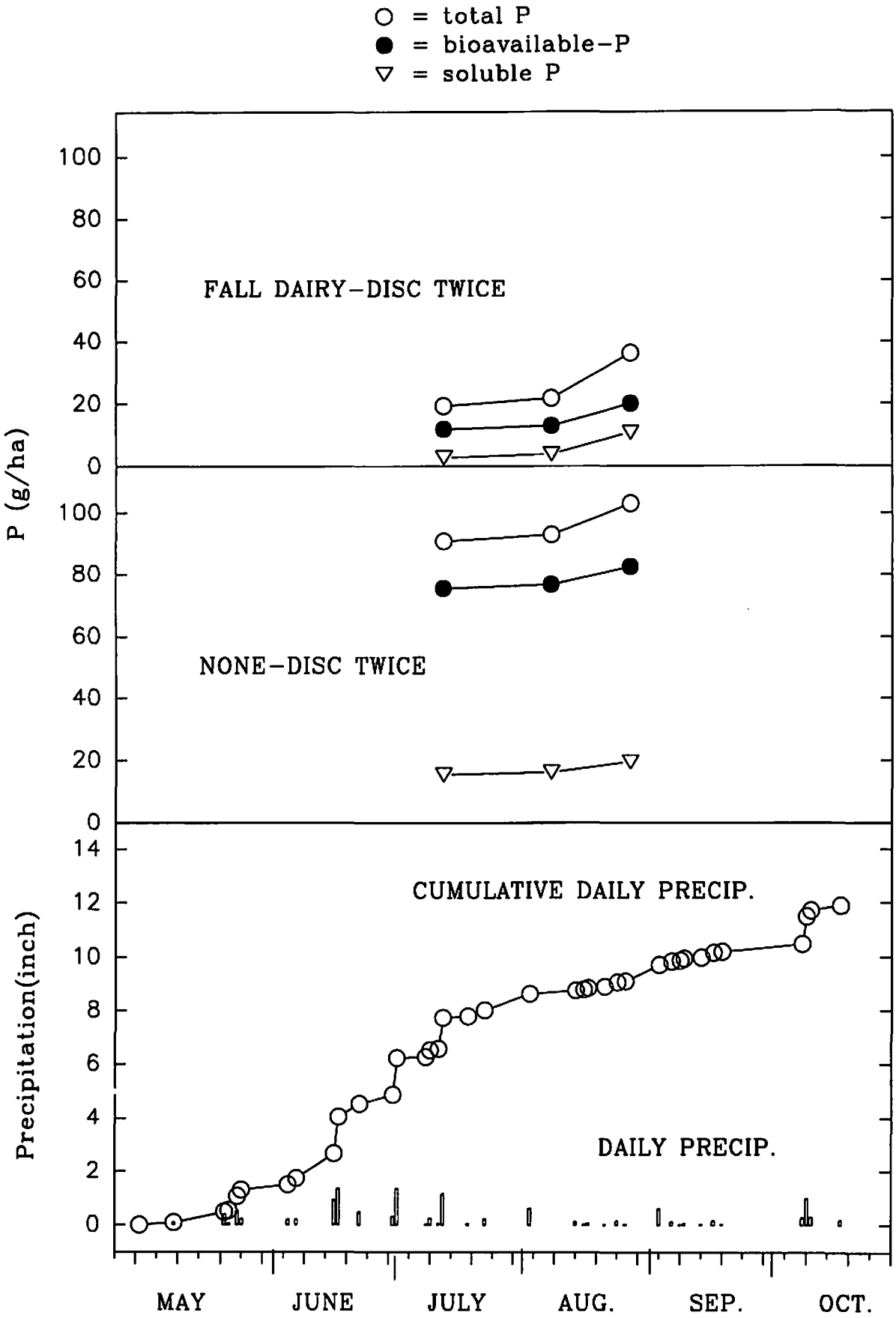

FIG. 4. CUMULATIVE PHOSPHORUS FROM RUNOFF PLOTS, AND PRECIPITATION AT ECKER FARM, MEEKER COUNTY, MN (1992).

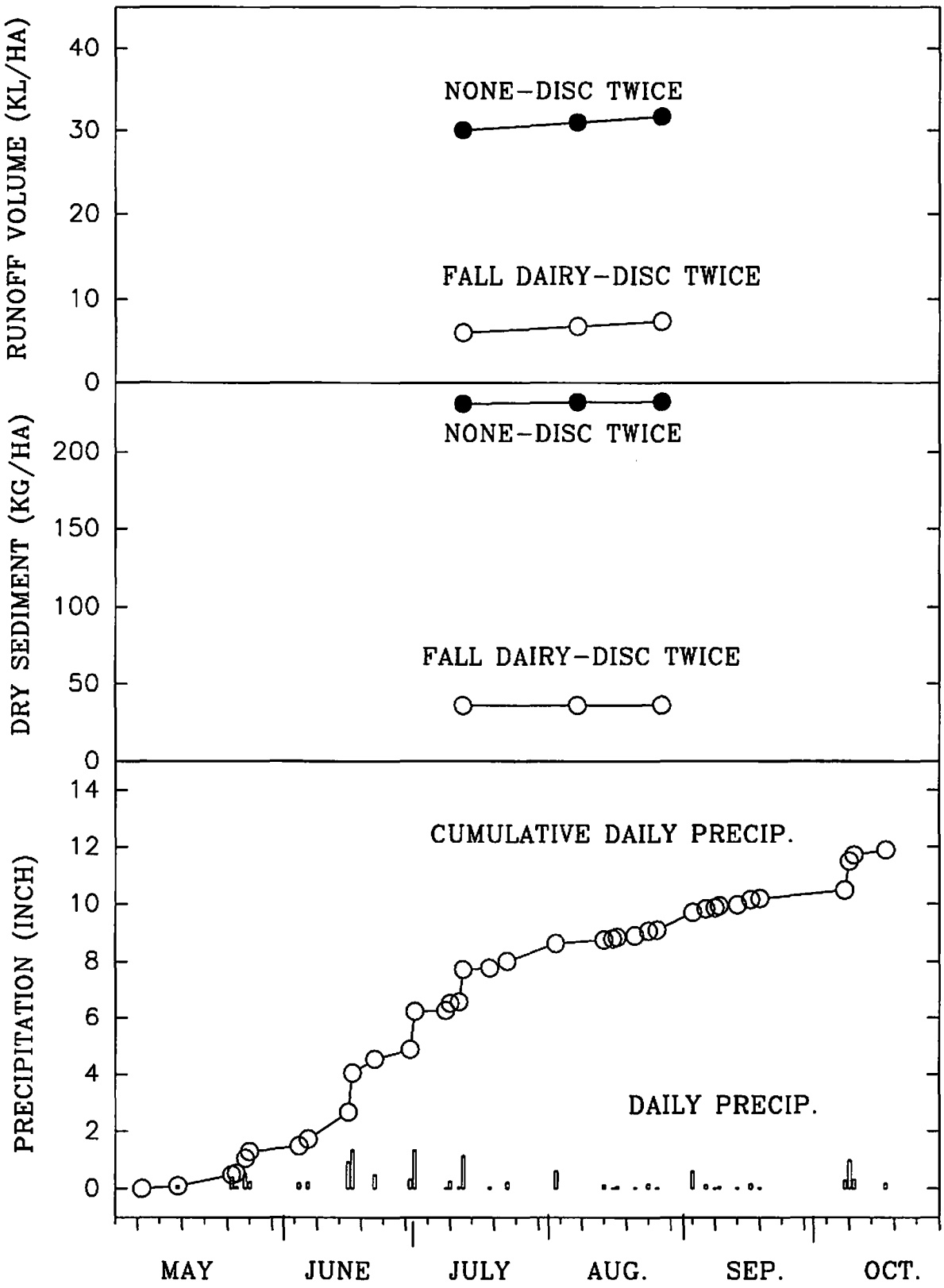

FIG. 5. MEASURED CUMULATIVE RUNOFF VOLUME AND SEDIMENT AND PRECIPITATION AT ECKER FARM, MEEKER COUNTY, MN (1992).

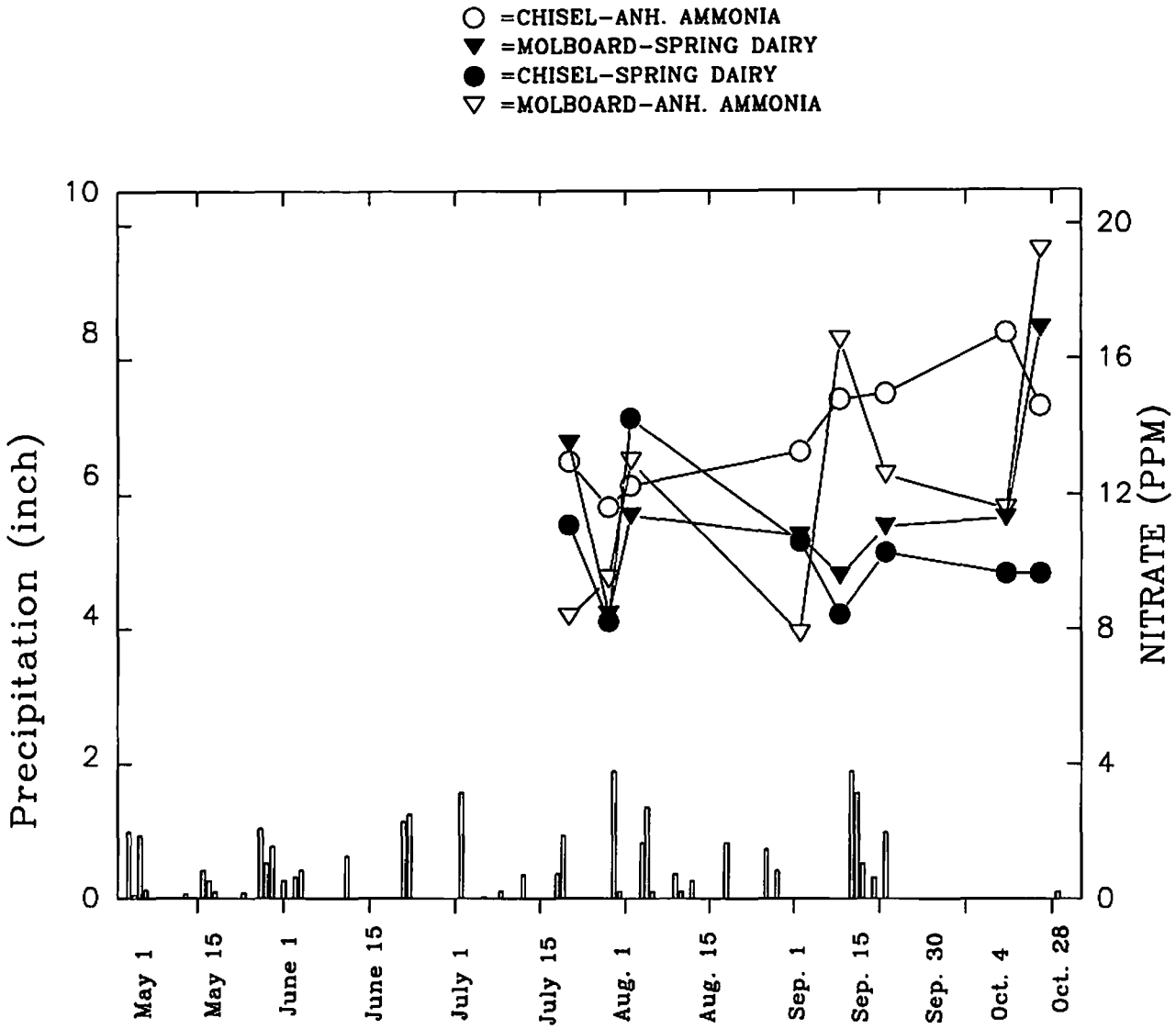

FIG. 6. PRECIPITATION AND SOIL WATER-NITRATE CONCENTRATION OVER TIME AT ECKER FARM, MEEKER COUNTY, MN (1991).

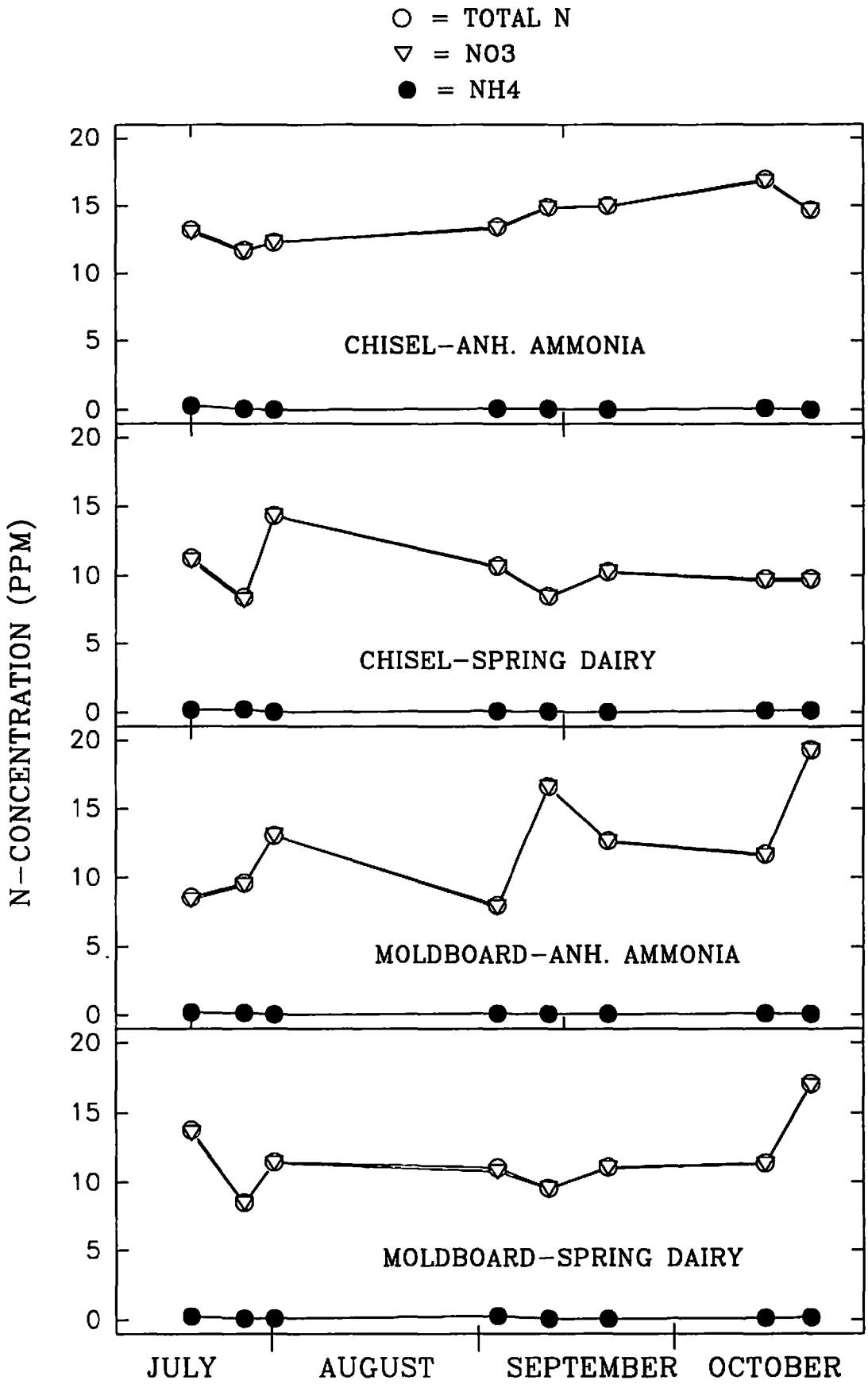

FIG. 7. SOIL WATER-N OVER TIME AS INFLUENCED BY TILLAGE AND MANURE APPLICATION AT ECKER FARM, MEEKER COUNTY, MN (1991).

TILLAGE EFFECTS ON SOYBEAN RESPONSE TO MANURE AT STEARNS COUNTY, MN[1]

D. Ginting, J.F. Moncrief, S.C. Gupta, M.B. Kells, and B.J. Johnson[2]

Abstract

Tillage (no till, ridge till, chisel and moldboard plow) influence on the residual effects of two sources of plant nutrients (manure and anhydrous ammonia) on soybean performance was evaluated. Residue cover was less than 30 % for all tillage systems. Moldboard plowing resulted in less than 3% residue cover. Plant population in the ridge till system was lower compared to other tillage systems due to a different planter. Growth stage of beans were not significantly influenced by tillage. Residual effects of manure and anhydrous ammonia resulted in similar bean yield. Moldboard plowing resulted in a similar yield as chisel and both are higher than ridge till or no till. Low yield in the no till system was mainly due to competition by Russian Thistle and lower yield in ridge till mainly due to the lower population. Bean grain moisture were also similar among tillage systems. Soil water mineral nitrogen was mainly nitrate. Manure treated plots indicates a reduction of nitrate during the growing season but there was a slight increase at the end of the growing season. Moldboard plowed plots treated with anhydrous ammonia indicates a slight increase of nitrate over time.

Materials and Methods

The experiment on soybean-corn rotation with different tillage systems (notill, ridge till, chisel and moldboard) and manure application was the continuation of the experiments in 1989, 1990 and 1991. In 1989 (corn-year) dairy manure (barnyard and barngutter) were evaluated for the ability to provide nutrients for corn production. In 1990 (soybean-year) no plant nutrient was applied and residual effect of previous manure application was evaluated. In 1991 (corn-year), Manure and anhydrous ammonia were applied, to evaluate the crop performances and soil-water nitrate content. In 1992 (soybean-year), no plant nutrients was applied and the residual effect of 1991 (corn year) treatment was evaluated on bean performances and soil-water nitrate, however, no soil water nitrate samples was taken in this year.

Measurements. Measurements made were corn residue cover, population and growth stage, grain yield and grain moisture. Soil cover was characterized relative to row position (in row and between row), and measurements were made over 10 feet of row with 25 points each treatment. In row is defined as 10 inch strip centered over the row and between the row is the remainder. Soybean stands were estimated by tallying the number of plants in 10 foot row from each treatment. Grain yield estimates were made from area 10 feet by 4 feet and reported as dry yield.

Experimental design The experiment was arranged as split plot, with tillage as main plots and nutrient source as subplots.The design was extended to split-split-split plot to adapt the analysis of the influence of row position and soil depth on Bray-P.

Result and Discussion

Residue cover. Means of Residue cover were less than 30%. The residue cover were similar with no till, ridge till and chisel systems. Residue cover, however, under moldboard plowing was the least, less than 3%. There were higher residue cover in the row than between the row (Table 2).

Plant population and growth stage. Soybean population was significantly influenced by tillage system. Moldboard plowing resulted in similar population with no till, but higher than ridge till or chisel (Table 3). Ridge till indicated the lowest population, which mainly due to the different planter. However, growth stages were similar among tillages.

Grain Yield and moisture. Previous year application of manure and anhydrous ammonia resulted in similar bean yield (Table 4). Moldboard plowing resulted in similar yield as chisel and both are higher than ridge till or notill. Low yield in no till is likely due to competition from Russian Thistle and lower yield in ridge till is mainly due to the lower population. Grain moisture is similar between previous year manure and anhydrous ammonia application. Bean moisture were also similar among tillage systems (Table 5).

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[1]Support for this project was provided by the Agricultural Utilization and Research Institute, the Minnesota Pollution Control Agency, the Soil Conservation service, the Clearwater River Watershed District, and the Minnesota Extension Service. Their support is greatly appreciated.

[2]D. Ginting, J.F. Moncrief, S.C Gupta, B.J. Johnson are Graduate Student, Associate Professor, Professor and Assistant Scientist respectively in the Soil Science Department at the University of Minnesota, St. Paul, MN, 55108. M. B. Kells is the Tri-County Project coordinator.

Soil Water Nitrogen. Soil water mineral nitrogen was mainly in the nitrate form. Ammonium was negligible (Fig. 2). Nitrate content over time and precipitation was presented in Fig.1. During the growing season, nitrate content both in the manure and in the anhydrous ammonia treated plots were decreasing. However nitrate slightly increased at the end of October.

STEARNS COUNTY

Table 1. Cultural practices at Stearns County, MN. 1992.

Tillage

No Till
Ridge Till
Chisel plow + discing
Spring Moldboard Plowing + discing

Cropping History

1981-red clover and oats, 1982-corn,
1983-soybeans, 1984-corn, 1985-corn,
1986-soybeans, 1987-corn, 1988-Soybeans
1989-corn, 1990-soybean , 1991-Corn
1992-soybean, Sturdy

Planting and Harvest Dates

Ridge till plots were planted with a four row Buffalo Till planter equipped with 12" sweeps at a 36 inch row spacing. Notill, moldboard and chisel plowed plots were planted with a Tye notill drill

	Planting		
Crop	Date	Rate	Harvested
soybean	May 21, 1992	225,000 seeds/A	Oct. 21 1992

Fertilization History 1981-1987

The fertilization history at this site is as follows: 1981-none, 1982-low rate of dry starter, 1983-low rate of starter and 0-0-60, 1984-4 gal/A of 9-18-9 only, 1985-60 lb/A of N and 4 gal/a of 9-18-9, 1986-all soybean plots were split with and without a row fertilizer treatment at planting, and in 1987-all corn plots were split with three rates of starter.

