Soil Science Research Report - 1987

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AN ECONOMIC AND RESOURCE ANALYSIS OF DEEP TILLAGE TO REDUCE SOIL COMPACTION FOR SOYBEAN PRODUCTION

Alice J. Jones, Bruce Evans, Steve Swanson, Joe Skopp, Ed Penas, Doug Duey, Leonard Bashford, Charles Shapiro, and Richard Ferguson

Objectives:

(1) to measure the effect of deep tillage on soil properties associated with soil compaction;

(2) to measure the effect of deep tillage on soybean yields and root growth;

(3) to evaluate the economic return to soybean production on deep tilled soils.

Procedures: Sixteen farmer fields representing 10 soil types were included in the study. Two tillage treatments were imposed on each field in the fall of 1986: 1) surface tillage only; 2) surface plus deep tillage. Each treatment was replicated six times in a randomized block design with each experimental unit being about 40 x 100 ft in area. Soil samples were collected to a depth of 2 ft. in the spring and fall of 1987. These samples were evaluated for bulk density, soil water content, and air-filled porosity. Penetrometer resistance was also monitored.

Soybeans (variety Hobbit) were planted in the spring by the cooperator. Crop growth was monitored at two times during the growing season. Grain samples were obtained at harvest.

Results: Management practices used by the cooperators are presented in Table 1. All cooperators used some tillage on the experimental area prior to planting. Tillage intensity ranged from 1 operation with a disk or field cultivator to 4 operations. Weed growth was controlled chemically at all locations and in conjunction with row crop cultivation at 11 of the 16 locations. Among sites, 14 different herbicides were applied. Starter fertilizer was applied with the seed at 2 sites. Tractors used in field operations included 2WD, 4WD and front-wheel assist models ranging in horse power from 65 to 235. Field plots under the direction of our research team were planted April 28 while most farm fields were planted between May 8 and May 31. Heavy rains in the Lancaster area in May delayed planting at 2 sites until mid-June. Harvest dates reflect the period from September 23 through October 19 when research samples were collected.

Results of 1987 soybean production generally indicated little differential growth as a result of subsoiling (Table 2). Plant height measured early or late in the growing season for the nonsubsoiled or subsoiled treatments was not substantially different, however, there was a consistent trend for the subsoiled treatment to be taller than the nonsubsoiled treatment. This difference across all locations was 1.3 and 1.7 cm for the early and late monitoring periods, respectively. Plant color ranged from a rating of 5GY 5/6 to 5GY 3/4 using the Munsell color system and tended to portray darker values and chromas later in the season. Phenology indicated the stage of plant development at the time of observation. Soybeans in the vegetative (V) or reproductive (R) stage exhibited the same degree of advancement (i.e. 3,4,5, etc.) except for 4 sites on the early season monitoring. For these exceptions the subsoiled plots had progressed one leaf node ahead of the nonsubsoiled plots in the vegetative stage. At the Nemaha Co. site the phenology difference was from V8 to R2.

No significant differences in plant population were observed except at 2 sites. There was no consistent trend among locations. Soybean yields were similar for subsoiled and nonsubsoiled treatments at all locations. At 7 of the locations the yields were greater on the subsoiled plots than on the nonsubsoiled plots. These differences, in general, were not significantly different. Yield increases due to subsoiling were greatest at the Rogers' and Gauchat's farms.

The lack of differential plant response as a result of subsoiling would lead one to believe that the tillage operation was not effective in reducing compaction. Two major factors influence the plant response of 1987. First, numerous soil types and field locations were used in this study to provide for diverse results which could be used to better understand the impact of subsoiling plant-soil relationship. This was accomplished using soils which ranged in compaction index from 0 to 76 (data not shown). Secondly, relatively good timely precipitation events occurring during the 1987 growing season never allowed stress conditions to develop which would demonstrate differential soil water holding capacities, root exploration and plant uptake of water and nutrients. There is substantial yield response difference to subsoiling that ranged from -6 to +17%. Additional years of data will more clearly define the cause of this yield response; however, the rapid development of the subsoiled plot at Gauchat's, as indicated by R2 at the early season observations, would seem to affect the timing of flowering and pod fill in a way that was most advantageous to production.

Changes in bulk density of the subsoiled plots, as compared to the nonsubsoiled plots, for the spring sampling period would indicate that the subsoiling operation was effective in shattering the compacted zone. This is illustrated by 63% of the field sites which had bulk densities reduced by at least 10% at one or more depths in the zone 2 inches away from the subsoil shank (Table 3). Greatest reduction in bulk density occurred in the 6-12 inch depths. Fracturing was less as soil samples were taken further from the shank slot. The reduction in bulk density observed in the spring persisted into the fall but was smaller in magnitude.

Results indicate that subsoiling was useful in reducing soil compaction but that good weather conditions minimized the yield difference which might have been observed in a drier year. Penetrometer resistance data are also being processed to further refine our knowledge of the reduction in soil compaction resulting from subsoiling and the persistence of that soil fracturing.

Table 1. Management practices for deep tillage research

Cooperator	Fertilizer	Tractor		Tillage	Herbicide		Herbicide Application	Plant Date	Harvest D
Ottjenbruns	None	160	4WD	Landsmen	Prowl	2 qt/A	Floater	5/12	10/08/8
		140	2WD	RCC[1]	Lexone	1/2 lb	Floater		
					Cobra	10 oz	Sprayer		
Jones	None	110	2WD	Disk	Poast, Crop Oil	1 pt	Broadcast-Sprayer	5/13	10/13/8
					Basagram	1 pt	Broadcast-Sprayer		
					Blazer	6 oz	Broadcast-Sprayer		
Nelson	None	125	2WD	Disk	Sencor	1/3 lb	Sprayer	5/8	10/12/8
		65	2WD	Field Cultiv.	Treflan	1 qt	Sprayer		
				RCC					
Schutte	None	98	2WD	Disk	Lasso	1.5 pt	Planter	5/10	10/15/8
		98	2WD	FC					
		125		RCC					
Lefler	None	100	4WD	FC	Treflan	2 pt	Broadcast-Incorporated	5/13	9/25/87
Center Pivot		140	2WD	RCC	Lasso	1 gal	Broadcast-Planter		
					Command	2 pt	Broadcast-Incorporated		
Schmidt	None	180	2WD	Disk	Treflan	1-1/2 pt	Broadcast-Incorporated	5/15	9/30/87
		170	FWA	FC	Secptor	2/3 pt	Broadcast-Incorporated		
				Chisel					
				RCC					
Clausen	None	180	FWA	FC	Lasso	2.5 qt	Broadcast-Incorporated	5/12	10/05/8
				Noble Blade					
				RCC					
Gauchat	None	100	2WD	FC	Sencor	2/3 lb	Broadcast-Incorporated	5/19	10/07/8
		145	4WD		Treflan	2 pt	Broadcast-Incorporated		
Harlan	None	235	4WD	Disk	Treflan	1 qt	Pivot	6/15	10/10/8
Pivot		165	2WD	FC	Fusilade	1 pt	Sprayer		
Glock	None	130	2WD	Disk	Lasso	3 qt	Broadcast-Sprayer	5/12	9/29/87
Furrow		75	2WD	Hiller	Lexone	1/2 lb	Broadcast-Sprayer		
				RCC					
Adelman	10-35-7-2	325	4WD	Disk	Prowl	1-1/2 pt	Incorporate	5/28	10/6/87
	45 lbs/A	140	2WD	FC	Sencor/Lexone	3/4 pt	Banded		
Schure	None	210	2WD	FC	Treflan	1-1/2 pt	Broadcast	5/31	10/01/8
		70	2WD	Disk	Amiben	1.25 lbs/A	Banded		
				RCC					
Laflin	18-46-0	115	2WD	FC	Treflan	1 qt	Incorporated	5/16	10/09/8
	80 lbs/A			Disk	Preview	7 oz	Broadcast		
				RCC					
Newsham	None	190	FWA	FC	Lasso	2 qt	Broadcast	6/18	10/19/8
		165	2WD		Sencor	1/4 pt	Broadcast-Floater		

[1]FC = Field Cultivator
RCC = Row Crop Cultivator

Table 2. Soybean growth characteristics for deep tillage research.

County	Cooperator	Tillage Treatment	Plant Height T_1	Plant Height T_2	Plant Color T_1	Plant Color T_2	Phenology T_1	Phenology T_2	Plant Population	Yield	% Change
			cm						Plant/A	Bu/A	
Butler	Glock	None	31.8	81.0	5GY 5/6	5GY 4/4	V6	R5	170701	56.6	+4
		Subsoil	32.8	82.4	5GY 5/6	5GY 4/4	V6	R5	165197	58.9	
Cuming	Schutte	None	35.1	93.2	5GY 5/6	5GY 3/4	V6	R6	164757	38.7	-1
		Subsoil	34.5	96.2	5GY 5/6	5GY 3/4	V6	R6	171109	38.5	
Fillmore	Lefler	None	29.9	69.7	5GY 5/4	5GY 4/4	V6	R6	123375	63.7	+1
		Subsoil	31.3	72.0	5GY 5/4	5GY 4/4	V6	R6	119835	64.1	
Johnson	Laflin	None	28.1	74.0	5GY 5/4	5GY 4/4	V6	R6	152369	55.0	-1
		Subsoil	28.1	74.4	5GY 5/4	5GY 4/4	V6	R6	146421	54.2	
Knox	Clausen	None	33.0	76.5	5GY 5/4	5GY 3/4	V7	R5	106314	38.0	+1
		Subsoil	33.7	79.2	5GY 5/4	5GY 3/4	V7	R5	111350	38.2	
Lancaster	Harlan	None	7.1	41.3	5GY 5/6	5GY 4/4	V5	R2	66248	33.8	-6
		Subsoil	7.4	43.9	5GY 5/6	5GY 4/4	V5	R2	71965	31.9	
	Ottjenbruns	None	28.8	50.4	5GY 5/4	5GY 4/4	V6	R6	114390†	28.4	+0
		Subsoil	31.3	53.2	5GY 5/4	5GY 4/4	V7	R6	130998	28.4	
	Rogers' Farm	None	39.1	74.6	5GY 5/4	5GY 4/4	R3	R6	161717	29.7†	+8
		Subsoil	43.8	76.4	5GY 5/4	5GY 5/4	R3	R6	153186	32.0	
	Waddell	None	28.6	61.8	5GY 5/4	5GY 4/4	R3	R6	176872†	35.0	-1
		Subsoil	29.3	62.8	5GY 5/4	5GY 4/4	R3	R6	159357	34.7	
Madison	Adelman	None	16.1	60.3	5GY 5/4	5GY 3/4	V4	R4	115389†	36.3	-1
		Subsoil	17.4	63.8	5GY 5/4	5GY 3/4	V4	R4	131860	35.1	
	Schmidt	None	17.4	62.2	5GY 5/4	5GY 3/4	V4	R4	94879	54.1	+5
		Subsoil	19.2	65.4	5GY 5/4	5GY 3/4	V5	R4	92747	57.0	
Nemaha	Gauchat	None	32.0	65.7	5GY 5/4	5GY 4/4	V8	R6	61256	33.0	+17
		Subsoil	35.3	64.0	5GY 5/4	5GY 4/4	R2	R6	75731	38.7	
Platte	Schure	None	22.0	72.5	5GY 5/4	5GY 4/4	V4	R3	273339	41.7	+4
		Subsoil	24.6	72.7	5GY 5/4	5GY 4/4	V4	R3	276515	43.5	
Richardson	Jones	None	22.4	79.1	5GY 5/4	5GY 4/4	V4	R5	96740	56.9	-2
		Subsoil	22.8	85.4	5GY 5/4	5GY 4/4	V5	R5	98464	55.9	
Saunders	Newsham	None	27.7	52.3	5GY 5/6	5GY 4/4	V5	R2	164938	46.9	-1
		Subsoil	28.2	52.0	5GY 5/6	5GY 4/4	V5	R2	159722	46.3	
Washington	Nelson	None	43.1	71.2	5GY 4/6	5GY 3/4	V7	R5	169340	60.3†	-3
		Subsoil	43.8	69.2	5GY 4/6	5GY 3/4	V7	R5	169884	58.2	

† Signifies that means for the tillage treatments at the location are significantly different at p=0.10.

T_1 and T_2 designate field observations of plant growth in the early and late periods of the growing season.

Table 3. Reduction in bulk density of subsoiled treatments as compared to nonsubsoiled treatments for 3 distances away from the shank slot. Percentage of sites observed in each category are given.

Reduction in bulk density as compared to nonsubsoiled treatment		
0-5%	5-10%	> 10%
2 in. from shank		
6%	31%	63%
6 in. from shank		
19%	75%	6%
1 in. from shank		
31%	63%	6%

Increasing Nitrogen Use Efficiency by Dryland Sorghum Under Conventional Disk and No-tillage Systems

M.V. Marake, D.T. Walters and D.H. Sander

Objectives:

1) To evaluate the effects of no-tillage and conventional disk systems on dryland sorghum production and fertilizer N use efficiency.

2) To determine the effect of different N sources, timing of N application and placement of N on dryland sorghum production under different tillage systems.

Procedures:

The experiment was conducted at the Agricultural Research and Development Center at Mead, Nebraska. The soils at the experiment site were the Sharpsburg silty clay loam (Typic Argiudoll) and the Butler silty clay loam (Abruptic Argiaquoll). The experiment was replicated four times as a split plot in a randomized complete block design. Blocking was carefully arranged on the basis of soil type. Main plots consisted of 2 tillage treatments (conventional spring disk (D) and no-tillage (NT) (30m x 30m) and a factorial combination of N rate, N source/placement and N application time as the subplot (9.2m x 4.6m). Subplot treatments consisted of:

A) N source and placement

1) Urea ammonium nitrate (28% N UAN) solution surface dribbled between sorghum rows (UD)
2) UAN knifed between sorghum rows (UK)
3) Anhydrous Ammonia (AA)

B) N timing

1) Preplant (PP)
2) Sidedress (SD)

C) N rate (kg N/ha): 0, 40, 80 and 120.

The control treatments (0 N rate) were knifed with no fertilizer applied at both times of application for UK and AA N sources. Sorghum (Pioneer 8333 - 72 day RM) was seeded on June 3 at a rate of 4.5 kg/ha in a 0.75m (30") row spacing. Weeds were chemically controlled with periodic hand hoeing of weed escapes. Nitrogen was applied preplant on May 19 and sidedressed on July 16 when sorghum was at the 8-leaf stage (growing point differentiation).

Three rows were combine harvested for grain yield and a single row was harvested for determination of stover yield. Total nitrogen content was determined on all grain and stover by the Kjeldahl method.

Results:

Sorghum grain yield averaged 4.84 Mg/ha (88 bu/A) and ranged between 3.75 to 5.61 mg/ha (68-102 bu/A) depending on treatment. Crop response to nitrogen rates was influenced by both tillage and timing of N application. Nitrogen rate requirement for maximum yield was 40 kg/ha greater for no-till than disk regardless of application time. However, when N was applied at sidedress time, an additional 40 kg N/ha was required to reach maximum yield when compared to preplant N application (Fig. 1). This is thought to be the combined effect of greater net N immobilization of fertilizer N under no-tillage and the lack of precipitation following sidedress application of N.

Sidedress application of N on July 16 preceded a 17-day dry period (Fig. 2). As a result, grain yield was significantly different at this time between no-till and disk systems with respect to N form and placement. Specifically, the yield response to surface applied UAN (UD) was significantly lower under disk tillage (Fig. 3). This reduction was not apparent under the no-tillage system and it is hypothesized that sufficient surface soil moisture was conserved to sustain an active root system near the surface to counteract the effects of dry weather on N availability.

There was a significant linear increase in stover yield in response to increased N rate up to 80 kg N/ha when N was applied preplant. Nitrogen application at sidedress time, however, did not result in an increase in vegetative growth (Fig. 4). Sidedressed N was applied at the time when the growing point changes from vegetative (leaf producing) to reproductive (head producing). At this time, total leaf number has been determined and nutrient uptake rate is at a maximum. Therefore, at 36 days post imergence, N applied was too late to effect vegetative growth. Interestingly, grain yield response to sidedressed N was quadratic and the difference between UD and UK in particular was greatest at sidedress time (Fig. 5). The sorghum plant utilized sidedress N for grain rather than vegetative production.

Grain N uptake was similarly influenced by tillage, time and rate of N application. The peak for grain N uptake was shifted upward by 40 kg N/ha between disk and no-till systems at both times of N application. This trend is consistent with the grain yield response and is due to the yield component of grain N calculations. Percent N in the grain was consistantly higher when N was sidedressed regardless of N form or placement.

Percent N in stover was significantly increased from sidedress N application when AA was the N source and from preplant N when urea forms were the N source reflecting, perhaps, the influence of soil moisture on hydrolysis of urea N and timing of uptake. This resulted in lower total stover N uptake for sidedressed urea N forms. With the exception of UD sidedressed under disk, this did not result in a reduction in total grain N uptake. Therefore, the sorghum plant first satisfied grain N needs when N was sidedressed.

Summary:

Dryland sorghum grain yield and N use efficiency were influenced by tillage, N form and placement, and time of N application in 1987. Nitrogen rate requirement to achieve maximum grain yield was approximately 40 kg N/ha greater for no-till than disk regardless of N application time and 40 kg N/ha

greater for sidedress time than preplant regardless of tillage system employed.

A 17-day dry spell following sidedress N applications resulted in a significant yield loss under conventional disk tillage when N was surface applied. This was not observed under no-tillage. Conservation of surface soil moisture and the maintenance of an active root system near the soil surface under no-tillage are thought to contribute to these results.

Root samples have been taken at various times during the season and are currently being processed. This data will add insight into the agronomic effects of tillage on N use efficiency by the sorghum plant.

Table 1. Analysis of variance for main effects and interactions, Mead 1987.

Source of variation*	df	Grain Yield	Stover Yield	Grain N Uptake	Stover N Uptake
			Prob. > F		
Tillage	1	.17	.85	.09	.49
NFP	2	.12	.51	.07	.89
Time	1	.34	.07	.95	.68
N Rate	3	.0001	.12	.0001	.0001
NR lin	1	.0001	.08	.0001	.0001
NR quad	1	.0001	.16	.0001	.22
Till*NFP	2	.10	.78	.08	.98
Till*Time	1	.83	.52	.79	.33
Till*N rate	3	.43	.45	.58	.65
NFP*Time	2	.58	.17	.72	.0004
NFP*N Rate	6	.34	.48	.22	.15
Time*N Rate	3	.72	.07	.47	.66
Till*NFP*Time	2	.15	.90	.52	.81
Till*NFP*N Rate	6	.42	.30	.34	.28
Till*Time*N Rate	3	.11	.86	.05	.96
NFP*Time*N Rate	6	.37	.33	.78	.20
Till*NFP*Time*N Rate	6	.16	.98	.20	.93

*NFP = N form/placement.
Time = preplant or sidedress N application.

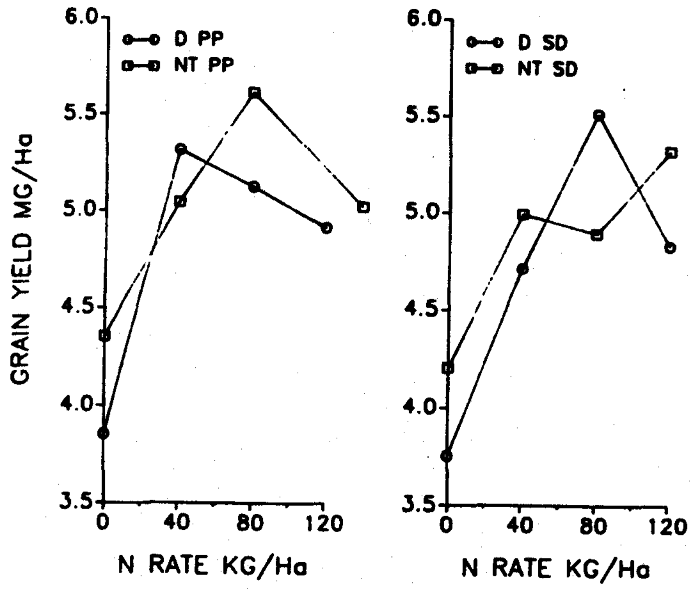

Fig. 1. N rate x N application time x tillage effects on dryland sorghum grain yield. Mead 1987.

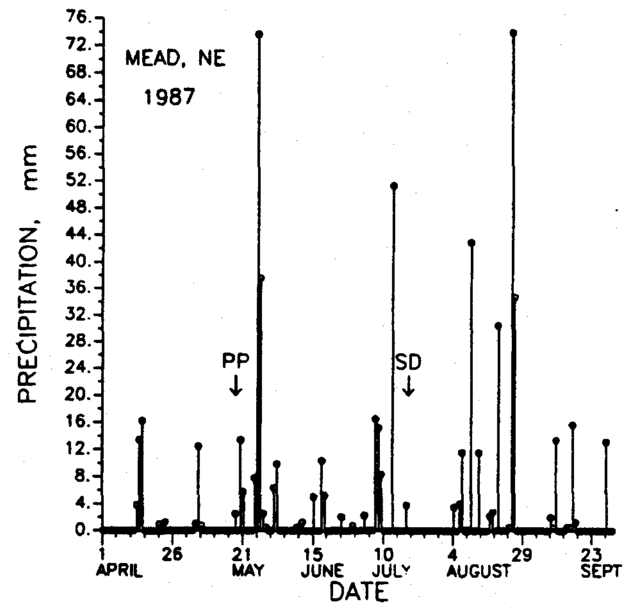

Fig. 2. Daily precipitation record for Mead, Nebraska, April-Sept. 1987.
PP = preplant, SD = sidedress

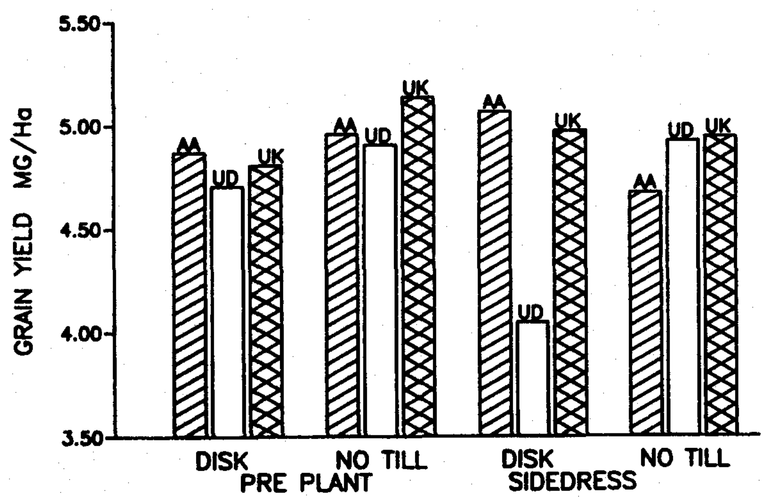

Fig. 3. Tillage x N form placement x N application time effects on dryland sorghum grain yield. Mead 1987.

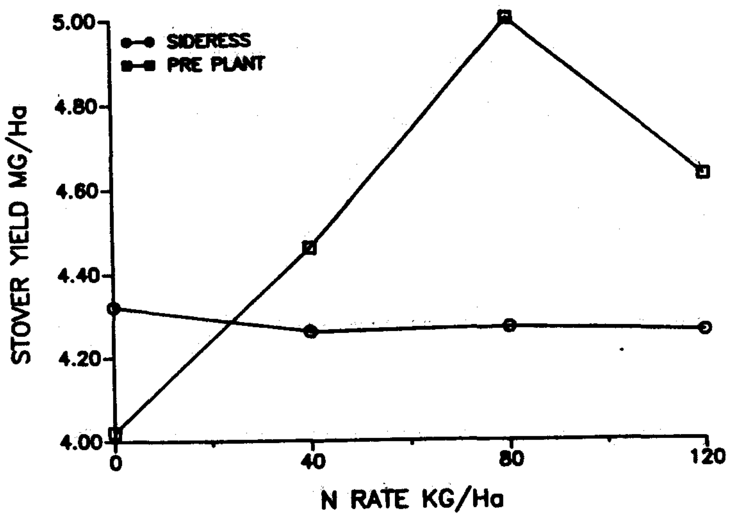

Fig. 4. N rate x N application time on dryland sorghum yield. Mead 1987.

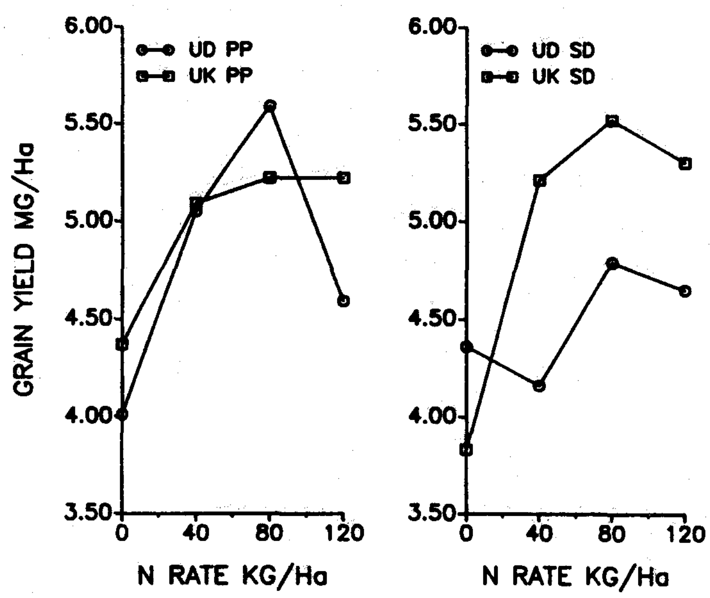

Fig. 5. N rate x N application time effects for urea N placement on dryland sorghum grain yield. Mead 1987.

THE EFFECT OF TILLAGE, RESIDUE, PRECIPITATION INTERVALS AND SOIL PROPERTIES ON SOIL CRUST CHARACTERISTICS

Joshua Lear (graduate student), Alice J. Jones, Elbert D. Dickey, Ken Hubbard, and Lloyd Mielke

Objective:

To quantify direct and interactive relationships between infiltration, runoff, soil depression storage, soil physical and chemical properties, tillage, and precipitation.

