a	6.7a	4.6a	1.2a	13.4a	142a
Man.-1500g/A		24.3b	24.2b	24.2b	2.4a	6.6a	4.6a	1.1a	13.5a	147a
Man.-3000g/A		26.4a	26.4a	26.4a	2.4a	6.5a	4.4a	1.2a	13.2a	151a
No Cultivation				24.5b			6.8a	1.3a	13.5a	146a
Cultivation				25.5a			6.4b	1.1a	13.2b	147a
Pr>F										
N Source		0.010	0.056	0.016	0.831	0.632	0.584	0.670	0.195	0.341
Cultivation			0.094			0.001		0.117	0.031	0.542
N*Cultivation			0.266			0.681		0.500	0.501	0.584

[1]Late emergence noted in heavy residue areas.
[2]Silking score based on color: 1=white or yellow (not pollinated) 5=brown (pollinated).
[3]Data followed by the same letter in the same column group are not significantly different at the 0.10 level. n=12 (before cultivation) n=24 (after cultivation).

Table 4a. Cultural practices used in the Highum farm tillage, nitrogen source, and corn variety study near Rushford in Fillmore County, 1994.

Tillage systems
1. Disc (4/22/94) 19' Ford with 20" discs
2. No till

Planting and harvest information

Crop	Hybrid	Plant	Pop.	Harvest
Corn	P3578	4/23&29	30,000s/A	10/24
"	Cg4327	"	"	"

105 day RM for both corn hybrids
Corn planted with Allis Chalmers with 2" fluted coulters

Crop history
1993 - Soybeans

Soils
Alluvial soil

Nutrients applied

Actual applied (lb/A)	Date	Analysis	N	P_2O_5	K_2O
	4/23&29	9-23-30	14	34	45
	6/6/94	82-0-0	102	0	0

Liquid hog manure applied

Manure Analysis (lb/1000 gallons)

Total N	NH_4^+	Org. N	P_2O_5	K_2O
70.3	44.1	26.1		

Date	Rate	Nutrients applied Total N	N_{avail}[1]	P_2O_5	K_2O
	gal/A	----------lb/A----------			
11/93	2500	176	133		

1. Estimated available N from manure =100% mineral N + 35% organic N Liquid hog manure stored in a pit.

Weed control

Date	Control	Rate
		lb ai/A
5/6/94	Dicamba + Atrazine (Marksman) +	1.2
"	Metolachlor (Dual)	2.0
6/2/94	Nicosulfuron (Accent)	0.03

Weeds present	% cover
Velvetleaf	1.0

Table 4b. Effect of tillage, nitrogen source, and hybrid on soybean residue, corn population, and corn leaf numbers at the Highum Farm, 1994.

			Soybean Residue					
	Nitrogen		6/1/94		6/18/94		Means	
Tillage	Source	Hybrid	In	Between	In	Between	In	Between
			----------%cover----------					
Disc	An.NH_3	Cg4327	7.5	14.4	8.1	15.6	8.0	15.1
		P3578	7.5	16.9	11.9	19.4	9.8	18.2
	Manure	Cg4327	16.2	16.9	15.6	23.1	16.0	20.1
		P3578	6.9	12.5	10.0	21.2	8.6	17.0
No-till	An.NH_3	Cg4327	38.1	51.9	39.4	53.8	38.8	52.9
		P3578	26.2	48.8	36.9	48.8	31.6	48.8
	Manure	Cg4327	21.9	56.9	37.5	59.4	29.9	58.2
		P3578	29.4	58.1	36.9	53.1	33.2	55.8
Disc[1]			12.3b[2]		15.6b		14.1b	
No-till			41.4a		45.7a		43.6a	
	An.NH_3[1]		26.4a		29.2a		27.9a	
	Manure		27.3a		32.1a		29.9a	
		Cg4327[1]	28.0a		31.6a		29.9a	
		P3578	25.8a		29.8a		27.9a	
		Row pos.	19.2b	34.5a	24.5b	36.8a	22.0b	35.8a
Pr>F								
Tillage			0.008		0.005		0.006	
N Source			0.703		0.264		0.404	
Tillage*N			0.798		0.727		0.764	
Hybrid			0.416		0.584		0.454	
Hybrid*Tillage			0.814		0.584		0.822	
Hybrid*N			0.724		0.584		0.878	
Tillage*N*Hybrid			0.078		0.552		0.208	
Row position			<0.001		<0.001		<0.001	
Row position*Tillage			<0.001		0.018		<0.001	
Row position*N			0.235		0.205		0.131	
Row position*Hybrid			0.494		0.718		0.796	
Row position*Tillage*N			0.015		0.505		0.041	
Row position*Tillage*Hybrid			0.731		0.332		0.428	
Row position*N*Hybrid			0.393		0.959		0.575	
Row position*Tillage*N*Hybid			0.235		0.572		0.276	

[1]Means over row position.