				Actual			
	Material			N	P_2O_5	K_2O	
Crop	Analysis	Rate	Tillage	----	lb/A	----	Date Applied
Soybeans	9-18-9[1]	4 gal/A	Ridge Till	4	8	4	May 16, 1986
	0-0-60[2]	90 lb/A	All Others	0	0	54	May 16, 1986
Corn	Starter Fertilizer Treatments						
	9-18-9[1]	0 gal/A	All	0	0	0	April 29, 1987
	9-18-9[1]	4.9 gal/A	All	4.7	10	4.7	April 29, 1987
	9-18-9[1]	9.7 gal/A	All	9.3	18.5	9.3	April 29, 1987
	Nitrogen Management						
	28-0-0	11 gal/A	No Till[3]	33	0	0	June 1, 1987
	28-0-0	11 gal/A	All Others[4]	33	0	0	June 1, 1987
	28-0-0	11 gal/A	No Till[3]	33	0	0	June 25, 1987
	28-0-0	11 gal/A	All Others[4]	33	0	0	June 25, 1987

1. Planter placement 1" below the seed. 2. Potash was surface banded ahead of and incorporated by the fluted coulters. 3. Nitrogen was surface banded. 4. Nitrogen was surface banded and incorporated by cultivation.

1989 Fertilizer and Manure Analysis

			Actual			
	Material		N	P_2O_5	K_2O	
Crop	Analysis	Rate	----	lb/A	----	Date Applied
Corn	9-18-9[1]	5 gal/A	5	10	5	May 11, 1989
	28-0-0[2]	11 gal/A	33	0	0	June 15, 1989
	28-0-0[3]	11 gal/A	33	0	0	June 30, 1989

1. Planter placement 1" below the seed. 2. Urea-ammonium nitrate (UAN) solution was surface banded and incorporated by cultivation on all non-manure plots. Solution was surface banded with no incorporation on no till plots. 3. Urea-ammonium nitrate (UAN) solution was surface banded and incorporated by cultivation on all plots manured and non-manured. Solution was surface banded with no incorporation on no till plots.

Analysis and rate of application of manure in 1989.

Manure Source	Date Applied	NH_4	NO_3	Mineral	Organic	Total N	Total P	Total K	Manure Density	Manure Rate	Solids Total	Solids Volatile	Solids Fixed
		%							lb/ft³	T/A	%		
Barn Gutter[1]	4/13/89	.260	.012	.272	.264	.536	.109	.424	64.8	16.4	27.66	45.96	54.04
Barnyard[2]	4/25/89	.050	.003	.053	.639	.692	.204	.377	33.8	15.0	16.50	64.62	35.38

1. Fresh daily manure collected every other day from barn gutters and applied the last two weeks of April.
2. A manure pack collected near a hay rack in the barnyard and applied April 25, 1989.

Rate of applied, available and value[1] of nitrogen[2], phosphorus, and potassium.

Source	Mineral	Organic	Total Nitrogen	$	Nitrogen Available 1989	1990	1991	P_2O_5	$	K_2O	$
	-- Applied N lb/acre ---				-- lb/A -			lb/A		lb/A	
Barn Gutter	89	87	176	17.60	111	11	6	82	16.40	167	16.70
Barnyard	16	192	208	20.80	64	24	12	140	28.00	136	13.60

1. It is assumed that fertilizer cost .10, .20, and .10 per pound of N, P_2O_5, and K_2O respectively.
2. It is assumed that all of the mineral N and 25% of the organic N will be available during the year of application.

1990 Treatment

No manure or anhydrous ammonia was applied.

1991 Fertilizer and Manure Analysis

Crop	Material Analysis	Rate	Actual N	Actual P_2O_5	Actual K_2O	Date Applied
			---- lb/A ----			
Corn	9-18-9	5 gal/A	5	10	5	May 23, 1991
	82-0-0	75 lb/A	62	0	0	June 4, 1991

1. Planter placement 1" below the seed.

Analysis and rate of application of manure on May 1991.

Manure Source	Date Applied	NH_4	NO_3	Mineral	Organic	Total N	Total P	Total K	Manure Density	Manure Rate	Solids Total	Solids Volatile	Solids Fixed
		%							lb/ft³	T/A	%		
Barnyard[2]	5/15/91	0.017	TR	0.017	0.559	0.576	0.02	0.08	33.8	22.7	21.03	71.54	28.46

2. A manure pack collected in and around a pole shed.
TR. Trace.

Rate of applied, available and value[1] of nitrogen[2], phosphorus, and potassium.

Source	Mineral	Organic	Total Nitrogen	$	Nitrogen Available 1989	1991	P_2O_5 1989	P_2O_5 1991	K_2O 1989	K_2O 1991
	-- Applied N lb/A ---				--lb/A--		-- lb/A--		---lb/A---	
Barnyard	8	254	262	26.20	64	72	140	21	136	44

1. It is assumed that fertilizer cost .10 $ per lb of N
2. It is assumed that all of the mineral N and 25% of the organic N will be available during the year of application.

1992 Treatment

No manure or anhydrous ammonia was applied.

Soil

The soils at the Stearns County site are Fairhaven loam (Typic Hapludolls) which is well drained on 54 percent of the plot. Estherville sandy loam (Typic Hapludolls) which is somewhat excessively drained on 36 percent of the plot, Hawick loamy sand (Entic Hapludolls), this soil is excessively drained on the remaining 10 percent of the plot. The slope average for all three soils is 2.5 percent with the highest being 4 percent.

Weed Control

0.252 lb a.i./A Pursuit 2L + non ionic surfactant.

Table 2. The influence of tillage and row position on corn residue in soybean at Eckman farm, MN. (6/3/92).

Tillage	Row Position		
	In Row	Between Row	Means
	%		
Notill	24.8(17.4)	16.5(15.2)	**20.6(16.6)a**
Ridge Till	11.5 (7.8)	17.5(12.6)	**16.1(11.1)a**
Chisel	22.8(16.2)	10.0(10.7)	**16.4(15.0)a**
Moldboard	3.0(3.0)	2.5(4.1)	**2.8(3.5)b**
means	**15.5(15.1)a**	**11.6(12.7)b**	

The P>F: tillage=0.011(n=32); row=0.014(n=64) tillage*row=0.002(n=16).

Table 3. The influence of tillage on soybean population and growth stage at Eckman farm, MN. (6/19/92).

Tillage	population x 1000	growth stage leaves
Notill	**236.9(59.3)ab**	**1.94(0.1)a**
Ridge Till	**118.2(29.2)c**	**1.88(0.1)a**
Chisel	**214.1(46.2)b**	**1.91(0.2)a**
Moldboard	**310.9(134.5)a**	**1.93(0.1)a**

The P>F for population tillage=0.007(n=16); for growth stage=0.778(n=16)

Table 4. The influence of tillage and manure on grain yield at Eckman farm, MN 10/21/92).

Tillage	Manure Treatment		
	manure	no manure	Means
	bu/a		
Notill	14.6(5.8)	8.9(5.4)	**10.4(5.9)b**
Ridge Till	11.5(5.5)	8.8(5.6)	**10.0(5.5)b**
Chisel	15.8(7.6)	15.6(2.6)	**15.7(4.5)a**
Moldboard	17.2(7.3)	19.6(8.0)	**18.6(7.6)a**
means	**14.8(6.6)a**	**13.7(7.3)a**	

The P>F:tillage=0.004(n=11-19); manure=0.264 (n=23-38);tillage*manure=0.264(n=3-11)

Table 5. The influence of tillage and manure on grain moisture at Eckman farm, MN 10/21/92).

Tillage	Manure Treatment		
	manure	no manure	Means
	%		
Notill	11.6(1.5)	9.1(2.3)	**9.8(2.3)a**
Ridge Till	10.6(1.2)	10.1(1.0)	**10.3(1.1)a**
Chisel	11.0(0.7)	10.9(1.2)	**10.9(1.1)a**
Moldboard	11.0(1.7)	10.3(1.1)	**10.6(1.4)a**
Means	**10.9(1.3)a**	**10.1(1.5)a**	

The P>F:tillage=0.561(n=11-19); manure=0.139 (n=24-38);tillage*manure=0.689(n=3-11)

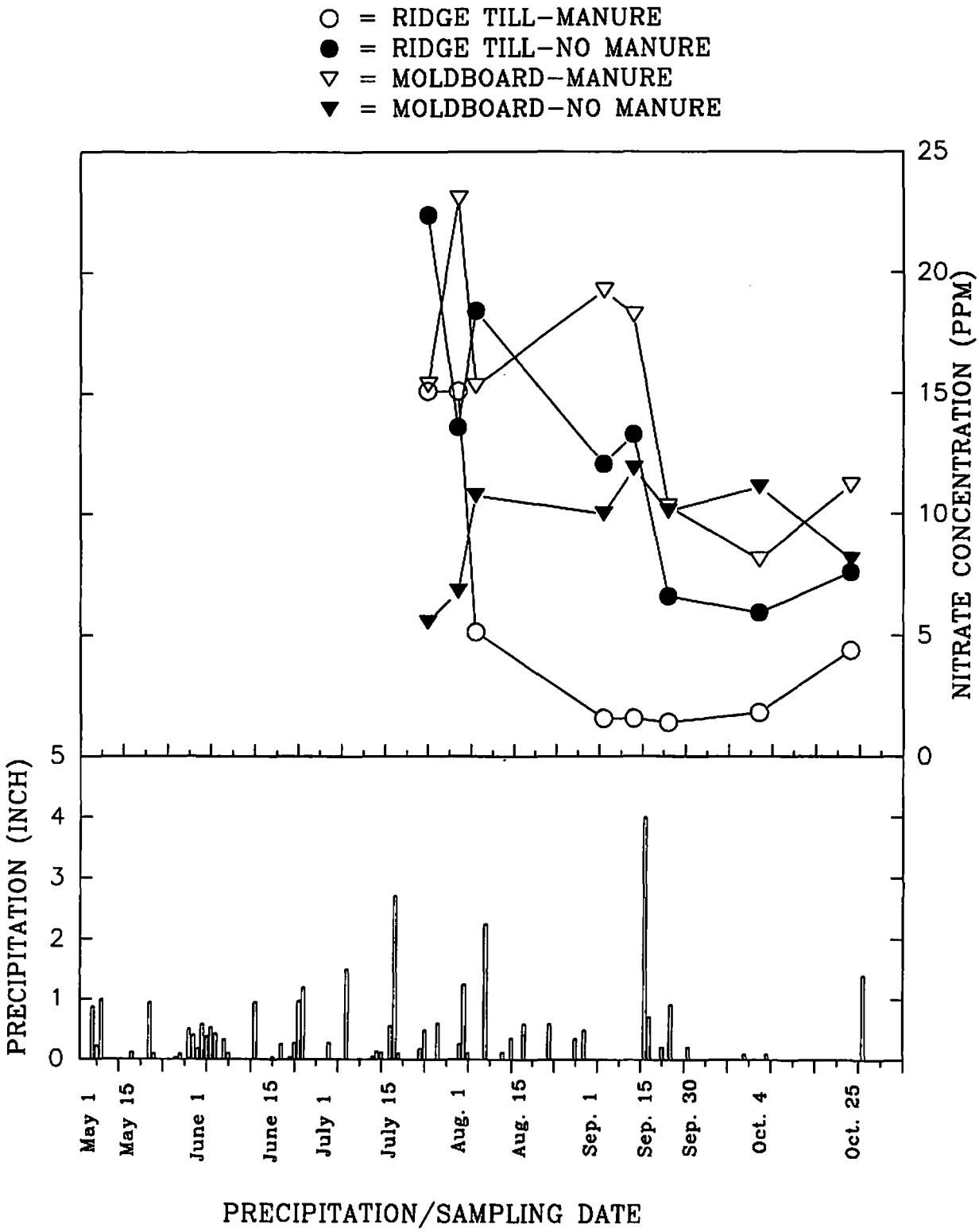

FIG. 1. PRECIPITATION AND SOL WATER NITRATE OVER TIME AT AS INFLUENCED BY TILLAGE AND MANURE AT ECKMAN FARM, STEARNS COUNTY, MN (1991).

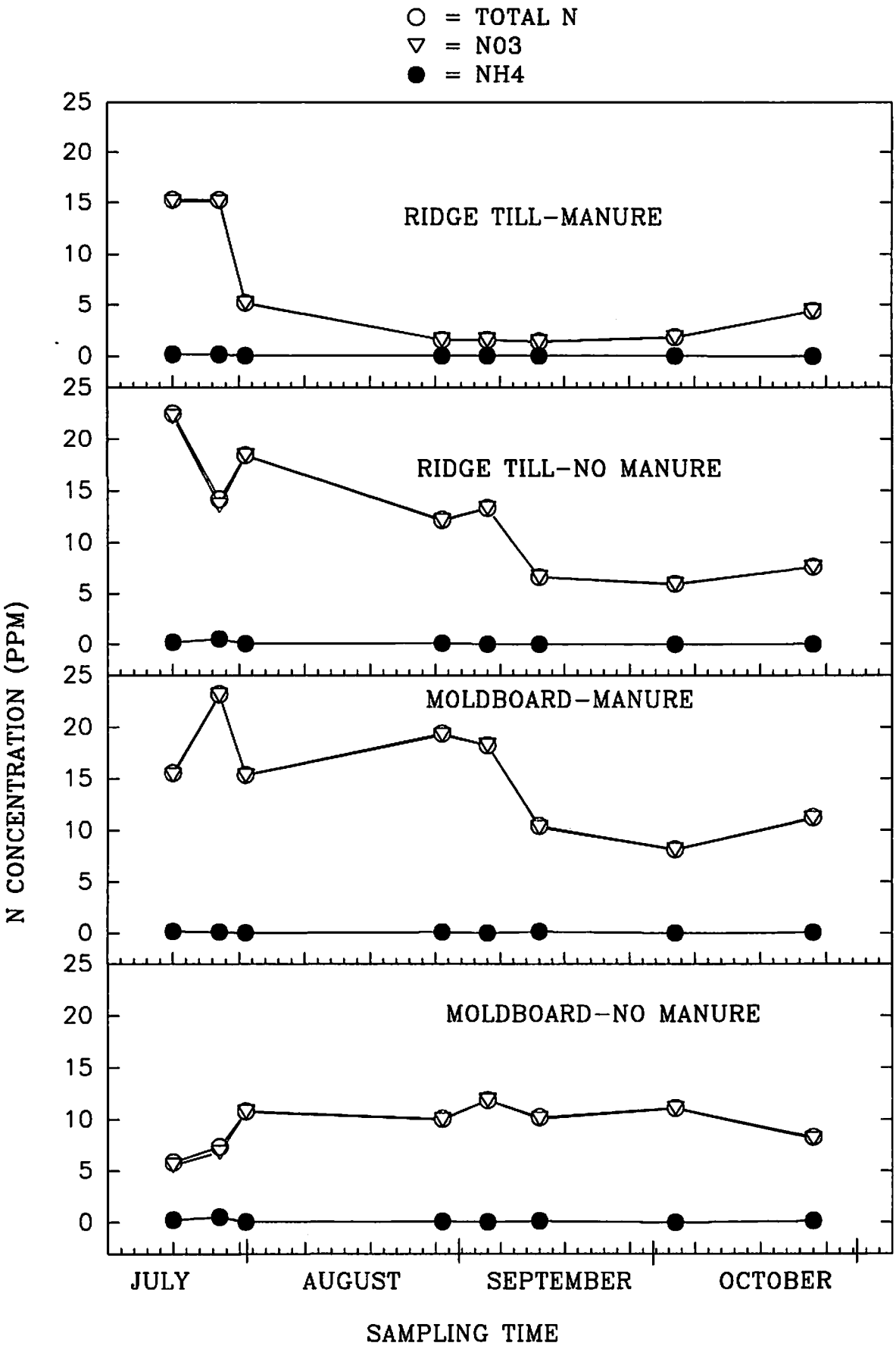

FIG. 2. SOIL WATER-N OVER TIME AS INFLUENCED BY TILLAGE AND MANURE APPLICATION AT ECKMAN FARM, STEARNS COUNTY, MN, (1991).

THE EFFECTS OF TILLAGE AND METHODS OF PHOSPHORUS APPLICATION ON CORN AND SOYBEAN RESPONSE AT KUECHLE FARM MEEKER COUNTY, MN[1]

D. Ginting, J.F. Moncrief, S.C. Gupta, M.B. Kells, and B.J. Johnson[2]

Abstract

Corn and soybeans were grown in rotation for seven years, to demonstrate the influence of tillage and method of P placement on corn, soybean growth and distribution soil P and its potential for loss due to water erosion.

Results showed that no till systems left more than 30% soybean or corn residue cover for erosion control. Corn growth stage was lower with no till systems, although the population is similar among tillages. Corn yield was similar for both methods of P placements. Corn yield was higher in moldboard and ridge till than chisel and no till systems. Soybean population under no till systems was higher than other tillage systems, however growth stages were similar. Soybean yield and grain moisture are similar for both P placements and among tillage systems. Row placement of P fertilizer resulted in higher P in the row. Soil movement in the ridge and furrow system in the ridge till resulted in similar P content in the row and between the row. Soil Bray-P distribution with depth under moldboard plowing was similar from 0 to 6 inch depth.

Materials and Methods

This is the seventh and final year of this study with a corn-soybean rotation with different tillage systems (no till, ridge till, chisel and moldboard) and phosphorus application (row application and broadcast). The land was divided in to two halves for simultaneous rotation of corn-soybean every year.

The experiment is arranged in a randomized complete block split-plot design, with tillage as the main plots and method of P placement as subplots. Measurements were taken on residue cover, plant population, growth stage, yield, and soil Bray-P. Residue cover was characterized relative to row position (in row and between row), over 10 feet row with 25 points in each treatment. In row is defined as four inches centered over the row and between the row is the remainder. Corn stands were estimated from a 10 foot row from each treatment. Soil samples for Bray-P determination were taken from plots cropped with corn. Soil samples were taken in the row and between the row at two inch depth interval (0-2, 2-4, 4-6 inch)

Result and Discussions

Corn as Present Crop

Soybean residue in corn plots was significantly influenced by tillage systems (Table 2). Residue was significantly reduced in the order of no till, ridge till, chisel and moldboard. No till systems resulted residue of 37.9%, whereas moldboard plowing resulted less than 3% soybean residue. Soybean residue was significantly higher between the row.

Corn populations were similar among the tillages. Corn growth stages were significantly influenced by tillage. No till, which showed the highest soybean residue, resulted in a lower growth stage whereas ridge till, chisel and moldboard are similar (Table 3).

Broadcast and row application of P resulted in similar corn grain yield. There was significant interaction between tillage systems and method of P application. The interaction indicated that row application of P in ridge tillage system increased yield significantly compared to broadcast application. There are significant differences in yield as influenced by tillage. Moldboard and ridge till system yielded higher than chisel and no-till systems (Table 4). Grain moisture were similar among tillage and method of P applications.

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[1]Support for this project was provided by the Agricultural Utilization and Research Institute, the Minnesota Pollution Control Agency, the Soil Conservation Service, The Clear Water River Watershed District, and the Minnesota Extension Service. Their support is greatly appreciated.

[2]D. Ginting, J.F Moncrief, S.C. Gupta, B.J. Johnson are Graduate Student, Associate Professor, Professor and Assistant Scientist respectively in the Soil Science Department at the University of Minnesota, St. Paul, MN, 55108. M.B. Kells is the Tri-County Project Coordinator.

Soybean as Present Crop

Corn residue cover on soybean plots were similar in the row and between the row. Tillage systems, however, significantly influences the residue cover. Residue cover were significantly reduced in the order of no till, ridge till, chisel and moldboard. No till and ridge till showed residue cover more than 30 % where as chisel and moldboard plowing resulted in 9.5 and 4.9 percent respectively (Table 6). There was an interaction between tillage and row position. No till, chisel and moldboard systems resulted a lower residue cover between the row but ridge till system resulted in higher residue between the row. This was beneficial for erosion control on the furrow where the runoff concentrated.

Soybean population under no till system was higher than the population under the ridge till, chisel and moldboard systems (Table 7). There was no difference in growth stage among the tillage systems (Table 7). Soybean yield (Table 8) was also similar by method of P application and tillage systems. Grain moisture was significantly influenced by tillage. Chisel plowing resulted in significantly higher grain moisture compared to the other tillage systems. Tillage and method of P application indicated that row application of P increased grain moisture significantly compared to broadcast application (Table 9).

Soil Bray-P. Soil Bray-P from corn plots of 1991 and 1992 were merged to evaluate the distribution of soil P with depth as influenced by tillage, method of application and row position under the soybean and corn rotation (Table 10). The distribution with depth was presented in Fig. 1. Row application resulted in higher P in the row for all tillage systems as expected. However, in the ridge tillage system, soil P is almost similar in the row and between the row. This was due to the movement of soil from in row (ridge) to between row (furrow) in the ridge till system. P distribution decreases with depth, except moldboard plowing which resulted in a similar distribution of P from 0 to 6 inch depth.

Table 1. Cultural practices at Kuechle Farm, Meeker County, MN, in 1992.

Tillage

No Till
Ridge Till
Fall Chisel Plowed-disced prior to planting
Fall Moldboard Plowed-disced prior to planting

Cropping History

Corn-soybean rotation since 1978.

1991 Crop

Corn- Northup king N 3624
Soybeans- Northrup king B 095

1992 Crop

Corn-Pioneer 3751
Soybean-Sturdy

Planting and Harvest Dates

Corn - was planted with a two row Hiniker Series 1 EconoTill planter with 30 inch row spacing.

Soybeans - ridge till was planted with a two row Hiniker Series 1 EconoTill planter with 30 inch row spacing and all other tillage treatments were planted with a Tye no till drill with 7 inch row spacing equipped with 1 inch fluted coulter ahead of the double disc openers.