Procedure:

Rainfall simulation experiments were conducted on four major agricultural soils (Keith, Sharpsburg, Valentine, and Holdrege). Tillage-residue treatments evaluated include no-till with 60% residue cover and disk with 0 or 30% residue cover. Rainfall events occurred on dry uncrusted, wet crusted and dry crusted soil conditions. These conditions represented an initial rainfall simulation on day 0 followed by a second simulation on day 1 or day 10, respectively. Runoff from the m^2 plots was measured at 5 minute intervals for 2 hours or until steady state infiltration was achieved. Soil properties evaluated in the laboratory are particle size analysis, aggregate size distribution, aggregate stability, swelling index, specific surface, plastic index, crusting tendency, moisture release, hydraulic conductivity, exchangeable cations, C.E.C., pH, and organic matter (Table 1). Field measurements included antecedant moisture, time to initiation of runoff, travel time, time to steady state infiltration, bulk density, and penetrometer resistance.

Results and Discussion

Results are presented for the Holdrege soil only. Initial and final infiltration was higher on the disked soils than on the no-till soils for the dry uncrusted conditions (Fig. 1). There was no apparent difference in initial or final infiltration between the 0% and 30% residue treatments for the dry uncrusted conditions. Time to steady state infiltration was consistently higher for the dry crusted conditions than for the wet crusted condition due to higher antecedant moisture. The dry crusted condition tended to have higher initial infiltration except for the disk-30% residue treatment. Dry crusted coils consistently took longer to reach steady state.

Runoff occurred faster on the dry uncrusted no-till than on the disk treatments (Fig. 2). Time to initiation of runoff was substantially lower for the residue treatments among tillage treatments but did not have an effect within the disked treatments.

This may indicate that runoff from small plots is influenced more by tillage than by residue. Also, runoff occurred earlier for the wet crusted than for the dry crusted condition.

The strength of the crust after the application of two rainfall events was similar among tillage treatments (Fig. 3). Shear strength was higher for dry crusted conditions than for wet crusted conditions. Neither tillage nor residue affected the strength of the crust formed by two rainfall events.

Bulk density was measured for the 0 to 2 cm and the 2 to 4 cm depth. For disked treatments, the bulk density of the 0 to 2 cm layer after two rainfall events tended to be similar to that of the dry uncrusted no-till plots (Fig. 4). There was no trend for bulk density among no-till treatments but the surface crust was significantly less dense than the 2 to 4 cm depth for the dry crusted condition.

Table 1. Physical and chemical properties of six Nebraska soils.

Soil / Property	Wymore	Keith	Sharpsburg	Valentine	Moody	Holdrege
Aggregate stability	32.4a	.4e	17.0b	0.0e	6.3c	3.3d
Aggregate size dist.						
MWD	188.6a	91.5d	137.9b	0.0e	114.6c	81.0d
GMD	8.0a	6.6d	7.2b	0.0f	6.9c	6.3e
Specific surface	140.3a	102.9c	108.8b	22.7e	102.6c	86.7d
pH	5.70	6.73	5.79	5.18	6.56	5.62
O.M.	2.64	1.31	2.64	1.42	3.55	1.38
C.E.C.	31.5	20.3	27.2	3.66	26.2	15.8
SAR	.045	.081	.057	.078	.067	.067
BASE SAT	.77	.87	.75	.52	.88	.74
Ca	16.6	12.7	14.3	1.2	16.7	7.9
Mg	6.4	3.3	4.9	.4	5.2	2.5
K	1.18	1.65	1.10	.29	.98	21.28
Na	.048	.065	.048	.022	.070	.048

Values within a row followed by the same letter are not significantly different at P = .10.

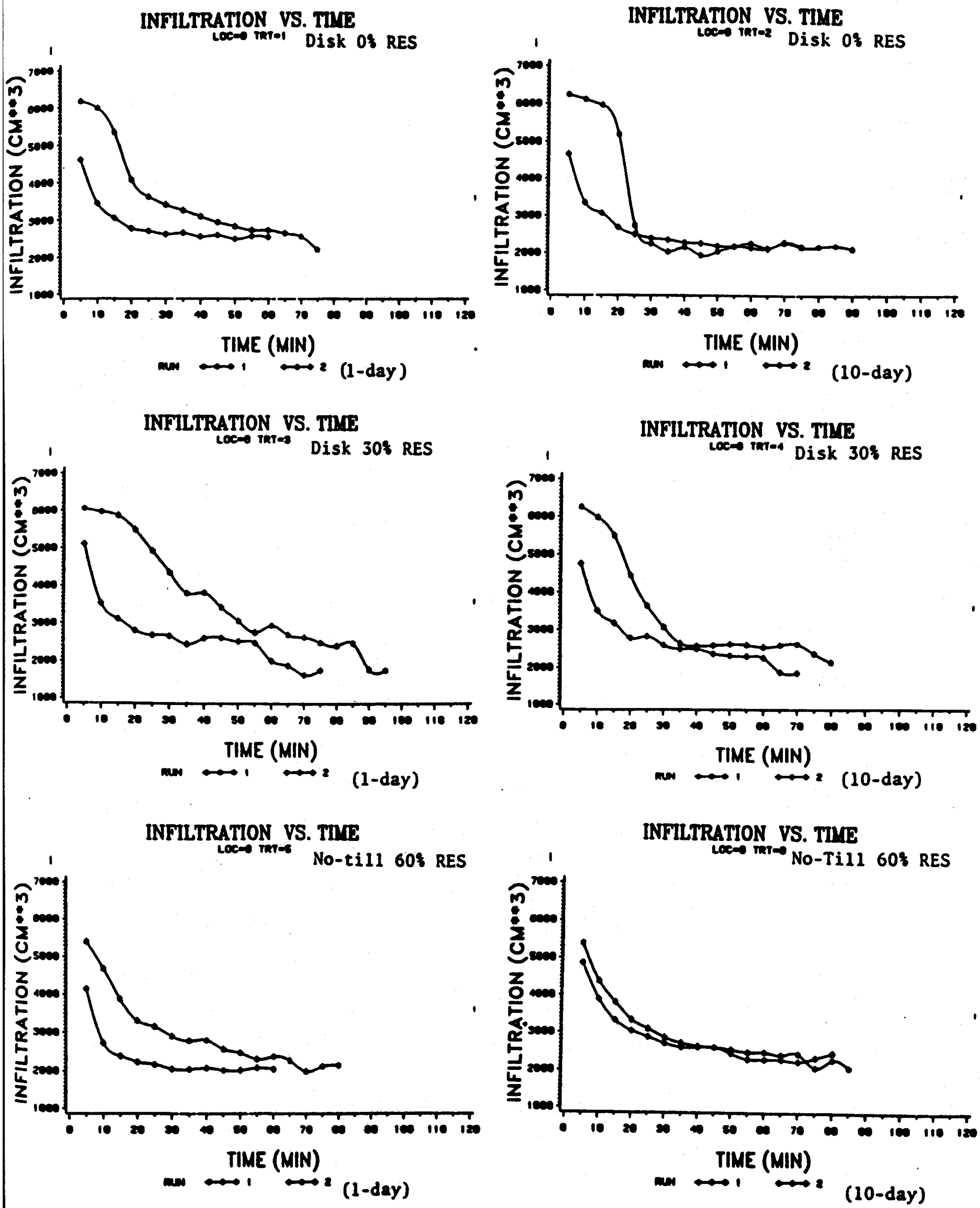

Fig. 1. Plot of infiltrations vs. time for 6 treatments and two simulations.

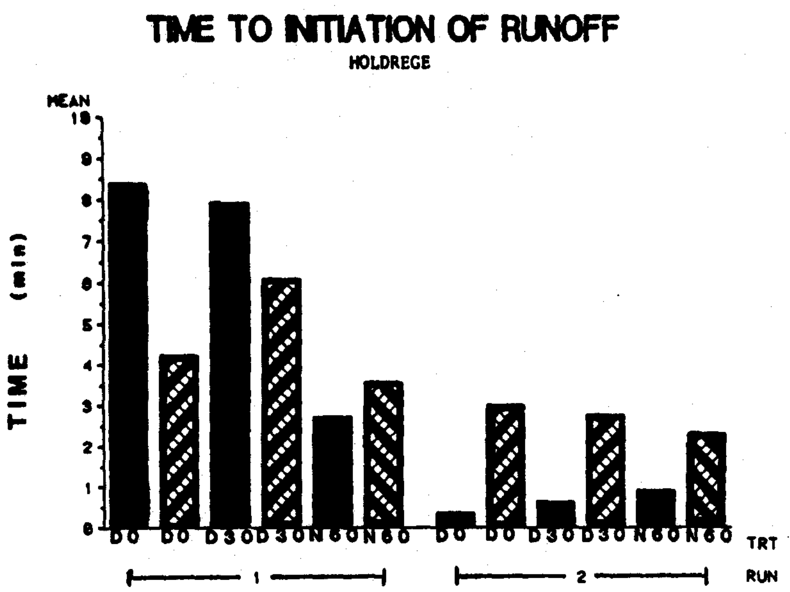

Fig. 2. Time to initiation of runoff for 6 treatments and two simulations.

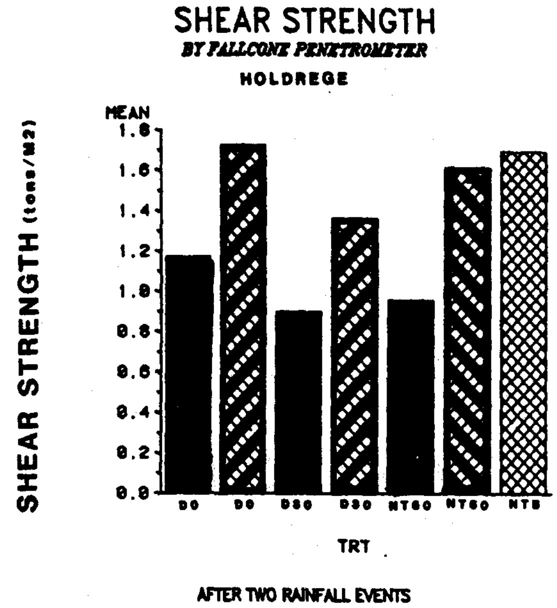

Fig. 3. Shear strength of the surfa crust for 6 treatments afte two simulations

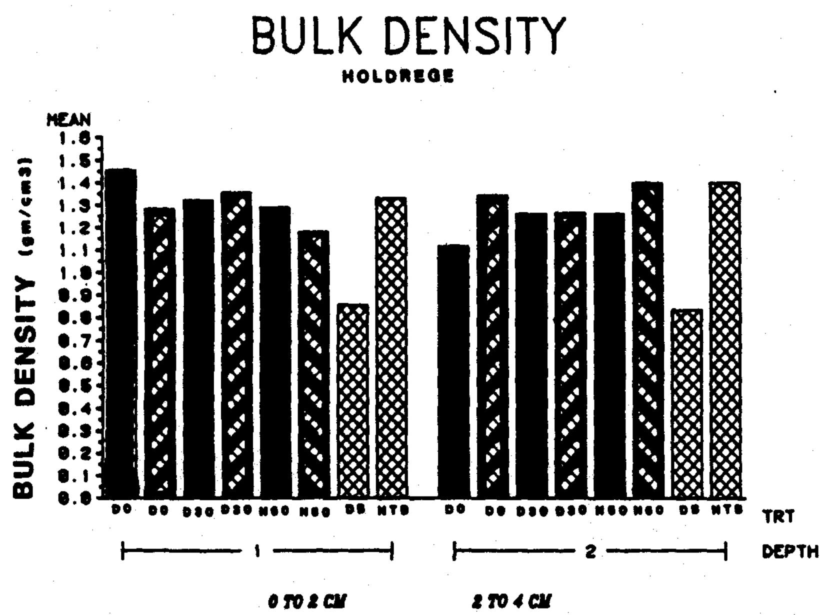

Fig. 4. Bulk density of 6 treatments after 2 simulations and 2 tillage treatments before simulation over 2 depths.

TILLAGE INFLUENCE ON SOYBEAN PRODUCTION AND SOIL PROPERTIES

Julie Baumert-Powers (graduate student), Alice J. Jones,
Lloyd Mielke, and Jim Specht

Objective: To quantify the dynamic relationship between tillage, rhizosphere characteristics and soybean production for use in developing management strategies which will maximize production efficiency and profits. Specifically:

To evaluate the influence of tillage on soybean water and osmotic potentials, rooting depth, water use and yield.

Procedure:

Field experiments were initiated by USDA-ARS in 1980 at tje Rogers Farm east of Lincoln, Nebraska. Soybean production was studied intensively for six tillage treatments—moldboard plow, chisel, subsoil, disk, no-till and till-plant. Soybeans were grown in rotation with corn on six replications in a randomized complete block design.

Many soil and crop parameters were measured throughout the growing season. Parameters and the method of evaluation are as follows:

Parameter	Method
Residue Cover	Line Transect
Soil Temperature	Thermocouples/data logger
Soil Water	Neutron Probe
Emergence	Plant Counts
Phenology	Crop Staging
Crop Color	Munsell Color Book
Root Growth	Soil Cores/Water Use
Plant Height	Measured by Hand
Osmotic Potential	Thermocouple Psychrometer
Water Potential	Pressure Bomb
Yield	Harvest Samples
Seeds per Pod	Hand Counted

Results and Discussion:

Measurements were made on all six treatments however only a selected group of results for the no till, disk and plow treatments are discussed.

Residue cover after planting averaged 34% for disk, 75% for no till and 12% for plow. Residue served to decrease soil temperature among the tillage treatments. Soil Temperature was measured at depths of 0, 5, 10 and 20 cm. At 5 cm and 10 cm depth there was a temperature difference between plow and no till. No-till was 2 or 3^{o}C lower than the plow treatment. Disk was almost identical to plow. The no-till was slightly cooler than plow because the high residue level on no-till reflected more solar radiation.

Rooting depth (Fig. 1), as illustrated by soil water use, indicated that three weeks after planting, significant amounts of water were being used at the 1-foot depth in plow. It was 5 weeks after planting before the same amount of water was depleted from the disk treatment and 6 weeks for no-till. It is possible that the warmer less dense of the plow treatment soils created an environment that promoted the early development of roots. The plow treatment continued to be associated with more rapid root growth throughout the growing season than the disk and no-till treatments to a maximum depth of five feet.

Leaf and root osmotic potentials (Fig. 2 and 3) show the plants adjustment to water loss. As a plant becomes more stressed, the osmotic potential becomes more negative. Since the roots are further away from the leaf-air interface, the root osmotic potential adjusted to a lesser degree than the osmotic potential in the leaves. The root osmotic potential fluctuated less than the leaf osmotic potential.

Monitoring soil water status throughout the season allows for the calculation of cumulative crop water use. The disk treatment had the highest water use at 65.5 cm while no-till used 60.9 cm and the plow treatment used the least at 58.5 cm.

Coupling the cumulative crop water use with the yields indicates the water use efficiency of the soybean plants. At a 10% alpha level the yield of the plow treatment was significantly different from that of the no-till with the disk treatment falling in between. The plow treatment was the most efficient water user at 40 kg/cm.

Table 1. Soybean yield and water use efficiency for three tillage treatments. 1987.

Treatment	Yield kg/ha	Water Use Efficiency kg/cm
No-till	2091.9 a	34
Disk	2109.6 ab	32
Plow	2374.6 b	40

Values in a column followed by the same letter are not significantly different at p=0.10.

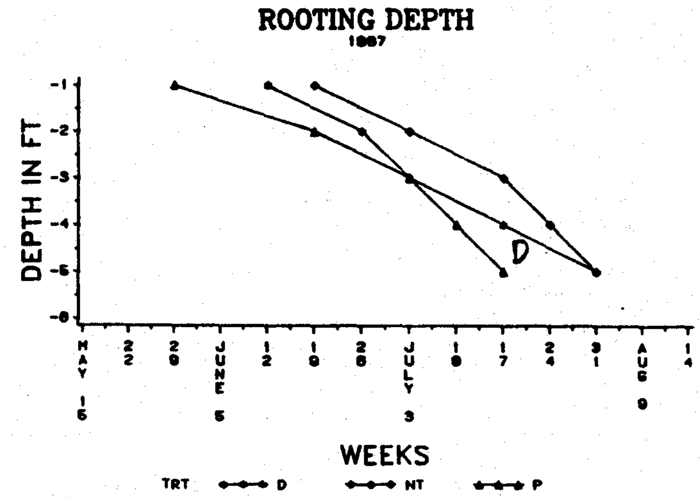

Fig. 1. Rooting depth of soybeans in weeks after planting.

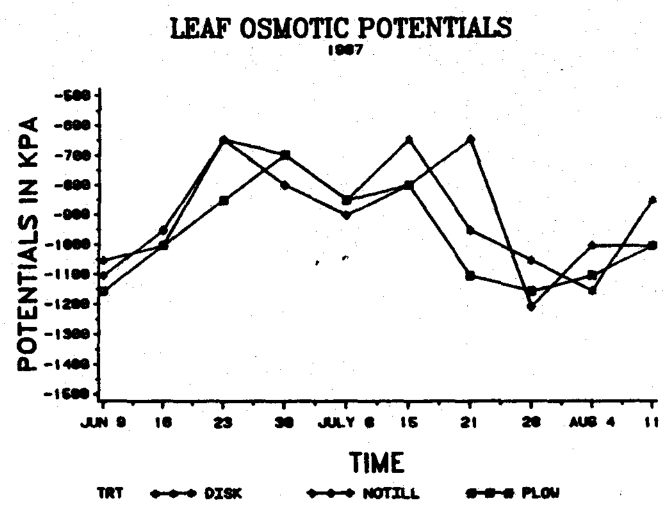

Fig. 2. Leaf osmotic potentials in KPa started at V4 growth stage.

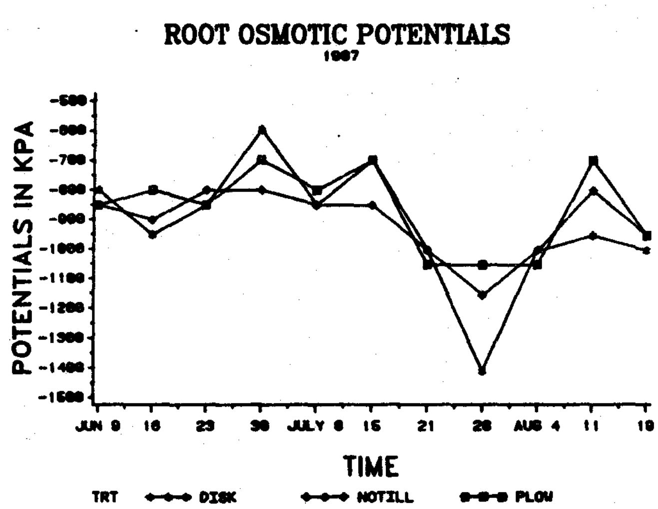

Fig. 3. Root osmotic potentials in KPa started at V4 growth stage.

Tillage, Rotation and N Rate Effects on Dryland Corn Production and Nitrogen Uptake in Northeastern Nebraska

D. T. Walters and C. A. Shapiro

Objective:

To determine the effects of tillage on corn yield and N use efficiency when grown in rotation with soybeans or continuously with or without a hairy vetch cover crop.

Procedures:

Three corn crop sequences: continuous corn (CC), corn-soybean (CB) and continuous corn with a hairy vetch (Vicia villosa) cover crop (CCV) were established in 1985 under three tillage systems (spring disk, spring plow and no-till) at the Northeast Research and Extension Center, Concord, NE. Five N rates (0, 40, 80, 120 and 160 kg N/ha) within each tillage x cropping sequence were applied annually as broadcast NH_4NO_3 prior to tillage in the spring. This experiment was designed as a split-split plot RCB with tillage as main plots (100' x 210'), rotations as subplots (100' x 35') and N rates as sub-subplots (20' x 35'). Soil type is a Kennebec silt loam (Cumulic Hapludoll).

Corn (Pioneer 3475, 110 RM) was planted on May 7 at 47,445 plants/ha in 0.75m (30" rows). Counter was applied to all corn for rootworm control. Century 84 soybeans were planted on June 4 at 90 kg seed/ha. Weeds were chemically controlled on all plots with the addition of a single cultivation in the disk and spring plow treatments on June 15. Corn grain and stover were hand harvested from 12.2m (40 ft) of row at physiological maturity on October 1. Soybeans were combine harvested on October 9.

Madison hairy vetch was seeded into standing corn on August 4, 1986 and a thick fall stand of vetch resulted. A very dry and warm winter resulted in loss of this vetch and spring growth was variable. Dry matter yield of vetch was poor under no-tillage and frequently no vetch growth was observed. Nitrogen returned in vetch biomass averaged 14 kg N/ha with a range of 0 to 37 kg N/ha. Nitrogen fertilizer had no apparent effect on N content of vetch.

Table 1. Dry matter production, percent N and N content of above ground biomass of hairy vetch sampled in the spring of 1987. Concord, NE.

Treatment	Dry Matter Yield	% N	N content
	kg/ha		kg/ha
Tillage			
Sp. Plow	584(64)*	3.27(10)	18.7(61)
No-till	196(77)	3.72(12)	6.8(68)
N-rate (kg/ha)			
0	362(104)	3.62(12)	12.1(100)
160	517(65)	3.24(9)	16.4(61)

* Number in parenthesis is the coefficient of variation of the mean (CV %).

Vetch was again seeded in standing corn on August 10, 1987 and established well.

Results

Corn yields were fair in 1987. Weather conditions in Northeast Nebraska were dry following planting and some moisture stress was observed in the corn crop during the latter part of June. Overall grain yields averaged 5.92 mg/ha (112 bu/A). An analysis of variance for selected variables is presented in Table 2.

More uniform emergence was observed from no-tilled plots following planting and emergence was erratic from disk and plowed treatments. This, however, did not result in a significant reduction in plant population by harvest time. Plant populations were 3 percent (1100 plants/ha) higher when corn followed soybeans regardless of tillage system employed. Also, no barren stalks were encountered in CB corn, however, barren stalks in CC and CCV corn averaged 10% of the stand.

Corn following soybeans averaged 1.87 Mg/ha (35 bu/A) more than either CC or CCV systems (Table 3). Grain yield response to N fertilizer was limited to 40 kg N/ha overall. Examination of the tillage x N rate interaction shows a significant linear N rate response under no-till with a 1.0 Mg/ha increase in grain yield with the application of 160 Kg N/ha. Grain yield with 0 N applied on corn following soybeans surpassed even the highest yielding CC or CCV treatments. Total N removal by the corn crop following soybeans averaged 39 kg N/ha more than CC and CCV sequences. Grain concentrations were significantly reduced under no-till when compared to spring plowing owing to the difference in net N mineralization between the two tillage extremes and is reflected in grain N removal at the 0 kg N/ha rate (Table 3).

Fertilizer N use efficiency (FUE) as measured by the ratio:

$$\frac{\text{grain N removed (fertilized - check)}}{\text{Fertilizer N rate}}$$

are presented in Table 3. FUE averaged 7.9, 6.5 and 17.7 percent for the disk, plow and no-tillage systems, respectively. Fertilizer N use efficiency for corn following soybeans averaged less than half that recorded for the CC or CCV systems. Significantly greater net N mineralization under spring plow and disk systems was reflected in both higher grain yield, grain N content and stover N content at the 0 kg N/ha rate. The increase in FUE under no-tillage resulted from lower net N mineralization and required an additional 40 kg N/ha to compensate.

Stover yield reflects the quantity of crop residue left for erosion protection and represents the portion of the corn crop left in the field to cycle nutrients back to the soil. The results in Table 4 indicate no increase in stover yield beyond the 40 kg/ha N rate for disk and plow tillage. A significant decrease in stover yield as a function of N rate under spring plow tillage did not result in any loss of grain yield. Stover N concentrations were lowest following soybeans although stover yields following soybeans were 1.5 times greater than those from CC or CCV systems. This resulted in a net increase of 9 kg N/ha more N returned in corn residue following soybeans.

In summary, corn in rotation with soybeans yielded 1.35 times more grain than continuous corn. Grain yield for the CB rotation with no N applied surpassed even the highest yielding CC treatments. Tillage influenced grain production and stover yield by an apparent stimulation of N mineralization under plow and disk tillage. Grain yield did not respond to the application of N fertilizer beyond the 40 kg N/ha rate except under no-tillage. Fertilizer use efficiency was increased nearly 3-fold when no-till was employed. The hairy vetch cover crop provided good fall cover but did not over winter well. Hairy vetch has historically been a successful crop in this region of the state, however, climatic conditions in 86-87 resulted in poor vetch stands across eastern Nebraska.

Table 2. Analysis of variance for selected variables, tillage x rotation x N-rate. Concord, NE. 1987.

Source	df	Grain Yield	Gr. N (%)	Grain N removed	Population	Stover Yield	Stover N (%)	Stover N removed	Soybean Yield
		Prob. > F							
Tillage	2	NS	.03	.001	NS	NS	.001	NS	NS
Rotation	2	.001	NS	.001	.01	.001	.001	.001	—
CB vs CC+CCV	1	.001	NS	.001	.005	.001	.001	.001	—
CC vs CCV	1	NS	NS	NS	NS	NS	NS	NS	—
Till x Rot	4	NS	NS	NS	NS	NS	NS	NS	—
N Rate	4	.02	.001	.001	NS	NS	.001	.001	NS*
NR lin	1	.01	.001	.001	NS	NS	.001	.001	NS
NR quad	1	NS	.01	NS	NS	.02	NS	.005	NS
Till x NR	8	NS	NS	.08	NS	NS	NS	NS	.02
Disk x NR lin	1	NS	NS	NS	NS	NS	.001	.001	NS
x NR quad	1	NS	.07	NS	NS	.001	NS	.06	.08
Sp.Pl. x NR lin	1	NS	.01	NS	NS	.03	.001	NS	NS
x NR quad	1	NS	NS	NS	NS	NS	NS	NS	.01
NT x NR lin	1	.001	.001	.001	NS	NS	.001	.001	.08
x NR quad	1	NS	NS	NS	NS	NS	NS	NS	.07
Rot x NR	8	NS	.08	NS	NS	NS	NS	NS	—
CB x NR lin	1	NS	.001	.01	NS	NS	.001	.005	—
x NR quad	1	NS	NS	NS	NS	NS	NS	NS	—
CC x NR lin	1	.04	.003	.006	NS	NS	.001	.03	—
x NR quad	1	.04	NS	.07	NS	NS	NS	NS	—
CC x NR lin	1	NS	.006	.05	NS	NS	.001	.001	—
x NR quad	1	NS	.001	NS	NS	NS	NS	.04	—
TillxRotxNR	16	NS	NS	NS	NS	NS	NS	—	

NS = Prob > F exceeds .10

* = N rate main effect and interactions for soybean yield are from previous year N application to corn.