[2]Data followed by the same letter in the same group (by date) are not significantly different at the 0.10 level. n=64

Significant interactions from Table 4b.

		Residue 6/9		Means			Residue 6/9		Residue 6/18		Residue means	
		Row position		Row Pos.			Row position		Row position		Row position	
Tillage	N	In	Between	In	Between	Tillage	In	Between	In	Between	In	Between
		---------%cover----------					----------%cover----------					
Disc	NH_3	7.5	15.6	8.9	16.6	Disc	9.5	15.2	11.4	19.8	10.6	17.6
	Manure	11.6	14.7	12.0	18.6	No-till	8.9	53.9	37.6	53.8	33.4	53.9
No-till	NH3	32.2	50.3	35.2	50.8							
	Manure	25.6	57.5	31.6	57.0							

Table 4c. Effect of tillage, nitrogen source, and hybrid on corn population, and corn leaf numbers at the Highum farm, 1994.

Tillage	N Source	Hybrid	Corn Population 6/1	Corn Population 6/18	Corn Population Mean	Leaf Numbers 6/1	Leaf Numbers 6/18	Leaf Numbers Mean
			----plants/Ax1000----			-----leaves/plant-----		
Disc	An.NH_3	Cg4327	19.8a[1]	20.0a	19.9a	4.6abc	8.2a	6.4ab
		P3578	20.7a	21.8a	21.2a	4.4abc	7.9ab	6.2ab
	Manure	Cg4327	21.8a	22.4a	22.1a	4.9a	8.3a	6.6a
		P3578	24.4a	25.0a	24.7a	4.7abc	8.1ab	6.4ab
No-till	An.NH_3	Cg4327	22.6a	23.5a	23.1a	4.4abc	7.4b	6.0ab
		P3578	23.5a	22.6a	23.1a	4.1c	7.6b	5.9b
	Manure	Cg4327	19.6a	20.2a	20.0a	4.7ab	8.1ab	6.4ab
		P3578	22.4a	21.6a	22.0a	4.3bc	7.9ab	6.2ab
Disc			21.7a	22.3a	22.0a	4.6a	8.1a	6.4a
No-till			22.0a	22.0a	22.1a	4.4a	7.7a	6.1a
	An.NH_3		21.7a	22.0a	21.9a	4.4b	7.8b	6.1b
	Manure		22.0a	22.3a	22.2a	4.6a	8.1a	6.4a
		Cg4327	21.0a	21.6a	21.3a	4.7a	8.0a	6.4a
		P3578	22.8a	22.8a	22.8a	4.4b	7.9a	6.1b
Pr>F								
Tillage			0.895	0.923	0.989	0.445	0.305	0.388
N Source			0.756	0.806	0.784	0.006	0.022	0.014
Tillage*N			0.082	0.097	0.087	0.651	0.138	0.363
Hybrid			0.172	0.270	0.201	0.003	0.515	0.088
Hybrid*Tillage			0.966	0.362	0.688	0.408	0.400	0.642
Hybrid*N			0.468	0.476	0.459	0.939	0.694	0.717
Tillage*N*Hybrid			0.966	0.758	0.863	0.939	0.474	0.570

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level. n=32

Significant interactions from Table 4c.

Tillage	Populaction 6/1 N Source NH_3	Populaction 6/1 N Source Manure	Population 6/18 N Source NH_3	Population 6/18 N Source Manure
	----------plants/A x 1000----------			
Disc	20.2	23.1	20.9	23.7
No-till	23.1	21.0	23.1	20.9

Table 4d. Effect of tillage, N source, and hybrid on corn tasselling , silking and grain moisture and yield (10/24) at the Highum Farm, 1994.