	Planting			
Crop	Date	Planter	Rate	Harvested
Corn	May 7, 1992	Row	32,000 seeds/A	October 13,1992
Soybeans	May 7, 1992	Drill	225,000 seeds/A	October 21,1992

Fertilizer History 1985-1990

			Actual			
	Material		N	P_2O_5	K_2O	
Crop	Analysis	Rate	----	lb/A	----	Date Applied
Corn:	82-0-0	183 lb/A	150	0	0	Spring 1985
	4-15-40[1]	250 lb/A	10	38	100	Planting 1985
Corn:	4-15-40	300 lb/A	12	45	120	October 27, 1986
	7-21-7[1]	17 gal/A	13	40	13	April 28, 1987
	82-0-0	159 lb/A	130	0	0	May 15, 1987
Soybeans:	4-15-40	300 lb/A	12	45	120	October 27, 1986
	0-46-0[2]	45 lb/A	0	21	0	May 5, 1987
Corn:	10-34-0[3]	19 gal/A	22	76	0	April 28, 1988
	10-34-0[1]	9 gal/A	11	36	0	May 5, 1988
	82-0-0	183 lb/A	150	0	0	June 7, 1988
Soybeans:	10-34-0[3]	10 gal/A	12	40	0	April 28, 1988
	10-34-0[1]	5 gal/A	6	20	0	May 5, 1988
	0-46-0[2]	358 lb/A	0	165	0	May 5, 1988
Corn:	7-21-7[4]	15 gal/A	12	35	12	May 10, 1989
	82-0-0	183 lb/A	150	0	0	May 31, 1989
Soybeans	7-21-7[5]	15 gal/A	12	35	12	May 22, 1989
Corn :	7-21-7[4]	18 gal/A	14	42	14	May 10, 1990
	82-0-0	220 lb/ A	180	0	0	July 5, 1990
Soybean :	7-21-7[5]	18 gal/A	14	42	14	May 10, 1990

1. Planter placement 2" beside and 2" below row.
2. Drill soybeans were split with row fertilizer which was surface banded ahead of and incorporated by the fluted coulters.
3. Broadcast applied.
4. Planter placement 2" x 2" on 1/2 the plots.
5. Planter placement 2" x 2" on 1/2 the plots, Ridge Till only.

1991 Fertilizer

Crop	Material Analysis	Rate	Actual N	Actual P_2O_5	Actual K_2O	Date Applied	Method of Application
			----	lb/A	----		
Corn:	10-34-0	5 gal/ac	6 -	20	- 0	5/16/91	Row placement 2"x2" below row.
	0-46-0	87lb/ac	0 -	40	- 0	5/13/91 5/15/91	Broadcasted.
	83-0-0	260lb/ac	217-	0	- 0	6/25/91	Injected.
soybean:	10-34-0	5 gal/ac	6 -	20	- 0	5/16/91	Row placement 2"x2" below row.
	0-46-0	87lb/ac	0 -	40	- 0	5/13/91 5/15/91	Broadcasted.

1992 Fertilizer

Crop	Material Analysis	Rate	Actual N	Actual P_2O_5	Actual K_2O	Date Applied	Method of Application
			----	lb/A	----		
Corn:	7-21-7	10 gal/ac	8 -	25	- 8	5/7/92	Row placement 2"x2" below row.
	83-0-0	180lb/ac	149-	0	- 0	6/4/92	Injected.
Soybean	7-21-7	10 gal/ac	8 -	25	- 8	5/7/92	Row placement 2"x2" below row.

Soil

The soils present at this site are as follows: 29% of plot area is Delft clay loam (Cumulic Haplaquolls, fine-loamy, mixed, mesic), 43% is Koronis fine sandy loam (Mollic Haplaudalfs, fine-loamy, mixed, mesic), and the remaining 28% is Marcellon loam (Aquic Argiudolls, fine-loamy, mixed, mesic).

Weed Control

Corn
Roundup 1.5 lb a.i./a + Lasso 2 lb a.i./a + Bladex 2 lb a.i./a + Basagran 1 lb a.i./a on May 14, 1992.

Soybeans
Roundup 1.5 lb a.i./a (May 14, 1992); Pursuit 0.252 lb a.i./a + Basagran 1 lb a.i./a on June 11,1992.

Table 2. Soybean residue cover as influenced by tillage and row position in corn at Kuechle farm, Meeker Co (5/29/92)

Tillage	Row Position		Weighted
	In Row	Between Row	Means
	%		
No till	21.2(14.2)	42.5(11.9)	**37.8(16.8)a**
Ridge Till	10.0(9.6)	24.7(10.4)	**21.4(12.4)b**
Chisel	6.0(6.6)	7.5(6.8)	**7.2(6.7)c**
Moldboard	2.2(3.1)	2.3(3.5)	**2.3(3.3)d**
Means	**9.8(11.6)b**	**19.3(18.1)a**	

The P>F: tillage=0.001(n=48);
row position=0.020 (n=96);
tillage*row position=0.413(n=24).

Table 3. Corn population and growth stage as influenced by tillage at Kuechle farm, Meeker county (6/11/92).

Tillage	Population	Growth Stage
	x 1000 plants/a	---leaves----
Notill	**30.2(4.0)a**	**4.05(0.5)b**
Ridge Till	**29.8(4.2)a**	**4.49(0.4)a**
Chisel	**29.3(2.5)a**	**4.43(0.5)a**
Moldboard	**29.9(2.6)a**	**4.61(0.4)a**

The P>F for population=0.804(n=24)
for growth stage=0.019(117-121).

Table 4. Corn yield as influenced by tillage and P-fertilizer methods of application at Kuechle farm, MN (10/13/92)

Tillage	Broadcast	Row application	Means
	bu/a		
Notill	79.0(24.7)	83.7(24.5)	**81.2(23.8)c**
Ridge Till	105.9(12.6)	114.5(11.3)	**110.1(12.4)a**
Chisel	96.5(11.9)	93.0(25.6)	**94.8(19.3)b**
Moldboard	113.0(20.9)	110.0(19.0)	**112.2(19.1)a**
Means	**97.7(21.7)a**	**100.7(23.5)a**	

The P>F: tillage=0.036(n=12-15); method of fertilizer application=0.905(n=28-29)
tillage*application=0.072(n=6-8).

Table 5. Corn grain moisture as influenced by tillage and P-fertilizer method of application at Kuechle farm, MN (10/13/92)

Tillage	Broadcast	Row Application	Means
	%		
Notill	38.9(5.2)	35.8(5.1)	**37.4(5.2)a**
Ridge Till	35.9(3.9)	34.6(3.1)	**35.2(3.5)a**
Chisel	33.1(5.9)	35.1(3.0)	**34.1(4.6)a**
Moldboard	36.7(2.5)	34.0(3.7)	**35.3(3.3)a**
Means	**36.2(4.9)a**	**34.9(3.7)a**	

The P>F: tillage=0.661(n=12-15); method of fertilizer application=0.195(n=28-29).
tillage*application=0.379(n=6-8)

Table 6. Corn residue cover as influenced by tillage and row position in soybean at Kuechle farm, Meeker Co.(5/29/92)

Tillage	Row Position		Weighted
	In Row	Between Row	Means
	%		
Notill	43.7(17.8)	37.0(20.1)	**38.5(19.2)a**
Ridge Till	21.3(26.7)	35.0(21.5)	**32.0(24.7)a**
Chisel	16.0(8.4)	7.7(4.3)	**9.5(7.8)b**
Moldboard	7.0(12.4)	4.3(3.5)	**4.9(10.0)b**
Means	**22.0(21.9)a**	**21.0(21.4)a**	

The P>F: tillage=0.002(n=24);
row position=0.581(n=48);
tillage*row position=0.003(n=12).

Table 7. Soybean population and growth stage as influenced by tillage at Kuechle farm, Meeker county (6/19/92).

Tillage	Population	Growth Stage
	1000 plants/a	---nodes----
Notill	**152.8(120.8)a**	**3.94(0.6)a**
Ridge Till	**103.2(93.8)b**	**4.26(0.5)a**
Chisel	**111.3(114.3)b**	**4.34(0.7)a**
Moldboard	**117.8(123.7)b**	**4.03(0.7)a**

The P>F for population,tillage=0.060(n=24)
for growth stage=0.358(n=53-62).

Table 8. Soybean yield as influenced by tillage and P-fertilizer methods of application at Kuechle farm, MN (10/21/92)

Tillage	Broadcast	Row application	Means
	bu/a		
Notill	39.6(5.8)	35.0(9.4)	**37.2(7.9)a**
Ridge Till	29.8(5.3)	30.9(5.3)	**30.4(5.1)a**
Chisel	42.1(5.0)	28.7(12.1)	**35.4(11.3)a**
Moldboard	42.9(13.7)	41.9(11.1)	**42.4(12.1)a**
Means	**38.9(9.5)a**	**34.2(10.7)a**	

The P>F: tillage=0.417(n=14-16); method of fertilizer application=0.103(n=31);
tillage*application=0.140(n=7-8).

Table 9. Soybean grain moisture as influenced by tillage and P-fertilizer method of application at Kuechle farm,MN (10/21/92)

Tillage	Broadcast	Row Application	Means
	%		
Notill	10.1(0.5)	10.1(0.3)	**10.1(0.4)b**
Ridge Till	10.3(0.3)	10.5(0.8)	**10.4(0.6)b**
Chisel	10.2(0.4)	12.5(2.6)	**11.3(2.2)a**
Moldboard	10.1(0.3)	10.1(0.4)	**10.1(0.4)b**
Means	**10.2(0.4)a**	**10.8(1.7)a**	

The P>F: tillage=0.037(n=14-16); method of fertilizer application=0.167(n=31).
tillage*application=0.008(n=7-8)

Table 10. Distribution of soil Bray-P with depth as influenced by tillage, method of P application, row position and soil depth at Kuechle Farm, Meeker Co., MN (August 19/92).

Tillage	Method of P Application	Depth	In row	Between Row	Means
		inch	ppm		
Notill	Broadcast	0-2	10.8(5.6)	16.0(8.6)	**13.4(7.4)**
		2-4	6.6(2.6)	7.6(2.0)	**7.1(2.4)**
		4-6	5.5(2.0)	5.5(1.6)	**5.5(1.7)**
		means	**7.6(4.2)**	**9.7(6.7)**	**8.6(5.6)**
	Row applied	0-2	26.0(8.3)	12.8(10.7)	**19.4(11.4)**
		2-4	9.7(6.7)	10.1(6.5)	**9.9(6.3)**
		4-6	9.7(5.3)	8.1(4.7)	**8.9(4.8)**
		means	**15.1(10.2)**	**10.3(7.5)**	**12.7(9.2)**
Ridge Till	Broadcast	0-2	14.3(5.6)	20.3(9.5)	**17.3(8.4)**
		2-4	10.2(6.3)	11.1(7.2)	**10.7(6.5)**
		4-6	8.9(5.6)	7.8(4.2)	**8.3(1.7)**
		means	**11.1(6.3)**	**13.1(8.7)**	**12.1(7.6)**
	Row applied	0-2	30.1(16.1)	25.3(19.2)	**27.5(17.2)**
		2-4	19.6(12.9)	14.5(10.8)	**17.1(11.6)**
		4-6	7.7(4.0)	8.8(4.5)	**8.2(4.1)**
		means	**18.5(14.4)**	**16.2(14.1)**	**17.3(14.1)**
Chisel	Broadcast	0-2	15.0(6.9)	13.7(6.0)	**14.4(6.2)**
		2-4	10.1(4.6)	10.4(4.7)	**10.2(4.4)**
		4-6	8.4(4.4)	7.4(3.9)	**7.9(4.0)**
		means	**11.2(5.8)**	**10.5(5.3)**	**10.8(5.5)**
	Row applied	0-2	16.5(10.4)	14.1(9.7)	**15.3(9.7)**
		2-4	13.3(8.0)	8.3(3.1)	**11.0(6.6)**
		4-6	7.4(3.4)	7.3(4.1)	**7.3(3.6)**
		means	**12.4(8.3)**	**10.0(6.8)**	**11.2(7.6)**
Moldboard	Broadcast	0-2	7.7(5.4)	8.7(5.1)	**8.2(5.0)**
		2-4	9.5(6.1)	7.5(2.9)	**8.5(4.6)**
		4-6	7.2(4.9)	7.1(3.4)	**7.1(4.0)**
		means	**8.2(5.2)**	**7.7(3.7)**	**7.9(4.4)**
	Row applied	0-2	8.9(5.7)	9.7(5.2)	**9.3(5.2)**
		2-4	9.1(5.9)	6.6(3.9)	**7.8(4.9)**
		4-6	8.4(3.5)	7.4(3.7)	**7.8(3.4)**
		means	**8.8(4.8)**	**7.9(4.2)**	**8.3(4.5)**

The significant P>F:tillage=0.001(n=59-72),application=0.004(n=135-138); tillage* application=0.094(n=29-36);application*row=0.011(n=67-69);depth=0.001(n=91);tillage* depth=0.001(n=19-24);application*depth=0.061(n=45-46);application*row*depth=0.04 n=(22-23);tillage*method of P-application*row position*soil depth interaction=0.093 (n=5-6)

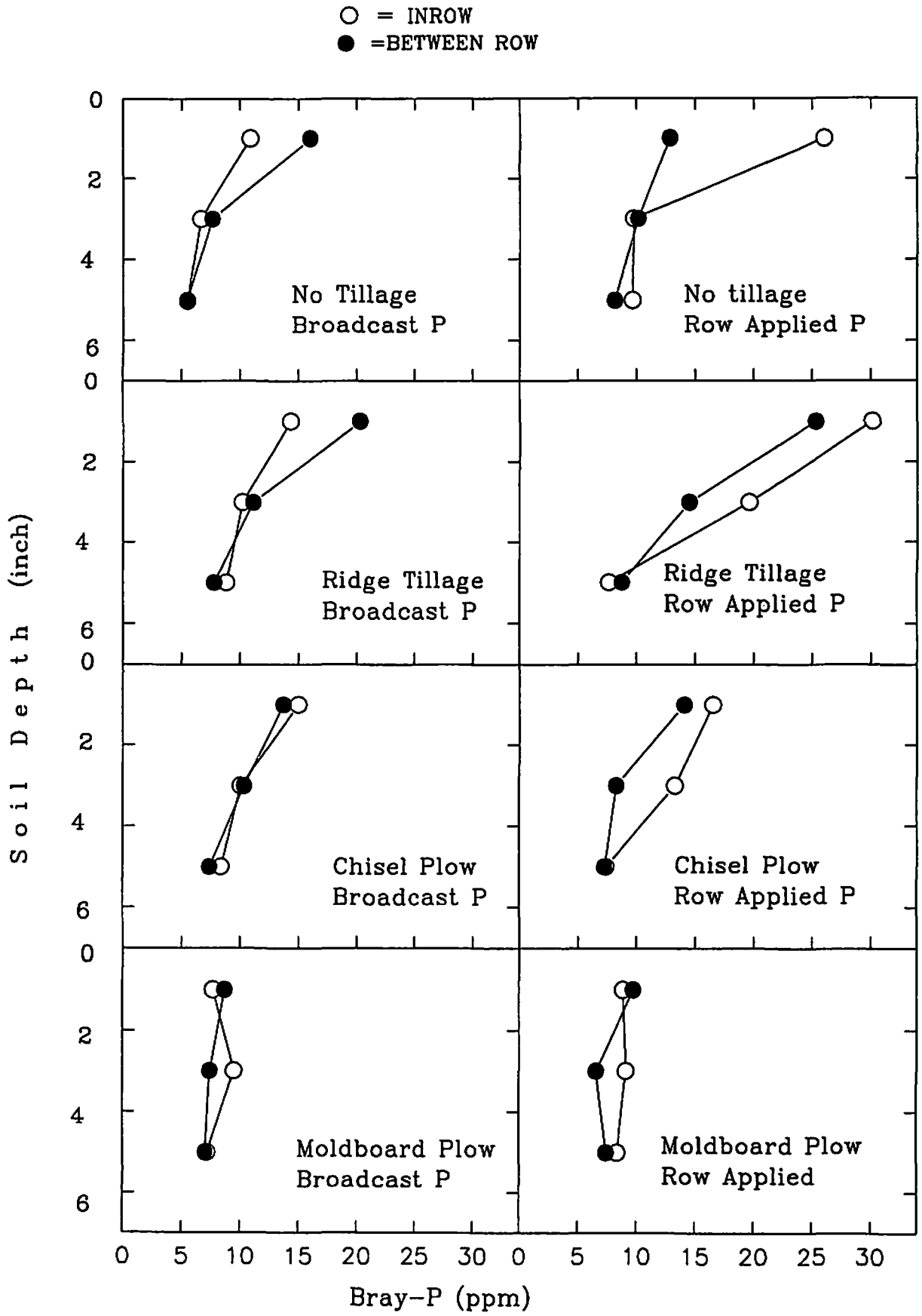

Fig. 1. Effects of tillage, phosphorus application methods and row position on soil profile P (Kuechle farm) MN.

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

J.F. Moncrief, H.J. Stanislowski, and B.J. Johnson[2]

Evaluation of tillage system, planter mounted row cleaners, and drill type was evaluated for spring wheat, corn, and soybeans on five farmer cooperator fields. Generally, tillage did not affect grain yields or quality. Rolling finger and disc row cleaners were about equally effective at removing residue from the row area. A conventional drill equipped with a coulter cart performed comparable to a no till drill with disc openers.

This the first year of a three year project evaluating residue management systems for corn, wheat, and soybeans in West Central Minnesota. Plots are located on five farmer cooperator fields. They are large to accommodate tillage equipment (50 to 100 ft. by 300 to 1400 ft.). The soils are highly erosive at most sites and the intent is to evaluate these systems for erosion control but with crop production as a priority. Each site has tillage main plots and are split with variables of interest at each site such as row cleaner type, manure source, drill type, etc.

The first site is described in table 1. This is the corn year in a corn, soybean, spring wheat crop sequence. The previous crop was spring wheat. The straw was not removed and the combine was equipped with an effective straw spreader. Two tillage systems were evaluated at this site (no till and chisel plowing followed with field cultivation). The planter was equipped with two types of row cleaners (rolling fingers and clearing discs). Weed control was excellent.

The affect of tillage and row cleaner type on soil cover with spring wheat straw is shown in table 2. Six days after planting the soil cover in the row was less than 10% with the rolling fingers with both no till and chisel systems. Clearing discs were not as effective under no till conditions and soil cover in the row was 18.5%. Soil cover measured diagonally or calculated as a weighted average is marginal for erosion control. Soil cover increased by June 1 in and between the row. Cover apparently blew back into the row area. The cover in the row is much higher than ideal for minimal effect on corn growth.

The corn response is shown in table 3. There is no affect of tillage or row cleaner type on stand establishment. The growth of corn was reduced an average of .4 leaves per plant with the no till system. Under no till conditions the clearing discs resulted in about .3 leaves per plant higher growth than chisel plowing system. There was about a 2.5 bushel per acre difference in grain yield due to tillage. Although this difference is small it is statistically significant. Test weight and grain moisture were not affected by treatments.

Cultural practices and treatment summary for the Julian Sjostrom farm are shown in tables 4 and 5. Tillage system and row cleaner type are evaluated at this site for corn planted into oat residue. Liquid dairy manure from a pit below the barn is also being evaluated at this site. No till plots were split with field cultivation to evaluate manure incorporation effects on corn response.

Following planting the soil cover in the row was 14 and 6% for the no till and chisel systems. Soil cover between the row or made diagonally showed adequate soil cover for erosion control with both systems. Several weeks later measurement of soil cover by crop residue in the row had increased to 20 and 36% for the chisel and no till systems respectively. This level of cover in the row would be expected to adversely affect corn development. As the season progresses, and the canopy closes, the soil cover in the row has less impact on corn development. Soil cover between the row had also increased to 50 to 60%.

There was no affect of tillage on stand establishment or early growth. Stands tended to be higher with clearing disc type row cleaner. This type of row cleaner appeared to cut oat straw and manure

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residues more aggressively and clear the row area more effectively. This may have been the reason for the stand response. The finger type row cleaner had significantly higher early corn growth however (.7 leaves per plant).

Yield and grain moisture was not affected by tillage system. The grain moisture content showed higher levels for the finger type row cleaner. This contradicts the early growth data. The ear leaf concentrations of nutrients were above sufficiency levels and not affected by tillage.

Table 1. Cultural practices for 1992 production season on the Dan Jennen farm, Fergus Falls, Mn.

Design A randomized complete block design with a split plot and 3 replications was used in this demonstration (tillage main plots and row cleaner subplots).

Tillage treatments

1. No Till-corn planted in wheat stubble.
2. Chisel plowed in fall of 1991; Field cultivated 5/6/92 with 27' Wil-Rich cultivator, 7" sweeps/harrow.
3. Two types of row cleaners (three rolling fingers and three clearing discs on six row planter) were evaluated.

All plots were row cultivated on 6/10 and 6/23 with a Yetter no till C-shank and John Deere S-tine cultivators respectively.

Fall moldboard plowed chisel plots 11/9/92 with John Deere 6-bottom 22" moldboard plow.

Planting and Harvesting Date

The planter is a John Deere 7000, 6-row 36" with rolling fingers (Yetter Residue Manager) and clearing discs (Trash Master). The corn hybrid was 85 day Agripro 077.

Planting			Harvested	
Crop	Date	Rate	Grain	chopped corn stalks
corn	May 8,1992	26,000seeds/A	10/22/92	11/9/92 (chisel plots)

Soil Type Barnes-Langhi loam complex 80% of plot area; slope 6-12%
Langhi-Barnes loam complex 15% of plot area; slope 12-20%
Lake Park loam; 5% of plot area; slope 2%

Fertilizer

Starter 9-23-30- 120 lb/acre applied on 5/8/92
NH_3 on fall chisel- 100 lb/acre applied on 10/23/91
NH_3 on No till- 120 lb/acre applied on 10/23/91

Weed control Dual 2 lb/acre at planting 5/8/92; Buctril 1.5 pt/acre on 6/13/92

Rainfall April-Nov. 14.58"

Table 2. The effect of tillage and planter mounted tillage tools on soil cover by wheat residue[1].