Table 3. Main Effect and 2-way interaction means for corn grain yield, N content, N removal, population, fertilizer use efficiency and soybean yield, 1987.

Source	Corn Grain Yield*	Corn Grain N	Grain N Removal	Population	FUE	Soybean Yield
	Mg/ha(bu/A)	%	kg/ha	1000/ha	%	Mg/ha(bu/A)
Tillage						
Disk	5.98(113)	1.53	92	37.0	7.9	2.57(47)
Sp. Plow	5.89(111)	1.55	91	36.7	6.5	2.69(50)
No-till	5.90(111)	1.51	89	38.4	17.7	2.59(48)
Rotation						
Corn/Soy (CB)	7.17(135)	1.53	110	38.1	6.3	
Cont. Corn (CC)	5.43(103)	1.52	83	37.2	12.9	
Cont. Corn w/vetch (CCV)	5.17(98)	1.54	80	36.8	12.9	
N-Rate (kg/ha)						
0	5.66(107)	1.48	84	37.2	—	2.61(48)
40	5.95(112)	1.53	91	37.3	18.2	2.61(48)
80	6.03(114)	1.54	93	36.8	11.4	2.61(48)
120	5.88(111)	1.55	91	37.7	6.0	2.66(48)
160	6.11(115)	1.56	95	37.8	7.1	2.60(48)
Till x N-rate						
Disk 0	5.81(110)	1.49	87	36.8	—	2.63(49)
40	6.04(114)	1.55	93	36.6	16.0	2.52(46)
80	5.94(112)	1.55	92	36.2	6.7	2.38(44)
120	6.00(113)	1.54	92	38.3	4.4	2.61(48)
160	6.10(115)	1.54	94	37.3	4.6	2.71(50)
Sp. Plow 0	5.79(109)	1.51	87	36.6	—	2.57(47)
40	5.96(112)	1.55	92	36.8	10.8	2.71(50)
80	6.14(116)	1.57	96	36.6	10.7	2.74(51)
120	5.76(109)	1.56	90	36.9	2.1	2.80(52)
160	5.82(110)	1.57	91	36.5	2.4	2.65(49)
No-till 0	5.39(102)	1.43	77	38.1	—	2.63(49)
40	5.84(110)	1.50	88	38.4	27.8	2.61(48)
80	6.00(113)	1.51	90	37.7	16.9	2.72(50)
120	5.87(111)	1.54	90	37.9	11.4	2.56(47)
160	6.40(121)	1.56	100	39.7	14.4	2.43(45)
Till x Rotation						
Disk CB	7.22(136)	1.55	112	37.9	1.6	
CC	5.37(101)	1.52	82	36.3	10.4	
CCV	5.34(101)	1.54	82	36.9	11.7	
Sp. Plow CB	7.09(134)	1.53	109	37.1	2.9	
CC	5.42(102)	1.55	84	36.4	7.4	
CCV	5.18(98)	1.57	81	36.5	9.3	
No-till CB	7.20(136)	1.52	109	39.3	14.6	
CC	5.52(104)	1.50	82	38.8	20.8	
CCV	4.99(94)	1.51	75	36.9	17.5	
Rotation x N-rate						
CB 0	7.03(133)	1.49	105	37.9	—	
40	7.14(135)	1.52	108	37.9	8.2	
80	7.04(133)	1.54	108	37.4	3.9	
120	7.40(140)	1.55	115	38.0	8.2	
160	7.23(136)	1.57	113	39.4	5.2	
CC 0	4.99(94)	1.49	74	37.0	—	
40	5.46(103)	1.52	83	37.6	20.1	
80	5.77(109)	1.52	87	37.0	16.1	
120	5.39(102)	1.54	83	37.2	7.0	
160	5.56(105)	1.55	86	37.1	7.5	
CCV 0	4.96(94)	1.45	72	36.5	—	
40	5.24(99)	1.57	82	36.8	25.6	
80	5.29(100)	1.57	83	36.1	14.3	
120	4.84(91)	1.55	75	37.9	2.8	
160	5.52(104)	1.55	86	37.0	8.7	

*Grain yield as Mg/ha is for dry matter yield, bu/A adjusted to 15.5% moisture for corn and 13% for soybean.

Table 4. Main effect and 2-way interaction means for stover yield, N content and stover N removal, 1986.

Source		Stover Yield	N	Stover N removal
		Mg/ha	%	kg/ha
<u>Tillage</u>				
Disk		3.85	0.80	30
Sp. Plow		3.99	0.82	32
No-till		4.15	0.73	31
<u>Rotation</u>				
Corn/Soy (CB)		5.03	0.73	37
Cont. Corn (CC)		3.52	0.81	28
Cont. Corn w/vetch (CCV)		3.44	0.82	28
<u>N-Rate (kg/ha)</u>				
0		3.87	0.66	25
40		4.16	0.73	30
80		4.08	0.78	32
120		4.07	0.88	36
160		3.80	0.87	33
<u>Till x N rate</u>				
Disk	0	3.58	0.70	25
	40	4.11	0.71	28
	80	3.97	0.75	29
	120	4.05	0.95	38
	160	3.56	0.89	31
Sp. Plow	0	4.14	0.72	29
	40	4.28	0.78	33
	80	4.14	0.83	34
	120	3.80	0.88	33
	160	3.61	0.91	33
No-till	0	3.89	0.58	23
	40	4.09	0.67	28
	80	4.13	0.77	32
	120	4.36	0.82	36
	160	4.25	0.82	34
<u>Till x Rotation</u>				
Disk	CB	4.88	0.70	34
	CC	3.24	0.83	27
	CCV	3.44	0.87	30
Sp. Plow	CB	4.99	0.78	39
	CC	3.70	0.84	31
	CCV	3.30	0.85	31
No-till	CB	5.22	0.71	38
	CC	3.63	0.76	28
	CCV	3.59	0.73	26
<u>Rotation x N-Rate</u>				
CB	0	4.85	0.62	30
	40	5.26	0.67	36
	80	4.99	0.75	37
	120	5.25	0.80	43
	160	4.79	0.81	39
CC	0	3.50	0.72	25
	40	3.71	0.71	26
	80	3.71	0.83	31
	120	3.43	0.86	30
	160	3.26	0.92	30
CCV	0	3.26	0.66	21
	40	3.50	0.80	27
	80	3.54	0.77	27
	120	3.53	0.98	35
	160	3.37	0.89	30

EFFECT OF POTASSIUM SALTS ON CHLOROSIS AND YIELD OF SOYBEANS

D. L. McCallister, R. A. Wiese, and N. J. Soleman

Objective: To evaluate the usefulness of potassium (K) salts in alleviating chlorosis in soybeans (Glycine max, L.). To identify changes in soil properties from the application of K salts which may cause chlorosis to decrease.

Procedure: Two experiments were conducted to address the objectives. In the first experiment, a chlorosis-intolerant soybean cultivar, Nebsoy, was grown in pots in the greenhouse either in a Gibbon silt loam soil (fine-silty, mixed (calcareous), mesic Typic Haplaquoll) or in a mixture of 1:1 Gibbon soil:quartz sand. Treatments were KCl, KNO_3, K_2SO_4, K_2HPO_4 or $KHCO_3$ at rates of 0, 250, or 500 mg K kg^{-1} soil. Plants were rated for chlorosis 5 weeks after planting using a 1 to 6 scale where 1 was normal green and 6 was severely chlorotic with some dead plants. Whole plants were harvested after 6 weeks of growth and analyzed.

A second experiment was conducted at 3 field sites where chlorosis had been documented: a Leshara silt loam (fine-silty, mixed, mesic Cumulic Haplustoll); a Lawet silt loam (fine-loamy, mesic Typic Calciaquoll); and the Gibbon silt loam used in the greenhouse study. Potassium sources, KCl, KNO_3, K_2SO_4, K_2HPO_4, and K_2CO_3, were applied as bands 7 cm to the side and 7 cm below each row at rates of 0, 20, and 40 g K m^{-1} of row. A semi-tolerant soybean variety, Century, was planted at a rate of 40 seeds m^{-1} of row with row spacings of 1.5 m. Only the results from the Leshara site are discussed below.

Results: In general, application of KCl, KNO_3, and K_2SO_4 to the Gibbon soil reduced chlorosis symptoms of soybeans in the greenhouse study. Treatment with K_2HPO_4 and $KHCO_3$ increased chlorosis (Table 1). Similar trends were seen for chlorophyll content of dried leaf tissue. The changes in chlorosis were not associated with dry matter yield, however, because the highest yield was found with one of the K_2HPO_4 treatments (Fig. 1).

In the greenhouse experiment in which plants were grown in a 1:1 soil:sand mixture, almost no chlorosis was observed, despite lower average Fe uptake than from plants grown in soil alone. Plant yield averaged across all treatments was lower in the soil:sand mix than in the soil alone.

Several explanations for the results of the greenhouse study are possible. Neither salinity nor pH of the soil were correlated with plant growth. Some authors have reported a negative relationship between soil K availability and plant P uptake. High P concentrations in the plant can inhibit Fe transport or utilization, thus inducing "Fe deficiency chlorosis" even when total Fe uptake would appear to be adequate. In this experiment, there was a clear inverse relationship between leaf P concentration and leaf Fe concentration (Table 1 and Fig. 2, Gibbon soil). There was, however, no relationship between chlorosis or yield and leaf tissue Fe concentration. Conversion of Fe in the leaves into some physiologically inactive form nevertheless remains a possibility.

Alternatively, increasing the HCO_3- content of the soil solution could immobilize Fe in the plant by alkalinizing the plant cells. Gibbon soil treated with KCl, KNO_3, and K_2SO_4 generally did not produce chlorosis and the soil solution HCO_3- concentrations in these soils were lower than in soil with K_2HPO_4 and K_2CO_3 treatments (Table 2). Similarly, the KCl, KNO_3, and K_2SO_4-treated soil-sand mixtures were low in HCO_3- and plants growing in these mixtures did not exhibit chlorosis. The K_2HPO_4 and $KHCO_3$ treatments were not consistent, however, in that they did not produce chlorosis in the soil-sand mixture, despite elevated HCO_3- concentrations.

The field study demonstrated the same basic relationships among chlorosis, Fe, P, and HCO_3- as did the greenhouse study. Leaf P concentration correlated negatively with chlorophyll concentration (Fig. 3). Soil-applied K_2HPO_4 was not related to plant P concentration, however, and chlorophyll concentrations in plants grown on P treated soils were actually higher than in the untreated control. It is likely that phosphate concentration of the rhizosphere is different from that of the bulk soil and the rhizosphere will influence P uptake by the plant. Leaf Fe concentrations were judged to be adequate and there was no relationship between leaf Fe concentration and chlorophyll concentration.

Several explanations may be proposed for the relationship among HCO_3-, P, and Fe in the soil and plant. One possibility is that applied or natural soil solution HCO_3- increases P availability and this P, after uptake by the plant, makes the plant Fe biochemically less active. A second possibility has to do with the balance between cations and anions taken up by the plant. If cation uptake is in excess of anion uptake, then the plant must balance its internal charge, possibly by excretion of H+, leaving behind the equivalent OH- or organic anions. Table 3 shows that the sum of inorganic cations, C, in the plant tissue ranged from 4.4 to 6.5 times the sum or inorganic anions, A, (where $A = Cl^- + NO_3^- + SO_4^{2-} + H_2PO_4^-$). Generally, as C/A increased, chlorophyll concentration decreased in the leaf tissues (Fig. 4). This could result from high H+ efflux from the roots, decreased rhizosphere pH, and increased P_4 availability. Absorption of P_4 by the plant would then lead to Fe immobilization in the plant. Other authors have suggested that high C/A ratios result in alkalinization of the plant sap and so a reduction in Fe activity. The mechanism is thus similar to that proposed for the pot study.

Potassium chloride, KNO_3, or K_2SO_4 may have some utility as treatments for soybean chlorosis on calcareous soils. These materials would probably find their greatest application in areas with mild chlorosis because their effectiveness is lower than EDDHA which would be considerably more costly.

TABLE 1

Effect of K Sources and Rates on Visual Chlorosis Rating, K Uptake and P Uptake of Soybean Leaves Grown in Gibbon Soil in the Greenhouse

Treatment	K applied mg kg-1					
	250	500	250	500	250	500
	Chlorosis Rating		K Uptake mg pot-1		P Uptake	
Control	2.57		72.8		3.93	
Fe-EDDHA	1.0		71.6		3.40	
KCl	2.5	2.5	50.6	44.1	3.47	2.95
KNO_3	3.0	2.5	71.5	66.4	4.84	4.19
K_2SO_4	2.0	2.0	82.2	61.2	3.92	3.38
K_2HPO_4	3.5	4.0	126.0	105.0	23.10	27.30
$KHCO_3$	3.0	4.0	63.5	80.9	3.15	4.24
LSD(0.05)			24.1		2.65	

TABLE 2

The HCO_3- Concentration (mg kg-1) of Soil Saturation Extract From Both Soils Following Harvest of Plants in the Greenhouse

Treatment	K applied mg kg-1			
	250	500	250	500
	Gibbon Soil		Soil-Sand Mixture	
Control	254		251	
Fe-EDDHA	235		228	
KCl	196	156	153	143
KNO_3	244	265	201	145
K_2SO_4	231	208	150	157
K_2HPO_4	237	266	274	298
$KHCO_3$	279	274	235	275
LSD (0.05)	41.2		37.2	

TABLE 3

Influence of Fe-EDDHA and K Sources and Rates on Inorganic Cation/Anion Ratios (C/A) (cmol P+ or e- kg-1 Dry Weight) or Upper Soybean Leaf Tissues Grown on Leshara Site

Treatment	K Applied (g mg-1 of row)	
	20	40
	C/A	
Control	5.11	
Fe-EDDHA	5.42	
KCl	4.99	6.03
KNO_3	5.69	5.04
K_2SO_4	4.41	5.35
K_2HPO_4	5.01	5.17
K_2CO_3	6.07	6.54

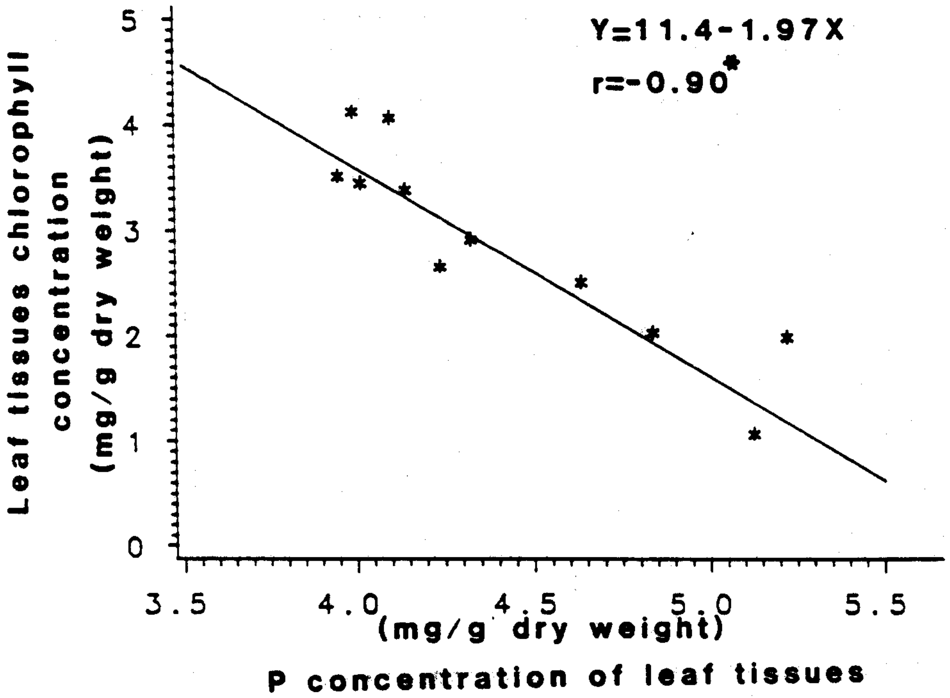

Figure 3. Relationship between P and chlorophyll concentrations in upper soybean leaf tissues from plants grown at Site A.

* Significant at 0.05

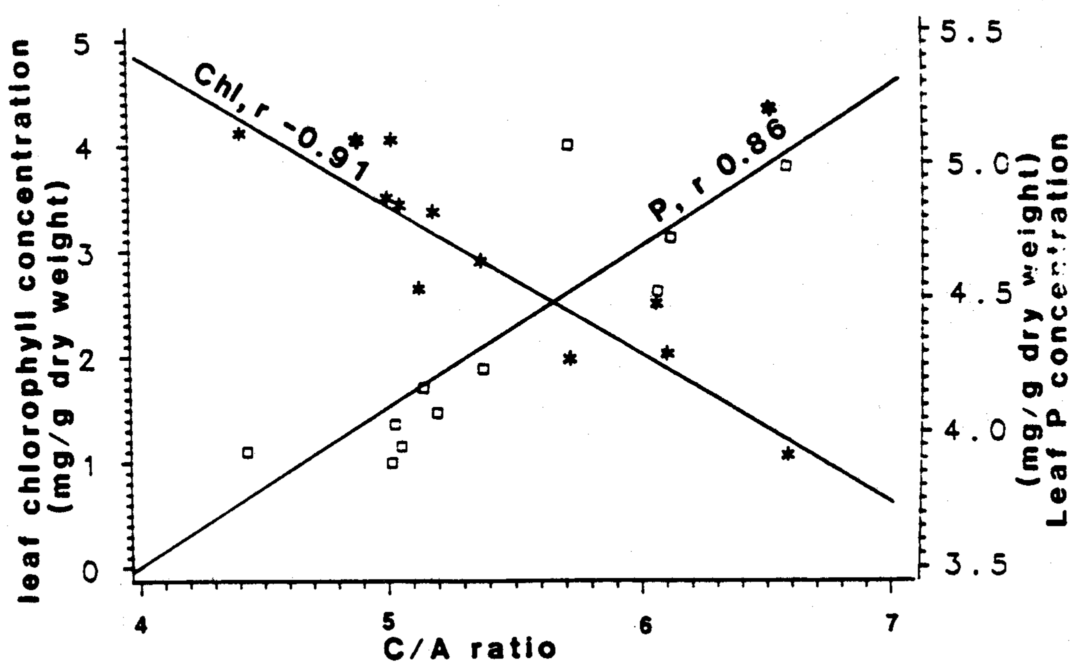

Figure 4. Relationship between cation/anion (C/A) ratio, P and chlorophyll concentrations of upper soybean leaf tissues from Leshara site.

* Significant at 0.05

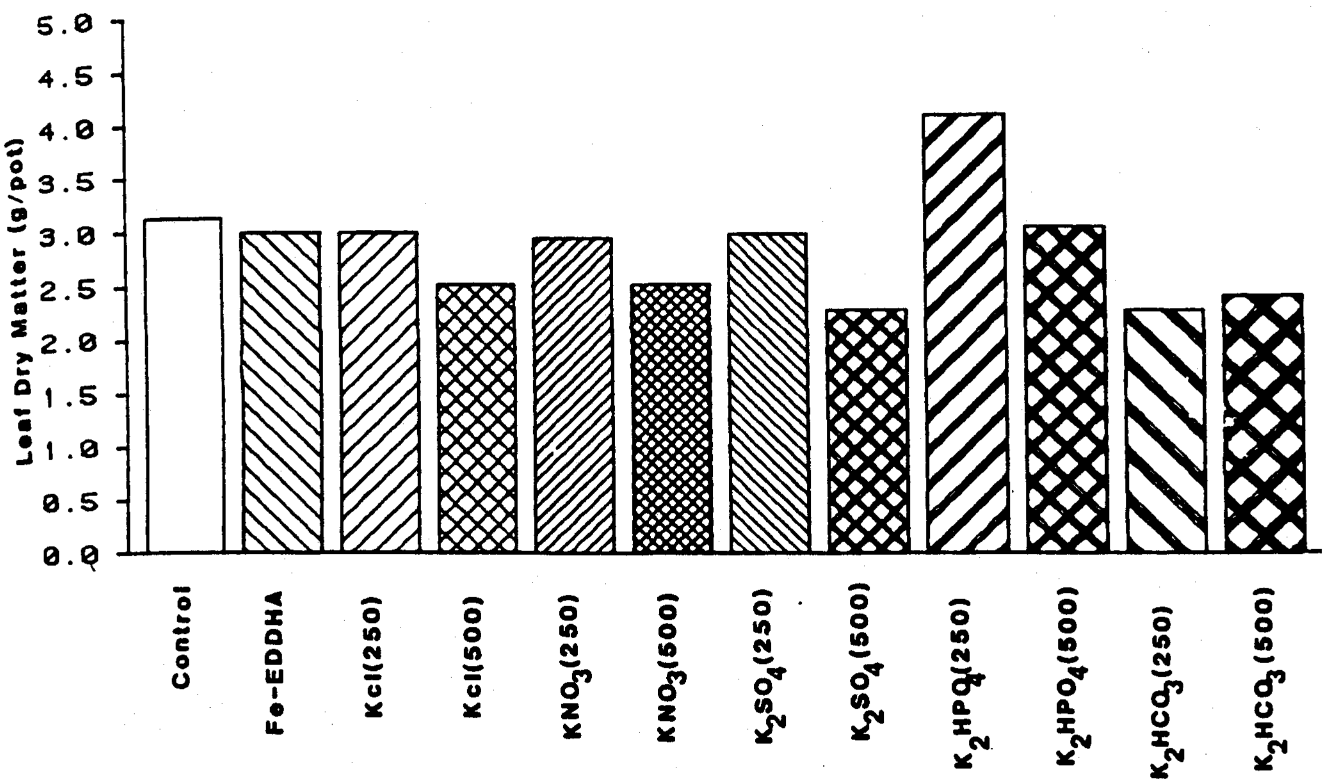

Figure 1. Effect of K sources and rates on leaf dry matter yield of leaves from soybeans grown on Gibbon soil in the greenhouse.

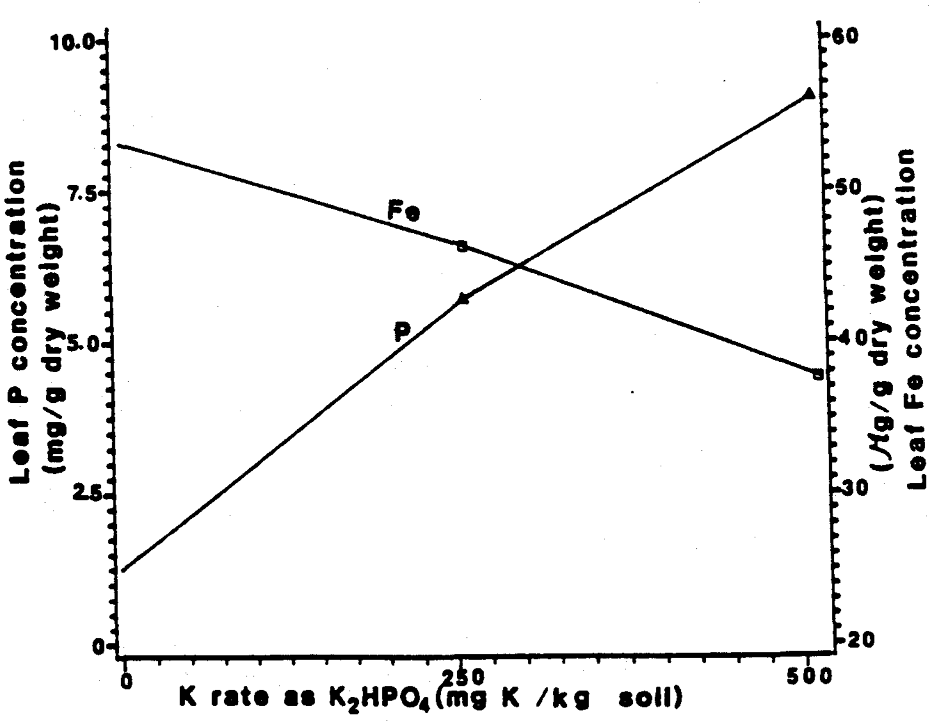

Figure 2. Effect of increasing K application as K_2HPO_4 on P and Fe concentration in soybean leaf tissues grown on Gibbon soil in the greenhouse.

THE EFFECT OF Fe-EDDHA ON SOIL AND PLANT MEASUREMENTS IN CONTROL OF SOYBEAN CHLOROSIS

R. A. Wiese, D. L. McCallister and N. J. Soleman

Introduction: Lime-induced chlorosis in soybeans is defined as the development of iron deficiency like symptoms when plants are grown in calcareous or alkaline soils. It is estimated that as much as 25-30 per cent of the world land surface is calcareous and chlorosis for low tolerance plants may be a crop production problem on these soils (Wallace and Lunt, 1960). Most hypotheses projected to explain the mechanism of chlorosis involve either soil or plant iron systems. No clear understanding of the mechanisms, however, has yet been offered. Some hypotheses offered have been as follows: (a) High pH and excess quantities of lime in soil favor the oxidation of Fe to the less active ferric state (DeKoch, 1956), (b) High soil moisture, poor aeration, and cool temperatures disturb plant metabolism so that Fe is inactivated (Brown et al, 1959), (c) Phosphate may precipitate Fe either in soil or in plant tissue (Wallace and Lunt, 1960), (d) High manganese in soils or plants may oxidize Fe to the less active ferric state (Boxma, 1972), and (e) An unbalanced cation-anion content of plant tissues may lead to disrupted biosynthesis activities with an abnormal accumulation of certain organic acids (Mengel and Geurfzer, 1986).