			Tasselling			Silking			Grain	Corn
Tillage	Source	Hybrid	7/11	7/15	Mean	7/11	7/15	Mean	Moisture	Yield
			----------% plants----------						--%--	bu/A
Disc	An.NH_3	Cg4327	46.9ab[1]	93.0a	70.0ab	9.0ab	63.5ab	36.3ab	21.1ab	173.0a
		P3578	3.5c	46.5a	25.0c	2.1b	19.6bc	10.8bc	20.7ab	194.0a
	Manure	Cg4327	62.7a	95.5a	79.1a	20.8a	83.4a	52.1a	20.6ab	180.0a
		P3578	14.9bc	67.3a	41.1abc	2.8b	35.7bc	19.2a	20.6ab	193.4a
No-till	An.NH_3	Cg4327	7.8bc	75.1a	41.5abc	1.2b	38.2bc	19.8bc	19.6b	187.2a
		P3578	3.6c	52.7a	28.2bc	0.0b	10.0c	5.0c	22.8a	189.6a
	Manure	Cg4327	30.1abc	90.8a	60.5abc	2.7b	60.0ab	31.4abc	20.4b	185.8a
		P3578	6.2bc	41.0a	23.6c	1.8b	15.9c	8.9bc	20.2b	190.5a
Disc			32.0a	75.6a	53.8a	8.6a	50.4a	29.6a	20.7a	185.1a
No-till			11.9a	64.9a	38.5a	1.4a	31.0a	16.2a	20.8a	188.3a
	An.NH_3		15.5b	66.8a	41.2b	3.1b	32.8b	18.0b	21.0a	186.0a
	Manure		28.4a	73.7a	51.1a	7.0a	48.7a	27.9a	20.4a	187.4a
		Cg4327	36.8a	88.6a	62.8a	8.4a	61.3a	34.9a	20.4a	181.5b
		P3578	7.0b	51.9b	29.5b	1.7b	20.3b	11.0b	21.0a	191.9a
Pr>F										
Tillage			0.271	0.642	0.452	0.334	0.355	0.343	0.966	0.707
N Source			0.014	0.310	0.007	0.062	0.005	<0.001	0.410	0.538
Tillage*N Source			0.878	0.465	0.319	0.231	0.592	0.162	0.695	0.477
Hybrid			<0.001	<0.001	<0.001	0.023	<0.001	<0.001	0.151	0.025
Hybrid*Tillage			0.018	0.924	0.046	0.047	0.284	0.078	0.071	0.117
Hybrid*N Source			0.319	0.736	0.282	0.325	0.280	0.193	0.107	0.756
Tillage*N*Hybrid			0.519	0.110	0.060	0.289	0.498	0.980	0.049	0.549

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level. n=32

Significant interactions from Table 4d.

	Tasselling 7/11		Silking 7/11		Grain Moisture		Corn Yield	
	Hybrid		Hybrid		Hybrid		Hybrid	
Tillage	Cg4327	P3578	Cg4327	P3578	Cg4327	P3578	Cg4327	P3578
	----------%plants----------				--------%------		-----bu/A-----	
Disc	54.8	9.2	14.9	2.4	20.8	20.6	176	194
No-till	19.0	4.9	2.0	0.9	20.0	21.5	186	190

	Grain Moisture	
N	Hybrid	
Source	Cg4327	P3578
NH_3	20.4	21.7
Manure	20.5	20.4

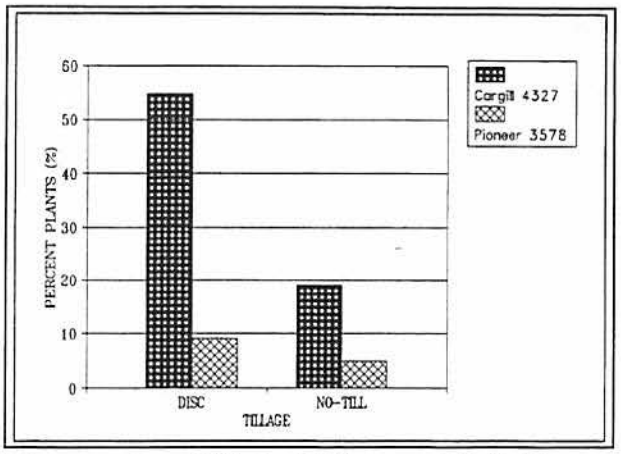

Figure 1. Effect of tillage and hybrid on corn tasselling at the Highum farm, July 11, 1994.