	5/14/92[2]					6/1/92[3]							
	Fingers[4]				Disc[5]	Fingers				Disc			
	In	Betwn	Diagn	Wtavg[6]	In	In	Betwn	Diagn	Wtavg	In	Betwn	Diagn	Wtavg
Tillage	%												
NoTill	9.2	81.2	72.9	65.2	18.6	61.2	86.7	72.0	80.4	47.0	73.7	66.3	68.5
Chisel	5.7	35.6	20.9	29.0	6.8	37.8	59.9	44.3	54.7	34.2	40.4	26.3	36.4

1. Column headings represent "in row" defined as a 8 inch strip centered over the row, the second column is the remainder of the area or "between the row", the next column is the cover made by a line transect measurement diagonal to the row, and the last column is a weighted average of the "in" and "between the row" measurements.
2. The p values for the analysis of variance for cover for the fingers treatment only, for tillage, row position, and the tillage by row position interaction are .022, <.001, and <.001 respectively.
3. The p values for the analysis of variance for cover for tillage, row position, and the tillage by row position interaction are .028, <.001, and <.001 respectively.
4. This row cleaner is a pair of discs oriented in a V shape with the concave outward.
5. This row cleaner is a pair of interlocking spiked wheels oriented in a V shape.
6. The weighted average =[(in row x 8") + (between x 28")]/36.

Table 3. Corn response to tillage and planter mounted tillage tools.

	Stand[1]			Growth[2]			Ear Leaf[3](8/29/92)				Yield[8]			Testwt[9]		Grain Moisture[10]		
	Fngr	Disc	avg.	Fngr	Disc	avg.	N[4]	P[5]	K[6]	Zn[7]	Fngr	Disc	avg.	Fngr	Disc	Fngr	Disc	avg.
Tillage	--plts/ac--			--lvs/plt--			------%------			-ppm	---bu/ac---			-lbs/bu-		-----%------		
NoTill	25.2	25.9	**25.6**	8.97	9.30	**9.14**	2.81	.275	1.45	16.5	63.8	66.0	**64.9**	47.8	47.8	27.1	26.8	**27.0**
Chisel	25.3	25.0	**25.2**	9.52	9.58	**9.55**	2.66	.254	1.46	18.8	69.0	66.0	**67.5**	48.2	48.2	26.4	27.0	**26.7**
average	**25.2**	**25.4**		**9.24**	**9.44**		**2.74**	**.264**	**1.46**	**17.6**	**66.4**	**66.0**		**48.0**	**48.0**	**26.8**	**26.9**	

1. Measurement taken on 6/1/92. The p values for the tillage, row cleaner, and the tillage by row cleaner interaction are .514, .684, and .389 respectively.
2. Measurement taken on 7/1/92. The p values for tillage, row cleaner and the tillage by row cleaner interaction are .112, .035, and .096 respectively.
3. Ear leaf samples were taken on 8/29/92. Fertilizer was applied at planting placed 2" below and 2" beside the seed (5/8/92) at 120 lbs/a as 9-23-30. The soil test is: pH=7.9, Olsen P=20ppm, and Ammonium Acetate Extractable K=178ppm.
4. The p value for tillage is .682. Sufficiency value for corn ear leaf N is 2.75%.
5. The p value for tillage is .350. Sufficiency value for corn ear leaf P is .25%.
6. The p value for tillage is .992. Sufficiency value for corn ear leaf K is 1.80%.
7. The p value for tillage is .150. Sufficiency value for corn ear leaf Zn is 20.0ppm.
8. Yields were measured on 10/19/92. The p values for the tillage, row cleaner, and the tillage by row cleaner interaction are .028, .823, and .169 respectively.
9. The p values for tillage, row cleaner and the tillage by row cleaner interaction are .422, 1.00, and 1.00 respectively.
10. The p values for tillage, row cleaner and the tillage by row cleaner interaction are .756, .831, and .461 respectively.

Table 4. Cultural practices for 1992 production season on the Julian Sjostrom farm, Pelican Rapids, Mn.

Design A randomized complete block design with 3 replications was used for this demonstration.

Tillage treatment

1. No Till split with and without manure incorporation with field cultivator 5/12/92
2. Fall chiseled 9/15/91 15" spacing, 4" twisted shovel. Field cultivated 5/12/92

Planting and Harvesting Date

The planter is a John Deere 7000 4-36"row with rolling fingers and clearing discs. Hybrid was 85 day Sigco 1885. Previous crop oats with straw removed.

	Planting		**Harvested**
Crop	Date	Rate	Grain
corn	May 12,1992	25,200seeds/A	10/17/92

Soil Chappett-Sisseton loam complex 100% slope 12-20, average = 15%

Fertilizer Starter 30-10-10 94 lb/acre applied on 5/12/92

Weed control

Accent/Banvil 2/3 oz and 3/4 pt/acre on 6/11/92
Ranger 1.4 qt./acre on 8/12/92

Rainfall April-Nov. 17.21"

Manure analysis and rate of applied nutrients

sample [1]	**Total**	**Volatile**	**Fixed**	**pH**	**Tot-N**	**Org-N**	**Min-N**	**Amm-N**	**Nit-N**	**Avail-N**[2]	**P_2O_5**	**K_2O**
	-------percent---------				----------Pounds per 1000 gals.----------							
Sjostrom 1.	7.84	81.25	18.75	6.6	32	17	16	15	.36	21	17	32
Sjostrom 2.	11.38	82.58	17.42	6.9	39	22	17	17	.02	24	24	34
Average	**9.61**	**81.92**	**18.08**	**6.8**	**36**	**19**	**16**	**16**	**.19**	**22**	**21**	**33**

1. Each sample was run in duplicate. Samples were taken in April and early summer or 1992 respectively.
2. Estimated available Nitrogen = Organic-N x .30 (mineralization factor) + Total mineral-N.

Table 5. The effect of planter mounted tools and tillage system on soil cover by oat residue on the Julian Sjostrom farm, Pelican Rapids, Mn. 1992

	5/14/92[2]				6/2/92[3]					
	Row position[1]				Fingers[4]			Disc[5]		
	In	Betwn	Diagn	Wtavg[6]	In	Betwn	Diagn	In	Betwn	Diagn
Tillage	----------%----------				------%------			------%------		
NoTill	14.0	40.0	32.0	34.0	37.2	59.0	48.0	36.0	57.8	50.0
Chisel	6.0	49.0	39.0	40.0	20.8	59.0	39.7	21.2	47.6	47.7

1. Column headings represent "in row" defined as a 8 inch strip centered over the row, the second column is the remainder of the area or "between the row", the next column is the cover made by a line transect measurement diagonal to the row, and the last column is a weighted average of the "in" and "between the row" measurements.
2. The p values for the analysis of variance for the fingers treatment only, for the tillage, row position, and the tillage by row position interaction are .945, .021, and .643 respectively.
3. The p values for the analysis of variance for tillage, row cleaner, and the tillage by row cleaner interaction are .531, .941, and .894 respectively.
4. This row cleaner is a pair of discs oriented in a V shape with the concave outward.
5. This row cleaner is a pair of interlocking spiked wheels oriented in a V shape.
6. The weighted average =[(in row x 8") + (between x 28")]/36.

Table 6. The effect of planter mounted tillage tools and tillage system on corn response.

	Stand[1]			Growth[2]			Ear Leaf[3](8/29/92)				Grain Yield[8]			Testwt[9]		Moisture[10]		
	Fngr	Disc	avg.	Fngr	Disc	avg.	N[4]	P[5]	K[6]	Zn[7]	Fngr	Disc	avg.	Fngr	Disc	Fngr	Disc	avg.
Tillage	--plts/ac--			--lvs/plt--			------%-------ppm				---bu/ac---			-lbs/bu-		-----%-----		
NoTill	20.4	23.5	**22.0**	11.4	10.8	**11.1**	2.72	.373	1.97	23.9	55.6	57.5	**56.6**	47.5	47.8	27.8	26.5	**27.2**
Chisel	21.3	22.4	**21.8**	11.4	10.6	**11.0**	2.84	.358	1.94	21.5	62.7	63.2	**63.0**	47.5	47.5	27.9	27.3	**27.6**
average	**20.8**	**23.0**		**11.4**	**10.7**		**2.78**	**.366**	**1.96**	**22.7**	**59.2**	**60.4**		**47.5**	**47.6**	**27.8**	**26.9**	

1. Measurement taken on 6/1/92. The p values for tillage, row cleaner, and the tillage by row cleaner interaction are .957, .173, and .468 respectively.
2. Measurement taken on 7/6/92. The p values for tillage, row cleaner, and the tillage by row cleaner interaction are .584, .005, and .734 respectively.
3. Ear leaf samples were taken on 8/29/92. Fertilizer was applied at planting placed 2" below and 2" beside the seed (5/12/92) at 94 lbs/a as 30-10-10. The soil test is: pH=7.8, Olsen P=>50ppm,and Ammonium Acetate Extractable K=233ppm.
4. The p value for tillage is .639. Sufficiency value for corn ear leaf N is 2.75%.
5. The p value for tillage is .687. Sufficiency value for corn ear leaf P is .25%.
6. The p value for tillage is .735. Sufficiency value for corn ear leaf K is 1.80%.
7. The p value for tillage is .304. Sufficiency value for corn ear leaf Zn is 20.0ppm.
8. Yields were measured on 10/17/92. The p values for the tillage, row cleaner, and the tillage by row cleaner interaction are .322, .137, and .304 respectively.
9. The p values for tillage, row cleaner and the tillage by row cleaner interaction are .423, .374, and .374 respectively.
10. The p values for tillage, row cleaner and the tillage by row cleaner interaction are .834, .107, and .461 respectively.

Table 7. Corn response to spring applied manure incorporation on oat stubble with field cultivation[1]

	10/17/92								
	Yield[2]			Testwt[3]			Moisture[4]		
	Fingers	Disc	avg	Fingers	Disc	avg	Fingers	Disc	avg
Manure	----bu/a----			----lb/bu----			-----%------		
No Incorp.	55.2	56.2	**55.7**	47.5	48.0	**47.8**	27.5	27.0	**27.2**
Incorp.	66.0	65.0	**66.0**	47.5	47.5	**47.5**	27.5	28.0	**27.8**

1. Liquid manure was applied to all plots on 5/4/92 at a rate of 4800 gal/a. Manure was incorporated on half of the no till plots with a field cultivator. Analysis of N,P, & K- (36 lbs, 21 lbs, & 33 lbs)/1000 gallons. As total N, P_2O_5, & K_2O respectively.
2. The p values for the analysis of variance for manure, row cleaner, and the manure by row cleaner interaction are .187, .979, and .347 respectively.
3. The p values for the analysis of variance for manure, row cleaner, and the manure by row cleaner interaction are .500, .423, and .423 respectively.
4. The p values for the analysis of variance for manure, row cleaner, and the manure by row cleaner interaction are .295, 1.00, and .184 respectively.
5. This row cleaner is a pair of interlocking spiked wheels oriented in a V shape.

Incorporation of spring applied dairy manure with field cultivation on plots with no other tillage did not affect corn yields, test weight, or moisture.

Data collected on the Orland Ohe farm are presented in tables 8 and 9. At this site two different drills are evaluated with two levels of spring tillage (none and discing). Although discing reduced soil cover by crop residue it was not affected by drill type. Stands were higher under no till conditions although plant stands are high enough to not be expected to influence yields. Soybean yields, test weight, and moisture were not affected by tillage or drill type. There was a significant affect of tillage, drill type, and tillage by drill type interaction for soil cover by lambsquarter. Lambsquarter were more prevalent under discing and Haybuster treatments.

Table 8. Cultural practices for 1992 production season on the Orland Ohe farm, Rothsay, Mn.

Design A randomized complete block with split plots with tillage main plots and drill type subplots was used on this demonstration. The number of replications is three.

Tillage treatment 1. No Till; 2. Spring disced 5/14/92 with 12' offset disc; fall chiseled 10/18/92 with 12" spacing and 3" twisted shovels.

Drill treatments Tillage plots were split with two drills: 1) International Harvester (IH) with Yetter 5/8" coulter cart with 7" row spacing and 2) Haybuster (HB) no till drill double disc openers, row spacing 7". Soybean variety Glenwood.

Planting			Harvested
Crop	Date	Rate	Grain
soybean	May 19,1992	56 lbs/acre	10/12/92

Soil
Formdale-Buse Udic Haploboroll-Udorthentic Haploboroll complex 60% clay loam slope 2-6, avg.= 4%
Formdale-Langhi clay loam Udic Haploboroll- complex slope 6-12 9 20%
Aazdahl clay loam Aquic Haploboroll slope 0-3 1 20%

Fertilizer None

Weed control
Basagran + Poast Plus .5 lb/acre and .25 lb/acre on 6/20/92
Blazer on 6/28/92

Rainfall April-Nov. 15.10"

Table 9. The effect of tillage and drill type on soil cover by corn residue and soybean response.

	Soil cover															
	Drill type[1]			Row postn.[2]			Yield[3]			Stand[4]		Testwt[5]		Moisture[6]		
	IH	HB	**avg.**	IN	BET	WTX[10]	IH	HB	**avg.**	avg.	sdev.	IH	HB	IH	HB	**avg.**
Tillage	----%-----			----%----			----bu/acre----			-10^3plts/ac-		-lbs/bu-		------%------		
No Till	76	76	**76.0**	79	88	**86**	17.9	15.3	**16.6**	232	64.9	59.1	59.0	10.2	10.4	**10.3**
Disced	33	33	**32.8**	37	54	**50**	21.8	18.0	**19.9**	175	56.8	59.1	59.1	10.2	10.1	**10.2**
average	**54**	**54**		**58**	**71**		**19.8**	**16.6**		**204**		**59.1**	**59.0**	**10.2**	**10.3**	

Table 9 (cont.) Weed response to tillage system and drill type.

	Weeds								
	Lambsqtr.[7]			Thist.[8]			Ragweed[9]		
	IH	HB	**avg.**	IH	HB	**avg.**	IH	HB	**avg.**
Tillage	---% cover---			---% cover--			--% cover---		
No Till	17.3	19.7	**18.5**	1.5	3.0	**2.2**	3.0	5.3	**4.2**
Disced	18.3	28.3	**23.3**	1.7	3.3	**2.5**	2.0	3.0	**2.5**
	17.8	**24.0**		**1.6**	**3.2**		**2.5**	**4.2**	

1. Measurement on 5/19/92. The p values for tillage, drill type, the tillage by drill type interaction are .006, .336, and .444 respectively. The two drills used were: 1)International Harvester (IH) with Yetter coulter cart and 2)Haybuster (HB) no till drill.
2. Measurement on 6/9/92. The p values for tillage, row, tillage by row interaction are .128, .143, and .652 respectively.
3. Measurements taken on 10/12/92 for variables 3-8. The p values for tillage, drill type, and the tillage by drill type interaction are .134, .152, and .737 respectively.
4. Measurement on 6/9/92. The p value for tillage is .076.
5. The p values for tillage, drill type, and the tillage by drill type interaction are .184, 1.00, and .230 respectively.
6. The p values for tillage, drill type, and the tillage by drill type interaction are .539, .696, and .276 respectively.
7. The p values for tillage, drill type, and the tillage by drill type interaction are .066, .018, and .074 respectively.
8. The p values for tillage, drill type, and the tillage by drill type interaction are .889, .305, and .954 respectively.
9. The p values for tillage, drill type, and the tillage by drill type interaction are .038, .298, and .658 respectively.
10. WTX represents the weighted average of " [(in row x 2") + (between x 5")]/7".

The cultural practices and spring wheat response to tillage system on the Evert Gilbertson farm are shown in tables 10 and 11. There was no affect of tillage on wheat stand, tillering, or yield. Protein levels were higher under disc system. Broadcast urea on soil covered with about 50% residue may have resulted in volatilization losses and a reduction in grain protein.

Table 10. Cultural practices for 1992 production season on the Evert Gilbertson farm, Battle Lake, Mn.

Design A randomized complete block design with 3 replications.

Tillage

1. No Till
2. Spring disced 4/30/92; disc is 22' and has 11" spacings with a spike toothed harrow pulled behind.

Fall chisel plowed 1992

Planting and Harvesting Date

The planter was a Haybuster 107 7"spacing
The spring wheat variety is Gus.
Previous crop soybeans.

Planting			**Harvested**
Crop	Date	Rate	Grain
wheat	May 1,1992	1.5 bu/acre	9/17/92

Soil

Chappett loam 70% of plot area; slope 4%
Chappett-Sisseton loam complex 25% of plot area; slope 9%
Friberg Weetown loam complex 5% of plot area; slope 2%

Fertilizer Urea (46-0-0) spread 150 lb/acre 4/29/92.

Weed control

Roundup + surfactant at 1 qt/a on 4/20/92
Curtail for thistle 2 pt/a on 6/1/62

Rainfall April-Nov. 11.06"

Table 11. Wheat response to tillage system in soybean residue.

	5/12	5/29	7/2	7/2	----------9/17----------			
	Residue	Stand	Heads	Tiller	Yield	Moist.	Tst.wt.	Protein
Tillage	--%--	10^3/a	10^6/a	hds/plt	bu/a	--%--	lb/bu	--%--
NoTill	44.1a	455a	1.59a	3.49	55.7a	18.6a	61.0a	13.0a
Disced	8.4b	476a	1.68a	3.52	55.9a	19.1a	60.3a	14.0b

1. Means in the same column followed by different letters are statistically different, α =.10.

The results of a study evaluating fall chisel plowing and no tillage on a loamy sand soil are shown in tables 12 and 13. Although residue levels were lower than the study on the Evert Gilbertson farm the results were similar. There was no effect of tillage on yield, stand, or protein. No tillage conditions did result in higher tillering.

The effect of stalk chopping on soil cover with corn stalks was evaluated at this site. Stalk chopping doubled soil cover after drilling no till soybeans with a John Deere 750 no till drill (36 to 70%). An additional chisel plowing followed with secondary tillage only slightly reduced soil cover.

Table 12. Cultural practices for 1992 production season on the Dave Holt farm. Elizabeth, Mn.

Design A randomized complete block design with 3 replications.

Tillage treatments

1. Fall chiseled in 1991. Spring field cultivation 1992 on chisel plots.
   Fall chiseled 9/10/92 12" spacing with John Deere Mulch chisel.
2. No Till

Planting and Harvesting Date

The planters were 1) John Deere 750 No-till 7" spacing on no-till plots and 2) John Deere 9300 drill on chiseled plots with 6" spacing.
The wheat variety is Butte 86.
Previous crop soybeans.

	Planting		**Harvested**
Crop	Date	Rate	Grain
wheat	April 8,1992	2.0 bu/acre	8/19/92

Soil Sandberg loamy sand on 100% of the plot area; slope 4-9%

Fertilizer

NH_3 72 lb/acre on 10/27/91
Starter 15-38-10 100 lb/acre on 4/8/92
0-0-60 bulk spread 80 lb/acre by spin spreader applied on 4/7/92.

Weed control MCPA ester 3/4 pt/acre on 5/21/92

Rainfall April-Nov. 16.75"

Table 13. The effect of tillage system on soil cover by soybean residue and wheat response.

	4/28	5/14	7/6	7/6	----------8/19----------			
	Residue	Stand	Heads	Tiller	Yield	moist.	Tst wt.	Protein
Tillage	--%--	-10^3/a-	10^6/a	hds/plt	-bu/a-	--%--	lb/bu	--%--
No Till	17.2a	444a	2.35a	5.29	47.4a	15.6a	63.0a	13.6a
Chisel	6.9b	555a	1.78b	3.21	48.5a	15.4a	62.7a	13.7a

1. Means in the same column followed by different letters are statistically different, α =.10.
2. This was a separate field study to look at residue amounts form several chopping. Soybeans were planted with a John Deere 750 No till planter.

	Cover with corn stalks
Chopping	--%--
1.chop	70.0a
2.nonchop	36.3b
3.chop, chisel multiweed	27.2b

TILLAGE COMPARISON AT ROSEMOUNT
ROSEMOUNT, 1992

T.L Hansmeyer, D.R. Linden, K.L. Walter,
R.H. Dowdy, R.R. Allmaras and C.E. Clapp

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 in a continuous corn and corn/soybean rotation. Nitrogen inputs remained constant across all plots planted to corn with no nitrogen applied to plots in soybeans. The objective of the study is to determine the long term effects of various cropping systems on herbicide movement, earthworm activity, grain yield, nutrient availability and nutrient uptake. Though it is too early in the study to examine the differences in many of the objectives, grain yields and surface residue have proven to be significantly different in various tillage and rotation comparisons.

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 elevations and depth to gravel prior to plot layout. Temperature and precipitation was collected at the Rosemount experiment station table 2.

Experimental Procedure The site was separated into 36 plots of 0.4 acre each. A continuous corn (CC), soybean/corn (SC) *[corn 1992]*, and corn/soybean (CS) *[soybean 1992]* rotation was planted into four tillage systems in a randomized complete block design with three replications. The four tillage systems are described as follows:

CONVENTIONAL (T1):
Fall moldboard plow following corn and fall chisel plow following soybeans. Disk or field cultivate to prepare seedbed. One or two cultivations after planting as needed.

CONSERVATION (T2):
Fall chisel plow following corn with no fall tillage following soybeans. Disk and/or field cultivate to prepare seed bed 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 re-establish ridges.

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

Corn (Pioneer 3751) was planted in the CC and SC plots across all tillage systems on May 13. The seeds were planted at a population of 28,000 seeds/acre. Force insecticide was banded over the row at a rate of 9 oz./1000 ft of row. Soybeans (Sibley) were planted into the T1, T2, and T3 tillage systems on May 13 and tillage T4 on May 21. All soybeans were planted at the rate of 60 lbs/acre. Alachlor (Lasso) was broadcast at a rate of .75 lb ai/ac on all CC and SC plots May 13. A mix of 2.5lb ai/ac alachlor (Lasso) and .75 lb ai/ac metribuzin (Sencor) was applied on all CS plots May 15. A photo slide of the surface residue was taken directly after planting. The developed slide is then projected onto a grid. Residue intersecting the grid lines are counted toward the percent residue coverage. A 28% solution of Nitrogen at 125 lbs N/acre was applied on all CC and SC plots during cultivation June 15. Cultivated all CS plots except T4 (Minimized tillage) plots, since corn residue prevented cultivation. Applied 3/4 pt/ac sethoxydim (Poast) with 2 pt/ac crop oil on all CS plots June 29. Broadcast 1 lb ai/ac bentazon (Basagran) across all plots July 1. Created ridges in all ridge-till (T3) plots planted to corn on July 6. Cultivated all soybean plots except T4 July 10. Created ridges in soybean T3 plots July 28. Observed and recorded stands during the season and recorded final plant populations in all plots on Oct. 2.