A common treatment for limiting the potential for chlorosis development in crops has been the use of Fe products. On calcareous soils the addition of Fe-EDDHA as a soil treatment has proven to give the most consistent yield enhancement. Fe-EDDHA effectiveness may be related to its stability in soil pH systems above 7.0 (Norvall, 1972).

Objective:

To determine the influence of Fe-EDDHA on soil and plant properties in order to postulate possible ways in which Fe-EDDHA reduces chlorosis in soybeans.

Procedure: Greenhouse and field experiments were conducted using soybeans as the indicator crop. A soybean intolerant cultivar, Nebsoy, was grown in the greenhouse and a semi-tolerant soybean cultivar, Century was grown in the field. Either a Gibbon silt loam soil (fine-silty, mixed(calcareous), mesic Typic Haplaquoll) or a 1:1 mixture of Gibbon soil: quartz sand provided the growing medium in the greenhouse. In the field Leshara silt loam (fine-silty, mixed, mesic Cumulic Haplustoll) and Lawet silt loam, (fine-loamy, mesic Typic Calciaquoll) were used as the growing medium. Fe-EDDHA was mixed with soil at 5 mg Fe kg^{-1}, and banded at 850 mg Fe-EDDHA m^{-1} row with four replications in the greenhouse and field experiments respectively. A large number of both plant and soil analyses were employed to measure the possible influence of Fe-EDDHA in controlling chlorosis in soybeans. Paired comparisons of the Fe-EDDHA treatment with controls were included in all analyses. In the greenhouse all plant leaves and plant stems were collected at the termination of the experiment and analysed. In the field experiments upper near mature trifoliate leaves and 5 cm by 15 cm cylindrical soil samples through the banded Fe-EDDHA zone were collected for plant and soil analyses respectively. Plant samples were collected 35 days after planting and soil samples were collected 60 days after planting at all field experimental sites.

Results: Various measurements of soil and soybean plant samples with and without Fe-EDDHA application resulted in some statistically significant differences at the 5 percent probability level. Those measurements which resulted in a statistical difference are given in Table 1. The most consistent effect of Fe-EDDHA in three of four experiments was on chlorophyl concentration, or chlorophyll production and the visual chlorosis rating. Seed yields in the field sites increased proportionately to chlorophyll concentration of upper leaves. Nutrient analysis of soybean leaves from the greenhouse experiment showed some enhancement of Fe uptake and concentration and some depression of Mn uptake and concentration from Fe-EDDHA applications. In field experiments NO_3^--N concentration of soybean leaves was increased from the application of Fe-EDDHA.

No soil properties were influenced by Fe-EDDHA application in either greenhouse or in field experiments. Soil measurements included pH, sodium absorption ratio, electrical conductivity, exchangeable K, DTPA extractible Fe, Zn, Mn, Cu, extractible Cu, Cl, NO_3^--N, SO_4^--S, HCO_3^- and saturated soil extracts of K, Na, Ca, Mg, HCO_3^-.

The application of Fe-EDDHA in greenhouse had no effect in changing leaf, dry matter production and uptake or concentration of Cl, K, Ca, Zn, S, P in leaves of soybeans.

The application of Fe-EDDHA in field experiments did not influence the concentration of K, Ca, Mg, Na, Fe, Ca, Zn or Cl in upper leaves of soybean.

Conclusion: No clear effect of Fe-EDDHA could be established to influence the mineral nutrition of soybean plants or affects on soil properties. It would appear that an attempt to identify a direct link or mechanism between Fe-EDDHA and chlorophyll biosynthesis could prove fruitful in future research.

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Table 1. Statistical significant differences in soybean plant and soil measurements resulting from the application of Fe-EDDHA in greenhouse and field experiments.

Measurement	Control	Fe-EDDHA
Greenhouse, Gibbon Soil only, Soybean Leaves[1]		
Chlorosis score[2]	2.7	1.0
Chlorophyll production	7.7	13.0 mg pot^{-1}
Chlorophyll conc.	2.4	4.4 mg g^{-1}
Nutrient uptake, Mn	757	398 mg pot^{-1}
Nutrient conc, Mn	240	129 mg g^{-1}
Mg	7.1	5.9 mg g^{-1}
Fe	53	61 mg g^{-1}
Cu	4.7	7.0 mg g^{-1}
Greenhouse, Gibbon Soil: Quartz Sand Mixture, Soybean Leaves		
Nutrient Uptake, Mn	125	88 mg pot^{-1}
Fe	82	128 mg pot^{-1}
Nutrient conc., Mn	74	51 mg g^{-1}
Fe	45	71 mg g^{-1}
Greenhouse, Gibbon Soil only, Soybean Stems		
Nutrient conc., Mn	38	18 mg g^{-1}
Greenhouse, Gibbon Soil: Quartz Sand Mixture, Soybean Stems		
Dry matter production	1.7	1.0 g pot^{-1}
Nutrient uptake, Mg	3.8	2.4 mg pot^{-1}
S	1.4	1.8 mg pot^{-1}
Cu	4.7	7.0 mg pot^{-1}
Field, Leshara Soil, Soybean Leaves[3]		
Chlorosis rating[3]	2.0	1.0
Chlorophyl Conc.	2.6	5.0 mg g^{-1}
Seed yield	1570	2014 kg ha^{-1}
Nutrient conc. NO_3-N	0.2	0.7 mg g^{-1}
P	4.2	3.8 mg g^{-1}
S	3.5	2.9 mg g^{-1}
Field, Lawet Soil, Soybean Leaves[3]		
Chlorosis rating[2]	4.0	1.0
Chlorophyll conc.	0.9	4.0 mg g^{-1}
Plant weight[4]	11	23 g 10 $plants^{-1}$
Seed yield	556	2287 kg ha^{-1}
Nutrient conc. NO_3-N	0.2	0.6 mg g^{-1}
Mn	117	168 mg g^{-1}

[1] All leaves included in sample.
[2] Chlorosis rating, 1 to 6 based upon degree of yellowing, 1 is normal green.
[3] Top leaves, 2/3 fully developed.
[4] Sampled at 5 weeks after planting.

SOYBEAN VARIETY EVALUATION ON HIGH pH SOIL - 1987 *

E. J. Penas, R. W. Elmore, R. S. Moomaw and G. W. Hergert

Objectives:

1. Evaluate approximately 50 soybean varieties each year to determine their performance under the soil conditions of high pH (7.5 and higher) found in the Platte Valley and similar soils.

2. Evaluate the influence of an iron chelate on chlorosis score and seed yield on about 20 varieties that have shown some tolerance to the soil conditions of the Platte Valley. Two tester varieties will also be included; Century, which has some tolerance and Nebsoy, which has no tolerance to these soils.

3. Determine what soil characteristics contribute to chlorosis in soybeans.

Procedure:

Fifty soybean varieties were planted at four sites (Dawson, Dodge, Merrick and Stanton Counties). At each site, plots were replicated six times except Dodge County where seven replications were planted.

Eighteen varieties were planted without and with EDDHA iron chelate placed in the seed furrow using two and four pounds of material in 20 gallons of water per acre. Sites were located in Colfax and Dawson Counties with six replications at each site.

Each plot was two rows wide (30-inch rows) by 20 feet long except the iron studies. There six row plots were used; two rows each with zero, two, and four pounds of iron chelate per acre.

Each plot was visually rated for green color (1 = normal green color to 5 = extreme chlorosis and 6 = dead plants) eight weeks after planting. Seed yields were harvested from five locations. The site in Merrick County was not harvested because of no evidence of chlorosis.

Experimental Results:

<u>Variety Evaluation Study</u>

Seed yields were harvested from three sites. Chlorosis was slight at all locations. Average seed yields are reported in Table 1. Even though these three sites are different in terms of seed yield level

* This research was supported in part by a grant from the Nebraska Soybean Development, Utilization and Marketing Board.

and there was a site by variety interaction, varieties are different when averaged across these three locations. Yields range from 39 to 53 bushels per acre.

Twenty-seven varieties are in the top group in terms of seed yield (49-53 bushels per acre). Of these, seven varieties are in the test for the first time. The others in the top group have been in the test for two or more years. Century, the standard variety used since the beginning of these studies, was not in the top group. Nebsoy, the tester variety being used, was at the bottom of the mid-group; whereas, Century was near the middle of the mid-group.

The soybean plants were visually scored for chlorosis at eight weeks after planting. Degree of chlorosis was slight in Dawson and Stanton Counties and very slight in Dodge County. This difference in sites did not result in a site by variety interaction. Varieties are different in terms of chlorosis score across the three sites. These data are shown in Table 2. Six varieties were in the top group (1.7 - 1.9); however, only four of these are in the top group in terms of seed yield.

Seed yield is negatively correlated to chlorosis score. This relationship is illustrated in Figure 1. As the degree of chlorosis increases (an increasing chlorosis score), seed yields are decreased.

Dawson County. Chlorosis was slight at this location. Chlorosis score for each variety is shown in Table 3. Sixteen varieties are in the top group (2.0 - 2.3). Seed yields by variety are given in Table 4. Eight varieties are in the top group (65 to 72 bu/ac) in terms of seed yield. Even though the degree of chlorosis was slight, seed yields are negatively correlated with chlorosis score. Figure 2 illustrates the decline in yield as chlorosis increases.

Dodge County. Chlorosis was very slight at this site. Chlorosis scores for each variety are given in Table 5. Only three varieties are in the top group (1.1 - 1.3). Seed yields by variety are shown in Table 6. Twelve varieties are in the top group (46 to 50 bu/ac) in terms of seed yield. Figure 3 shows that even with very slight chlorosis, seed yield of soybeans is reduced as the degree of chlorosis increases.

Stanton County. Chlorosis was slight in this field. Chlorosis scores by variety are listed in Table 7. Thirty-seven varieties are in the top group (2.0 - 2.4). Seed yields for each variety are given in Table 8. Twenty-five varieties are in the top group (43 - 48 bu/ac). Even though chlorosis was slight, twenty varieties that are in the top group in terms of seed yield are also in the top group in chlorosis score. The reduction in yield as influenced by increase in chlorosis is illustrated in Figure 4.

Variety X Iron Chelate Study

Seed yields were harvested from two sites. At Colfax County, chlorosis was very severe; however at Dawson County, chlorosis was slight. Since these two sites are extremely different, data are shown separately for each site.

Colfax County. Table 9 shows the seed yield of eighteen varieties as influenced by iron chelate. The application of four pounds per acre of Fe-EDDHA increased the seed yield from nine bu/ac to 38 bu/ac. Figure 5 illustrates the affect of iron chelate rate on the seed yield of fifteen private varieties. Maximum yield was calculated to occur at 3.5 lbs/ac of Fe-EDDHA; whereas, maximum profit was obtained at 3.1 lbs/ac assuming $6.00/bu for soybeans and $12.00/lb of Fe-EDDHA. Also shown in Table 9 is the difference in varieties, particularly when no iron chelate was applied. Ten varieties were in the top group without iron; whereas, fifteen varieties were in the top group with four pounds/ac Fe-EDDHA applied.

In Table 10, chlorosis scores are listed by variety for each level of applied iron chelate. The application of iron chelate improved chlorosis score greatly. Varieties were greatly different in terms of chlorosis score, especially when no iron chelate was applied. Eleven varieties were in the top group; all of which, except for Century 84, were also in the top group in terms of seed yield. Thirteen varieties were in the top group in terms of color score where four pounds of chelate was applied and all were also in the top group in terms of seed yield.

The relationship of seed yield to chlorosis score is shown in Figure 6. Data points include all eighteen varieties, each at the three rates of applied iron chelate. For each increase of one unit in chlorosis score, seed yield is reduced 11.12 bushels per acre.

Dawson County. The chlorosis score of eighteen varieties planted with three rates of applied iron are listed in Table 11. Chlorosis was not severe in this study; however, varieties were slightly different in terms of chlorosis score. The application of iron did not significantly affect chlorosis score. Seed yields of these eighteen varieties are given in Table 12. Again, varieties are significantly different, but not affected by applied iron. Although chlorosis was slight, there is a significant relationship between chlorosis score and seed yield. This is illustrated in Figure 7.

Summary:

Since this study began in 1980, 154 varieties have been included in field tests. Table 13 lists those varieties that have been included in one or more years. Table 14 gives the seed yields of 31 varieties grown at five sites for two years. All varieties tested in both of these two years were similar in terms of seed yield except for Mead, Century 84 and Nebsoy. Lower yielding varieties are eliminated after the first year of testing for those varieties.

Table 1. Soybean seed yields, bu/ac, of 50 varieties grown at three sites, 1987.

Brand	Entry	Yield	Group
S Brand	S46D	53.5	a
Jacques	J103	52.9	ab
MSR	X532	52.7	abc
Golden Harvest	X277	52.7	abc
Ohlde	2190	52.1	abcd
Golden Harvest	H1285	51.6	abcde
Stine	2330	50.9	abcdef
NC+	2D90+	50.8	abcdefg
Superior	SPB308T	50.7	abcdefgh
Horizon	H21	50.6	abcdefgh
Ohlde	2193	50.5	abcdefghi
Stine	2920	50.5	abcdefghi
S Brand	S44A	50.3	abcdefghi
Profiseed	PS1152	50.2	abcdefghi
Jacques	J231	50.1	abcdefghi
Northrup King	23-03	50.1	abcdefghi
Horizon	H29	49.8	abcdefghij
McCubbin	Taylor	49.8	abcdefghijk
Jacobsen	824	49.7	abcdefghijk
Horizon	H25	49.6	abcdefghijk
Hoegemeyer	200	49.4	abcdefghijk
Dekalb-Pfizer	CX174	49.3	abcdefghijk
S Brand	S47B	49.1	abcdefghijk
Superior	SPB308	49.0	abcdefghijk
Dekalb-Pfizer	CX283	48.7	abcdefghijk
Asgrow	A2187	48.6	abcdefghijk
MSR	Royal	48.6	abcdefghijk
-----	BSR101	48.5	bcdefghijk
McCubbin	Troy	48.4	bcdefghijkl
Northrup King	29-20	48.4	bcdefghijkl
Jacques	J201	48.4	bcdefghijkl
Golden Harvest	X257	48.3	bcdefghijkl
Hoegemeyer	205	47.9	cdefghijkl
NC+	3H49	47.8	cdefghijkl
Lynks	8252	47.5	defghijkl
Jacobsen	771	47.4	defghijkl
-----	Century 84	47.4	defghijkl
Stine	2050+	47.3	defghijkl
Profiseed	PS1350	47.1	defghijkl
Fontanelle	4545	46.7	efghijklm
S Brand	S67	46.5	fghijklm
Asgrow	A3427	45.9	fghijklm
Land O'Lakes	L3145	45.8	ghijklm
-----	Mead	45.7	hijklm
Lynks	8165	45.6	ijklm
Jacobsen	679	44.9	jklm
Pioneer	9181	44.8	klm
-----	Nebsoy	43.5	lm
Fontanelle	X5003	42.0	mn
Pioneer	1082	38.7	n

Table 2. Soybean chlorosis score of 50 varieties grown at three sites, 1987.

Brand	Entry	Score	Group
Jacques	J201	1.7	a
Asgrow	A2187	1.8	ab
Jacques	J103	1.8	ab
Northrup King	23-03	1.8	abc
Jacques	J231	1.9	abcd
Pioneer	9181	1.9	abcde
Dekalb-Pfizer	CX174	1.9	bcdef
S Brand	S46D	1.9	bcdef
Profiseed	PS1152	2.0	cdefg
Horizon	H25	2.0	cdefg
Lynks	8165	2.0	cdefg
Pioneer	1082	2.0	cdefg
S Brand	S44A	2.0	cdefg
Stine	2330	2.0	cdefg
Stine	2920	2.0	cdefg
Superior	SPB308T	2.0	cdefg
Profiseed	PS1350	2.0	cdefg
Superior	SPB308	2.0	cdefg
-----	BSR101	2.1	defgh
Horizon	H29	2.1	defgh
Jacobsen	679	2.1	defgh
Northrup King	29-20	2.1	defgh
Asgrow	A3427	2.1	defghi
Dekalb-Pfizer	CX283	2.1	defghi
Hoegemeyer	200	2.1	defghi
Jacobsen	771	2.1	defghi
Jacobsen	824	2.1	defghi
Lynks	8252	2.1	defghi
McCubbin	Taylor	2.1	defghi
MSR	Royal	2.1	defghi
Horizon	H21	2.1	efghi
Ohlde	2193	2.1	efghi
S Brand	S47B	2.1	efghi
-----	Century 84	2.1	efghij
Fontanelle	4545	2.1	efghij
McCubbin	Troy	2.1	efghij
MSR	X532	2.1	efghij
NC+	2D90+	2.1	efghij
Stine	2050+	2.1	efghij
Golden Harvest	H1285	2.2	fghij
Golden Harvest	X257	2.2	fghij
Golden Harvest	X277	2.2	fghij
NC+	3H49	2.2	fghij
S Brand	S67	2.2	fghij
Hoegemeyer	205	2.2	ghij
Land O'Lakes	L3145	2.2	ghij
Fontanelle	X5003	2.3	hij
-----	Mead	2.3	ij
Ohlde	2190	2.3	j
-----	Nebsoy	2.6	k

Table 3. Soybean chlorosis score eight weeks after planting of 50 varieties grown in Dawson County, 1987.

Brand	Entry	Score	Group
Asgrow	A2187	2.0	a
Jacques	J103	2.0	a
Northrup King	23-03	2.0	a
Jacques	J201	2.1	ab
Jacques	J231	2.2	abc
Dekalb-Pfizer	CX174	2.3	abcd
Pioneer	9181	2.3	abcd
Stine	2920	2.3	abcd
-----	Century 84	2.3	abcde
Asgrow	A3427	2.3	abcde
Horizon	H29	2.3	abcde
Pioneer	1082	2.3	abcde
Profiseed	PS1152	2.3	abcde
S Brand	S46D	2.3	abcde
Stine	2330	2.3	abcde
Superior	SPB308T	2.3	abcde
Golden Harvest	X277	2.4	bcde
Horizon	H25	2.4	bcde
Jacobsen	771	2.4	bcde
Lynks	8165	2.4	bcde
Lynks	8252	2.4	bcde
Ohlde	2193	2.4	bcde
Profiseed	PS1350	2.4	bcde
Superior	SPB308	2.4	bcde
-----	BSR101	2.5	bcde
-----	Mead	2.5	bcde
Dekalb-Pfizer	CX283	2.5	bcde
Fontanelle	X5003	2.5	bcde
Golden Harvest	H1285	2.5	bcde
Golden Harvest	X257	2.5	bcde
Hoegemeyer	200	2.5	bcde
Horizon	H21	2.5	bcde
Jacobsen	824	2.5	bcde
McCubbin	Troy	2.5	bcde
MSR	Royal	2.5	bcde
NC+	2D90+	2.5	bcde
NC+	3H49	2.5	bcde
Northrup King	29-20	2.5	bcde
Ohlde	2190	2.5	bcde
S Brand	S44A	2.5	bcde
S Brand	S67	2.5	bcde
Fontanelle	4545	2.6	cdef
Jacobsen	679	2.6	cdef
McCubbin	Taylor	2.6	cdef
MSR	X532	2.6	cdef
S Brand	S47B	2.6	cdef
Stine	2050+	2.6	cdef
Land O'Lakes	L3145	2.7	def
Hoegemeyer	205	2.8	ef
-----	Nebsoy	2.9	f

Table 4. Seed yield, bu/ac, of 50 soybean varieties grown in Dawson County, 1987.

Brand	Entry	Yield	Group
S Brand	S46D	71.7	a
Jacques	J103	66.5	ab
Stine	2920	66.5	ab
Ohlde	2190	66.3	abc
Golden Harvest	X277	65.6	abcd
Asgrow	A3427	64.9	abcde
Golden Harvest	H1285	64.9	abcde
NC+	2D90+	64.7	abcde
Superior	SPB308T	64.0	bcdef
Horizon	H29	62.8	bcdefg
MSR	Royal	62.8	bcdefgh
Dekalb-Pfizer	CX174	62.6	bcdefghi
Stine	2330	62.5	bcdefghi
MSR	X532	62.5	bcdefghi
McCubbin	Troy	62.0	bcdefghij
NC+	3H49	61.8	bcdefghij
S Brand	S67	61.7	bcdefghij
Jacobsen	824	61.6	bcdefghij
Horizon	H21	61.5	bcdefghij
Ohlde	2193	61.2	bcdefghij
Jacques	J231	61.1	bcdefghij
Horizon	H25	60.7	bcdefghij
Northrup King	23-03	60.7	bcdefghij
S Brand	S44A	60.6	bcdefghij
Asgrow	A2187	60.1	bcdefghij
Jacques	J201	59.9	bcdefghij
Superior	SPB308	59.9	bcdefghij
Profiseed	PS1152	59.8	bcdefghij
Hoegemeyer	200	59.8	bcdefghij
McCubbin	Taylor	59.1	bcdefghijk
Dekalb-Pfizer	CX283	59.0	bcdefghijk
Jacobsen	771	58.9	bcdefghijk
-----	BSR101	58.8	bcdefghijk
Northrup King	29-20	58.7	bcdefghijk
Hoegemeyer	205	58.6	cdefghijk
Stine	2050+	58.3	defghijk
-----	Century 84	58.1	defghijk
Land O'Lakes	L3145	58.0	defghijk
-----	Mead	57.8	defghijk
Lynks	8252	57.7	efghijk
Fontanelle	4545	56.9	fghijk
Fontanelle	X5003	56.8	fghijk
S Brand	S47B	56.6	fghijk
Profiseed	PS1350	55.9	ghijk
Lynks	8165	55.7	ghijk
Pioneer	9181	55.0	hijk
Golden Harvest	X257	54.8	ijk
Jacobsen	679	54.4	jk
-----	Nebsoy	51.6	k
Pioneer	1082	43.4	l

Table 5. Soybean chlorosis score eight weeks after planting of 50 varieties grown in Dodge County, 1987.

Brand	Entry	Score	Group
Asgrow	A2187	1.1	a
Jacques	J201	1.2	ab
Jacques	J231	1.3	abc
Jacques	J103	1.4	bcd
-----	BSR101	1.4	cde
Asgrow	A3427	1.4	cde
Northrup King	23-03	1.4	cde
Northrup King	29-20	1.4	cde
Pioneer	1082	1.4	cde
Dekalb-Pfizer	CX174	1.5	cde
Dekalb-Pfizer	CX283	1.5	cde
Hoegemeyer	200	1.5	cde
Horizon	H21	1.5	cde
Horizon	H25	1.5	cde
Jacobsen	679	1.5	cde
Jacobsen	771	1.5	cde
Jacobsen	824	1.5	cde
Land O'Lakes	L3145	1.5	cde
Lynks	8165	1.5	cde
Lynks	8252	1.5	cde
McCubbin	Taylor	1.5	cde
McCubbin	Troy	1.5	cde
MSR	Royal	1.5	cde
MSR	X532	1.5	cde
NC+	2D90+	1.5	cde
Pioneer	9181	1.5	cde
Profiseed	PS1152	1.5	cde
Profiseed	PS1350	1.5	cde
S Brand	S44A	1.5	cde
S Brand	S46D	1.5	cde
S Brand	S47B	1.5	cde
S Brand	S67	1.5	cde
Stine	2330	1.5	cde
Stine	2920	1.5	cde
Superior	SPB308	1.5	cde
Superior	SPB308T	1.5	cde
-----	Century 84	1.6	de
Golden Harvest	H1285	1.6	de
Golden Harvest	X257	1.6	de
Golden Harvest	X277	1.6	de
Hoegemeyer	205	1.6	de
Horizon	H29	1.6	de
Ohlde	2193	1.6	de
Stine	2050+	1.6	de
Fontanelle	4545	1.6	ef
NC+	3H49	1.6	ef
Fontanelle	X5003	1.8	fg
-----	Mead	1.9	gh
Ohlde	2190	2.0	h
-----	Nebsoy	2.1	h

Table 6. Soybean seed yields, bu/ac, of 50 varieties grown in Dodge County, 1987.

Brand	Entry	Yield	Group
MSR	X532	50.0	a
Golden Harvest	X277	49.4	ab
Jacques	J103	48.3	abc
Golden Harvest	X257	47.2	abcd
Northrup King	23-03	47.1	abcde
Profiseed	PS1152	47.1	abcde
S Brand	S44A	47.0	abcdef
S Brand	S47B	46.5	abcdefg
Hoegemeyer	200	46.4	abcdefg
Stine	2330	46.3	abcdefgh
Ohlde	2193	46.2	abcdefgh
McCubbin	Taylor	45.9	abcdefghi
S Brand	S46D	45.7	bcdefghi
Horizon	H29	45.6	bcdefghi
Horizon	H21	45.6	bcdefghi
NC+	2D90+	45.5	bcdefghi
Golden Harvest	H1285	45.5	bcdefghi
Jacques	J201	45.4	bcdefghi
Horizon	H25	45.4	bcdefghij
Northrup King	29-20	45.4	bcdefghij
Jacques	J231	45.3	bcdefghij
-----	BSR101	45.3	bcdefghij
Superior	SPB308T	45.2	bcdefghijk
Stine	2920	45.1	bcdefghijk
Dekalb-Pfizer	CX283	45.0	cdefghijk
Lynks	8252	44.8	cdefghijk
Superior	SPB308	44.5	cdefghijk
Jacobsen	824	44.1	cdefghijk
Jacobsen	771	44.0	cdefghijk
McCubbin	Troy	43.5	defghijkl
Ohlde	2190	43.2	defghijkl
Asgrow	A2187	43.1	defghijklm
Dekalb-Pfizer	CX174	43.0	defghijklm
Fontanelle	4545	42.9	defghijklm
Hoegemeyer	205	42.9	defghijklm
Stine	2050+	42.8	defghijklm
Pioneer	9181	42.8	defghijklm
-----	Century 84	42.7	efghijklm
Profiseed	PS1350	42.7	efghijklm
MSR	Royal	42.6	fghijklm
NC+	3H49	42.2	ghijklm
-----	Mead	41.8	hijklm
Lynks	8165	41.6	ijklmn
Land O'Lakes	L3145	41.0	jklmn
-----	Nebsoy	40.8	klmn
S Brand	S67	39.2	lmno
Jacobsen	679	38.8	mno
Asgrow	A3427	37.6	no
Fontanelle	X5003	37.6	no
Pioneer	1082	36.7	o

Table 7. Soybean chlorosis score eight weeks after planting of 50 varieties grown in Stanton County, 1987.