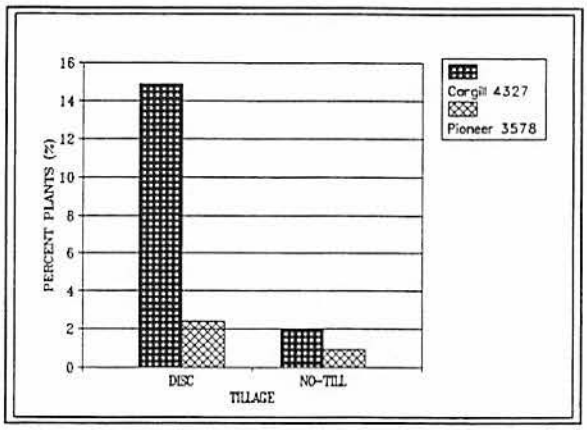

Figure 2. Effect of tillage and hybrid on corn silking at the Highum farm, July 11, 1994.

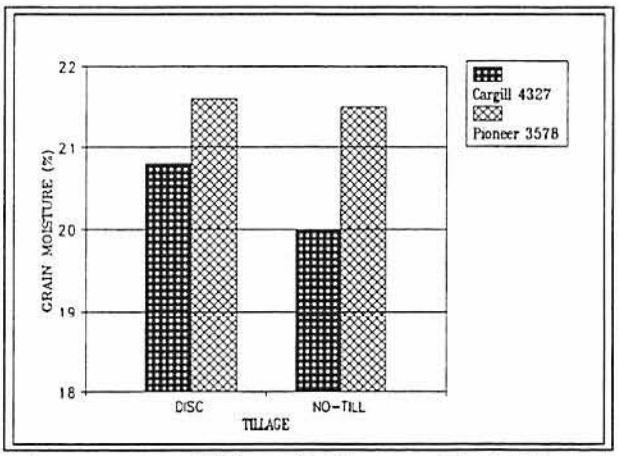

Figure 3. Effect of tillage and hybrid on grain moisture at the Highum farm, October 24, 1994.

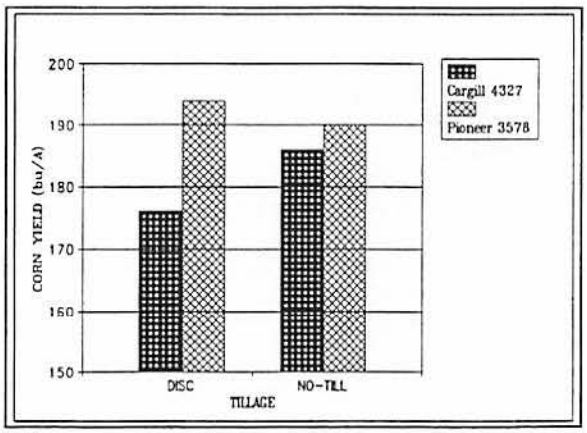

Figure 4. Effect of tillage and hybrid on corn yield at the Highum farm, October 24, 1994.

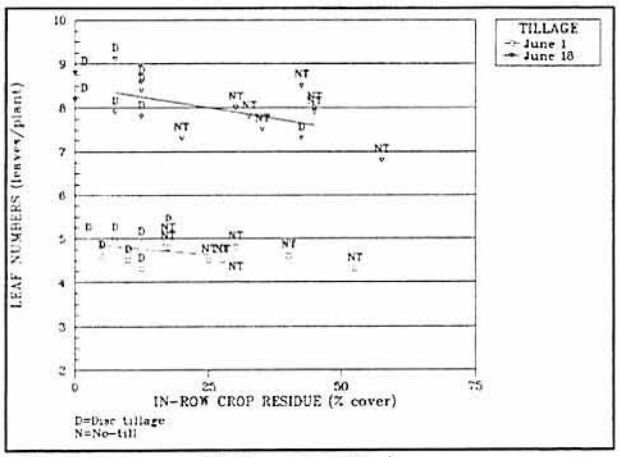

Figure 5. Effect of in-row crop residue on corn leaf numbers (**Cg4327**) June 1 and 18 at the Highum farm, 1994.