Combined 12 center rows in all soybean plots Oct. 26. Combined 12 center rows in all corn plots Nov. 11. Corn stalks chopped and fall tillage performed Nov. 12-14.

Results Grain yields from all tillages and rotations are given in figures 1-3 and table 1. Grain moisture contents, final plant stand and a Crop Stress Rating (CSR) are also shown in figure 1-3. The crop stress rating is a qualitative estimate of potential yield reduction. All crop stress conditions including grass and/or broadleaf competition and frost damage are evaluated for each cropping system. The crop stress conditions occurring in each system are then tallied creating the CSR values. Larger CSR values indicate a higher potential of yield reduction.

Within the continuous corn system, grain yields from the ridge-till plots out yielded all other tillages followed by conventional, conservation and minimum-till in that order. Statistically, ridge-till yields were significantly higher than yields from the conservation and minimum-till plots. Yields from the conventional tillage plots were significantly higher than yields from the minimum-till plots (fig. 1).

Corn grain yields in the various tillages under the Soybean/Corn rotation were not significantly different (Fig 2). The same was true when comparing the soybean yields in the Corn/Soybean rotation (Fig 3).

The mean yield for each tillage indicates that ridge-till produced the highest yield followed by conventional, conservation and minimum-till, respectively. The grain yields from ridge and conventional tillage are significantly higher than the yields from conservation or minimum-till (figure 5). Also, the mean corn grain yields for each rotation in 1992 indicates that the rotation soybean/corn (CS) with a mean yield of 148 bu/ac had a significantly higher yield than continuous corn (CC) at 116 bu/ac (figure 4). Ridge-tillage reacted much more favorably under the continuous corn yielding 18.5% above the mean yield for that rotation, whereas ridge-till out yielded the mean yield under the Soybean/Corn rotation by only 3%.

Residue cover after planting is shown in fig. 5. As expected, both Conservation and Minimum-till provide sufficient corn and soybean residue to qualify for the recent requirements for erosion control, where residue must provide at least 30% coverage after planting. It must be noted that in the conservation tillage plots, corn is no-tilled into the previous years soybean stubble, leaving the soybeans stubble on the surface. Ridge-till provided sufficient residue to qualify under the corn/soybean rotation, but only produced 28% residue cover under the continuous corn rotation. Ridge-till buried a majority of the soybean stubble under the soybean/corn rotation leaving only 12% 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, one might expect at least 30% residue cover. However, the fall chisel plowed soybean plots only produced 24% residue cover at planting.

Analysis of variance has shown that a significant difference exists between the soybean and corn residue cover of each tillage. Statistically, an interaction effect occurs between the rotation and tillage. The interaction effect is caused by the unusually high amount of soybean residue remaining immediately after planting under the conventional and conservation tillage systems (fig. 5). In the conventional system, the soybean stubble is chisel plowed whereas corn stubble is plowed burying a higher percentage of the residue. A similar situation occurs under the conservation system. Corn is no-tilled into the soybean stubble leaving all soybean residue on the surface whilst corn residue is chisel plowed.

Table 1 Grain yields for the tillage study at Rosemount Study, 1992.

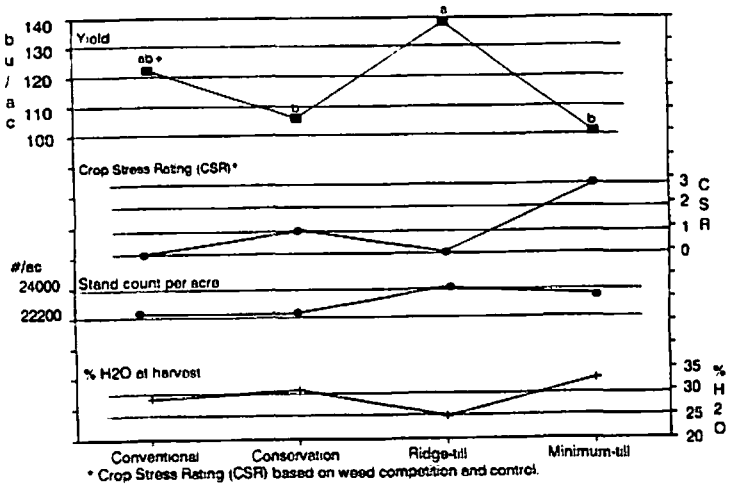
Treatment			Yield	
Tillage	Rotation		bu/ac	mt/ha
Conventional (T1)	Cont.Corn	(CC)	122	6.49
	Corn 92	(SC)	152	8.08
	Soybean 92	(CS)	41	2.38
Conservation (T2)	Cont.Corn	(CC)	106	5.61
	Corn 92	(SC)	143	7.58
	Soybean 92	(CS)	41	2.39
Ridge-Till (T3)	Cont.Corn	(CC)	138	7.33
	Corn 92	(SC)	153	8.13
	Soybean 92	(CS)	38	2.23
Minimum-Till (T4)	Cont.Corn	(CC)	101	5.35
	Corn 92	(SC)	145	7.69
	Soybean 92	(CS)	37	2.18

Table 2
Growing season precipitation and degrees days at Rosemount, Minnesota (1992).

	Precipitation			Degree Days 2/		
	Normal 1/	1992	Departure from normal	Avg	1992	Departure from normal
	cm			°C		
May	9.37	2.46	-6.91	156	233	+77
June	12.12	12.50	+0.38	270	264	-8
July	9.09	15.80	+6.71	385	268	-117
Aug.	10.9	10.95	+0.05	328	264	-64
Sept.	8.05	14.61	+6.56	160	205	+45
Totals	49.53	56.32	+6.79	1300	1234	-66

1/ Normal monthly precipitation for Rosemount, MN (1951-1980).
2/ Base temperature = 10°C.

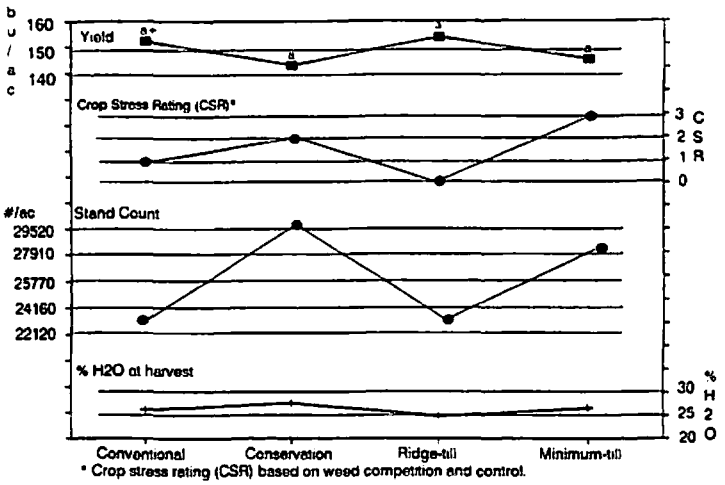
Figure 1 CONTINUOUS CORN (CC)



* Crop Stress Rating (CSR) based on weed competition and control.

+ Letters represent significant differences at the 5% significance level using the Student Newman Keuls Test.

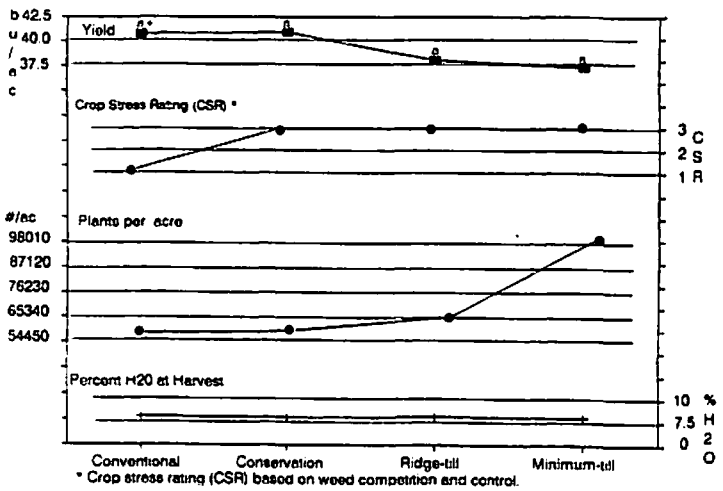
Figure 2 CORN FOLLOWING SOYBEANS (SC)



* Crop stress rating (CSR) based on weed competition and control.

+ Letters represent significant differences at the 5% significance level using the Student Newman Keuls Test.

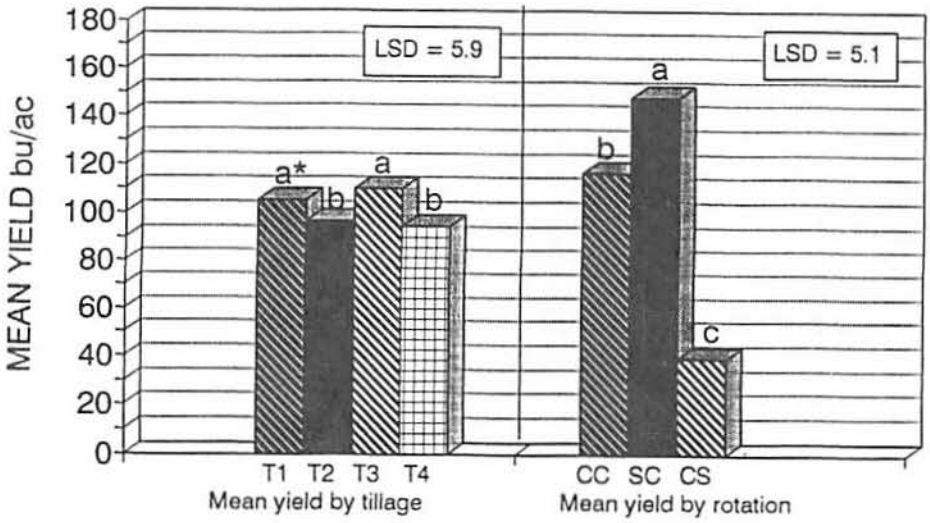
Figure 3 SOYBEANS FOLLOWING CORN (CS)



* Crop stress rating (CSR) based on weed competition and control.

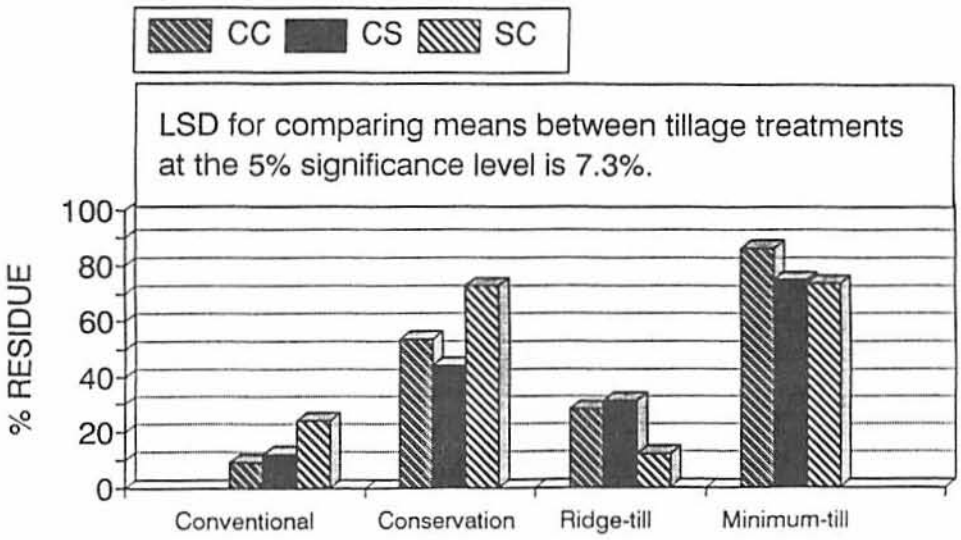
+ Letters represent significant differences at the 5% significance level using the Student Newman Keuls Test.

Figure 4
MEAN YIELD COMPARISON
by Tillage and Rotation



* Letters represent significant differences at the 5% significance level using the Student Newman Keuls Test.

Figure 5
RESIDUE COMPARISON
by Tillage and Rotation



THE EFFECT OF TILLAGE AND NUTRIENT SOURCE ON CORN YIELD AND SOIL PHOSPHORUS DISTRIBUTION[1]

P. M. Bongard, T. L. Wagar, J. F. Moncrief, R. B. Hamer, and T. J. Arlt[2]

Abstract. Two sites were selected in the south central Minnesota to demonstrate nutrient contributions from turkey manure. Applications rates were based on anticipated nitrogen needs for a corn crop following soybeans, and the manure was spring incorporated with a disc or a field cultivator. Soil phosphorus (P) levels in the top four inches of the manured treatments were increased two-fold over the check. Phosphorus distribution between the incorporation techniques did not differ significantly at the Morristown site. However, soil P of the disc-incorporated manure at Medford showed a more even distribution from the surface to a six-inch depth. At Morristown, manured treatment ear leaf nitrogen (N) contents and yields were at least as high as those in the fertilizer treatment. In contrast, fertilizer treatment ear leaf N contents and yields were significantly better than manured treatments and the check at Medford. While turkey manure can provide significant amounts of nutrients to crops, relying on the manure as the only nitrogen source may be risky under certain environmental conditions.

Introduction

Animal wastes can contribute substantial amounts of nutrients to crops, thus reducing producers' reliance on chemical fertilizers to maintain yields and profitability. Since turkey production has become a major industry in Minnesota, opportunities for wisely utilizing this animal waste are increasing. The objective of this demonstration was to show nutrient contributions to corn and to compare incorporation techniques of turkey manure. This demonstration is a follow-up to a study reported in the "Report on Field Research in Soils - 1991" that demonstrated nutrient contributions from tom-finish and brood turkey manures.

Materials and methods

Two sites which had no previous history of manure applications were selected near Morristown and Medford, Minnesota, for this demonstration. Soil classification and spring soil test results can be found in Table 1.

Turkey tom-finish manure with wood chip litter was taken from a storage pile for use in this demonstration. The tom-finish barns are skimmed after every flock (every 14-15 weeks), cleaned yearly and roto-tilled regularly.

The turkey manure was applied to meet the anticipated nitrogen (N) needs of the corn crop. The resulting rates were based on manure analysis (Table 2), previous crop, soil organic matter contents, and corn yield goals. The manure was applied at eight tons per acre at Morristown, and at six-and-a-half tons per acre at Medford on May 5 and incorporated immediately.

Two incorporation techniques of the manure were compared at each site: 1) incorporation with a disc; and 2) incorporation with a field cultivator. An untreated plot and a pre-plant commercial fertilizer treatment were also included in the demonstration. The fertilizer nitrogen, phosphate and potash rates can be

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[2]Environmental Agriculture Educator, Cluster 16; Area Extension Agent, Crops and Soils; Extension Specialist; Extension Educators, Rice and Steele counties, respectively; Minnesota Extension Service.

seen in Table 3. Fertilizer was applied on May 6 and incorporated immediately. Rainfall records and additional cultural practices can be seen in Tables 4 and 5.

The demonstrations were arranged in a randomized complete block with four replications. The fourth replication was dropped at Medford because of uneven manure spread. Plots were eight-row plots wide and 150 feet long at Morristown and six-rows wide and 200 feet long at Medford.

Soil P stratification was measured in the two manured treatments and the untreated plots at the end of July. Ten core composite samples were taken in two-inch increments from the soil surface to a depth of six inches both in and between the row. Ear leaves were sampled for total N (Kjeldahl with nitrate reduction) in these treatments at this time, also. Corn grain yields were measured at Morristown by hand harvesting and shelling ears from thirty-five feet of row, weighing the samples, and oven drying sub-samples to measure dry weight. At Medford, plots were machine combined with the farmer's eight-row equipment, weighed, and adjusted to 15.5% moisture. Rainfall amounts for the season are recorded in Table 5.

Results and discussion

Soil P levels in the top four inches were doubled in the turkey manure treatments over the untreated check at both sites (Figures 1 and 2), while there were no significant increases at the four-to-six inch depth increment. Soil P was distributed more evenly in the disc-incorporated treatment than in the field cultivator treatment at Medford, while there were no significant differences between incorporation methods at Morristown. Only 39% of the total P was found in the top two inches in the disc-incorporated manure treatment at Medford, while 50% of the total P remained in the top two inches in the rest of the manured treatments at the sites. The more even soil P distribution of this treatment could be expected from the large disc used at Medford (Table 4).

Ear leaf N contents were statistically equal between the manured and fertilizer treatments at Morristown, but these levels were significantly higher than those in the check (Table 6). In contrast, N contents differed significantly in all treatments at Medford. Nitrogen contents of the fertilizer treatment were significantly better than manured treatments, and all treatments had higher N contents than the control.

At Morristown, manured treatment yields were equal to or better than the fertilizer treatment, and all treatments with additional N were significantly better than the check (Figure 3). In contrast, the manured treatments at Medford yielded less than the fertilizer treatment and were statistically equal to the control (Figure 4). At this site, plants in the check and manured plots exhibited stunting and the typical leaf chlorosis and necrosis which is symptomatic of N stress. The cool summer may have limited mineralization of the organic nitrogen, thus reducing the expected N contribution from the manure. It is also possible that there was more denitrification in the finer soil at Medford than in the loam soil at Morristown. The cool summer, mid-season and early frosts also delayed development of the corn, as evidenced by the grain moisture contents at harvest (Figure 4). These combined factors may explain the poor performance of the turkey manure at the Medford site. Corresponding returns over the nutrient costs can be seen in Figure 5.

Conclusions

Turkey manure can contribute substantial amounts of nutrients to corn. Grain yields from the 1990 study and the Morristown site in 1992 were at least as high as those in the commercial fertilizer treatments. However, relying on turkey manure as the only source of nitrogen may be risky, as evidenced by the results at Medford. At these rates of turkey manure (6-8 tons/acre), phosphorus and potassium are often applied in significant excess of crop needs. While these

minerals are immobile in the soil, nutrient displacement could occur with soil runoff and should be examined. Future work could also examine a range of turkey manure rates for optimum nutrient utilization.

Acknowledgements

The authors would like to thank Dan Morris of Morristown and Jeff Bruessel of Medford for the use of their land, equipment, and labor to conduct these demonstrations. We would also like to thank Gene Morris of Morristown for providing seed, and George Raab at Jerome Foods, Inc. for providing the turkey manure.

Table 1. Soil classification and spring soil test results for turkey manure field demonstrations at two sites, April 1992.

LOCATION	SOIL CLASSIFICATION			SOIL TEST		
	SERIES	SUBGROUP	ORDER	O.M.	P	K
				------ppm-----		
Morristown	Clarion- Storden (loam)	Typic Hapludoll Typic Udorthent	Mollisol Entisol	Med	32	166
Medford	Maxcreek (sicl)	Typic Haplaquoll	Mollisol	High	20	119

Table 2. Turkey manure analysis, application rates and estimated nutrients applied to demonstration sites, 1992.

LOCATION	TURKEY MANURE ANALYSIS							ESTIMATED MANURE NUTRIENTS APPLIED[1]			
	MOISTURE	N_{TOT}	N_{MIN}	N_{ORG}	P_2O_5	K_2O	RATE	N_{TOT}	N_{AVAIL}	P_2O_5	K_2O
	----------%						ton/A	------lb./A-------			
Morristown	44.3	2.25	1.58	0.68	2.7	1.8	8.0	360	184	432	264
Medford	44.3	2.25	1.58	0.68	2.7	1.8	6.5	292	150	351	214

[1]First year N availability based on 30% organic N and 100% mineral N contents.

Table 3. Fertilizer application at demonstration sites, May 6, 1992.

NUTRIENT	MORRISTOWN[1]	MEDFORD
	---------lb./A--------	
N	191	150
P_2O_5	29	0
K_2O	38	60

[1]125 lb. 9-23-30 applied as starter to all treatments.

Table 4. Rainfall records for demonstration sites, 1992.

MONTH	MORRISTOWN[1]	MEDFORD
	----------inches----------	
April	1.5	not
May	0	avail-
June	3.6	able
July	3.6	
Aug.	5.0	
Sept.	3.2	

[1]Frost dates: 5/28, 6/21, and 9/21.

Table 5. Management practices used at turkey manure demonstrations sites, 1992.

	MORRISTOWN	MEDFORD
Variety	DeKalb 501	DeKalb 501
Planting date	May 6	May 8
Population	27,500	26,600
Primary tillage	none	none
Disc	14' Oliver	24' Kewanee Tandem
Field cult.	28' Case Int. digger 6"spacing w/ 7" sweeps	27' Kewanee 6" spacing w/ 7.5" shovels

Herbicide	Partner[3] pre-em (2.5 lb. ai/A) Bladex (3 lb. ai/A) Marksman post. (1.2 lb. ai/A)	Accent post. (0.031 lb. ai/A) Marksman post. (1.4 lb. ai/A)

Table 6. Ear leaf nitrogen contents for turkey manure demonstrations at Morristown and Medford, July 28, 1992.

SOURCE	EAR LEAF NITROGEN MORRISTOWN	MEDFORD
	----------%	----------
Check	2.2 b[1]	2.3 d
Fertilizer	3.0 a	3.0 a
Manure-disc	2.8 a	2.8 b
Manure-F.C.	2.8 a	2.6 c

[1]Data followed by the same letter in the same column are not significantly different at the 0.05 level.

[3]Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Minnesota Extension Service is implied.

Figure 1. In-row soil P distribution at three two-inch depth intervals at Morristown, July 28, 1992.