Brand	Entry	Score	Group
Jacques	J103	2.0	a
Jacques	J201	2.0	a
Northrup King	23-03	2.1	ab
Pioneer	9181	2.1	ab
S Brand	S44A	2.1	ab
S Brand	S46D	2.1	ab
Dekalb-Pfizer	CX174	2.2	abc
Horizon	H25	2.2	abc
Jacobsen	679	2.2	abc
Lynks	8165	2.2	abc
Profiseed	PS1152	2.2	abc
Asgrow	A2187	2.2	abc
Fontanelle	4545	2.2	abc
Jacques	J231	2.2	abc
McCubbin	Taylor	2.2	abc
Profiseed	PS1350	2.2	abc
Stine	2330	2.2	abc
Superior	SPB308	2.2	abc
Superior	SPB308T	2.2	abc
-----	BSR101	2.3	abc
Dekalb-Pfizer	CX283	2.3	abc
Hoegemeyer	200	2.3	abc
Hoegemeyer	205	2.3	abc
Horizon	H29	2.3	abc
Jacobsen	824	2.3	abc
MSR	Royal	2.3	abc
Northup King	29-20	2.3	abc
Pioneer	1082	2.3	abc
S Brand	S47B	2.3	abc
Stine	2050+	2.3	abc
Stine	2920	2.3	abc
Horizon	H21	2.4	abc
Jacobsen	771	2.4	abc
Lynks	8252	2.4	abc
MSR	X532	2.4	abc
NC+	3H49	2.4	abc
Ohlde	2193	2.4	abc
-----	Mead	2.5	bc
Golden Harvest	H1285	2.5	bc
Golden Harvest	X257	2.5	bc
Land O'Lakes	L3145	2.5	bc
McCubbin	Troy	2.5	bc
NC+	2D90+	2.5	bc
-----	Century 84	2.6	cd
Asgrow	A3427	2.6	cd
Fontanelle	X5003	2.6	cd
Golden Harvest	X277	2.6	cd
Ohlde	2190	2.6	cd
S Brand	S67	2.6	cd
-----	Nebsoy	2.9	d

Table 8. Soybean seed yields, bu/ac, of 50 varieties grown in Stanton County, 1987.

Brand	Entry	Yield	Group
Ohlde	2190	48.2	a
MSR	X532	46.0	ab
Horizon	H21	45.6	abc
Golden Harvest	H1285	45.3	abcd
McCubbin	Taylor	45.0	abcde
Ohlde	2193	44.9	abcde
Stine	2330	44.7	abcde
Jacques	J103	44.7	abcde
Jacques	J231	44.7	abcdef
S Brand	S47B	44.6	abcdef
S Brand	S46D	44.4	abcdef
Profiseed	PS1152	44.3	abcdef
Jacobsen	824	44.2	abcdef
S Brand	S44A	43.9	abcdefg
Superior	SPB308T	43.8	abcdefg
Superior	SPB308	43.6	abcdefg
Asgrow	A2187	43.5	abcdefg
Golden Harvest	X277	43.5	abcdefg
Dekalb-Pfizer	CX174	43.5	abcdefg
Profiseed	PS1350	43.3	abcdefg
Horizon	H25	43.3	abcdefg
Golden Harvest	X257	43.1	abcdefgh
Hoegemeyer	205	43.1	abcdefgh
NC+	2D90+	43.1	abcdefgh
Northrup King	23-03	42.9	abcdefgh
Dekalb-Pfizer	CX283	42.8	bcdefgh
Hoegemeyer	200	42.6	bcdefgh
Jacobsen	679	42.5	bcdefgh
-----	Century 84	42.0	bcdefghi
-----	BSR101	41.8	bcdefghij
Horizon	H29	41.7	bcdefghijk
Northrup King	29-20	41.6	bcdefghijk
Stine	2050+	41.6	bcdefghijk
MSR	Royal	41.3	bcdefghijk
Fontanelle	4545	41.0	bcdefghijk
Stine	2920	40.8	bcdefghijk
McCubbin	Troy	40.6	cdefghijk
Lynks	8252	40.4	cdefghijk
NC+	3H49	40.4	cdefghijk
Jacques	J201	40.2	defghijk
Lynks	8165	40.0	defghijk
Jacobsen	771	39.9	efghijk
S Brand	S67	39.8	efghijk
Land O'Lakes	L3145	39.3	fghijk
-----	Nebsoy	38.7	ghijk
-----	Mead	37.9	hijk
Pioneer	9181	36.9	ijkl
Asgrow	A3427	36.6	jkl
Pioneer	1082	36.5	kl
Fontanelle	X5003	32.3	l

Table 9. Influence of three rates of iron chelate (Fe-EDDHA) on the seed yield (bu/ac) of eighteen soybean varieties grown in Colfax County, 1987.

		Iron Chelate Applied (Fe-EDDHA), lbs/ac			
Brand	Entry	0	2	4	Mean
-----	Century 84	6.3 bcd*	34.8 abc*	38.2 abc*	26.4
-----	Mead	0.2 d	19.5 d	31.5 c	17.1
-----	Nebsoy	0.0 d	0.7 e	6.7 d	2.4
Dekalb-Pfizer	CX283	15.9 ab	40.7 ab	42.1 ab	32.9
Fontanelle	4545	9.4 abcd	30.8 bc	34.3 bc	24.9
Golden Harvest	H1285	2.2 cd	33.7 abc	39.5 ab	25.1
Hoegemeyer	200	11.5 abcd	39.6 abc	42.4 ab	31.1
Hoegemeyer	205	10.2 abcd	32.6 abc	42.5 a	28.4
Jacques	J103	11.9 abcd	36.8 abc	41.4 ab	30.0
McCubbin	Taylor	13.0 abc	38.4 abc	43.6 a	31.7
MSR	Royal	5.4 bcd	35.7 abc	37.9 abc	26.3
NC+	2D90+	6.2 bcd	36.4 abc	38.5 abc	27.0
S Brand	S44A	13.1 abc	41.2 a	45.0 a	33.1
S Brand	S46D	10.9 abcd	36.8 abc	42.7 a	30.1
S Brand	S47B	13.2 abc	30.3 c	41.6 ab	28.4
Stine	2050+	4.5 bcd	30.9 bc	41.8 ab	25.7
Stine	2330	19.6 a	40.4 abc	42.2 ab	34.1
Stine	2920	0.7 d	33.1 abc	38.8 abc	24.2
	Mean	8.6	32.9	38.4	26.6

*Values within individual columns followed by the same letter are not significantly different @ .05.

Table 10. Influence of three rates of iron chelate (Fe-EDDHA) on the chlorosis score of eighteen soybean varieties grown in Colfax County, 1987.

		Iron Chelate Applied (Fe-EDDHA), lbs/ac			
Brand	Entry	0	2	4	Mean
-----	Century 84	4.8 abc*	2.7 abc*	2.2 abc*	3.2
-----	Mead	5.7 cd	3.3 c	2.6 c	3.9
-----	Nebsoy	6.0 d	5.2 d	4.2 d	5.1
Dekalb-Pfizer	CX283	4.2 ab	2.2 ab	1.8 abc	2.8
Fontanelle	4545	4.7 abc	2.9 abc	2.6 c	3.4
Golden Harvest	H1285	5.2 bcd	3.0 abc	2.3 bc	3.5
Hoegemeyer	200	4.6 abc	2.8 abc	2.0 abc	3.1
Hoegemeyer	205	4.2 ab	3.0 abc	2.1 abc	3.1
Jacques	J103	4.3 ab	2.2 ab	1.5 ab	2.7
McCubbin	Taylor	4.4 ab	2.3 ab	2.0 abc	2.9
MSR	Royal	4.9 bcd	3.0 abc	2.2 abc	3.4
NC+	2D90+	4.9 bcd	2.6 abc	2.2 abc	3.2
S Brand	S44A	4.5 ab	2.3 ab	1.7 ab	2.8
S Brand	S46D	4.4 ab	2.4 ab	1.8 abc	2.9
S Brand	S47B	4.2 ab	3.1 bc	2.2 abc	3.2
Stine	2050+	4.9 bcd	3.1 bc	2.3 bc	3.4
Stine	2330	3.6 a	2.3 ab	1.4 a	2.4
Stine	2920	5.0 bcd	2.5 abc	1.8 abc	3.1
	Mean	4.7	2.8	2.2	3.2

*Values within individual columns followed by the same letter are not significantly different @ .05.

Table 11. Influence of iron chelate (Fe-EDDHA) on the chlorosis score of eighteen soybean varieties grown in Dawson County, 1987.

Brand	Entry	Iron Chelate Applied (Fe-EDDHA), lbs/ac			
		0	2	4	Mean
-----	Century 84	2.5 a*	2.5 abcd*	2.4 ab*	2.5
-----	Mead	2.6 a	2.4 abc	2.5 abc	2.5
-----	Nebsoy	3.0 b	2.8 d	2.8 c	2.9
Dekalb-Pfizer	CX283	2.6 a	2.5 abcd	2.4 ab	2.5
Fontanelle	4545	2.7 ab	2.7 bcd	2.5 abc	2.6
Golden Harvest	H1285	2.4 a	2.6 abcd	2.7 bc	2.6
Hoegemeyer	200	2.5 a	2.4 abc	2.5 abc	2.5
Hoegemeyer	205	2.7 ab	2.4 abc	2.5 abc	2.5
Jacques	J103	2.4 a	2.3 ab	2.4 ab	2.4
McCubbin	Taylor	2.5 a	2.7 bcd	2.5 abc	2.6
MSR	Royal	2.6 a	2.4 abc	2.3 a	2.4
NC+	2D90+	2.4 a	2.4 abc	2.5 abc	2.4
S Brand	S44A	2.5 a	2.6 abcd	2.3 a	2.5
S Brand	S46D	2.4 a	2.4 abc	2.5 abc	2.4
S Brand	S47B	2.6 a	2.5 abcd	2.5 abc	2.5
Stine	2050+	2.6 a	2.8 cd	2.6 abc	2.6
Stine	2330	2.6 a	2.6 abcd	2.5 abc	2.6
Stine	2920	2.4 a	2.2 a	2.4 ab	2.4
	Mean	2.6	2.5	2.5	2.5

*Values within individual columns followed by the same letter are not significantly different @ .05.

Table 12. Influence of iron chelate (Fe-EDDHA) on the seed yield (bu/ac) of eighteen soybean varieties grown in Dawson County, 1987.

		Iron Chelate Applied (Fe-EDDHA), lbs/ac			
Brand	Entry	0	2	4	Mean
-----	Century 84	48.5 ab*	48.6 abc*	46.9 bcd*	48.0
-----	Mead	54.0 a	56.8 a	56.8 a	55.9
-----	Nebsoy	44.4 b	43.8 c	44.5 d	44.2
Dekalb-Pfizer	CX283	48.7 ab	51.9 abc	50.4 abcd	50.3
Fontanelle	4545	48.4 ab	49.4 abc	50.1 abcd	49.3
Golden Harvest	H1285	55.6 a	55.7 ab	52.5 abc	54.6
Hoegemeyer	200	51.6 a	53.0 ab	52.0 abcd	52.2
Hoegemeyer	205	52.9 a	50.0 abc	50.7 abcd	51.2
Jacques	J103	52.0 a	49.8 abc	49.6 abcd	50.4
McCubbin	Taylor	55.3 a	50.6 abc	52.5 abc	52.8
MSR	Royal	50.7 ab	53.1 ab	50.4 abcd	51.4
NC+	2D90+	52.6 a	51.6 abc	51.8 abcd	52.0
S Brand	S44A	52.4 a	50.0 abc	50.9 abcd	51.1
S Brand	S46D	53.1 a	49.5 abc	50.9 abcd	51.2
S Brand	S47B	53.0 a	53.3 ab	54.2 ab	53.5
Stine	2050+	52.1 a	51.1 abc	50.2 abcd	51.1
Stine	2330	49.4 ab	47.0 bc	45.9 cd	47.4
Stine	2920	54.8 a	54.2 ab	48.5 bcd	52.5
	Mean	51.6	51.1	50.5	51.1

*Values within individual columns followed by the same letter are not significantly different @ .05.

Table 13. Soybean varieties that have been tested on high pH soils, 1980-87.

Brand	Entry	Brand	Entry	Brand	Entry
-----	Amcor	Fontanelle	F4747	MSR	X532
-----	Amsoy 71	Fontanelle	X5003	MSR	X5557
-----	BSR 101	Funk Seed	12213	NAPB	Exp.9649
-----	Century	Funk Seed	12227	NC+	2A34
-----	Century 84	Golden Harvest	Cherokee III	NC+	2D90
-----	Calland	Golden Harvest	H1233	NC+	2D90+
-----	Corsoy 79	Golden Harvest	H1276	NC+	3H49
-----	Cumberland	Golden Harvest	H1285	New Harvest	270
-----	Elf	Golden Harvest	X257	Northrup King	S23-03
-----	Elgin	Golden Harvest	X277	Northrup King	S2596
-----	Fremont	Golden Harvest	X360	Northrup King	S27-10
-----	Hack	Hoegemeyer	200	Northrup King	S30-31
-----	Harper	Hoegemeyer	205	Northrup King	S4044
-----	Hobbit	Hoegemyer	264	Northrup King	S4501
-----	Lakota	Hoegemeyer	350	Northrup King	X735028
-----	Logan	Hofler	Censoy	Northrup King	S29-20
-----	Mead	Hofler	Gem	Ohlde	2188
-----	Nebsoy	Hofler	Topaz	Ohlde	2190
-----	Pella	Horizon	H21	Ohlde	2193
-----	Platte	Horizon	H25	Ohlde	3000
-----	Wayne	Horizon	H29	Pioneer	1082
-----	Weber	Hy-Vigor	Rotunda	Pioneer	9181
-----	Will	Hy-Vigor	900	Pioneer	9271
-----	Williams	Jacobsen	679	Pioneer	9292
-----	Williams 79	Jacobsen	771	Pride	B216
-----	Williams 82	Jacobsen	824	Pride	B220
-----	Winchester	Jacobsen	799	Profiseed	1152
-----	Zane	Jacques	J-103	Profiseed	1350
Agripro	AP225C	Jacques	J-105	Riverside	4041
Agripro	AP250	Jacques	J-201	S Brand	S44A
Agripro	AP350	Jacques	J231	S Brand	S46D/S47
Americana	Clinton	Jacques	J271	S Brand	S47A
Asgrow	A2187	Land O'Lakes	L2330	S Brand	S47B
Asgrow	A2575	Land O'Lakes	L2456	S Brand	S48
Asgrow	A2680	Land O'Lakes	L3145	S Brand	S50a
Asgrow	A3127	Land O'Lakes	L2665	S Brand	S67
Asgrow	A3427	Land O'Lakes	L4106	SRF	Matsoy
Dekalb-Pfizer	CX174	Land O'Lakes	L4207	Stine	2050/2050+
Dekalb-Pfizer	CX264	Land O'Lakes	Exp.79-1746	Stine	2330
Dekalb-Pfizer	CX283	Land O'Lakes	Exp.79-3068	Stine	2920
Dekalb-Pfizer	CX290	Latham	650	Stine	3500
Dekalb-Pfizer	CX324	Latham	1010	Stock Seed	SS462A
Dekalb-Pfizer	CX350	Lynks	8165	Stock Seed	SS500
Diamond	Eagle	Lynks	8252	Stock Seed	SS793
Diamond	D220	McCubbin	EXP.40510	Superior	SPB289
Diamond	D310	McCubbin	Taylor	Superior	SPB308
Diamond	83-32	McCubbin	Troy	Superior	SPB308T
Diamond	TC204A	Midwest Oilseeds	328	Superior	SPB340
Ferry Morse	GT1310	Midwest Oilseeds	397	Superior	X250
Ferry Morse	GT1380	MSR/Agri-gold	Royal	Valley	778
Fontanelle	F4545	MSR/Agri-gold	Royal II	Valley	1178
Fontanelle	F4646				

Table 14. Soybean seed yields, bu/ac, of 31 varieties grown at five sites, 1986-87.

Brand	Entry	Yield	Group
S Brand	S46D	47.6	a
NC+	2D90+	47.0	ab
-----	BSR101	47.0	ab
Horizon	H29	46.8	ab
Asgrow	A2187	45.9	ab
Jacques	J103	45.7	ab
McCubbin	Troy	45.5	ab
Golden Harvest	H1285	45.1	ab
McCubbin	Taylor	45.1	ab
Ohlde	2193	44.8	ab
Hoegemeyer	200	44.5	ab
Jacques	J231	44.3	ab
Dekalb-Pfizer	CX283	44.2	ab
S Brand	S47B	44.1	ab
S Brand	S44A	44.0	ab
Northrup King	S29-20	43.8	ab
Stine	2050+	43.7	ab
Stine	2330	43.6	ab
MSR	Royal	43.5	ab
Superior	SPB308	43.4	ab
Stine	2920	43.3	ab
Profiseed	PS1152	42.9	ab
Hoegemeyer	205	42.7	ab
Horizon	H25	42.7	ab
Asgrow	A3427	42.2	ab
Profiseed	PS1350	42.1	ab
Fontanelle	4545	41.9	ab
Northrup King	S23-03	41.6	ab
-----	Mead	40.4	b
-----	Century 84	40.2	b
-----	Nebsoy	29.7	c

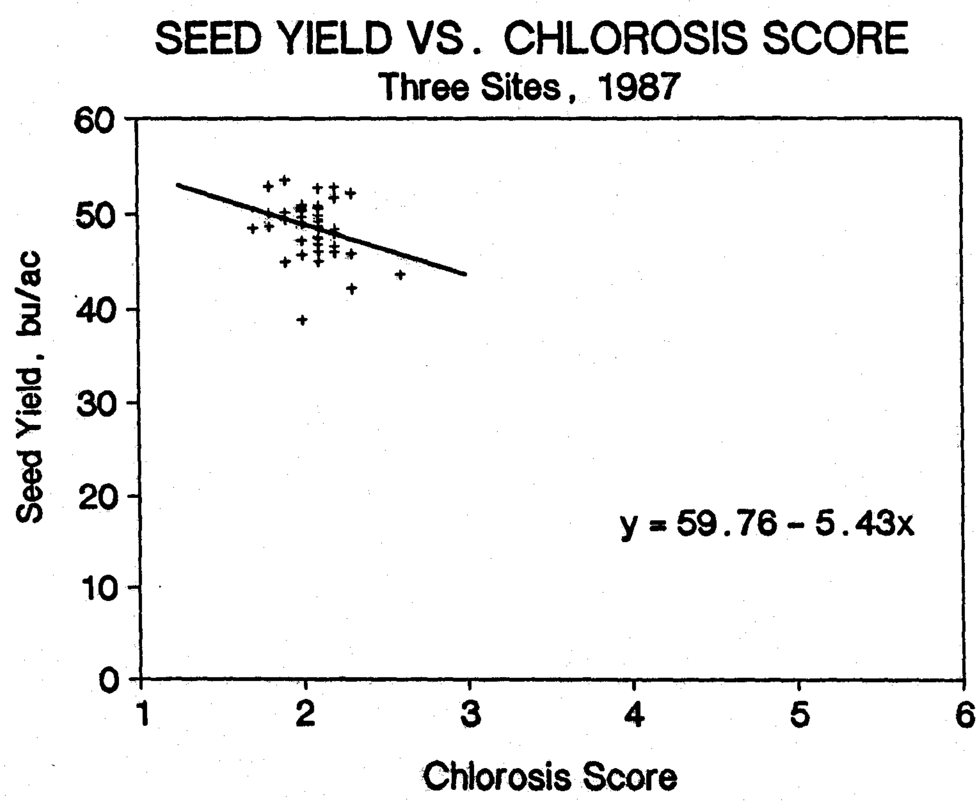

Figure 1. Relationship of seed yield to chlorosis score eight weeks after planting for 50 soybean varieties grown at three sites, 1987.

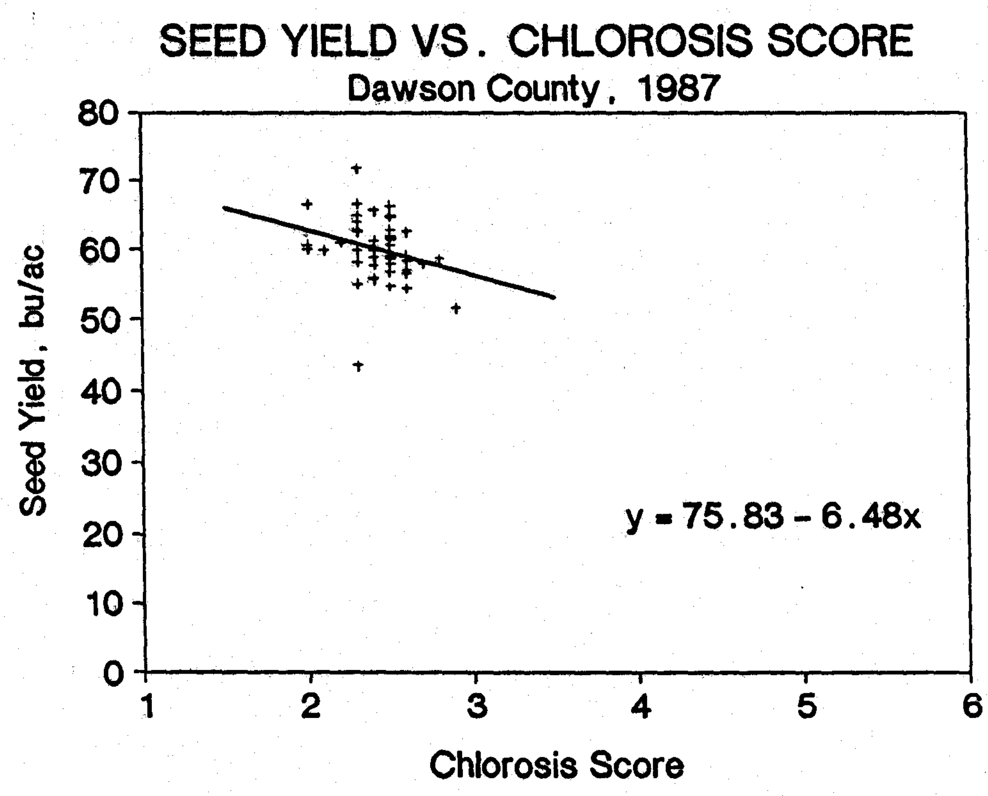

Figure 2. Relationship of seed yield to chlorosis score eight weeks after planting for 50 soybean varieties grown in Dawson County, 1987.

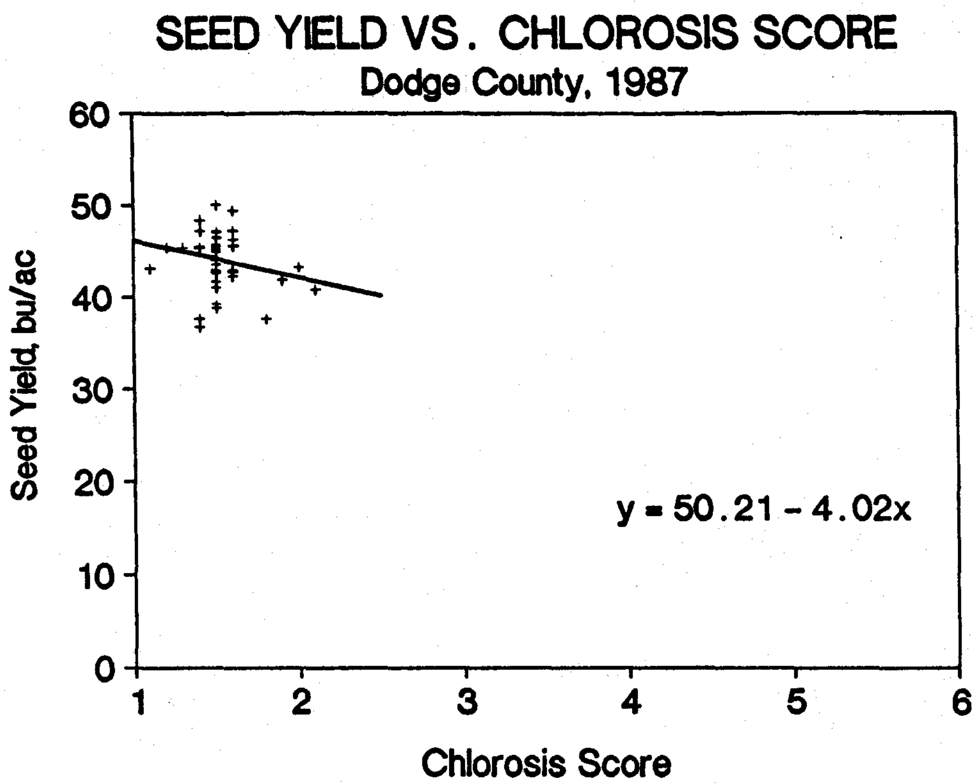

Figure 3. Relationship of seed yield to chlorosis score eight weeks after planting for 50 soybean varieties grown in Dodge County, 1987.