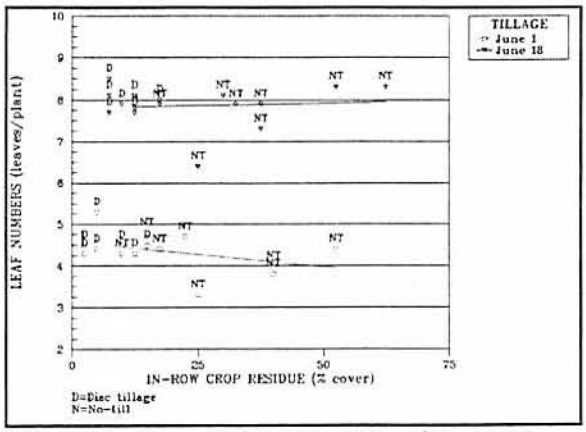

Figure 6. Effect of in-row crop residue on corn leaf numbers **(P3578)** June 1 and 18 at the Highum farm, 1994.

EFFECTS OF TILLAGE AND LIQUID DAIRY MANURE ON NITROGEN AVAILABILITY TO CORN[1]

T. W. Schumacher, J. F. Moncrief, and B. J. Johnson[2]

Abstract: The study to determine the influence of tillage and manure application on corn production at the Dale Flueger farm in Goodhue county, MN was continued in 1994. Results from 1994 showed much greater yields and lower moisture contents than the previous two years at this site. Annually applied manure produced the greatest yields (142 bu/A) and anhydrous ammonia applied at 200 lb N/A produced 123 bu/A. Biennially applied manure produced 115 bu/A of grain in the year of application and 64 bu/A of grain in the year following application. Triennially applied manure produced 98 bu/A the year of application, 88 bu/A the year after application, and 55 bu/A two years after application. Due to a damaged mixer in the manure pit, the manure applied to the plots in 1994 was unusually watery and resulted in numbers not typical to what would be expected from liquid dairy manure under a sloted floor barn.

Introduction

This study is being conducted to determine the long term impacts of tillage and frequency of manure application on corn yield and soil N levels. The Dale Flueger farm is located near Red Wing in Goodhue County, Minnesota. The research plots are on a Seaton silt loam soil. This study began in 1982.

The experimental design is a randomized complete block with tillage main plots (chisel plow and no till) with N source (commercial fertilizer and manure) and N frequency (annual, biennial, and triennially applied manure) subplots. Liquid dairy manure is injected each spring into the chisel plow and no till annual manure plots, and into the biennial manure plots that did not receive manure the previous year. Triennially applied manure plots only receive chisel plowing, and liquid dairy manure is injected at the same time into the plots that did not receive manure over the previous two years. Commercial fertilizer (anhydrous ammonia) was applied side dress and manure injected in the spring, preplant. Zero N check treatments are also included in this study. Refer to table 1 for details on N treatments and other cultural practices.

From 1982 to 1986 the manure treatments were split with 0 and 200 lbs/A K_2O treatments, and the commercial fertilizer treatments were split with 0, 200, and 400 lbs/A K_2O treatments. These potassium additions were stopped in 1987, but some data in this report is split by K_2O treatment to check for residual effects of the added potassium.

Results and Discussion

The cultural practices and timing of the cultural practices at the Flueger farm can be seen in Table 1. The effects of the various annual and biennial treatments on corn grain yields, grain moisture, and grain percent N, can be found in Table 2. Grain yields were greater than in recent years, probably due to more favorable weather conditions. The trend of yields was as follows: annual manure>biennial manure in year of application>commercial fertilizer>biennial manure in the year following application. Grain moisture was much lower in 1994 compared to recent years, most likely due to the dry autumn and the good weather during the growing season. The effects of the various triennial treatments on corn grain yields and grain moisture can be found in Table 3. Grain yields, as expected, decreased with each year after N was applied.

1. Support for this project was provided by the USDA-CSRS, LCMR, and the Natural Resource Conservation Service. Their support is greatly appreciated.

2. Research Assistant, Associate Professor, and Assistant Scientist respectively, at the Soil, Water, and Climate Dept., University of Minnesota, St. Paul, MN 55108.

Table 1. 1994 cultural practices at the Flueger farm in Goodhue County, MN.

Soil: Seaton silt loam (mixed, mesic, fine silty Typic hapludalf), well drained, 2 to 12% slope.

Cropping History:

1981-1988	Corn	Pioneer 3906
1989	Corn	Pioneer 3737
1990	Corn	Pioneer 3751
1991	Corn	NK 3624
1992-1993	Corn	Pioneer 3751
1994	Corn	Pioneer 3769

Manure Application and Analysis: Liquid dairy manure injected on May 6, 1994.