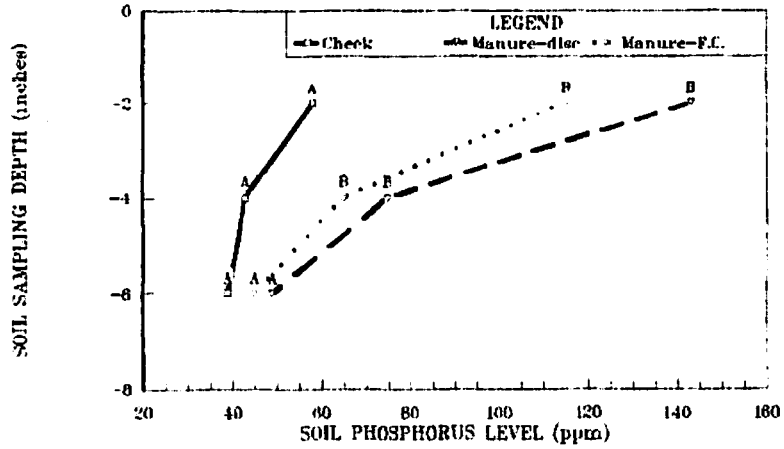
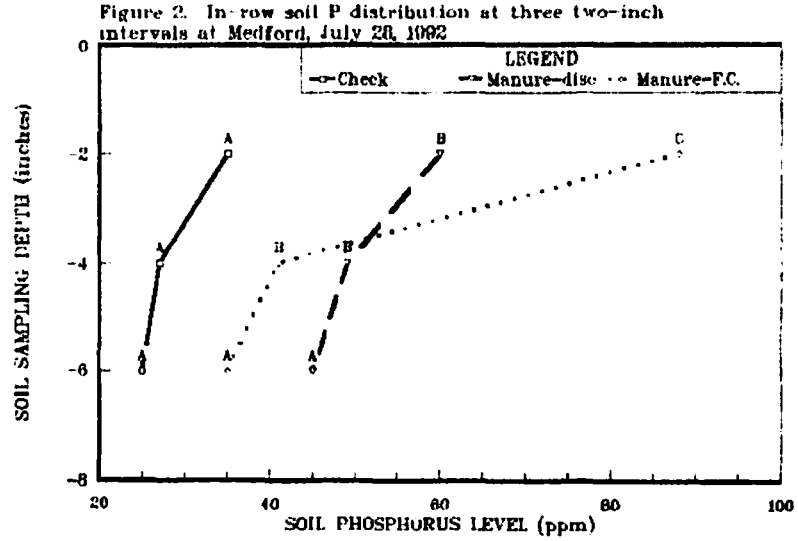
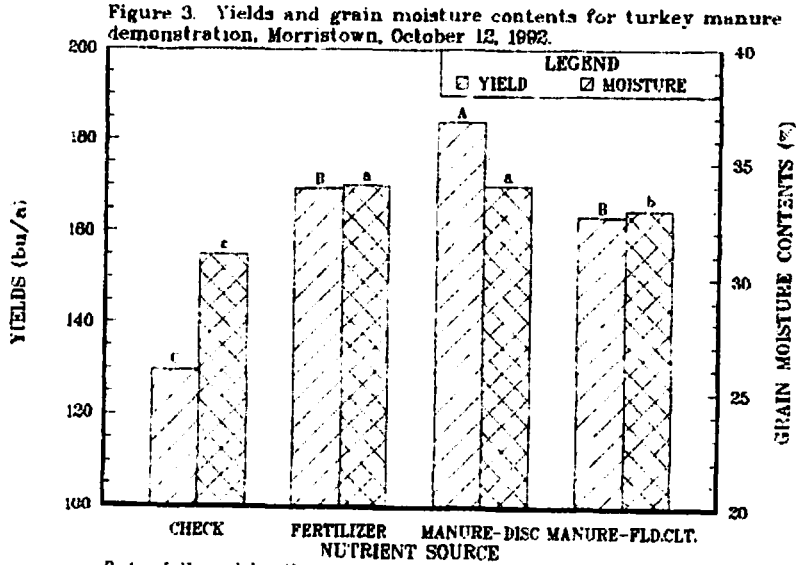


Figure 2. In-row soil P distribution at three two-inch intervals at Medford, July 28, 1992



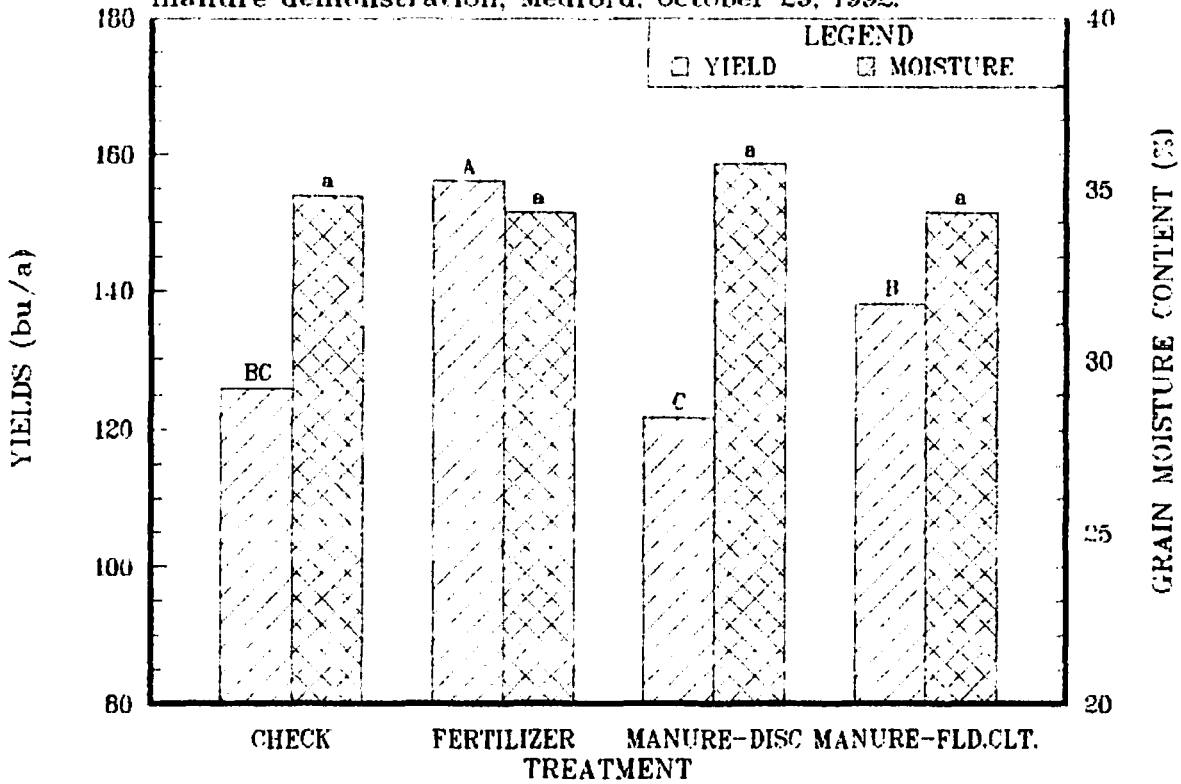
Data followed by the same letter at the same sampling depth and site are not significantly different at the 0.05 level

Figure 3. Yields and grain moisture contents for turkey manure demonstration, Morristown, October 12, 1992.



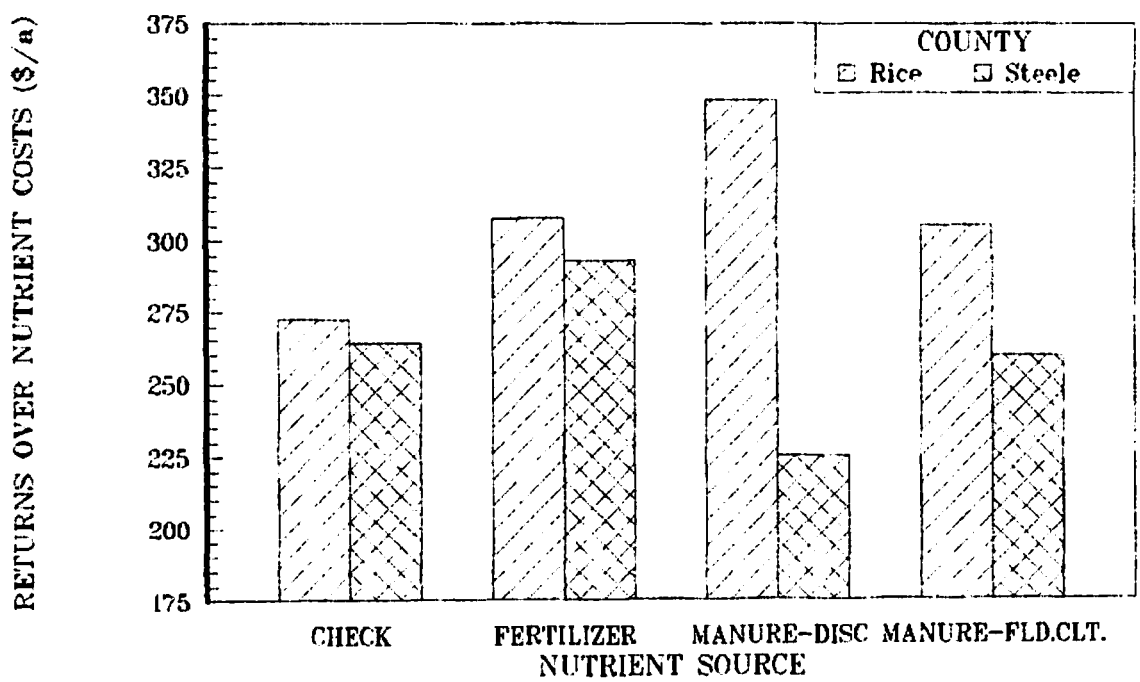
Data followed by the same upper- or lower- case letter are not significantly different at the 0.05 level.

Figure 4. Yields and grain moisture contents for turkey manure demonstration, Medford, October 29, 1992.



Data followed by the same upper- or lower-case letter are not significantly different at the 0.05 level.

Figure 5. Returns over nutrient costs for turkey manure demonstrations, 1992



Using $2.10/bu; $4.75/T manure; $0.18/#N; $0.30/# P2O5; $0.13/# K2O

MECHANICAL AND CHEMICAL WEED CONTROL DEMONSTRATIONS IN CORN AND SOYBEANS[1]

P. M. Bongard, F. Breitenbach, R. B. Hamer, T. J. Arlt, and K. D. Langseth[2]

Abstract. Three sites (one corn and two soybean) were selected in south central Minnesota to demonstrate optimum mechanical and chemical weed control practices. Low-label and below-label rates of Lasso and Pursuit were effective in controlling weeds at these high weed pressure sites. Mechanical practices (rotary hoe and cultivation) did not enhance yields within the herbicide treatments. However, these mechanical treatments did reduce yield losses where no herbicide had been applied.

Introduction

Results from 1990 demonstrations conducted in south central Minnesota suggested that timely mechanical weed control practices can reduce or eliminate the need for herbicides at low-weed pressure sites, thus reducing the inherent risk of pesticide contamination to the environment. As a follow-up, the demonstrations in 1992 focused on below- or low-labelled rates of herbicides in combination with mechanical practices. These demonstrations were part of the Environmental Agriculture Education Program of County Cluster 16 of the Minnesota Extension Service.

Materials and Methods

One corn and two soybean demonstration sites were selected in the Cluster 16 area. All demonstrations were arranged in a split-plot design and replicated four times. Management practices used by the farmer cooperators can be seen in Table 1.

Corn demonstration

The corn demonstration was located in Freeborn County near London on a Mayer loam (Table 2). The herbicide main plots included the following treatments: 1) No herbicide; 2) Lasso[3] (alachlor) at 3 lb. ai/A; and 3) Lasso at 2 lb. ai/A. The pre-emergence herbicide application was made on May 8. The mechanical practices (split plots) included in each of the herbicide treatments were the following: 1) No mechanical control; 2) Rotary hoe and cultivation; and 3) Cultivation only. The schedule of mechanical practices can be seen in Table 3. Each sub-plot was four rows wide (36-inch spacing) and 150 feet long.

Early season weed densities and species compositions were measured June 19. Plots were also visually rated for weed control on a scale from 1 (no control) to 10 (excellent control) shortly before harvest (September 22). The demonstration was machine combined with the farmer's 6-row equipment on November 10, weighed, and yields were adjusted to 15.5% moisture.

Soybean demonstrations

The soybean demonstrations were located in Rice County near Faribault and

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[1]Funding provided by the Board of Soil and Water Resources through Environmental Agriculture Education Program Challenge Grant of County Cluster 16 (Freeborn, Mower, Rice, and Steele counties), Minnesota Extension Service.

[2]Environmental Agriculture Educator, Cluster 16; Area Extension Agent, Crop Pest Management; Extension Educators, Rice, Steele and Freeborn counties, respectively; Minnesota Extension Service.

[3]Reference to commercial products or trade names in made with the understanding that no discrimination is intended and no endorsement by the Minnesota Extension Service is implied.

in Steele County near Owatonna. Soil classification and spring soil test results are listed in Table 2. The herbicide main plots included the following treatments: 1) No herbicide; 2) Lasso (alachlor) pre-emergence at 2.5 lb. ai/A (omitted at Faribault site); 3) Lasso (2.5 lb. ai/A) and Pursuit (imazethapyr) at 0.032 lb. a.i./A; and 4) Pursuit (0.032 lb ai/A). The Pursuit was applied at one-half the labelled rate. Lasso was applied pre-emergence at both sites on May 13, and Pursuit was applied postemergence on June 10. The mechanical split-plot treatments were the same as those used in the corn demonstration (Table 3). Plots were 8 rows wide and 100 feet long at Faribault, and 6-rows wide and 150 feet long at Owatonna.

Early season weed counts were taken June 24 and 30 at Faribault and Owatonna, respectively. A final visual evaluation was made before harvest. These demonstrations were machine combined between October 15 and 22 with the farmer's equipment, weighed and adjusted to 12.2% moisture.

Results and discussion

Corn demonstration

Lasso at the 2 lb./A and 3 lb./A rates significantly improved weed control over the no herbicide treatment throughout the 1992 growing season (Tables 4 and 5). During the early season, mechanical practices did not significantly enhance weed control in the herbicide treated areas. Later in the season, however, cultivation with or without rotary hoeing provided better control than using no mechanical practice. These mechanical differences in visual control did not translate into final plot yields (Figure 1). At this relatively high weed pressure site, the mechanical practices performed equally where Lasso had been applied, regardless of the herbicide rate. As a result, returns over weed control costs were highest for Lasso-treated plots where there had been no mechanical control (Figure 2). In the no-herbicide treatment, yield losses were reduced by using mechanical weed control.

Soybean demonstrations

Herbicide usage at both soybean sites significantly improved weed control throughout the season (Tables 4 and 6). At the Faribault site, mechanical practices did not significantly improve weed control either early or late in the season where herbicide had been applied. This was reflected in plot yields (Figure 3). Overall plot yields from both herbicide treatments were better than using no herbicide, and mechanical control practices performed equally within these herbicide-treated areas. The highest returns over weed control costs were found in the cultivated herbicide-treated plots and the Lasso and Pursuit plot where no mechanical control was used (Figure 4).

At the Owatonna site, the best visual evaluation for late season weed control was in the Lasso and Pursuit combination treatment. Evaluations of the individual Pursuit and Lasso treatments ranked second and third, respectively. All herbicide treated areas provided significantly better control than the no herbicide treatment. Cultivation alone provided better visual weed control late in the season than cultivation with rotary hoeing or no mechanical control. Yields of the herbicide treatments reflected the late season weed control evaluation pattern (Figure 5). However, mechanical control practices did not significantly enhance yields in herbicide treated areas. The resulting returns over weed control costs for this site can be seen in Figure 6.

Conclusions

All demonstration sites in 1992 had significant weed pressure. As a result, herbicides were needed to maintain yields and profitability. Although herbicides were needed, low-label (Lasso) and below-label (Pursuit) rates were as effective in controlling weeds as higher herbicide rates. When herbicides have been effective in controlling weeds, mechanical practices have not

significantly enhanced yields at high weed pressure sites (1990-1992 demonstrations). However, when no herbicide has been used or when a herbicide failed in these situations, cultivation has reduced losses.

Acknowledgements

The authors would like to thank Tony Mudra of London, Ron Keller of Faribault, and Tom Polacek of Owatonna for providing land, machinery and labor to conduct these demonstrations.

Table 1. Management practices used in weed control demonstrations, 1992

	LONDON	FARIBAULT	OWATONNA
	(corn)	(soybeans)	(soybeans)
Variety	Pioneer 3751	Hardin	Hardin
Planting date	May 4	May 7	May 11
Population	25,000	150,000	140,000
Previous crop	Corn	Corn	Corn
Primary tillage	Disc & soil finisher	None (Ridge till system)	Mulch tiller
Fertilizer			None
N	130	5000 gal.	
P_2O_5	32	hog manure	
K_2O	10	(winter application)	

Table 2. Schedule of mechanical weed control practices for demonstrations, 1992.

LOCATION	CROP	ROTARY HOEING		CULTIVATION	
		----DAP[1]----		----WAP[2]----	
London	Corn	6	-	4	7
Faribault	Soybeans	7	17	4	7
Owatonna	Soybeans	7	14	4	-

[1]Days after planting
[2]Weeks after planting

Table 3. Soil classification and spring soil test results for weed control demonstration sites, 1992.

SITE	SOIL CLASSIFICATION			SOIL TEST RESULTS			
	SERIES	SUBGROUP	ORDER	O.M.	pH	P	K
						---ppm---	
London	Mayer (loam)	Typic Haplaquoll	Mollisol	High	7.2	95	300+
Faribault	Maxfield (sicl)	Typic Haplaquoll	Mollisol	High	8.0	6	64
Owatonna	Lester (loam)	Mollic Hapludalf	Alfisol	High	6.6	36	200

Table 4. Weed densities and species composition in no mechanical treatment plots of herbicide treatments in corn and soybean weed control demonstrations in late June, 1992.

HERBICIDE	WEED DENSITY	SPECIES COMPOSITION[1]						
		Fxt sp.	CoLQ	RRPW	Vele	PSW	CoRW	OTHER
London (corn)	plt/ft^2	----------%----------						
None	8.5 a[2]	63.0	5.2	30.7	-	-	-	1.2
Lasso-3 qt./A	1.8 b	96.8	0.2	1.6	-	-	-	1.5
Lasso-2 qt./A	1.8 b	85.2	-	14.6	-	-	-	0.2
Faribault (soybeans)								
None	27.5 a	84.5	0.6	0.3	14.6	-	-	-
Lasso+Pursuit	2.5 b	91.6	4.2	-	4.2	-	-	-
Pursuit	4.3 b	91.2	-	-	8.5	-	-	0.3
Owatonna (soybeans)								
None	7.8 A	37.6	19.0	22.7	3.0	15.2	2.5	-
Lasso+Pursuit	0.6 C	-	46.0	-	24.8	29.2	0.1	-
Lasso	4.0 B	22.2	12.4	12.4	2.8	37.2	2.8	-

Pursuit	1.5 BC	32.7	51.8	-	-	15.5	-	-

[1]Fxt sp.=Foxtail species; CoLQ=Common lambsquarters; RRPW=Redroot pigweed; Vele =Velvetleaf; PSW=Pennsylvania Smartweed; and CoRW=Common ragweed.
[2] Data followed by the same letter at the same site are not significantly different at the 0.05 level.

Table 5. Visual evaluations of early (6/24) and late (9/22) season weed control in corn demonstration, 1992.

HERBICIDE	MECHANICAL	EARLY SEASON WEED CONTROL	LATE SEASON WEED CONTROL[1]
		--%--	-score-
None	None	-	1.0 e
	Rotary hoe + cultivation	68 b[2]	3.5 d
	Cultivation	68 b	3.3 d
Lasso	None	93 a	5.5 c
(3 lb./A)	Rotary hoe + cultivation	99 a	8.0 ab
	Cultivation	96 a	8.5 ab
Lasso	None	93 a	4.8 cd
(2 lb./A)	Rotary hoe + cultivation	98 a	7.8 b
	Cultivation	98 a	9.5 a

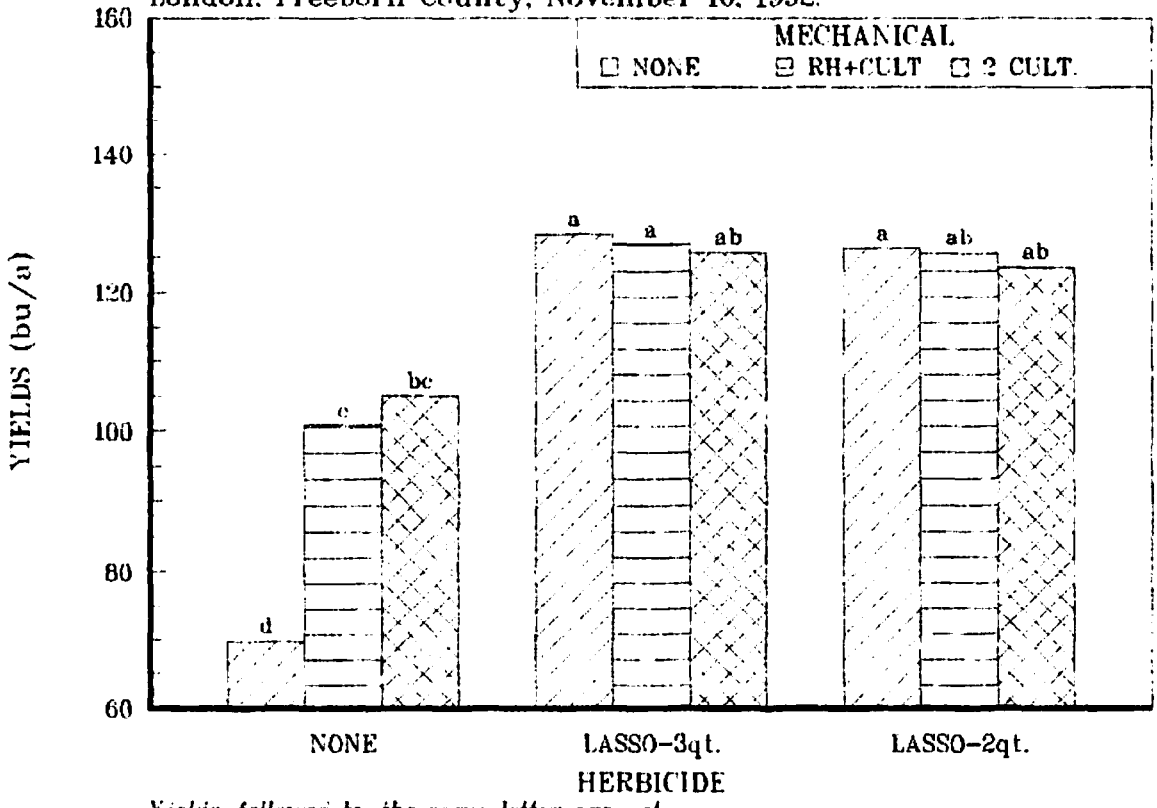
[1]Scale based on 1=no control to 10=excellent control
[2]Data followed by the same letter in the same column are not significantly different at the 0.05 level.