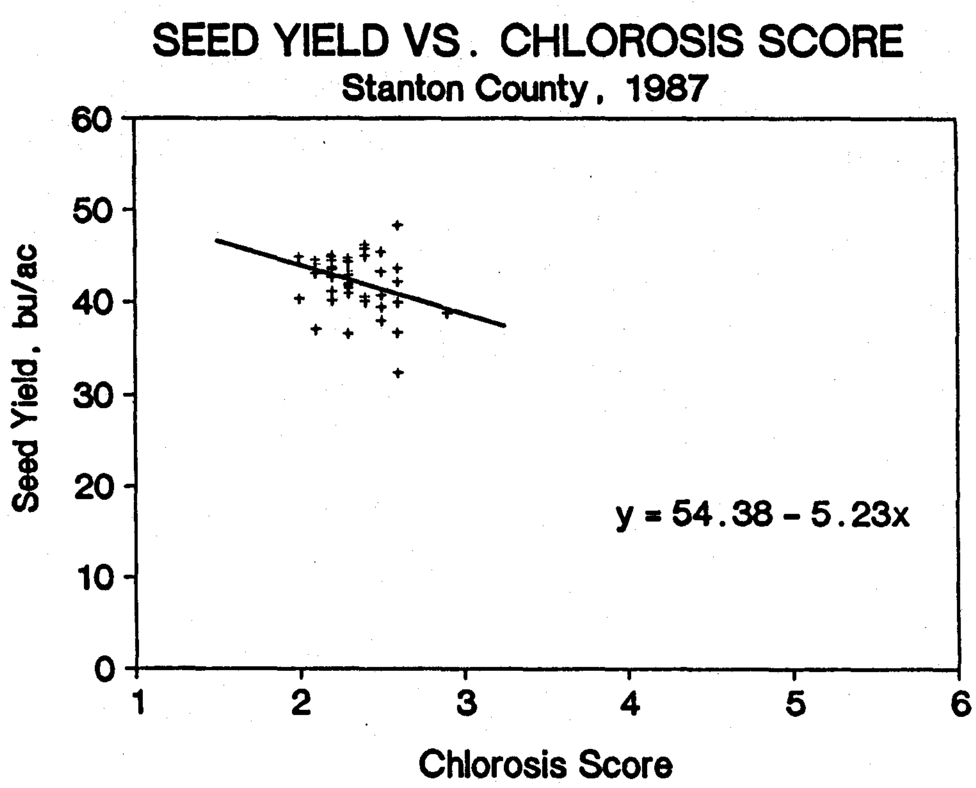

Figure 4. Relationship of seed yield to chlorosis score eight weeks after planting for 50 soybean varieties grown in Stanton County, 1987.

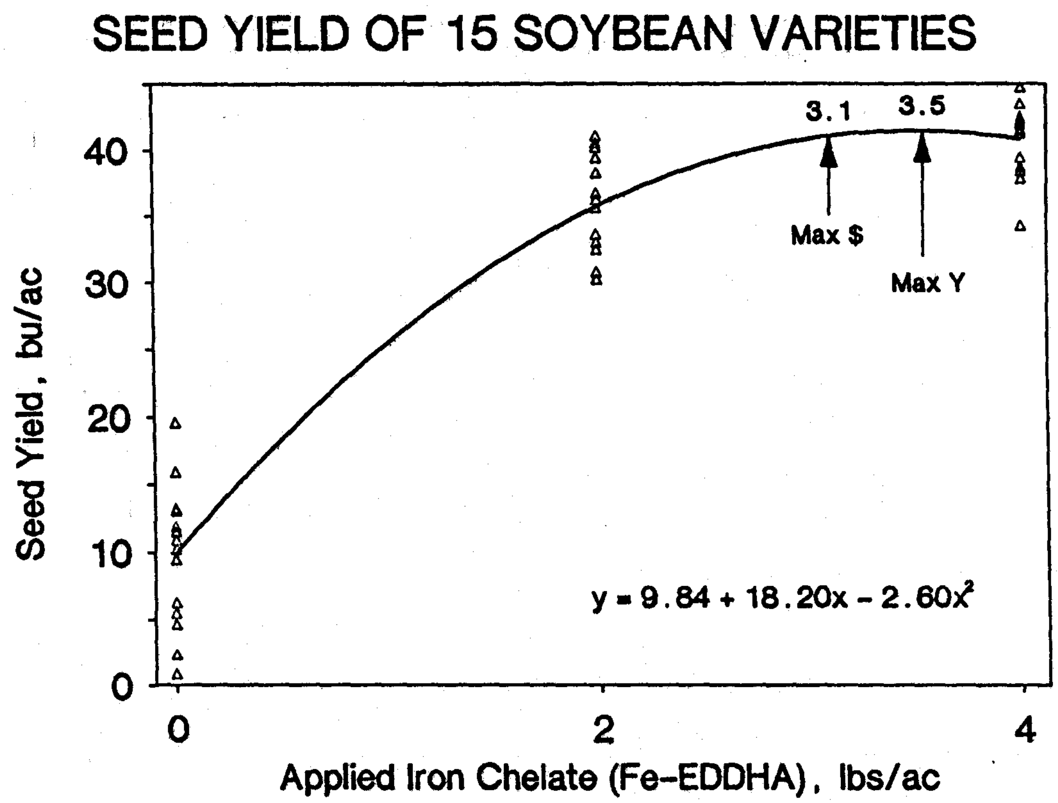

Figure 5. Influence of iron chelate (Fe-EDDHA) on the seed yield of fifteen soybean varieties grown in Colfax County, 1987.

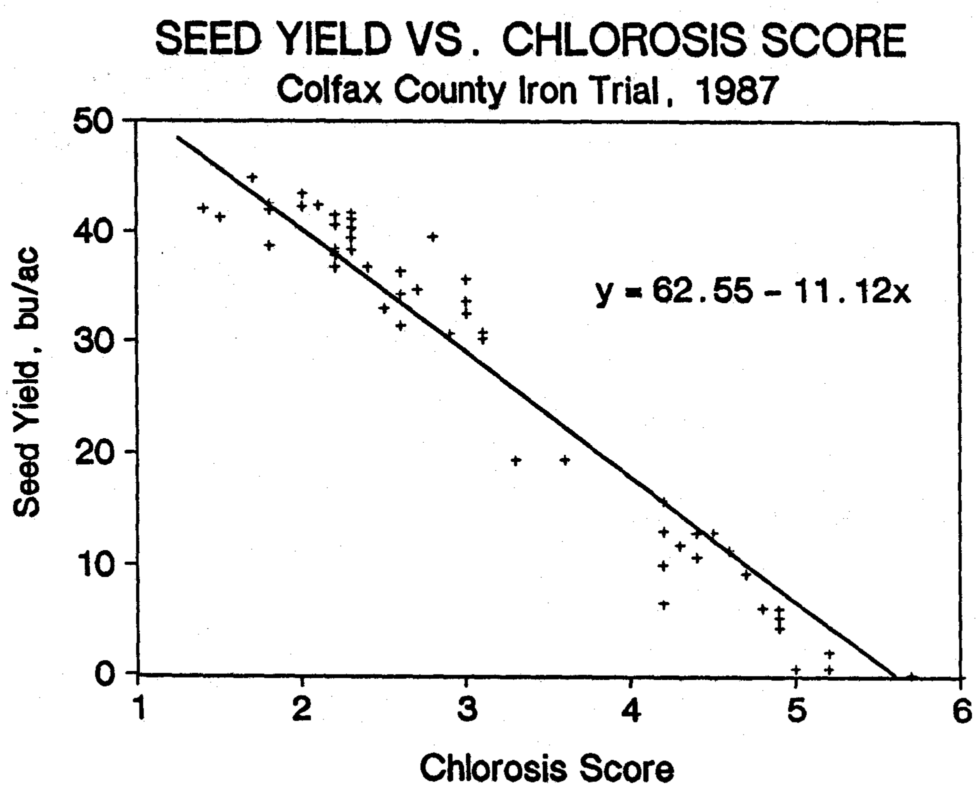

Figure 6. Relationship of seed yield to chlorosis score eight weeks after planting for eighteen soybean varieties grown with three rates of iron in Colfax County, 1987.

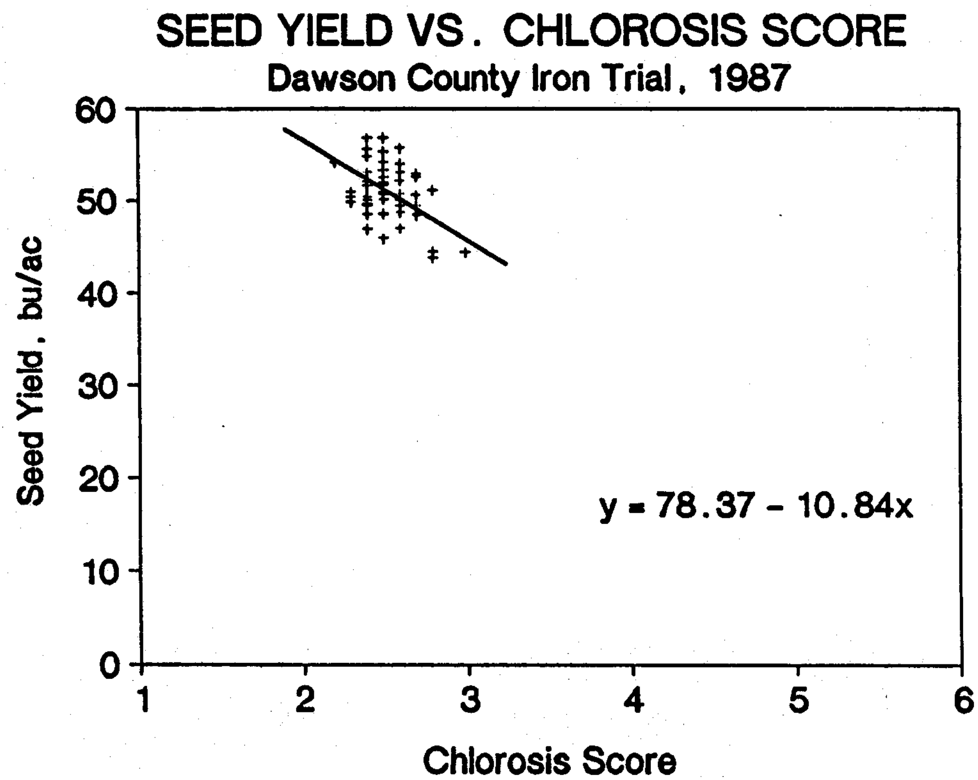

Figure 7. Relationship of seed yield to chlorosis score eight weeks after planting for eighteen soybean varieties grown with three rates of iron in Dawson County, 1987.

Effect of Broadcast Phosphorus on P Response of Ridge-Planted Corn

Gary W. Hergert

Objectives:

1. Determine the broadcast P rate needed to obtain maximum yield of corn on a low phosphorus Cozad silt loam.

2. Determine the effect of annual applications of P on yield response and influence on soil P level.

Procedure:

More ridge-till planted corn is being planted in central and southwest Nebraska every year. Since there is very little tillage in this system one might assume that broadcast phosphorus would be a poor method for correcting phosphorus deficiency. A field at the WCREC has been in continuous no-till corn production about 20 years. An area in the field was identified with a phosphorus level of 6 ppm Bray-1 P. A phosphorus recommendation depending upon which soil test is used would be somewhere between 40 to 80 pounds of broadcast phosphorus per acre annually according to our current NebGuide on fertilizer suggestions for corn. The phosphorus level in the sub soil was low (4 ppm Bray-1 P) but uniform throughout the plot area.

In the spring of 1985 a P rate study was designed as a five by five Latin Square. P rates were 0, 25, 50, 75, and 100 pounds of P_2O_5 per acre. Plots were 60 feet long by eight-30 inch rows wide. 0-46-0 was broadcast with 180 pounds of N as ammonium nitrate after corn stalks were chopped. Corn was planted with a four row Buffalo till planter. This planter takes off about 5 inches of the ridge by splitting it into the old row covering the chopped corn residue. In all three years the only operation after planting was a ditching the first part of July. In the spring of 1986 the plots were split and half of the plots received an annual application of the P rate.

The first P application did increase soil test levels, but all were below 15 ppm Bray-1 P in the spring of 1986 (Table 1).

The grain yield data for the three years showed that an annual P rate of 50 pounds per acre maximized and maintained the yield. The initial 100 pound application maximized yield in 1985 and 1986 but did not produce maximum yield in 1987. Yield levels are very high and P removal ranges from 20 to 40 pounds P/A in the grain. Phosphorus in the grain was determined in 1985 and 1987. Analyses for 1986 have not been completed yet. The research does show that broadcasting in this minimum tillage system with recommended rates of phosphorus was an effective method for correcting phosphorus deficiency.

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Table 1. Soil analysis of Cozad silt loam after one P application - spring 1986.

lbs P_2O_5/A	Bray-1 P	Olsen P
0	5.8	3.0
25	7.6	3.9
50	10.9	5.4
75	11.4	6.0
100	13.5	7.0

Table 2. Effect of P rate on grain yield.

P rate	1985	1986	1987	Avg.	Relative Y
	-----------bu/A----------				%
Check	145	173	194	171	81
25	160	192	194	182	86
25 annual	---	207	218	195	92
50	178	213	203	198	93
50 annual	---	218	207	208	98
75	180	216	206	201	95
75 annual	---	220	230	210	99
100	186	219	217	207	98
100 annual	---	220	230	212	100

Table 1. Effect of method and rate of P application on winter wheat yield and P uptake. Saline Co. 1987 (Location 87-8).

Parameter		Yield			P uptake		
		Grain	Straw	Total	Grain	Straw	Total
		-------- Mg ha^{-1} --------			------- kg ha^{-1} ----		
Method of P Application							
Seed		3.47	4.92	8.39	17.4	4.5	21.9
Knife		2.96	4.29	7.25	14.5	3.8	18.3
Broadcast		3.10	4.26	7.36	15.8	3.7	19.5
P Rate kg ha^{-1}							
0		2.90	3.92	6.81	14.0	3.6	17.6
9		2.89	4.20	7.09	14.0	3.8	17.8
18		3.24	4.48	7.72	16.3	3.9	20.2
27		3.41	4.79	8.20	17.4	4.4	21.8
Method x Rate							
Seed	9	3.30	4.62	7.92	15.9	4.1	20.0
	18	3.51	4.96	8.47	17.7	4.6	22.3
	27	3.61	5.18	8.80	18.4	4.9	23.3
Knife	9	2.69	3.92	6.61	12.6	3.8	16.3
	18	2.95	4.22	7.17	14.6	3.4	18.1
	27	3.25	4.72	7.97	16.2	4.3	20.6
Broadcast	9	2.68	4.06	6.75	13.4	3.5	16.9
	18	3.25	4.25	7.51	16.5	3.7	20.1
	27	3.37	4.46	7.83	17.6	4.0	21.6
Analyses of Variance							
Method		.01	.01	.01	.01	.01	.01
Rate		.01	.01	.01	.01	.03	.01
Linear		.01	.01	.01	.01	.03	.01
Quadratic		NS	NS	NS	.17	NS	NS
Rate x Method		NS	NS	NS	NS	NS	NS

EFFECT ON NITROGEN RATE, APPLICATION TIMING AND MEFLUIDIDE APPLICATION ON BROMEGRASS YIELD

Charles A. Shapiro, Bruce Anderson, and Russell Moomaw

OBJECTIVE:

Bromegrass produces most of its growth in the spring. During the hot summer months bromegrass loses its palatability and other feed is needed for cattle on pasture. Warm season grasses are recommended to fill forage needs between the spring and fall growth of bomegrass. Mefluidide is a growth regulator that suppresses seed head production in cool season grasses. The objective of this study was to determine the effect of nitrogen fertilizer rate and application timing and the use of mefluidide on bromegrass growth.

PROCEDURE:

The experiment was conducted in Dixon County in 1985 and 1986 on an Alcester silt loam soil (Cumulic Haplustoll, fine-silty, mixed, mesic) with a 2-6% slope. Soil analysis indicated the soil had 3.8 % organic matter, pH ranged from 6.3 to 7.9, Bray and Kurtz #1 ranged from 6-10 ppm and extractable potassium was between 231 and 264 ppm. A factorial arrangement of nitrogen rate and time of application treatments were included in the design. All these treatments had mefluidide applied to them at 1.25 lb AI per acre. Control treatments without mefluidide but with the same application timings and nitrogen rates were also included although this part of the experiment was not a complete factorial. A list of the treatments is included in Table 1. Nitrogen was applied as ammonium nitrate and spread by hand. Phosphorus (0-45-0) was applied according to soil test recommendations across the experimental area with a 12 ft wide Gandy applicator at the rate of 24 lbs P_2O_5 per acre each year.

Three nitrogen applications were applied on 18 April, 2 May, 17 May and 4 April, 2 May, 21 May in 1985 and 1986, respectively. Harvest dates were 5 May, 19 July, 3 October and 15 May, 16 June, 11 August in 1985 and 1986, respectively. Harvest was accomplished with a Carter Forage Harvester. Plots were 5 ft wide and 16 ft long. The Harvester cut a 3 ft wide strip the length of the plot. Alleys were cut 2 ft on either side of the plot border before harvest. Subsamples were taken for moisture determination and forage quality analysis. All weights are reported as 100% dry matter. Nutrient analysis was conducted on all samples. Only dry matter results will be reported at this time.

RESULTS AND DISCUSSION:

The yield results by cutting and season are shown in table 1 and table 2. They are presented in two tables since the effect on the control may be cumulative for the second year. Nitrogen application increased yields in both years. When mefluidide was applied in 1985 maximum yield was achieved at 80 lbs N per acre. Without mefluidide the 120 lbs N rate produced maximum yields. In 1986 the 120 lbs N produced maximum yields for both the mefluidide and no mefluidide treatments.

Mefluidide decreased yields when similar nitrogen rates and timings were compared. One of our objectives was to determine if mefluidide application would distribute dry matter production so that more dry matter was produced during the summer when bromegrass is normally dormant. Increasing production in the summer would have value even when spring production and total production are decreased since summer production is the limiting factor in carrying capacity. The value of the change in time of production is dependent on the nutrient and quality value of the forage produced. The analysis of this aspect of the experiment is incomplete at this point.

Table 1. Effect of mefluidide application, nitrogen rate and time of nitrogen application on bromegrass dry matter yield. 1985.

Mefluidide+	Fertilizer Application 4-18	5-2	5-17	Trt#	Harvest Dates 5-20	7-19	10-3	Total Harv.	Percent of Harvest in Summer
	lbs/acre								%
1	40	0	0	1	2102	236	194	2532	17.0
1	80	0	0	2	1951	348	447	2746	28.9
1	120	0	0	3	1913	437	692	3042	37.1
1	0	40	0	4	1306	349	252	1906	31.5
1	0	80	0	5	1778	559	609	2946	39.6
1	0	120	0	6	1879	1069	778	3726	49.6
1	0	0	40	7	1296	374	327	1997	35.1
1	0	0	80	8	1075	835	639	2550	57.8
1	0	0	120	9	1235	1283	911	3429	64.0
1	20	20	0	10	2005	182	324	2511	20.2
1	20	0	20	11	1696	180	292	2167	21.8
1	0	20	20	12	1465	354	376	2195	33.3
1	40	40	0	13	2127	323	365	2815	24.4
1	40	0	40	14	2419	674	449	3543	31.7
1	0	40	40	15	1476	833	519	2828	47.8
1	60	60	0	16	1916	725	557	3197	40.1
1	60	0	60	17	2799	809	720	4328	35.3
1	0	60	60	18	1549	890	913	3352	53.8
1	0	0	0	19	1737	28	87	1852	6.2
0	0	0	0	20	1855	111	126	2092	11.3
0	40	0	0	21	3162	229	331	3722	15.0
0	80	0	0	22	3992	189	383	4564	12.5
0	120	0	0	23	3917	258	471	4646	15.7
0	0	40	0	24	2115	209	221	2546	16.9
0	0	80	0	25	2130	634	458	3222	33.9
0	0	120	0	26	2699	850	685	4234	36.3
0	20	0	20	27	2528	266	303	3097	18.4
0	40	0	40	28	3360	413	454	4227	20.5
0	60	0	60	29	3630	437	728	4796	24.3
LSD 0.05					877	192	192	940	

+Applied at 0.25 lbs AI/acre; 1 = Applied, 0 = Not applied

Table 2. Effect of mefluidide application nitrogen rate and time of nitrogen rate and time of nitrogen application on bromegrass dry matter yield. 1986.

Mefluidide+	Fertilizer Application 4-8	5-2	5-21	Trt#	Harvest Dates 5-15	6-18	8-11	Total Harv.	Percent of Harvest in Summer
	----------lbs/acre----------								----%----
1	40	0	0	1	653	605	326	1584	20.6%
1	80	0	0	2	881	888	405	2175	18.6%
1	120	0	0	3	840	799	396	2035	19.4%
1	0	40	0	4	338	931	303	1572	19.3%
1	0	80	0	5	387	1371	368	2127	17.3%
1	0	120	0	6	524	1927	385	2836	13.6%
1	0	0	40	7	209	810	322	1341	24.0%
1	0	0	80	8	227	1149	432	1807	23.9%
1	0	0	120	9	290	1272	752	2314	32.5%
1	20	20	0	10	520	627	262	1408	18.6%
1	20	0	20	11	478	665	321	1464	22.0%
1	0	20	20	12	259	913	294	1466	20.1%
1	40	40	0	13	725	825	336	1886	17.8%
1	40	0	40	14	786	1221	394	2402	16.4%
1	0	40	40	15	367	1353	332	2052	16.2%
1	60	60	0	16	894	1011	389	2293	16.9%
1	60	0	60	17	882	1201	450	2533	17.7%
1	0	60	60	18	389	1322	489	2200	22.2%
1	0	0	0	19	163	330	293	787	37.2%
0	0	0	0	20	314	429	320	1063	30.1%
0	40	0	0	21	1348	513	300	2160	13.9%
0	80	0	0	22	1527	598	365	2491	14.7%
0	120	0	0	23	2069	751	484	3305	14.6%
0	0	40	0	24	570	791	281	1642	17.1%
0	0	80	0	25	781	1119	291	2190	13.3%
0	0	120	0	26	802	1401	381	2584	14.7%
0	20	0	20	27	771	719	294	1784	16.5%
0	40	0	40	28	1229	1047	325	2600	12.5%
0	60	0	60	29	1548	934	583	3065	19.0%
LSD 0.05					208	298	129	444	

+Applied at 0.25 lbs AI/acre; 1 = Applied, 0 = Not applied

EFFECT OF N SOURCE AND RATE ON WHEAT YIELD

D. H. Sander

Objective: To determine the performance of common N fertilizer sources for wheat.

Procedures: An experiment was established in Saline County in 1986 which involved three N sources - ammonia, urea, and UAN (urea ammonium nitrate) at four rates of application (33, 67, 100, 133 kg N ha^{-1}). A check or ON treatment was included along with an ammonium nitrate rate of 67 kg N ha^{-1} for comparison purposes. The ammonia was knifed in 30 cm spacings in the fall prior to seeding. Other N sources were topdressed in the spring. Yields were harvested from two rows 30 cm apart and 3 meters long.

Results and Discussion: Applied N increased grain and straw yields primarily with with ammonia (Table 1). Urea and UAN lacked the consistancy of NH_3. This consistancy is shown by the significant interaction between N source and rate for both the straw and total straw and grain production. Straw and total production increased up to about the 100 kg ha^{-1} N rate for NH_3 compared to essentially no effect of urea or UAN on yield from 33 to 133 kg N ha^{-1}.

Table 1. Effect of N source and rate on wheat yield. Saline Co. 1987.

Parameter		Yield		Harvest
	Grain	Straw	Total	Index
		Mg ha^{-1}		
NH_3	3.42	4.50	7.92	43.2
Urea	3.22	4.21	7.39	42.2
UAN	3.11	4.08	7.30	44.1
N Rate kg N ha^{-1}				
0	3.14	4.00	7.15	43.9
33	3.29	4.14	7.43	44.2
67	3.33	4.19	7.61	43.7
100	3.13	4.28	7.32	42.7
133	3.26	4.45	7.76	42.2
Source x Method				
NH_3 33	3.09	3.98	7.07	43.7
67	3.45	4.43	7.88	43.8
100	3.54	4.84	8.38	42.2
133	3.63	4.85	8.48	42.7
Urea 33	3.57	4.28	7.85	45.5
67	3.22	4.05	7.27	44.4
100	3.02	3.91	6.93	43.6
133	3.09	4.07	7.16	43.1
UAN 33	3.22	4.15	7.37	43.5
67	3.31	4.41	7.71	42.6
100	2.95	3.98	6.93	42.0
133	3.00	4.40	7.63	40.5
NH_4NO_3 67	3.14	4.23	7.37	42.0
Analysis of Variance				
N Source	.12	.02	.06	.01
N Rate	NS	NS	NS	.04
Source x Rate	NS	.09	.12	NS

EFFECT OF PHOSPHORUS APPLICATION RATE AND METHOD ON SOYBEAN YIELD

Charles A. Shapiro, Richard Ferguson, and Don Sander

OBJECTIVE: Soybeans are not highly responsive to phosphorus application when applied either broadcast or in the row at planting. Soils testing above 9 ppm Bray and Kurtz #1 do not usually respond to applied phosphorus. However, most of this data has been collected using conventional tillage procedures. As more producers adapt to planting in crop residue, information is needed to determine if soybeans will respond to phosphorus under reduced tillage conditions. In addition, knifing phosphorus deep in the soil is gaining popularity in corn production. There is little information documenting this procedure in soybean production. The objective of these experiments is to determine the effect of rate and method of phosphorus application on soybean yield in conventional and reduced tillage cropping systems.

PROCEDURE: The experiment was conducted at Clay Center and in Dixon County in 1987. The reduced tillage component was not included in 1987. The experiment was a factorial arrangement of three application methods: preplant banding at 15 in., preplant broadcast, and at-planting row application. The phosphorus rates used were 0, 18, 37, 55, and 74 lbs P_2O_5 per acre. The phosphorus source was 10-34-0. All treatments received a total of 21 lbs nitrogen per acre. Urea-ammonium nitrate solution (28-0-0) was used to balance the nitrogen applied.