	1994 rate Mean
Manure (gal/A)	9320
Total N (lbs/A)	535
NH_4 N (lbs/A)	265
Solids (%)	2.2

Fertilizer:

Material	Tillage	N (lbs/A)	Date Applied	Application
82-0-0	Both	200	June 21, 1994	Injected
5-14-42	Both	6	May 16, 1994	As a starter

Planting and Harvest Information: A four row John Deere Maxi-Emerge planter with two inch fluted coulters was used to plant on May 16, 1994. Corn was harvested on October 29, 1994.

Insect control: 5.2 lbs/A Thimet 20G applied May 16, 1994.

Table 2. Grain yield and grain moisture as influenced by tillage, N source and frequency and potassium rates at the Flueger farm in Goodhue Co., MN.

N source & freq.	K_2O lbs/A	Grain Yield NoTill	Grain Yield Chsl	Grain Yield Mean	Grain Moisture NoTill	Grain Moisture Chsl	Grain Moisture Mean
		------bu/A------			--------%-------		
Annual	0	111	164	**138**	20.0	18.9	**19.5**
Manure	200	131	159	**145**	18.8	18.2	**18.5**
	Mean	**121**	**162**	**142**	**19.4**	**18.6**	**19.0**
Biennial	0	99	137	**118**	19.7	19.9	**19.8**
Manure	200	84	141	**113**	19.1	17.9	**18.5**
(yr of)	**Mean**	**92**	**139**	**115**	**19.4**	**18.9**	**19.2**
Biennial	0	45	91	**68**	20.7	19.0	**19.9**
Manure	200	30	87	**59**	19.9	20.8	**20.4**
(yr after)	**Mean**	**38**	**89**	**64**	**20.3**	**19.9**	**20.1**
Anhydrous	0	91	145	**118**	23.9	19.0	**21.5**
Ammonia	200	97	149	**123**	22.4	18.9	**20.7**
	400	115	139	**127**	22.5	21.4	**22.0**
	Mean	**101**	**144**	**123**	**22.9**	**19.8**	**21.4**
Overall Mean		**88**	**134**	**111**	**20.5**	**19.3**	**19.9**
Check (0 N)[1]		43	54	**49**	18.2	19.4	**18.8**

	Till(T)	N source(N)	T*N	K rate(K)	K*T	K*N	K*N*T
Grain Yield	.000	.000	.949	.842	.445	.840	.893
Grain Moisture	.096	.011	.019	.285	.095	.836	.754

[1] Check plots not included in the statistical analysis.

Table 3. Grain yields and percent moisture at harvest for triennially applied manure with chisel plowing system at the Flueger farm in Goodhue Co., MN.

Year of manure Application	K_2O lbs/A	Grain Yield ---bu/A----	Grain Moisture ------%-----
First Year	0	102	20.6
	200	94	20.7
	Mean	**98**	**20.7**
Second Year	0	82	19.5
	200	94	18.8
	Mean	**88**	**19.2**
Third Year	0	53	20.6
	200	57	20.1
	Mean	**55**	**20.4**

THE EFFECT OF TIME OF MANURE APPLICATION ON CORN RESPONSE FOLLOWING SOYBEANS ON POORLY DRAINED SOILS[1]

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Abstract Time of application of a 50-50 mix of liquid hog and liquid chicken egg layer manure was evaluated for corn production following soybeans on poorly drained soils. Corn yields with N were about 30 bushels per acre higher than the no N control. There was no difference in grain yields between fall, winter, and side dress manure applications. Manure applied in the spring before planting and side dress fertilizer N resulted in a modest yield advantage over other treatments (3-7 bushels per acre).

Results

This study was designed to evaluate the timing of manure applications as an N source for corn production on poorly drained soils in southern MN. Corn was grown following soybeans with a ridge till tillage system (four row-38" equipment). All plots received dry starter fertilizer (8 pounds N per acre). Manure was applied in the fall before "freeze up", in the winter "after snow fall", in the "spring preplant", and "side dress" at ridging. The manure source was a 50-50 mix of liquid manure from a chicken egg laying operation and a finishing pig facility. Manure was applied in a band on either side of the ridge. The 2,000 gallons per acre manure rate was based on a chemical analysis and designed to deliver about 85 pounds per acre of estimated available N. This was based on the assumption that all of the ammonium-N and 35% of the organic-N in the manure was available in the year of application. There was a fertilized and unfertilized control. The commercial N source was a urea-ammonium nitrate solution (28% N) applied and incorporated with the ridge till cultivator at 100 pounds N per acre. Although the total N in the manure at the three times of application varied very little, the proportion of ammonium and organic N varied considerably. Estimated available N ranged from 79 to 97 pounds per acre from the fall to side dress applications, respectively.