Table 6. Visual evaluations of early (6/24 & 6/30) and late (9/22) season weed control at two soybean demonstration sites, 1992.

		FARIBAULT SITE		OWATONNA SITE	
HERBICIDE	MECHANICAL	EARLY CONTROL	LATE CONTROL[1]	EARLY CONTROL	LATE CONTROL
		--%--	score	--%--	score
None	None	-	1.8 d[2]	-	1.0 h
	Rotary hoe + cultivation	68 b	2.8 cd	0 c	1.0 h
	Cultivation	64 b	3.0 cd	62 b	1.8 gh
Lasso +	None	73 b	6.8 ab	94 a	6.5 bc
Pursuit	Rotary hoe + cultivation	98 a	6.3 a	97 a	7.3 b
	Cultivation	95 a	8.5 a	98 a	8.5 a
Lasso	None	-	-	56 b	2.0 gh
	Rotary hoe + cultivation	-	-	68 b	2.8 fg
	Cultivation	-	-	90 a	5.3 d
Pursuit	None	96 a	6.5 ab	89 a	3.8 ef
	Rotary hoe + cultivation	98 a	5.0 bc	94 a	4.8 de
	Cultivation	98 a	9.0 a	98 a	6.0 c

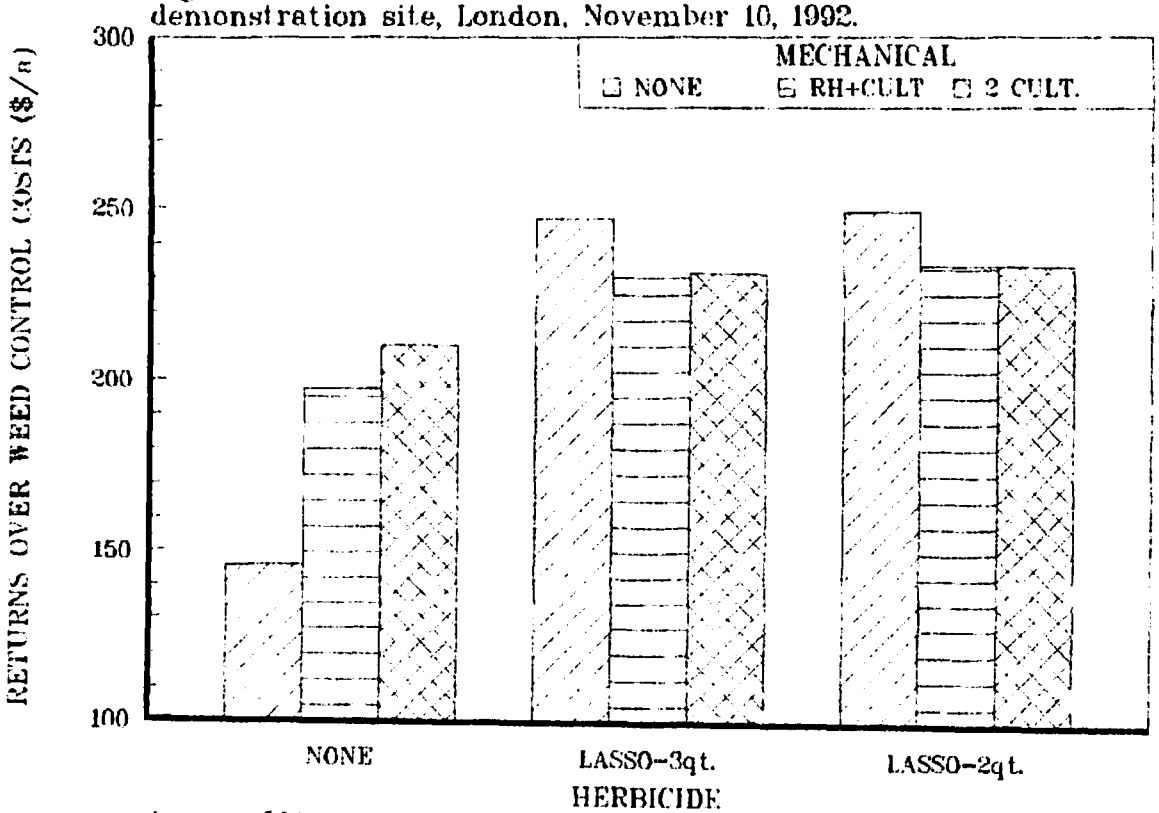
[1]Scale based on 1=no control to 10=excellent control.
[2]Data followed by the same letter in the same column are not significantly different at the 0.05 level.

Figure 1. Corn yields at weed control site near London, Freeborn County, November 10, 1992.



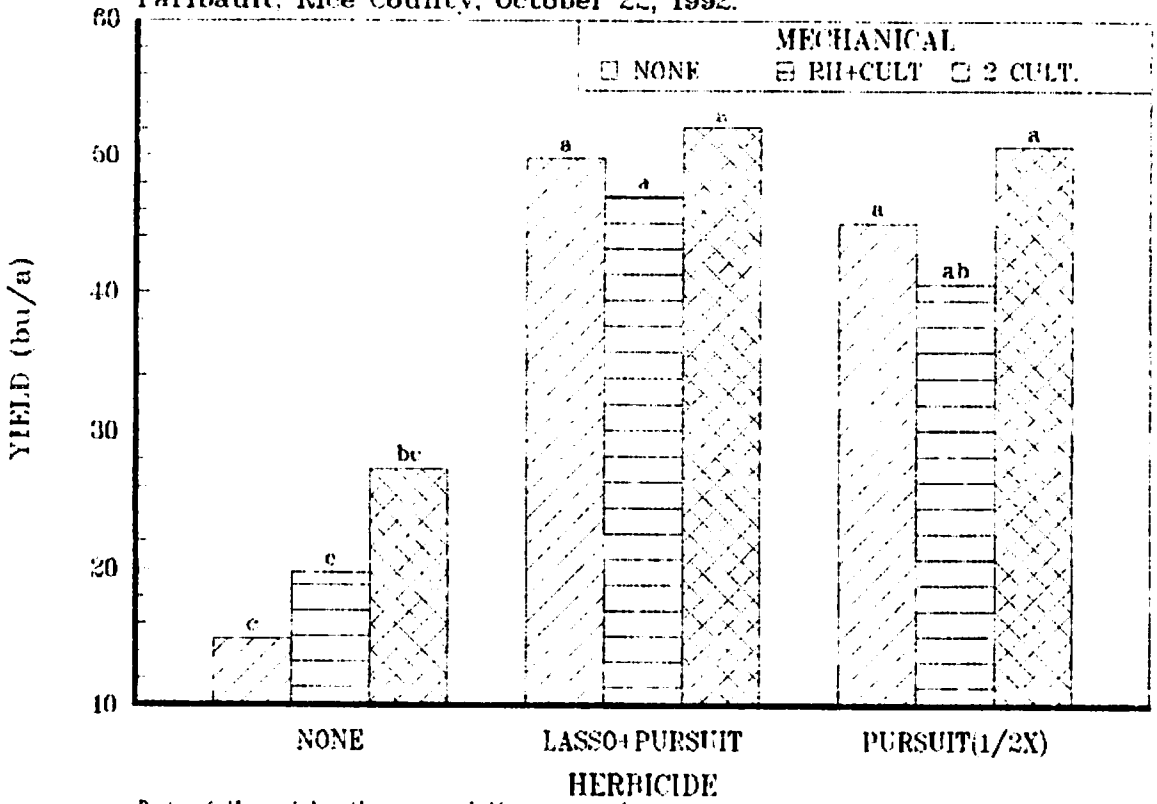
Yields followed by the same letter are not significantly different at the 0.05 level.

Figure 2. Returns over weed control costs at corn demonstration site, London, November 10, 1992.



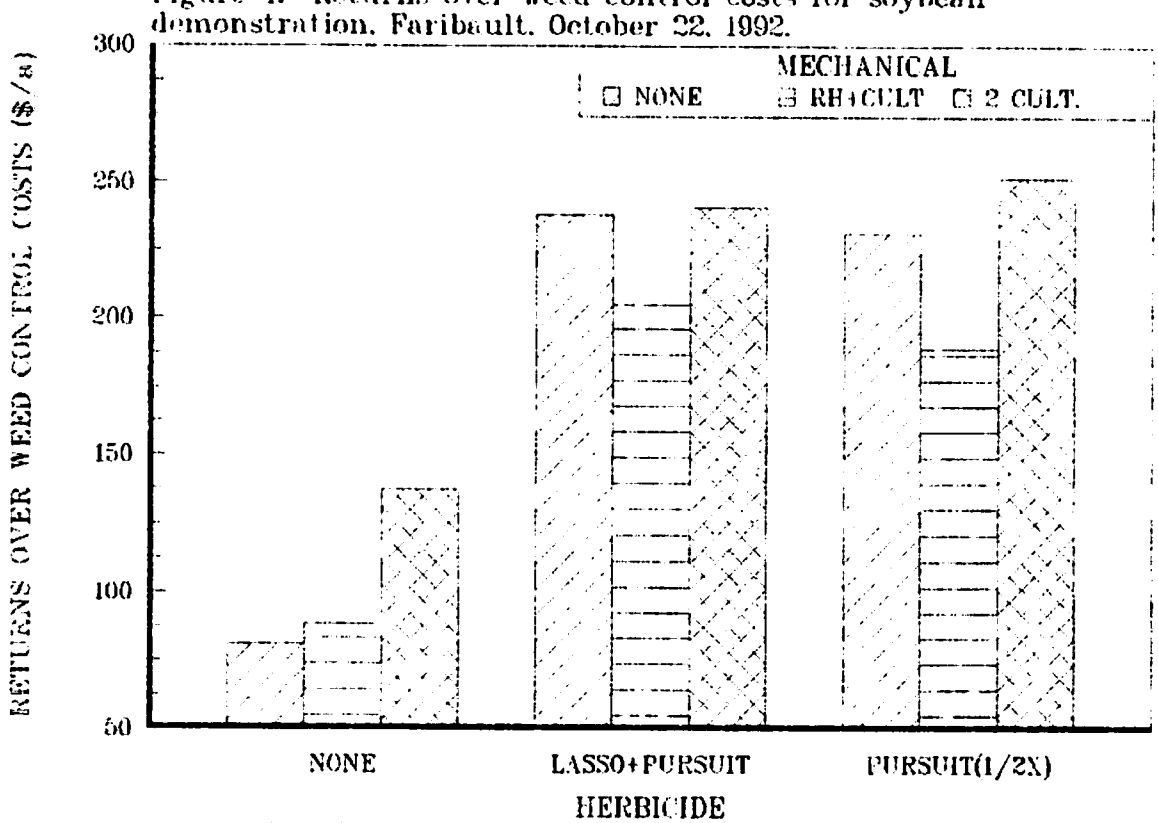
Assumes $2.10/bu; $4/rotary hoeing; $5/cultivation $25.37/gal Lasso + $3/application

Figure 3. Soybean yields at weed control site in Faribault, Rice County, October 22, 1992.



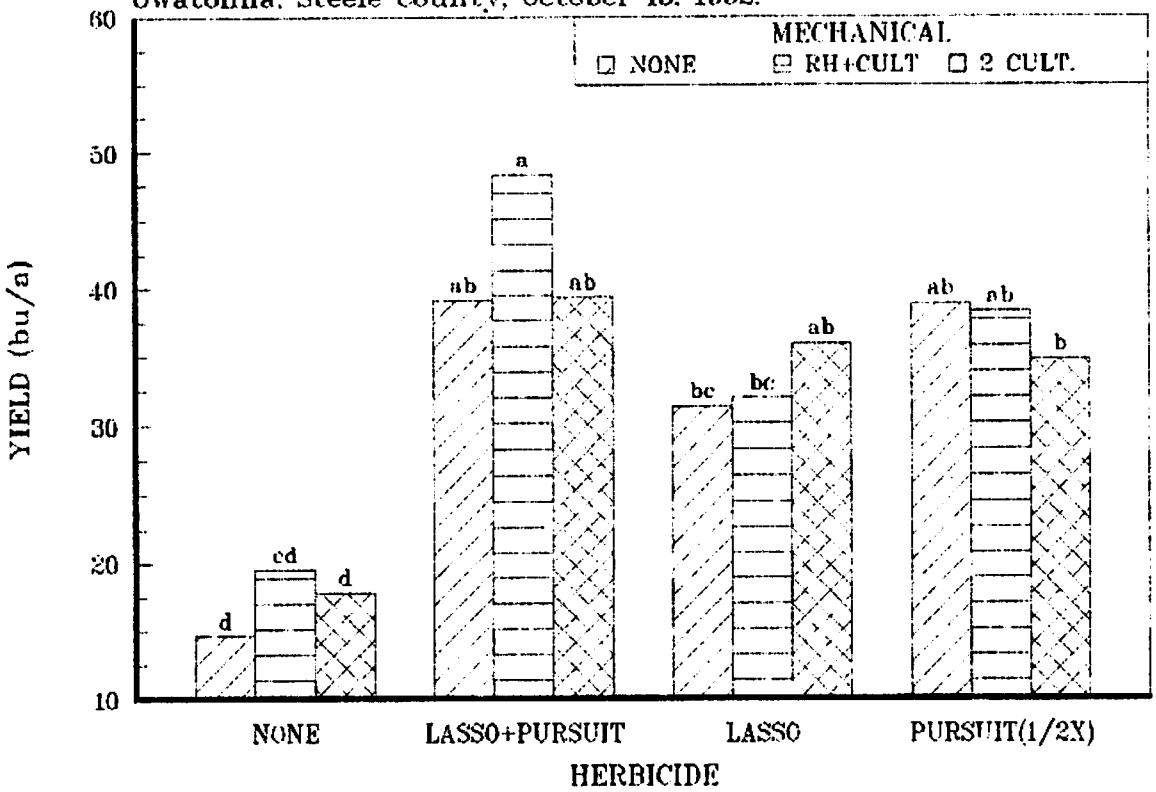
Data followed by the same letter are not significantly different at the 0.05 level.

Figure 4. Returns over weed control costs for soybean demonstration, Faribault, October 22, 1992.



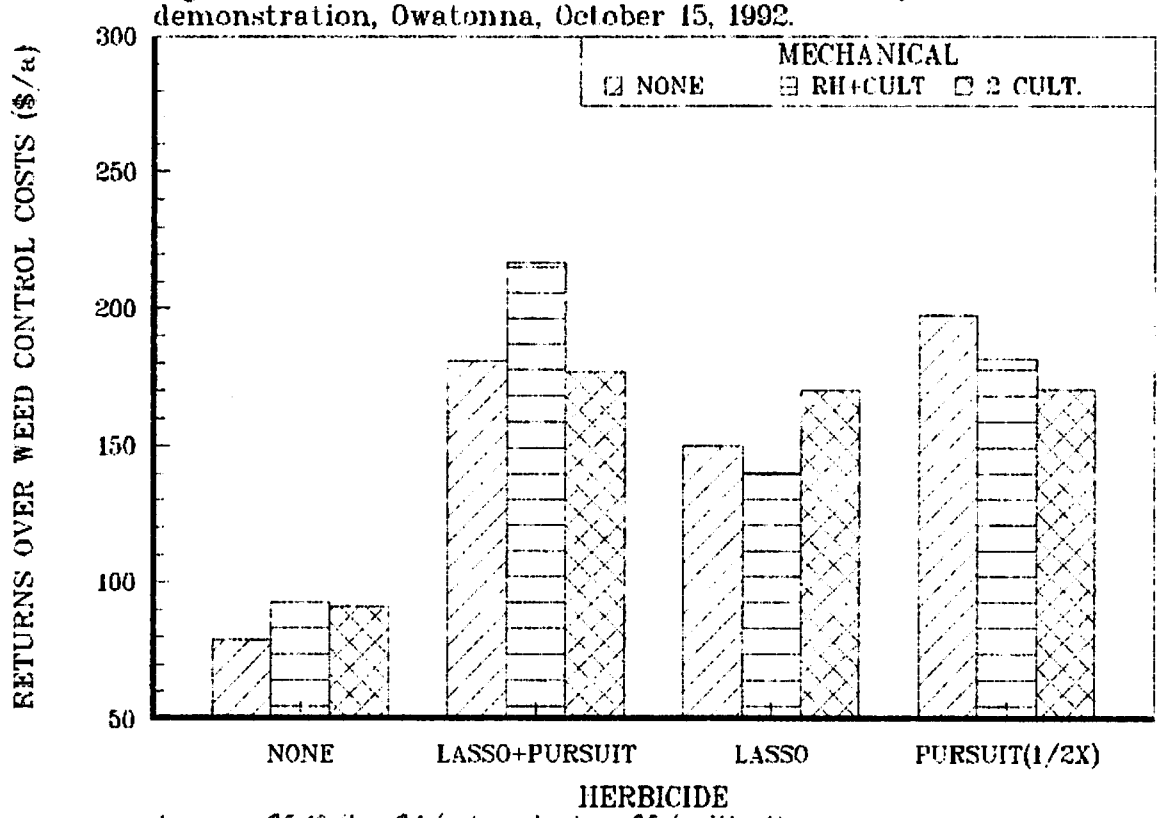
Assumes $5.40/bu; $4/rotary hoeing; $5/cultivation $25.37/g Lasso; $8.94/2 oz Pursuit; $3/appl.

Figure 5. Soybean yields at weed control site near Owatonna, Steele County, October 15, 1992.



Data followed by the same letter are not significantly different at the 0.05 level.

Figure 6. Returns over weed control costs for soybean demonstration, Owatonna, October 15, 1992.



Assumes $5.40/bu; $4/rotary hoeing; $5/cultivation $25.37/g Lasso; $8.94/2 oz. Pursuit; $3/appl.

CORN-TILLAGE RESIDUE MANAGEMENT, LANCASTER, WI. 1990

J. B. Swan, A. E. Peterson, W. H. Paulson, R. L. Higgs, J. F. Moncrief, and D. L. Linden[1/]

ABSTRACT: Growing conditions were generally favorable in 1990 and corn yields for continuous corn ranged from 137 bu/acre for no-till mulch coulter to 163 bu/acre for the no-till normal residue treatment. On chisel and moldboard treatments, surface additions of corn residue significantly reduced populations and consistently decreased yields. No-till mulch coulter had significantly lower plant population than chisel normal and moldboard normal treatments. Surface residue treatments emerged later, silked later, and had higher grain moisture at harvest than comparable tillage treatments without surface residue. Surface residue decreased planting depth on conventional (moldboard) and chisel tillage treatments. Depth to residuum had little effect on grain yields with lowest Rep. avg. yields (154 bu/acre) on the shallowest depth (29 inches in Rep. 1) and greatest Rep. avg. yields (157 bu/acre) on Reps. 3 and 4. Final 20-minute infiltration rates averaged 1.25 and 1.27 in/hour on treatments without surface cover, no-till bare and normal moldboard, respectively. For the mulch treatment, final Infiltration rates were 2.16 in/hour for moldboard mulch, 2.49 for no-till mulch, and 2.88 for chisel plow mulch treatments. This completes the tenth year of the tillage-residue management study. Since the major objectives of determining the effect of tillage and residue management on corn growth and yield at the Lancaster site have been achieved, the study will be terminated.

Summary of Results From Lancaster Tillage Research

Data from the corn tillage-residue management research at Lancaster were used to develop a method to estimate corn growth, yield and grain moisture from air growing degree days (Swan et al., 1987a). A simulation model (NTRM) was used in determining grain yields as a function of soil depth for specific probability levels based on simulated site-specific daily climatic values generated for a 100-year frequency (Swan et. al., 1987b). A model of the corn yield response to water stress, heat units, and management for the period 1972 through 1984 for the tillage-residue management research was developed, calibrated, and validated (Staricka, 1984 and Swan et al., 1990). The effect of tillage and residue management on seed depth, soil temperature, and corn growth was determined for the period 1984 through 1988 (Swan et al., 1988). Measurements on tillage residue management treatments were part of a larger study to determine the presence of macropores under no tillage and moldboard tillage systems and their effect on soil water and solute movement. (Logsdon et al., 1990 and Swan et al., 1990).

Introduction

The driftless soil area has the greatest county average estimated soil losses from cropland in Minnesota, ranging from 4.0 to 6.6 t/A/year in the six counties involved. Typical soils of the region such as Fayette, Dubuque, Seaton, and associated soils, are highly erodible, form dense crusts if unprotected from raindrop impact, and consequently, have low final infiltration rates and high runoff from the intense storm events common to the region. New and improved tillage practices are increasingly being relied upon to meet environmental goals under more intense cropping systems. These systems modify the soil and water losses as well as the kind and concentration of the materials in the runoff. A more complete understanding of these tillage-residue management systems and of their effect on soil physical conditions will allow a more accurate prediction of their effect on the environment and will permit them to be more effectively incorporated into the overall farming systems of the region.