RESULTS AND DISCUSSION: At the Dixon site, where soil phosphorus levels were very low, soybeans responded to applied phosphorus (Table 1). Yields were the same for the knife and broadcast treatments. The at-planting row applied yields were reduced. This was due to the method of application. The available equipment placed the fertilizer too close to the seed. This caused reduced stand in some at-planting treatments. At Clay Center, where soil phosphorus levels were higher, soybeans did not respond to applied phosphorus or method of application.

Table 1. Effect of phosphorus rate and placement on soybean yields. 1987. Cedar Ct.*

Method+	Rate++ (lbs P_2O_5/acre) 0	18	37	55	74
	bu/acre				
At-planting	-	31.6	33.0	35.0	37.7
Knife	33.0	36.7	38.3	37.5	38.9
Broadcast	32.2	34.4	39.0	37.2	38.7
Mean	32.6	34.2	36.7	36.6	38.4

* Crofton silt loam, Bray #1 = 5; Olsen-P = 5; Organic matter = 1.1%; K = 119; ZN = .72
+ Application method PR>F = 0.07
++ Phosphorus rate PR>F = 0.03
CV = 13%

Table 2. Effect of phosphorus rate and placement on soybean yields. 1987. South Central Research and Extension Center.*

Method+	Rate++ (lbs P_2O_5/acre) 0	18	37	55	74
	bu/acre				
At-planting	-	35.3	35.8	35.8	35.5
Knife	36.2	31.3	37.2	35.9	36.9
Broadcast	36.2	36.9	36.9	33.7	35.9
Mean	36.2	36.0	36.7	35.1	36.1

* Butler silt loam, Bray #1 = 12
+ Application method PR>F = 0.41
++ Phosphorus rate PR>F = 0.24
CV = 5.2

EFFECT OF PHOSPHORUS APPLICATION METHOD AND RATES ON IRRIGATED CORN YIELDS AND SOIL PHOSPHORUS LEVELS

Charles A. Shapiro

OBJECTIVE: It is hypothesized that having more than one location for phosphorus application would enhance yields at locations where soil phosphorus levels are low. The objective of this study was to determine if phosphorus applications made in addition to the row applied starter would increase yields. Additionally, the effect of these treatments applied annually would determine if multiple phosphorus bands affect yield levels.

PROCEDURE: The experiment was conducted on a Valentine-Thurman sandy textured site located 5 miles north of Tilden, Ne with a low soil phosphorus (Bray and Kurtz #1 = 7) level. The site was center pivot irrigated since 1980.

The experiment was a factorial arrangement of starter use, broadcast or knifed phosphorus, and phosphorus rates. The design was a split plot with starter use being the whole plots. Method and rate of phosphorus application where randomly allocated within the starter blocks. Individual plots were 6 rows wide (15 ft.) and 80 ft. long. There were 4 replications.

The broadcast treatments were spread by hand and were pre-weighted 0-46-0. The knife phosphorus was applied with a 6 row knife applicator that could apply anhydrous ammonia simultaneous with the application of a fertilizer solution. Knife spacing was 30 inches apart and band placement was 7 inches deep. Fertilizer was applied in the direction of the planted rows. Either 100 lbs or 200 lbs of 10-34-0 was applied with the anhydrous ammonia. The anhydrous ammonia applicator was calibrated and settings were determined to adjust anhydrous ammonia rate in order that all nitrogen applications equaled 110 lbs N per acre after planting. Each season 60 lbs of nitrogen and 15 lbs of sulfur were applied with the irrigation water before tasseling.

Starter applications were applied by the cooperator at planting. In 1985 a starter mixture of 7-22-5-8S-1Zn was applied. In 1986 a starter mixture of 12-36-0-8S-1.6Zn was applied. Irrigation water contained 4.5 ppm nitrate nitrogen. Approximately 12 in of irrigation water was applied annually and this would contain 12 lbs of nitrate nitrogen per acre foot of water.

Based on soil test results, sulfur (4 ppm SO_4-S), zinc (0.33 ppm DTPA Zn) and potassium (114 ppm K) was applied preplant over the whole plot before final tillage. In 1985, 100 lbs of 0-0-40-10S-9Mg was applied preplant. Zinc was applied as ZnO at a rate of 8.6 lbs Zn/acre. The experimental area was disked and field cultivated before planting. In 1986, potassium and sulfur were applied at 50 lbs K_2O and 20 lbs S per acre preplant.

Whole corn plant samples were collected at the 6 LS, earleaf samples were collected at silking, grain samples collected at harvest, and in 1986 stover samples were collected at harvest. Plant material was analyzed for both N and P.

Soil samples were taken on March 27, 1986, and February 9, 1988. In selected plots. Each sample was a composite of ten probes per plot. The sample was split into 0-2, 2-4, and 4-8 inches for the March 1986 sampling and 0-4 and 4-8 inches for the February 1987 sampling. At both sampling times samples were taken from the corn row and between the corn rows. They were analyzed separately. There were 3 replications sampled in 1986 and 1987.

RESULTS AND DISCUSSION: Due to the Food Security Act of 1985 the experimental site was enrolled in the Conservation Reserve Program for the 1987 season. This shortened the proposed length of the experiment from five years to two. The second objective of determining the long term effect of these treatments will not be achieved since the site was lost.

Yield levels were higher in 1986 than in 1985. This was due in part to improved management for both years. Nineteen eighty-five was the first year the cooperator farmed the field. It had been poorly managed in years previous to his management. The analysis of variance for 1985 yields shows that phosphorus rate was the only significant effect. In 1986 phosphorus placement, phosphorus rate, phosphorus placement*starter, and phosphorus rate*starter were all significant effects. The starter treatment was effective in raising yields and the additional phosphorus applied broadcast did not increase yields (Table 2). The knife band applied additional phosphorus tended to have higher yields than the additional broadcast phosphorus. When no starter phosphorus was applied at the 34 lb treatment the broadcast phosphorus increased yields compared to the same knife treatment.

Soil sampling fields that have a history of banded fertilizer is becoming a growing problem for agronomists. In order to determine if fertilizer bands present problems, soil samples were taken at the locations described in the material and methods section. The analysis of variance for the soil sampling is also in table 1 and generally indicates differences at all sampling levels for phosphorus placement, phosphorus rate and the interaction of placement and rate. Surprisingly, the main effects of starter and the location of sampling were not significant. Interestingly in the 1987 sampling, the significant interaction between phosphorus placement and rate at both sampling levels disappears when the average of the two locations is analyzed. These soil samples were taken after two years of phosphorus band applications and with some tillage between the two years. With the 1986 sampling, phosphorus bands were not found at the 4-8 inch depth. However, after two years the soil phosphorus level was increased at 4-8 inches with knife applications.

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Charles A. Shapiro

OBJECTIVE: It is hypothesized that having more than one location for phosphorus application would enhance yields at locations where soil phosphorus levels are low. The objective of this study was to determine if phosphorus applications made in addition to the row applied starter would increase yields. Additionally, the effect of these treatments applied annually would determine if multiple phosphorus bands affect yield levels.

PROCEDURE: The experiment was conducted on a Valentine-Thurman sandy textured site located 5 miles north of Tilden, Ne with a low soil phosphorus (Bray and Kurtz #1 = 7) level. The site was center pivot irrigated since 1980.

The experiment was a factorial arrangement of starter use, broadcast or knifed phosphorus, and phosphorus rates. The design was a split plot with starter use being the whole plots. Method and rate of phosphorus application where randomly allocated within the starter blocks. Individual plots were 6 rows wide (15 ft.) and 80 ft. long. There were 4 replications.

The broadcast treatments were spread by hand and were pre-weighted 0-46-0. The knife phosphorus was applied with a 6 row knife applicator that could apply anhydrous ammonia simultaneous with the application of a fertilizer solution. Knife spacing was 30 inches apart and band placement was 7 inches deep. Fertilizer was applied in the direction of the planted rows. Either 100 lbs or 200 lbs of 10-34-0 was applied with the anhydrous ammonia. The anhydrous ammonia applicator was calibrated and settings were determined to adjust anhydrous ammonia rate in order that all nitrogen applications equaled 110 lbs N per acre after planting. Each season 60 lbs of nitrogen and 15 lbs of sulfur were applied with the irrigation water before tasseling.

Starter applications were applied by the cooperator at planting. In 1985 a starter mixture of 7-22-5-8S-1Zn was applied. In 1986 a starter mixture of 12-36-0-8S-1.6Zn was applied. Irrigation water contained 4.5 ppm nitrate nitrogen. Approximately 12 in of irrigation water was applied annually and this would contain 12 lbs of nitrate nitrogen per acre foot of water.

Based on soil test results, sulfur (4 ppm SO_4-S), zinc (0.33 ppm DTPA Zn) and potassium (114 ppm K) was applied preplant over the whole plot before final tillage. In 1985, 100 lbs of 0-0-40-10S-9Mg was applied preplant. Zinc was applied as ZnO at a rate of 8.6 lbs Zn/acre. The experimental area was disked and field cultivated before planting. In 1986, potassium and sulfur were applied at 50 lbs K_2O and 20 lbs S per acre preplant.

Whole corn plant samples were collected at the 6 LS, earleaf samples were collected at silking, grain samples collected at harvest, and in 1986 stover samples were collected at harvest. Plant material was analyzed for both N and P.

Soil samples were taken on March 27, 1986, and February 9, 1988. In selected plots. Each sample was a composite of ten probes per plot. The sample was split into 0-2, 2-4, and 4-8 inches for the March 1986 sampling and 0-4 and 4-8 inches for the February 1987 sampling. At both sampling times samples were taken from the corn row and between the corn rows. They were analyzed separately. There were 3 replications sampled in 1986 and 1987.

RESULTS AND DISCUSSION: Due to the Food Security Act of 1985 the experimental site was enrolled in the Conservation Reserve Program for the 1987 season. This shortened the proposed length of the experiment from five years to two. The second objective of determining the long term effect of these treatments will not be achieved since the site was lost.

Yield levels were higher in 1986 than in 1985. This was due in part to improved management for both years. Nineteen eighty-five was the first year the cooperator farmed the field. It had been poorly managed in years previous to his management. The analysis of variance for 1985 yields shows that phosphorus rate was the only significant effect. In 1986 phosphorus placement, phosphorus rate, phosphorus placement*starter, and phosphorus rate*starter were all significant effects. The starter treatment was effective in raising yields and the additional phosphorus applied broadcast did not increase yields (Table 2). The knife band applied additional phosphorus tended to have higher yields than the additional broadcast phosphorus. When no starter phosphorus was applied at the 34 lb treatment the broadcast phosphorus increased yields compared to the same knife treatment.

Soil sampling fields that have a history of banded fertilizer is becoming a growing problem for agronomists. In order to determine if fertilizer bands present problems, soil samples were taken at the locations described in the material and methods section. The analysis of variance for the soil sampling is also in table 1 and generally indicates differences at all sampling levels for phosphorus placement, phosphorus rate and the interaction of placement and rate. Surprisingly, the main effects of starter and the location of sampling were not significant. Interestingly in the 1987 sampling, the significant interaction between phosphorus placement and rate at both sampling levels disappears when the average of the two locations is analyzed. These soil samples were taken after two years of phosphorus band applications and with some tillage between the two years. With the 1986 sampling, phosphorus bands were not found at the 4-8 inch depth. However, after two years the soil phosphorus level was increased at 4-8 inches with knife applications.

Table 1. Analysis of variance for the effect of phosphorus application methods and rates. Tilden, NE. 1985-1986

Source	df	Yield 1985	Yield 1986	Soil Phosphorus Level 3/86 0-2"	2-4"	4-8"	Ave	(Sample depth & date) 2/87 0-4"	4-8"	Ave
		Pr. of F>0								
Rep	3									
Starter(S)	1	0.1071	0.0650	.7665	.8478	.8585	0.9992	0.0981	0.339	0.6093
Error A	3									
P Place (PP)	1	0.6725	0.0477	.0001	.01551	.0393	0.0644	0.0001	0.0008	0.4922
P Rate (PR)	2	0.0317	0.0011	.0001	.0140	.0327	0.0001	0.0001	0.0001	0.0001
Chk vs Applied	1	0.0639	0.0004	.0001	.0239	.0129	0.0001	0.0001	0.0004	0.0001
34 vs 68	1	0.0529	0.2895	.0001	.0533	.3917	0.0141	0.0001	0.0002	0.0001
Location[&]	1	-	-	.2553	.5678	.9805	0.5608	-	-	-
PP * PR	2	0.7291	0.2409	.0001	.0865	.0614	0.0040	0.0002	0.0013	0.2351
PR * S	2	0.1610	0.0515	.5342	.5662	.1194	0.1551	0.2537	0.7916	0.4983
PP * S	1	0.8203	0.0283	.6591	.7840	.4741	0.8700	0.7707	0.2540	0.4448
PP * PR * S	2	0.6178	0.1339	-	-	-	-	0.9609	0.5450	0.7505
Residual	47									
CV		7.6	6.0	22	47	41	28	20	41	22

[&]Location of soil sample was either in row or between row.

Table 2. Effect of phosphorus rate, method of application and starter fertilizer on corn grain yields. Tilden, NE[+].

Application Method	1985 Phosphorus rate (lbs P_2O_5/acre) 0	34	68	1986 0	34	68
	bu/acre					
Broadcast						
W/O Starter	116	121	129	133	156	149
Starter[&]	127	129	130	151	147	151
Knife						
W/O Starter	116	113	132	125	134	146
Starter	125	130	130	144	151	156
Mean	121	123	130	138	147	150

[&]Starter in 1985 was 7-22-5-1ZN-8S
Starter in 1986 was 12-36-0-1.6Zn-8S
[+]See table 1 for ANOVA

Table 3. Effect of phosphorus placement and rate on soil phosphorus levels at 2, depths after one application. Tilden. 1986.

Phosphorus		Depth (in)			Weighted
Placement	Rate	0-2	2-4	4-8	Average
Broadcast	0	13.5	11.8	8.7	10.7
Broadcast	34	22.5	15.2	8.5	13.7
Broadcast	68	30.2	21.4	11.6	18.7
Knife	0	14.6	13.7	9.5	11.8
Knife	34	14.2	13.8	13.4	13.7
Knife	68	14.9	14.8	12.1	13.5
Placement x Rate Interaction (Pr F>0)		0.0001	0.09	0.06	.0040

Table 4. Effect of phosphorus placement and rate on soil phosphorus levels at 2 depths after two years application. Tilden. 1987.

Phosphorus		Depth (in)		
Placement	Rate	0-4	4-8	Average
		-Bray + Kurtz #1, ppm-		
Broadcast	0	12.8	8	10.4
Broadcast	34	23.2	10	16.6
Broadcast	68	33.6	12.5	23.0
Knife	0	11.8	8.4	10.1
Knife	34	12.8	13.1	12.9
Knife	68	17.4	31.6	24.4
Placement x Rate Interaction (Pr F>0)		.0002	.0013	.2351

EFFECT OF PLANTING DATE, SEEDING RATE AND PHOSPHORUS APPLICATION RATE ON THE YIELD AND YIELD COMPONENTS OF WINTER WHEAT IN SOUTHEAST NEBRASKA

N. Blue, S. C. Mason and D. H. Sander

Objective: To determine the effect of planting date, seeding rate, and phosphorus application rate on the yield and yield components of hard red winter wheat in southeast Nebraska.

Procedure: Experiments were established in the fall of 1986 on two low available P soils in Gage (Location 87-3 and 87-5) and one soil in Saline county. Because of poor emergence and thin stands only the first planting date was harvested from the Saline county location. The results from the Saline county location are not included in this report. Bray and Kurtz No. 1 soil test levels for P were 5 ppm for location 87-3 and 6 ppm for location 87-5 (0-15 cm).

The experimental design involved three planting dates (12 Sept., 9 Oct., and 31 Oct.), three seeding rates (33.6, 67.2 and 100.8 kg ha^{-1}) and three P rates (0, 16.8 and 33.6 kg ha^{-1}). All plots were planted with a hoe drill. Phosphorus was applied with the seed. No nitrogen was applied since soil residual nitrate levels were high (152 and 115 kg ha^{-1} NO_3^{-1}-N) to a depth of 180 cm for locations 87-3 and 87-5 respectively. Plots were 2.4 meters wide by 8.8 meters long with 0.3 meters between the wheat rows. Yield and yield components were determined from the 2 center rows, 3 meters in length. Spike counts were made from 60 cm of row. Seed counts and seed weights were determined from 30 spikes selected at random.

Results and Discussion: As planting was delayed from the early to middle planting date, grain yield was similar but decreased 39% as planting was delayed from the middle to late planting date (Table 1). As seeding rate was increased from 33.6 to 67.2 and from 67.2 to 100.8 kg ha^{-1} grain yield increased 15% and 10% respectively across both locations. Grain yield responded positively to P rate but the response was different at each location (Table 2). At location 87-5 the maximum grain yield occurred at the 16.8 kg ha^{-1} P rate while at location 87-3 it occurred at the 33.6 kg ha^{-1} P rate.

The number of spikes m^{-2} averaged over all treatments was 394 at location 87-5 and 502 at location 87-3. As planting date was delayed from the early to late date the number of spikes m^{-2} decreased by 35% with most of this decrease occurring when the planting was delayed from the early to middle date (Table 1). Spikes m^{-2} increased by 16% and 2% as seeding rate was increased from 33.6 to 67.2 and from 67.2 to 100.8 kg ha^{-1} (Table 3). The number of spikes m^{-2} were 428, 467, and 448 at the P rates of 0, 16.8, and 33.6 kg ha^{-1}, respectively.

The planting date by P rate and location by planting date by seeding rate interactions for kernels $spike^{-1}$ between seeding and P rates were greatest at the middle planting date (Tables 3 and 4). At the middle planting date the number of kernels $spike^{-1}$ was greatest at the lowest seeding and P rates. The same interactions observed for kernel weight indicated that kernel weight was similar for all seeding and P rates at the early and middle planting dates, but large differences in kernel weight between seeding rates and P rates occurred at the late planting date. At the late planting date the highest kernel weights occurred at the highest seeding and P rates (Tables 3 and 4).

These results indicate that grain yield and spikes m-2 were generally influenced only by the main effects of the treatment variables. Kernels spike^{-1} and kernel weight on the other hand were influenced by interactions involving 2 or 3 treatment variables. This suggests that compensation is occurring between the yield components. The fact that grain yield remained nearly the same, while the number of spikes m^{-1} decreased as planting was delayed from the early to middle date suggests that kernels spike^{-1} and kernel weight compensated for this decrease in spikes m^{-2}.

In general, P rates did not interact with other treatment variables indicating that P rate had statistically equal effects at all planting dates and seeding rates.

Table 1. The effect of planting date and seeding rate on the grain yield and the number of spikes m^{-1} of 'Brule' wheat. Means of two locations. Gage County, 1987.

Main Effect		Grain Yield (Mg ha^{-1})	Spikes m^{-2}
Planting Date	12 September	2.73	615
	9 October	2.72	398
	31 October	1.67	331
Seeding Rate (kg ha^{-1})	33.6	2.08	402
	67.2	2.40	466
	100.8	2.64	475

Table 2. **The effect of the applied phosphorus on grain yield of 'Brule' wheat at two locations in Gage County. 1987.**

Applied Phosphorus (kg ha^{-1})	Location 87-5	Location 87-3
	grain yield (Mg ha^{-1})	
0	1.96	2.29
16.8	2.25	2.70
33.6	2.17	2.85

Table 3. The effect of planting date and applied phosphorus on the number of kernels $spike^{-1}$, kernel weight, and harvest index of 'Brule' wheat at two locations. Gage County. 1987.

Applied Phosphorus ($kg\ ha^{-1}$)	Planting Date 12 Sept.	9 Oct.	31 Oct.
	kernels $spike^{-1}$		
0	22.8	37.3	33.9
16.8	20.4	32.5	34.0
33.6	23.6	31.5	34.8
	General weight (mg $seed^{-1}$)		
0	30.1	29.9	23.1
16.8	29.5	30.3	27.7
33.6	29.9	31.3	28.7

Table 4. The effect of the planting date and seeding rate on the number of kernels $spike^{-1}$, kernel weight, and harvest index of 'Brule' wheat. Mean of two locations in Gage County. 1987.

Seeding Rate	Planting Date 19 Sept.		26 Oct.		8 Nov.	
($kg\ ha^{-1}$)	Loc 3	Loc 4	Loc 3	Loc 4	Loc 3	Loc 4
	kernels $spike^{-1}$					
33.6	24.2	20.4	20.3	21.2	21.6	25.7
67.2	37.0	38.8	32.8	32.2	31.6	30.2
100.8	37.2	35.0	35.5	33.4	33.7	30.5
	kernel weight (mg $seed^{-1}$)					
33.6	29.3	30.3	29.5	28.7	28.6	32.6
67.2	29.2	29.8	31.3	30.9	30.8	30.9
100.8	22.0	23.3	26.0	28.0	30.0	29.5

EFFECT OF TIME OF SEEDING, METHOD AND RATE OF P APPLICATION ON WINTER WHEAT YIELD, P UPTAKE, AND YIELD COMPONENTS

D. H. Sander

Objective: To determine the interaction between date of seeding and methods of P application for growing winter wheat in southeast Nebraska.

Procedure: Three experiments were established in the fall of 1986 on low available P soils in Gage (2 locations) and Saline County (1 location). Experimental design involved three seeding dates, two P application methods (knife-dual placed N and P, and seed application) with 3 P rates (9, 18, and 27 kg P ha^{-1}) and a check or no P treatment. All plots received 80 kg N ha^{-1} as NH_3 except the check plot which was also knifed. Plots were 2.4 meters wide by 12 meters long with 0.3 meter between wheat rows. Grain and straw yields were determined from two rows 3 meters in length. Stem counts were made from 60 cm of row. Seed counts and seed weights were determined from 10 heads selected at random.

Results and discussion: Applied P increased yield and P uptake at each of the three locations (Table 1 and 2). Knife and seed applications performed similarly although seed application produced more straw weight and stems than knife application at location 87-5. Time of seeding significantly affected yield, P uptake, and yield components. Yields decreased greatly as time of seeding was delayed especially when delayed to late October or early November. Seeding dates were delayed more than was planned due to frequent precipitation. Seeding Nov. 7, at location 87-9 was too late to produce harvestable wheat. While wheat seeded Oct. 31 at locations 87-3 and 87-5 did not emerge in the fall, spring stands were excellent but low yielding compared to earlier seeding dates.

It seems logical to assume that since knifing places P at variable distance (30 cm spacing) from the seed row, knifing might be less effective with late seeding because of the increased time required for root-P contact which could decrease tillering and therefore head numbers. While grain yield and yield components were not consistantly affected by the method x time interaction, knifing P tended to produce higher yields than seed application when seeded in September (Locations 87-3 and 87-9). When seeded in early October, seed application of P tended to increase yields more than knifed P. However, results are erratic because of a relatively good performance of knifing P in the October 31 planting at location 87-3.

Table 1. Analysis of Variance for wheat studies.

Source of Variation	Yield			P Uptake			Seeds per head	Head wt.	Seed wt. per 1000	No. of Stems
	Grain	Straw	Grain + Straw	Grain	Straw	Total				
	-----kg ha^{-1} --------			-----kg ha^{-1} -----				g	g	Stems m^{-2}
				Location 87-5 (Gage County)						
Time (T)	.04	.07	.05	.07	NS	.13	NS	NS	.02	.11
P Method (M)	NS	.04	.08	NS	NS	NS	NS	NS	NS	.04
P Rate (R)	NS	NS	NS	NS	NS	NS	.17	NS	.10	NS
Linear	NS	NS	NS	NS	NS	NS	NS	NS	.07	NS
Quadratic	.19	NS	NS	.16	NS	.11	.06	NS	NS	NS
T x M	NS	NS	NS	NS	NS	NS	.05	.01	.02	NS
T x R	NS	NS	NS	NS	NS	NS	.14	.02	.01	.04
M x R	NS	NS	NS	NS	NS	NS	NS	NS	.07	NS
T x M x R	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
				Location 87-3 (Gage County)						
Time (T)	.01	.01	.01	.01	.01	.01	.19	.14	NS	.01
P Method (M)	NS	NS	NS	NS	NS	NS	.09	.09	NS	NS
P Rate (R)	NS	NS	NS	NS	NS	NS	.04	.04	NS	.19
Linear	NS	NS	NS	NS	NS	NS	.01	.01	NS	.07
Quadratic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
T x M	.12	NS	.18	.05	NS	.19	NS	.11	.01	NS
T x R	NS	.08	.05	.19	NS	.18	.01	.01	NS	NS
M x R	NS	.07	NS	NS	.18	NS	NS	NS	.04	NS
T x M x R	NS	NS	NS	NS	NS	NS	NS	NS	.08	NS
				Location 87-9 (Saline County)						
Time (T)	.17	NS	NS	NS	NS	NS	.08	.05	NS	.04
P Method (M)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P Rate (R)	.06	.18	.04	.03	NS	.05	NS	NS	NS	NS
Linear	.02	.10	.01	.01	.19	.02	NS	NS	NS	NS
Quadratic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
T x M	NS	.11	NS	NS	NS	NS	NS	NS	NS	NS
T x R	NS	NS	NS	NS	NS	NS	NS	.12	NS	NS
M x R	NS	.02	.03	NS	NS	.18	NS	.13	NS	NS
T x M x R	NS	.15	.16	.14	NS	NS	NS	.10	NS	.05

Table 2. Effect of time of wheat seeding, method and rate of P application on yield, P uptake, and yield components from three experimental locations. 1987.