The grain yields are shown in table 2. Corn yields with N were about 30 bushels per acre higher than the no N control. There was no difference in grain yields between fall, winter, and side dress manure applications. Manure applied in the spring before planting and side dress fertilizer N resulted in a modest yield advantage over other treatments (3-7 bushels per acre). This study will be continued for two more years.

Table 1. Cultural practices used in the manure application study at Dwight Ault's farm in Mower County, 1994.

Study design

Design is a randomized complete block with six treatments and four replications:

1. Fall manure application (11/1/93), after ridges built in the fall due to wet conditions in 1993 preventing ridging during the growing season
2. Winter manure application, 6-7 inches of snow (1/94)
3. Early spring manure application (5/10/94)
4. Side dress-at cultivation manure application (6/16/94)
5. No manure (starter fertilizer only)
6. Fertilizer N (UAN-28%) applied at 1st cultivation (6/17/94)

The method of application is surface band with two tubes delivering to the middle of the center two rows and one each to the outside rows. This method was used to avoid the wheel traffic areas.

Tillage

Ridge till system

Fall 1993 ridged - 4-36" row Buffalo ridge till cultivator with 1-14" sweep per row with ridging wings

Planting and harvest information

Crop	Hybrid	Planted	Pop.	Harvested
Corn	P3751	5/10	27,000s/A	11/9

Cropping history

1993-Soybeans

Soils

Shandep silty clay loam (Cumulic Haplaquoll)
Mayer loam (Typic Endoaquoll)
Soils test high in P, medium in K

Fertilizer

		Applied (lb/A)		
Date	Analysis	N	P_2O_5	K_2O
5/10	7-18-36	8	20	40
6/17	28-0-0	100	0	0

[1] This project was supported by the MN Department of Agriculture and the MN Extension Service. Their support is greatly appreciated.

[2] Dwight Ault is a farmer in Mower County MN; Tim J. Arlt is the Steele County Extension Educator, Owatonna, MN; John F. Moncrief and Brian J. Johnson are Extension Specialist and Assistant Scientist, Department of Soil, Water, and Climate, Univ. of MN, St. Paul, MN; Phyllis Bongard is an independent data analysis specialist, Faribault, MN.

Manure analysis and application

Date	Total N	NH_4^+	Org.N	P_2O_5	K_2O
	----------lb/1000 gal.----------				
11/93	53.3	32.0	21.3	44.2	31.2
1/94	54.4	29.8	24.6	32.3	30.6
6/94	57.8	43.4	14.4	23.0	24.6
Mean	**55.2**	**35.1**	**20.1**	**33.2**	**28.8**

Manure is a mix of liquid hog and egg laying poultry manures (approx. 50:50).

	Est. Nutrients Applied				
Date	Rate	N_{tot}	N_{avail}	P_2O_5	K_2O
	gal/A	----------lb/A----------			
11/93	2000	107	79	88	62
1/94	2000	109	77	65	61
6/94	2000	116	97	46	49
Mean		111	84	66	57

N Availability = 100% Mineral N + 35% Organic

Weed Control

Date	Product	Rate (lb ai/A)
6/14	Nicosulfuron (Accent) +	0.01
	Bromoxynil (Buctril)	0.10
	applied in 12" bands over the row	

6/17 Cultivation only once 4-row with 1-14" sweep per row and ridging wings

Table 2. Effect of timing of manure application on corn grain moisture and yield at the Ault farm, November 9, 1994.

Treatment	Grain Moisture	Corn Yield
	--%--	bu/A
Early fall manure	17.8a[1]	137.5b
Winter manure	17.8a	135.8b
Early spring manure	17.8a	144.3a
side dress-at cult. manure	17.8a	137.5b
None	17.8a	108.3c
UAN (28%) at 1st cult.	17.8a	140.3ab
Pr>F		
Treatment	0.248	<0.001

1. Data followed by the same letter in the same column are not significantly different at the 0.10 level.