Experimental Procedures

The experimental site is located on the Lancaster Agricultural Research Station. Four tillage treatments are replicated four times (Table 1), the first replicate is located on Palsgrove silt loam: the other three replicates are on Rozetta silt loam. Each treatment is split into normal and mulched subtreatments. On the no-till plots an additional subtreatment (bare) is established by removing all residue prior to planting; this residue is then placed on the adjacent no-till mulched plot. Corn residue additions are made after tillage but before planting to obtain approximately 60 to 80 percent surface cover. Plots are approximately 90 to 100 feet in width and 80 feet in length. Row width was 36 inches in 1990. Pioneer 3747 was planted at 31,500 plants per acre. Residue was moved on the no-tillage plots on April 17-18 and all plots staked. Primary tillage on the conventional (moldboard) treatment was done prior to April 17 and spring chiseling was done on April 18. The chisel and moldboard plots were disked on April 25. On April 26, herbicide was applied to all treatments prior to addition of corn stalk residue on chisel and moldboard treatments. No-till treatments were planted April 26 with a 4-row John Deere 7000 Max-Emerge planter equipped with fluted coulters on one side and "trash whip" units on the other side which removed residue from an 8 to 9-inch area over the row. Fluted coulters were used on all rows of conventional and chisel treatments. Rain interrupted

planting chisel and conventional treatments on April 27 after 16 rows were planted; planting was completed on April 30.

Nitrogen (200 lbs/A) was broadcast as urea. Starter fertilizer at planting was 200 lb/A of 6-24-24. The insecticide was 8 lb/A of counter. Pre-emergence herbicide was applied April 26 (2.5 qt/A of Bladex and 2.5 pt/A of Dual). On June 5, Banvel (0.5 pt/A) and Buctril (1.0 pt/A) were applied.

Percent cover was determined from slides taken June 6, 1990. Planting depth, rate of emergence, and silking date measurements were made on designated portions of each plot. Crop height measurements were also recorded. Hourly soil temperatures, leaf number, soil moisture, bulk density, and percent cover were measured on chisel and no-till treatments in Rep. 3 for mulch added, bare and normal treatments. Soil temperature was measured at depths of 1, 6, 11, 16, and 50 cm. Yields for individual plots were determined by hand harvesting 60-foot of row (two subsamples each consisting of paired 15-foot lengths of row) in October.

Ten plot frames (45 3/4 by 45 3/4 inches) were put in place following planting. Infiltration measurements were made on chisel mulch, no-till bare and mulch, and conventional normal and mulch treatments during the period June 5-8.

Results-Corn Yields and Crop Height

Precipitation was above normal in April, May, June and August, but was 2.04 inches below normal in July (Table 2). Precipitation was 0.68 inches below average for the months of April-October. Monthly air temperature in May averaged 3.3 deg. F below average and in July were 1.7 deg. F below average. Depth to residuum had little effect on yields in 1990 (Table 3).

Grain yields of individual plots ranged from 137 to 163 bu/A and were significantly different. Normal residue chisel and moldboard treatments were significantly greater than no-till mulch coulter. There were no significant differences among no-till treatments in yield or in plant population. Normal residue chisel and moldboard treatments had significantly greater plant population than all mulch treatments except no-till trash whip. Plant population was significantly different between treatments at the 1 percent level and was significantly different at the 5 percent level between reps. When subplots with less than 23,000 PPA were deleted from the analysis, treatment yields were not significantly different. Treatment yield differences were closely associated with differences in plant population.

Tillage and residue effects on grain moisture were significant at the 5 percent level. No-till bare treatments were significantly lower in percent grain moisture than no-till mulch treatments. Interestingly, grain moisture on normal residue and mulch moldboard plow treatments was not significantly different. Grain moisture on no-till normal residue coulter and bare coulter treatments also was not significantly different. Similarly, grain moisture for spring chisel normal residue and mulch treatments was not significantly different. The delay in emergence on mulch treatments was consistently expressed in differences in leaf number, silking date, and grain moisture at harvest.

Corn height reductions on mulch treatments were apparent by day 167 (June 15) and differences increased with time over the period of measurement ending day 200 (July 19) [Fig. 1 and 2]. By day 200 on the no-till mulch plots, the TW treatment was 20 cm taller than the coulter treatment. These results contrast markedly with the 1988 when a reversal of crop height for high and low cover treatments occurred on all treatments.

Seedbed Conditions and Corn Growth

Surface residue significantly reduced average planting depth on chisel and moldboard treatments but did not significantly affect planting depth on the no-till treatments. Compared to the no-till bare and normal residue treatments, no-till mulch slightly increased seed depth. The effect of mulch on reducing planting depths occurred only on tilled treatments.

The standard deviation (S_d) of planting depths was significantly different among treatments. Conventional mulch had significantly greater S_d than conventional normal. Similarly, S_d of no-till normal coulter was significantly greater than no-till normal TW. Conventional normal had significantly smaller S_d than all other treatments with the exception of no-till normal TW. Except for the conventional and no-till normal treatment, neither mulch nor TW significantly affected the S_d of planting depth. Emergence (75%) was delayed approximately 5 to 6 days by mulch additions, while silking (50%) was delayed 1 to 4 days by mulch additions (Tables 1 and 4).

Effect of Treatments of Infiltration Rate

Large differences in "final" (40-60) minute average infiltration rates were measured between treatments in 1990 (Tables 5 and 6). Final infiltration rates from conventional tillage mulch treatments were approximately 1.0 inches/hr greater than conventional tillage normal treatments. For the nine year period of measurement, mulch has approximately doubled the infiltration rate on conventional tillage. On the no-till treatments, double mulch increased final infiltration rates by a factor of 2. For the six years of data (1984-1989) double mulch on the no-tillage treatment increased the infiltration rate an average of 50 percent compared to the no-tillage bare treatment.

The results again illustrate the requirements for rapid infiltration of 1) a porous surface layer with high saturated conductivity, 2) a protective mulch cover, 3) absence of flow restricting layers within the depth of infiltration. Residue cover alone has not been sufficient to produce a high infiltration rate when significant restriction to flow occurs within the infiltrating profile.

Summary

Five year yield results (1979-1983) with continuous corn at Lancaster show nearly equal yields from conventional (moldboard) tillage, ridge till, and chisel treatments. Twelve year yield results (1979-1990) show nearly equal yields for conventional, chisel and no-till normal treatments (Table 7). In 1986, 1987, 1988, 1989, and 1990, no-till was the highest yielding normal treatment. Thus farmers in the driftless soil area can choose between a variety of tillage options which have yields comparable to conventional tillage, but which are superior in soil and water conservation and offer savings in time, labor, and fuel compared to the conventional moldboard plow tillage method.

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Table 1. Effect of Tillage and Mulch Treatments on Percent Cover, Planting Depth, Emergence, Silking Date, Population, and Grain Yield. 1990 Lancaster, WI

Treatments Tillage	Residue	In-Row Residue Mgt.	% Cover In-Row	% Cover Ent. Area	Planting Depth Avg. mm	Planting Depth S.D. mm	Days Post Plant to 75% Emerg.	Avg. Date 50% silked July	Avg. popln. at harvest PPA in K	Avg Grain yield Bu/Ac	Avg Grain yield Pop. >23K* Bu/Ac	Avg/ Grain moist
No-till	NORMAL	C	51	69	33ab	7.9a	25	24	27.7 bcd	163a	163	18.1 bcdef
	(N)	Tw	46	63	32abc	4.6bc	27	-	26.0 abcd	160a	164	18.8 abcde
	BARE	C	3	5	32.5abc	5.4ab	24	24	26.7 ab	154ab	155	17.7ef
	(B)	Tw	4	3	35a	5.1ab	26	24	26.5	157a	157	17.5f
	MULCH	C	83	92	34ab	6.3ab	29	28	24.9 abc	137b	148	19.2ab
	(2X)	Tw	64	81	36a	4.9ab	31	26	26.1 abcd	147ab	151	19.3a
Fall Chisel	NORMAL	C	10	8	36a	2.6ab	24	24	28.1d	158a	158	17.9def
	MULCH	C	89	96	24cd	7.5a	31	28	23.7a	142ab	145	19.0abcd
Spring Chisel	NORMAL	C	8	12	36a	5.3ab	25	24	28.7bcd	161a	161	18.0cdef
	MULCH	C	87	90	20d	8.5a	30	25	24.9a	144ab	143	19.1abc
Conv. (MBD).	NORMAL	C	3	3	38a	3.0c	25	-	28.0cd	162a	162	18.2abcdef
	MULCH	C	87	87	26bcd	8.3a	30	-	24.5a	146ab	148	19.2ab
	AVG.				32	6.0			26.3	153	155	18.5
SIGNIFICANCE LEVEL					0.01	0.05			0.01	0.05	NS	0.05

*Subplots with population <23000 omitted.

Table 2. 1990 Weather Summary, University of Wisconsin Lancaster Agriculture Research Station.

Month	Precipitation Total	Precipitation Departure	Growing Degree Days 1990	Growing Degree Days Depart.	Air Temperatures Avg. Max.	Air Temperatures Avg. Min	Air Temperatures Avg. Daily	Air Temperatures Departure
	inches				°F			
April	3.67	0.65	—	—	57.6	36.4	47.0	0
May	4.83	1.37	197	-101	64.5	44.7	54.6	-3.3
June	5.48	1.10	523	4	79.9	57.3	68.6	1.4
July	2.02	-2.04	615	-47	80.2	59.8	70.0	-1.7
August	5.87	1.37	604	11	80.5	58.8	69.6	0.6
September	0.68	-2.77	401	-44	74.0	52.1	63.0	2.0
October	2.02	-0.36	—	—	59.6	36.2	47.9	-2.0
Growing Season Totals	24.57	-0.68	2340	-89				

Last Date in spring with minimum temperature
32° or less 5/10
28° or less 4/18

First Day in fall with minimum temperature
32° or less 10/11
28° or less 10/11

Table 3. Average Yields and Depth to clay Residuum by Replicate and Monthly Precipitation for 1981 through 1990, Lancaster, WI

Year	Replicate Number 1	2	3	4	Monthly Precipitation May	June	July	August
	Bu/ac				inches			
1981	146.8	146.7	142.1	147.1	0.85	4.28	2.91	11.35
1982	150.0	143.4	142.8	147.3	5.46	3.45	5.29*	4.06*
1983	72.8	85.2	96.4	111.2	5.18	3.28	3.34**	3.12**
1984	107.3	110.4	118.0	120.1	3.92	7.77***	2.57***	137
1985	118.5	121.1	129.6	130.6	4.95	1.32	2.11	3.34
1986	159.5	162.4	168.6	164.8	3.90	5.47	1.85	3.65
1987	168.3	167.7	170.9	168.0	3.78	4.15	6.71	6.78
1988	52.4	56.9	64.6	62.6	0.87	0.42	1.80	2.92
1989	152.8	159.3	165.0	157.1	2.34	2.44	2.51	5.16
1990	153.6	150.2	157.1	157.3	4.83	5.48	2.02	5.87
Avg. Depth to Clay Residuum Inches	29	41	46	62				

1981 - Subplots with population <17,000 omitted.
1982 - Missing values estimated for 8 plots out of a total or 48 plots.
1983 - Subplots with population <18,000 omitted Rep. II, III, IV.
* 1983 - 1.13 inches precipitation from July 3 to August 25 (53 days).
** 1984 - 1.52 inches precipitation from July 18 to August. 31 (45 days).
*** 1985 - 1.59 inches precipitation from May 28 to July 25 (57 days). Largest rain was 0.36 inches.

Table 4. Influence of Tillage Method and Residue Management on Rate of Emergence. 1990, Lancaster, WI

Treatment Tillage	Residue	In Row Residue Mgt.	June 11	17	21	23	26	29	June 1
No Till	Normal	C	0	22	80	90	96	100	100
		TW	1	20	62	77	86	100	100
	Bare	C	0	51	84	95	100	100	100
		TW	0	45	71	84	96	100	100
	Mulch	C	0	6	28	55	83	96	100
		TW	0	12	35	48	73	84	100
Fall Chisel	Normal	C	0	35	82	86	100	100	100
	Mulch	C	0	7	15	42	73	81	100
Spring Chisel	Normal	C	2	24	77	88	98	100	100
	Mulch	C	0	1	21	38	75	90	100
Convent. (MBD).	Normal	C	0	43	77	90	97	99	100
	Mulch	C	0	12	50	62	78	93	100

Table 5. 1990 Lancaster, WI Infiltration Rate Measurement

Tillage	Residue	Rep.	Application rate	Water applied before runoff	Infiltration rate x min. after runoff commences - in/hr											
					2.5	7.5	12.5	17.5	22.5	27.5	32.5	37.5	42.5	47.5	52.5	57.5
			in/hr	in.	Inches/hour											
No Till	Bare	E	4.16	0.28	1.76	1.52	1.04	0.80	1.28	1.04	1.28	1.04	1.04	1.28	1.52	1.52
		W	3.84	0.34	1.68	1.44	1.20	0.96	0.96	1.20	0.96	0.72	0.96	0.96	1.44	1.44
	Mulch	E	4.16	0.45	3.08	3.08	2.48	2.48	2.48	2.00	2.00	1.88	1.88	1.76	2.00	2.00
		W	3.84	1.15	3.12	3.12	3.12	3.00	3.00	3.12	2.88	2.88	3.12	3.12	3.12	—
Conv.	Normal	E	4.16	0.69	2.00	1.68	1.04	1.04	1.04	0.80	0.80	1.28	0.80	1.04	0.80	0.80
		W	4.40	0.46	3.20	2.24	2.00	1.52	1.52	1.28	1.28	1.76	1.52	1.76	1.52	—
	Mulch	E	4.48	6.72	NO Runoff											
		W	4.32	1.22	3.36	2.88	2.64	2.16	2.16	1.92	1.92	2.16	2.16	2.16	2.16	2.16
Sp. chisel	Mulch	E	4.80	1.16	3.84	3.12	2.88	2.88	2.64	2.40	2.64	2.88	2.64	2.88	2.64	2.88
		W	4.00	7.00	NO Runoff											

Table 6. Infiltration Rate 55 Minutes After Runoff Begins (paired Obvservations). Lancaster, 1990.

Tillage	Treatment Residue	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Avg. in/hr
		Inches/hour										
No Till	Bare	—	—	—	1.68	1.00	1.24	1.26	0.84	0.32	1.48	--
	Mulch	1.46	1.10	3.53*	0.60	3.02	2.10	1.22	0.82	1.75	2.56	1.82
Conventional	Bare	0.97	1.52	0.54	1.70	1.40	1.83	1.15	1.80	0.45	1.22**	1.26
	Mulch	2.72	2.34	1.49	2.90	2.14**	2.25	4.81	2.58	2.21	2.16**	2.56
		Ratio										
Conv.Bare/ Conv.	Mulch	0.36	0.65	0.36	0.58	0.65	0.81	0.24	0.70	0.20	0.56	0.51
No Till Mulch/ Conv.	Bare	1.51	0.72	6.53	0.35	2.16	1.15	1.06	0.46	3.89	1.73	1.45+

* Soil disturbed prior to planting by anhydrous ammonia injection.

**One observation only.

\+ Omit 1983.

Table 7. 1979-1990 Continuous Corn Tillage Yield Results. Lancaster, WI

Tillage Treatment with normal residue	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1973-83	1979-90
	Bu/A												Bu/A	
Ridge Plant	162	157	157	147	100	--	—	—	--	—	—	—	145	—
No Till (slot plant)	163	146	151	141	85	108	120	165	177	59	171	163	137	137
Chisel	160	150	167	154	95	115	125	159	168	57	157	158	145	139
Conventional	169	159	168	151	89	121	133	164	168	43	159	162	147	141
Paraplow*	—	—	—	—	—	106	125	162	--	—	--	—	—	--
Ro Till	—	—	—	—	--	—	—	—	172	54	163	—	—	—

*Fall 1983 and Fall 1984.

FIG 1 CROP HEIGHT VS TIME FOR NO-TILLAGE TREATMENTS

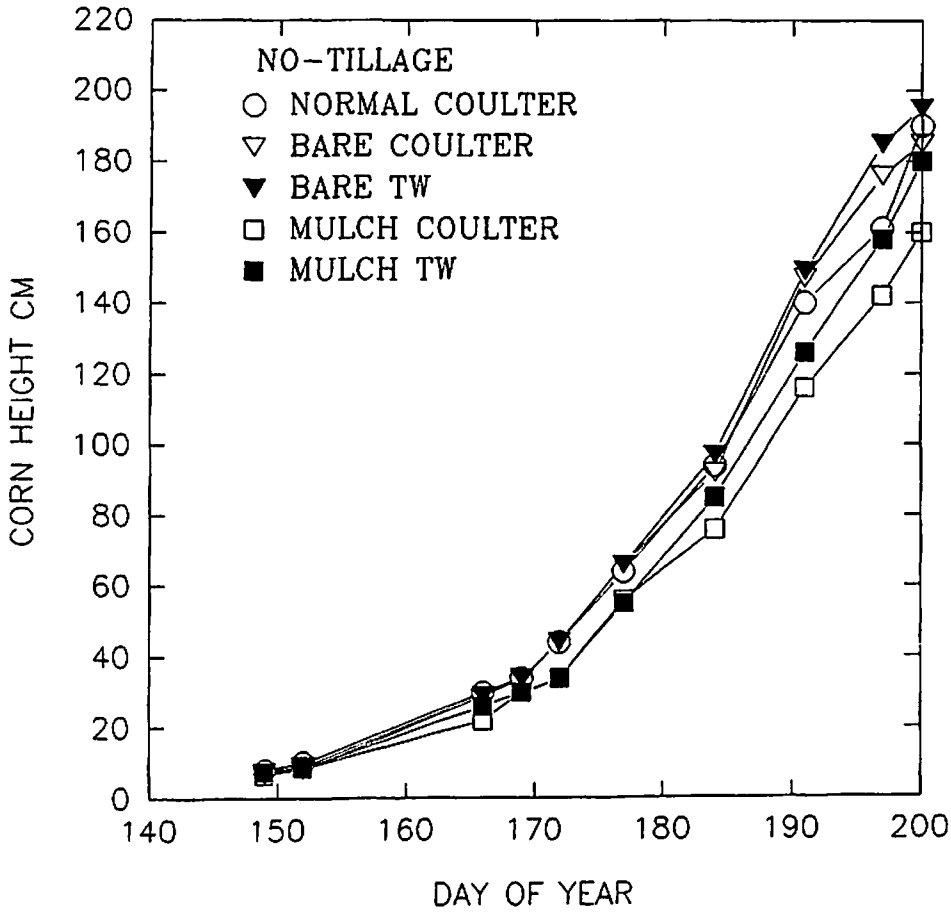
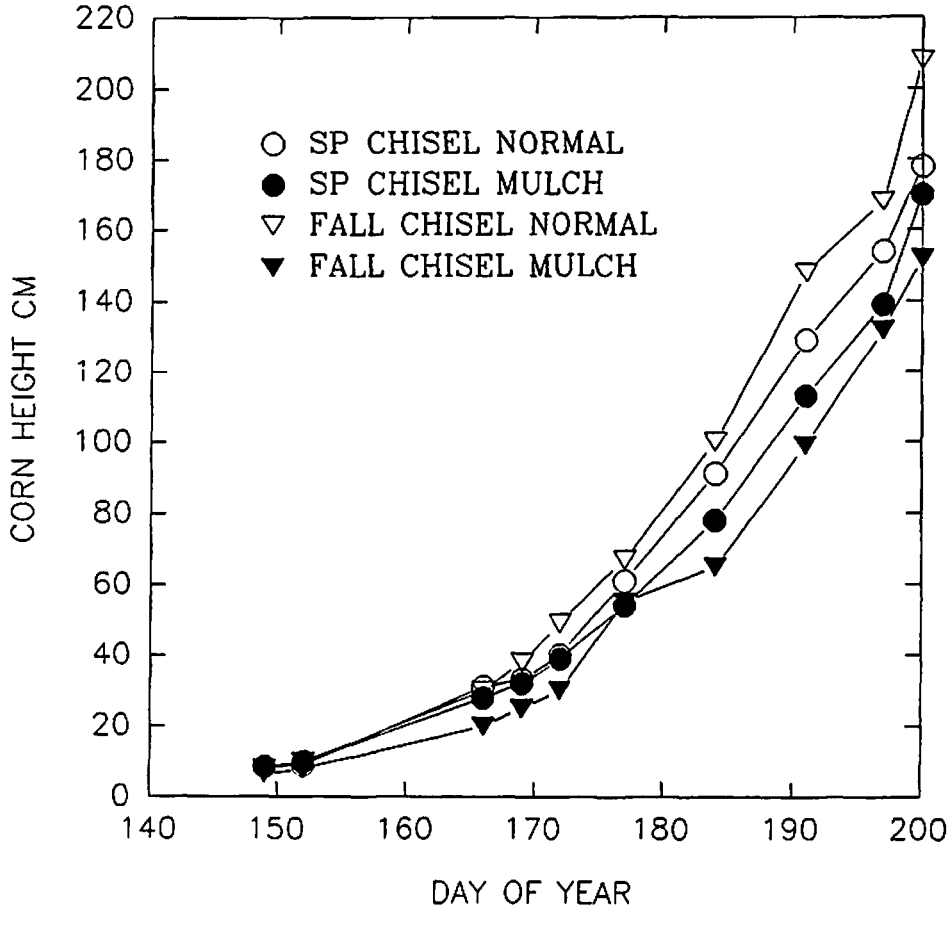
FIG 2 CROP HEIGHT VS TIME FOR CHISEL TREATMENTS