Parameter		Yield Grain	Yield Straw	Yield Total	P Uptake Grain	P Uptake Straw	P Uptake Total	Seeds per head	Head wt.	Seed wt.	No. of Stems
		Mg ha^{-1}			kg ha^{-1}				g	g 1000^{-1}	Stems m^{-2}
					Location 87-3 (Gage Co.)						
Time of Seeding											
9-12-86 (time 1)		3.56	6.43	9.99	17.9	9.2	27.1	34	11.6	35	1350
10-7-86 (time 2)		3.28	4.85	8.13	16.2	6.9	23.1	40	13.8	34	789
10-31-86 (time 3)		1.90	3.40	5.30	10.3	5.8	16.2	36	12.2	34	700
Method of P Application											
Knife (dual placement)		2.99	4.94	7.93	15.1	7.5	22.6	38	12.8	34	950
Seed		3.04	5.15	8.20	15.5	7.4	22.9	36	12.3	34	944
P Rate, kg P ha^{-1}											
0		2.70	4.58	7.28	13.6	6.8	20.4	38	12.8	34	879
9		3.03	5.32	8.35	15.5	7.6	23.1	38	13.0	34	878
18		2.91	4.84	7.75	15.0	7.4	22.3	37	12.6	34	944
27		3.12	5.04	8.15	15.4	7.4	22.9	35	12.0	34	1022
Time of Seeding x Method											
Time 1	Knife	3.68	6.31	10.0	18.9	8.9	27.8	34	12.1	35	1311
	Seed	3.43	6.55	9.98	17.0	9.4	26.3	33	11.1	34	1394
Time 2	Knife	3.05	4.52	7.57	14.6	7.0	21.6	42	14.3	34	811
	Seed	3.51	5.18	8.69	17.8	6.8	24.6	39	13.2	34	772
Time 3	Knife	2.04	3.72	5.76	10.9	6.4	17.3	37	12.0	33	728
	Seed	1.75	3.02	4.78	9.7	5.2	14.9	36	12.4	35	672
					Location 87-5 (Gage Co.)						
Time of Seeding											
10-7-86		2.86	3.92	6.78	14.5	3.3	17.6	38	9.0	28	900
10-31-86		1.50	2.61	4.12	8.3	2.6	10.9	40	11.1	26	820
Method of P Application											
Knife (dual placement)		2.02	2.93	4.95	10.6	2.8	13.1	39	10.1	27	811
Seed		2.32	3.57	5.89	12.1	3.0	14.9	39	10.0	28	911
P Rate, kg P ha^{-1}											
0		1.99	3.13	5.12	10.7	3.1	13.8	38	10.2	27	881
9		2.13	3.28	5.41	11.2	2.8	13.5	37	10.0	27	842
18		2.43	3.38	5.80	12.6	3.3	15.9	41	10.1	27	889
27		1.97	3.14	5.11	10.2	2.6	12.3	38	10.1	28	850
Time of Seeding x Method of Application											
Time 1	Knife	2.66	3.60	6.26	13.4	3.2	16.3	39	9.2	28	872
	Seed	3.04	4.21	7.25	15.4	3.3	18.7	36	8.8	28	928
Time 2	Knife	1.38	2.27	3.65	7.8	2.5	10.2	38	11.1	25	750
	Seed	1.61	2.92	4.53	8.8	2.7	11.5	42	11.3	27	894

					Location 87-9 (Saline Co.)					
Time of Seeding										
9-19-86 (Time 1)	4.17	5.75	9.92	18.5	6.4	24.4	32	9.0	28	1361
10-9-86 (Time 2)	3.30	4.79	8.09	15.6	5.7	21.6	39	11.2	28	933
11-7-86 (Time 3)						No Harvest				
Method of P Application										
Knife (dual application)	3.75	5.16	8.91	16.8	6.1	23.2	36	10.1	28	1122
Seed	3.72	5.39	9.10	17.3	6.0	22.8	35	10.0	28	1172
P Rate, kg P ha-1										
0	3.16	5.02	8.18	14.3	5.8	20.0	35	10.3	29	1036
9	3.47	4.91	8.38	15.5	5.6	21.6	36	10.0	28	1172
18	3.69	5.44	9.13	17.0	6.2	23.3	35	10.1	28	1050
27	4.03	5.47	9.51	18.6	6.3	24.0	36	10.1	29	1217
Time of Seeding x Method										
Time 1 Knife	4.24	5.41	9.65	18.3	6.2	24.5	33	9.2	28	1311
Time 1 Seed	4.10	6.09	10.19	18.6	6.7	24.2	31	8.8	28	1411
Time 2 Knife	3.25	4.90	8.16	15.2	5.9	21.8	40	11.1	28	933
Time 2 Seed	3.34	4.68	8.02	16.0	5.5	21.5	39	11.3	29	928

Soil Test P - Bray No. 1, ppm

87-3 = 5
87-5 = 6
87-9 = 5

EVALUATION OF THE INFLUENCE OF STARTER FERTILIZER ON CORN, GRAIN SORGHUM, AND SOYBEANS, 1987

E. J. Penas, R. A. Wiese, & G. W. Hergert

Objective:

Determine the influence of farmer-applied starter fertilizer on plant emergence, early plant growth, grain yield, grain moisture at harvest and final plant populations of corn, grain sorghum, and soybeans.

Procedure:

Cooperating farmers were selected that use starter fertilizer on their row crops. They were asked to leave five strips without starter fertilizer that were each approximately 150 feet in length. Strips were alternated with strips with starter fertilizer (each one-planter width). Thus, each no-starter strip was bordered on both sides with starter fertilizer. Measurements were made on ten pairs of two-row plots. Information was obtained from each farmer to determine the analysis and rate of fertilizer used. County agents collected most of the data prior to harvest. Soil temperature was determined at planting time and again two weeks after planting. Separate soil samples (0-6 inches deep) were collected from each of the no-starter strips. Plant counts per 40 feet of row were taken in the starter and no starter rows in each of the ten pairs of plots. Plant height measurements were taken 30-40 days after planting. Grain yields for corn were determined by harvesting two 25-foot lengths of row in each of the ten pairs of comparisons (two 15-foot row for grain sorghum and soybeans). Grain moisture was determined at harvest time for corn.

Experimental Results:

Information was collected from twenty-two corn trials, three grain sorghum trials, one popcorn trial, and one soybean trial. Data are summarized in Table 1. Locations are listed in order of increasing soil phosphorus. For the corn sites, phosphorus ranged from 8 to 160 ppm phosphorus. For grain sorghum, the range was 6 to 28 ppm phosphorus. The soil for the popcorn trial was 13 ppm P and for the soybean trial 6 ppm P. The nutrients contained in the starter fertilizer that was used are also given in Table 1.

<u>Corn Experiments</u>. Early growth measurements were obtained at twelve locations, and at seven of these, there was a significant growth response to applied starter fertilizer. This growth response occurred on soils testing as high as 42 ppm P. Only at two sites where soil phosphorus was low to medium (below 25 ppm P) and measurements obtained did starter fertilizer fail to increase early growth. One of these was low in phosphorus but received only N as the starter fertilizer.

Grain yields were high in 1987 with an average yield of 167 bushels per acre. Grain yields from seven non-irrigated sites averaged 148 bushels per acre with a range from 119 to 189 bushels per acre between sites. Grain yields from fifteen irrigated sites averaged 176 bushels per acre with a range from 129 to 228 bushels per acre between sites.

Starter fertilizer increased grain yield at six sites out of 22. At four sites in Perkins County on sandy soils that are medium to high in phosphorus, yield increase was due to the nitrogen and/or sulfur in the starter. The site in Dawson County was low in phosphorus and would be expected to respond to starter fertilizer with phosphorus. The one site in Saunders County that responded to starter fertilizer was medium in phosphorus. Starter fertilizer significantly reduced grain yield at four sites. Three of these were high in soil phosphorus. The other site where starter fertilizer reduced yield was low in soil phosphorus; however, fertilizer was placed with the seed which resulted in stand loss and reduced yields.

Grain moisture at harvest time was reduced by starter fertilizer at seven locations; however, reductions were usually less than 1%. At two sites, grain moisture was significantly higher at the time of harvest where starter fertilizer was used.

Popcorn Experiment. The application of starter fertilizer for popcorn grown on a low phosphorus soil did not result in an increase in yield; however, there was a significant reduction in grain moisture at harvest time.

Grain Sorghum Experiments. Starter fertilizer increased early growth of grain sorghum at three of four sites. Growth response did not appear to be related to soil phosphorus level. Starter fertilizer increased the grain yield of grain sorghum on the three sites where soil phosphorus was low to medium (less than 25 ppm P), but not at the site where phosphorus was high.

Soybean Experiment. The application of starter fertilizer on soybeans had no effect on early growth or seed yield of soybeans even though soil phosphorus was low at the one trial site.

Table 1. Influence of starter fertilizer applied by producers on early growth, grain yield and grain moisture of corn, popcorn, grain sorghum, and soybeans, 1987.

Location	Soil Texture	Soil P, ppm	Soil Zinc Index	Starter Used	Early Growth Increase,%	Yield Increase, bu/ac	Grain Moisture Change,%
			Corn				
Saunders (Slegl)	Si Clay loam	8	4.5	NPKZn	8*	4	-0.5*
Dawson (Stuart)	Silt loam	9	8.3	NP	-	6*	-0.2
Richardson (Thiltges)	Silt loam	10	6.1	NPZn	21*	- 8*	-0.4*
Butler (Medinger)	Silt loam	11	3.8	N	0	- 3	0.1
Washington (Fuchs)	Si Clay loam	11	4.7	NPK	16*	4	0.2
Dodge (Poppe)	Si Clay loam	12	3.5	NPZn	7	5	-0.1
Saunders (Williams)	Si Clay loam	18	3.9	NP	11*	8*	-0.1
Perkins (Kurkowski)	Sand	19	4.5	NPS	-	16	1.1*
Saunders (Sladky)	Si Clay loam	19	4.5	NPZn	18*	- 4	-0.7*
Perkins (Gengenbach)	Sand	21	9.0	NS	-	17*	0.4*
Hitchcock (Stehno)	Silt loam	24	7.1	NPKSZn	-	7	-0.1
WCREC (April 28)	Silt loam	24	11.3	NPZn	-	0	-0.6*
WCREC (May 11)	Silt loam	24	11.4	NPZn	-	3	-0.4
Perkins (Gengenbach)	Loamy sand	25	10.6	NPS	-	15*	-0.3
Perkins (Gengenbach)	Sand	28	9.3	NPS	-	21*	-1.1*
Perkins (Gengenbach)	Loamy sand	29	11.0	NS	-	14*	-0.5*
Lincoln (Fritz)	Loam	31	0.1	NP	-	-10*	0.0
Dodge (Parr)	Si Clay loam	32	5.7	NPZn	11*	- 4	0.5
Hamilton (Parpart)	Silt loam	42	-	NP	13*	-10*	-2.1*
Platte (Nielsen)	Silt loam	46	4.4	NPKSZn	2	- 4*	0.0
Gage (Gronewold)	Si Clay loam	73	8.9	NPKSZn	7	- 4	-0.2
Washington (Holstein)	Si Clay loam	160	14.4	NP	0	- 5	0.3

(continued)

Table 1 (continued). Influence of starter fertilizer applied by producers on early growth, grain yield and grain moisture of corn, popcorn, grain sorghum, and soybeans, 1987.

Location	Soil Texture	Soil P, ppm	Soil Zinc Index	Starter Used	Early Growth Increase,%	Yield Increase, bu/ac	Grain Moisture Change,%
			Popcorn				
Chase (Kunneman)	Loamy sand	13	16.0	NP	-	268 lbs.	-1.4*
			Grain Sorghum				
Saunders (Woita)	Si Clay loam	6	-	NP	12*	5*	-
Gage (Rohe)	Si Clay loam	8	-	NPK	57*	7*	-
Gage (Parde)	Si Clay loam	22	-	NPK	0	6*	-
Gage (Huls)	Silt loam	28	-	NPK	17*	4	-
			Soybeans				
Stanton (Christ)		6	-	NPK	-3	0	-

*Significant effect from starter fertilizer (P = .10)

Long Term Effects of N-Serve on Improving Nitrogen Use Efficiency for Furrow Irrigated Corn

Gary W. Hergert

Objective

1. Determine whether there is a long term yield advantage from using annual applications of N-Serve in preplant spring applied ammonia on a furrow irrigated silt loam soil.

2. Determine the effect of N-Serve on corn grain nitrogen removal, apparent nitrogen use efficiency, and soil residual nitrate levels after a 5 year period of time.

Procedure

At a given location for a given year there may or may not be a significant response to N-Serve if the conditions for leaching or denitrification are not severe enough to cause significant differences in nitrogen loss. If the use of N-Serve results in higher carryover of residual nitrate over time, the increased yield at lower nitrogen rates should show a cumulative effect over time if the residual nitrogen accumulation is not lost.

This study is designed as a two factor factorial with N rates and N-Serve. Nitrogen rates in 40 lb. increments from 40 to 200 lbs. are used with and without 0.5 lbs. of N-Serve/acre. A check plot receiving no nitrogen was also included. The ammonia applicator is run through the check plots to simulate the tillage effect from applying ammonia in other plots. Five replications were used with the plot size of 70'long by 4-30" rows wide. The soil is a Cozad silt loam which is furrow irrigated. The site had been in continuous ridge-till corn production for at least 15 years before the initiation of this study. Much of the time the area has not received nitrogen fertilizer. The residual nitrate level was low in the spring of 1985 when the study was initiated (54# NO_3-N per A-6'). The phosphorus level was low and 80 pounds of phosphorus as 0-46-0 was broadcast in the spring of 1985. The low baseline level of nitrate will serve as a comparison for future samplings of various nitrogen rates to determine nitrate leaching under various treatments. Each replication of the study was sampled to the 12 foot depth. Corn variety Pioneer 3541 was planted May 3, 1985 and on April 30, 1986 and 1987 BoJac 603 was planted. Grain yields and various plant parameters for 1985 are summarized in Table 1. The only significant factor affecting yields was nitrogen rate.

Response variables for grain yield, earleaf nitrogen and grain nitrogen all show curvilinear responses to nitrogen applied.

This is a continuous corn plot and the only nitrogen removal is in the grain. An apparent nitrogen use efficiency can be calculated by subtracting the nitrogen removal in the check from the nitrogen removed for a nitrogen rate divided by the nitrogen rate. These values for 1985 and 1986 show 2 year averages nitrogen efficiencies of 63%, 63%, 58%, 52%, and 42% for the N rates from 40 to 200 pounds. Data for 1987 are not yet available. For 1985 and 1986 the maximum yield was obtained with about 160 pounds of nitrogen/acre. This represents an average apparent nitrogen use efficiency of about 52%. Nitrogen removal in the grain can be plotted against nitrogen rate for the linear portions of the curve. Extrapolation of the line back to the X axis gives a value for the amount of nitrogen from mineralization. Using three nitrogen rates in 1985 shows an apparent mineralization of 75 pounds N/acre. The data from 1986 show a value of about 78 pounds N/acre. Growing conditions both seasons were ideal for good corn production. The soil contains about 1.5% organic matter. These value show that the soil is mineralizing about 50 pounds of nitrogen per percent organic matter. For the 10 years previous to this experiment no nitrogen was used in this area so the mineralization should be near a steady state level.

Table 1. Yield results for 1985, 1986, and 1987 N-Serve study.

		1985	1986	1987
N-Rate	N-Serve		Grain yield, Bu/A	
0	-	87	102	76
40	-	137	147	114
40	+	134	134	137
80	-	168	178	148
80	+	170	175	164
120	-	175	207	180
120	+	175	201	173
160	-	185	225	192
160	+	171	222	182
200	-	178	226	202
200	+	177	222	206
N-Rate				
0		87	102	76
40		136	142	112
80		169	177	156
120		175	204	177
160		178	224	187
200		178	224	204
	N-Serve			
	With	166	191	167
	Without	169	197	167
AOV				
			PR>F	
N-Rate		.001	.001	.001
N-Serve		.20	.15	.95
Rate * NI		.35	.98	.03
CV		5.4%	5.8%	5.8%

Nitrogen Fertilization of Smooth Brome

R. B. Ferguson

Objective: To evaluate the long-term effects of nitrogen fertilizer rate, source and application method on the yield and nitrogen use efficiency of smooth brome.

Location: The U.S. Meat Animal Research Center, adjacent to the South Central Research and Extension Center Farm, Clay Center.

Procedures: This was the second year of this study. Three nitrogen fertilizer rates (50, 100 and 150 lb N/acre) were applied with three nitrogen sources (ammonium nitrate, urea and UAN solution). The UAN solution was applied by three methods (broadcast, surface-band, and knife). The ammonium nitrate and urea were broadcast. Knife and surface-band UAN treatments were applied on 15 inch centers. Since an additional treatment was added in 1987 which was not in the 1986 study, the plots were located on a new site adjacent to the 1986 location. In future years, treatments will be re-applied to the same plots. The study site is located on a Crete silt loam soil. Fertilizer application was April 8, 1987.

Experimental results: Residual effects of manure and urine patches were still seen in 1987, even though no livestock had been on the site for two years. Consequently, C.V. values associated with yield are still rather large (Table 1). Forage yields were reduced somewhat from what they had been in 1986. The optimum N rate appears to be 100 lb N/acre in 1987. Urea-ammonium nitrate solution resulted in lower yields than either ammonium nitrate or urea. This may be related to ammonia volatilization (there was a four-day interval between fertilizer application and significant rain) or root immobilization in the case of the knife treatment. The knife treatment tended to result in the lowest yield, as was the case in 1986. This study will be continued without change in 1988.

Table 1.

Comparison of nitrogen rate, sources and application methods for smooth brome, Clay Center, NE.

Trt	N Rate lb/A	N Source	Method	Forage Yield lb/A @ 12.5% H O	Forage Percent N	Percent Apparent N Recovery
1	Check	-----	-----	3395	1.53	-----
2	Kn Check	-----	-----	2908	1.69	-----
3	50	AN	BR	8248	1.63	-----
4	100	AN	BR	9153	1.82	-----
5	150	AN	BR	8886	2.00	-----
6	50	UREA	BR	8455	1.43	-----
7	100	UREA	BR	11089	1.86	
8	150	UREA	BR	9549	2.19	-----
9	50	UAN	BR	6073	1.47	-----
10	100	UAN	BR	6961	1.38	-----
11	150	UAN	BR	7111	1.62	-----
12	50	UAN	KN	4071	1.64	-----
13	100	UAN	KN	4806	1.81	-----
14	150	UAN	KN	8008	2.52	-----
15	50	UAN	DR	5683	1.58	-----
16	100	UAN	DR	6820	1.64	-----
17	150	UAN	DR	7522	2.18	-----
		LSD (0.05)		1698	0.29	
		F VALUE		14.2	8.77	
		C.V.		17.2	11.7	

Mean Values

		Forage Yield	Forage Percent N	Percent Apparent N Recovery
N Rate	50	6506 b	1.55 b	98.7 a
	100	7766 a	1.70 b	82.9 a
	150	8215 a	2.10 a	81.4 a
	PR > F	0.0008	0.0001	0.2520
	C.V.	18.3	13.3	41.1

		Forage Yield	Forage Percent N	Percent Apparent N Recovery
N Source	AN	8762 a	1.82 a	122.6 a
	UREA	9698 a	1.83 a	134.1 a
	UAN-BR	6715 b	1.49 b	55.3 b
	UAN-DR	6675 b	1.80 a	70.9 b
	UAN-KN	5629 b	1.99 a	55.6 b
	PR > F	0.0001	0.0001	0.0001
	C.V.	18.3	13.3	41.1

PHOSPHORUS PLACEMENT FOR GRAIN SORGHUM

Richard Ferguson

Introduction

The primary objective of this study was to evaluate the effects of different phosphorus placement methods on grain yield and phosphorus uptake of grain sorghum. Four methods were used for comparison; broadcast and incorporated with a rotary tiller (BR), surface-banded and incorporated with a rotary tiller (BI), starter (ST), and knifed on both sides of the row (KN). These four methods were compared at four rates of phosphorus application: 9, 18, 27 and 36 kg P ha^{-1}. These rates are equivalent to 18, 37, 55 and 74 lb P_2O_5 A^{-1}. Two sites, both dryland, were selected for the study, both located in Webster county in south-central Nebraska. One site, near Lawrence, had an average soil P level of 12 ppm. The soil type was a Crete-Hord complex. The other site, near Bladen, had an average soil P concentration of 5 ppm. The soil type was a Holdrege silt loam, 7- 10% slope, severely eroded.

Procedure

Both fields had been previously fertilized with anhydrous ammonia prior to planting. The Lawrence site (8740) received 85 lb N A^{-1}. The Bladen site (8741) received 110 lb N A^{-1}. The previous crop for 8740 was grain sorghum, for 8741 corn. Site 8740 was planted, along with fertilizer treatments, on June 1. Site 8741 was planted June 3. Nitrogen solution was applied to all plots (except those receiving the 36 kg ha^{-1} rate of P) at varying rates to balance the N applied with the P carrier. Plots received a total of 22 lb N A^{-1} in addition to preplant rates of anhydrous ammonia. Balancing N was applied as a broadcast spray, which was incorporated with the final rotary tiller pass. Broadcast treatments were applied uniformly across the plot, then incorporated to a depth of 7-8 cm. Starter treatments were applied in one band per row, 7 cm to the side and 3 cm below the seed. Band-incorporated treatments were dribbled directly over the row location, tilled to a depth of 7-8 cm, then planted. Knife treatments were applied with two knives per row, 19 cm on either side of the row, at a depth of 13 cm. All plots were tilled after application of both P and balancing N fertilizers with the exception of the starter plots, which had N applied, then were tilled, then planted along with starter fertilizer. A tiller which incorporated soil vertically was used. The location of the fertilizer bands at the center of the plots were marked with flags on plots receiving 36 kg P ha^{-1} with the BI, ST and KN treatments. These were marked so the band could be located for later detailed soil sampling across and below the band.

Soil samples were taken across bands on July 6-10 at 8741, and July 14-15 at 8740. A soil probe was used to sample across the band in one inch intervals, four inches on either side of the band location. Samples were taken to a depth of 8 inches, again in one inch increments. A total of 64 samples were taken in a grid pattern across the band. Two sections were taken across the band from each plot sampled, composited into one sample for each grid - cell location. A total of 1536 soil samples were obtained in this manner from the two locations. The samples were frozen until analysis could be performed.

Leaf samples (uppermost fully emerged leaf) were taken for N and P analysis from both 8740 and 8741 on July 17. Plants at both sites were at approximately the 8 leaf stage.

Both sites were observed at least weekly during the season for signs of P deficiency. Site 8740, located on a soil testing 12 ppm P, never showed any differences among plots, and no P deficiency symptoms. The site did experience fairly severe greenbug infestation, enough that yield probably was suppressed. The site was aerially sprayed Aug. 3 with Cygon. The site received very little rainfall during August, which also probably served to reduce yield.

Site 8741 did have visual differences among plots, especially later in the season. Check plots, receiving no P fertilizer, became quite evident by early August. The site was located on an eroded hillside, with replication proceeding down the slope. There were significant visual differences among replications, with greater plant growth lower on the slope. Differences among application methods or application rates were more difficult to discern visually. Site 8741 had a severe infestation of volunteer corn. The site was mechanically cultivated twice, and hand-rogued four times. Even so, the fourth replication was lost due to volunteer corn. Consequently, yield was measured from only three replications. Soil samples across the band were still taken from the fourth replication. Site 8741 also experienced a period of hot, dry weather in August which served to reduce yield.

Whole plant samples were taken at physiological maturity at both sites. Plots were sampled Oct. 5 and 6, taking 2 meters of plant material from the center two rows of the plots. These samples were weighed, a subsample was obtained which was weighed, dried, then weighed again for moisture determination. The subsample was then ground and analyzed for P content.

Grain was harvested from 8741 on Oct. 13, and from 8740 Oct. 14, using a two-row plot combine to harvest the center two rows of the four row plots. Grain samples were taken at harvest for P analysis.

Results and Discussion

Results comparing the two sites are shown in Table 1. There were significant differences between sites for all parameters measured except leaf tissue P concentration at the 8 leaf stage.

Table 1. Analysis by site.

SITE	YIELD (BU/A)	MOISTURE %	DRY MATTER (LB/A)	LEAF P %	STOVER P %	GRAIN P %	P UPTAKE (LB/A) GRAIN	STOVER	TOTAL
8740	100.7	16.3	11094	.296	.169	.251	14.1	18.9	33.1
8741	79.7	15.2	9208	.287	.140	.233	10.5	13.1	23.7
PR> F	.0001	.0001	.0001	.1994	.0001	.0173	.0001	.0001	.0001
C.V.	12.5	6.8	13.3	8.9	21.1	18.5	24.7	28.1	22.3

Treatment and replication means for site 8740 are shown in Tables 2A and 2B. There was no effect of treatment on grain yield at this site. Available P did not appear to be a limiting factor for yield.

Tables 3A, 3B and 3C separate dependent variables according to application method, P rate and interactions among replication, application method and P rate. Here again, there are no clear trends according to application method or P rate. An apparent P fertilizer recovery was calculated, for grain and stover, according to the following equation;

$$\text{Apparent P recovery (\%)} = \frac{\text{Trt P uptake (lb/A) - Ck P uptake (lb/A)}}{\text{lb P/A applied}} *100$$

Total P recovery is the sum of grain P recovery and stover P recovery. For site 8740, little can be made of the P recovery data because of very high C.V. values. This is likely due again to adequate soil levels of P to meet crop requirements.

Table 2A. Treatment effects, site 8740.

TRT	P RATE (kg/ha)	P METHOD	YIELD (BU/A)	MOISTURE %	DRY MATTER (LB/A)	LEAF N %	LEAF P %	STOVER P %	GRAIN P %	TOTAL P UPTAKE (LB/A)
1	0	--	98.0	17.2	10557	2.77	.282	.169	.245	31.3
2	9	BR	96.4	16.6	11274	2.82	.297	.144	.209	28.1
3	18	BR	103.0	15.7	11481	2.86	.292	.191	.265	37.2
4	27	BR	104.5	16.6	11872	2.85	.309	.182	.252	36.5
5	36	BR	102.5	16.5	11629	2.81	.294	.177	.232	33.9
6	9	KN	102.3	17.2	11336	2.86	.304	.147	.229	29.8
7	18	KN	101.8	16.6	11180	2.85	.285	.172	.240	33.2
8	27	KN	103.2	16.3	11521	2.76	.291	.192	.279	38.4
9	36	KN	101.3	16.8	10081	2.76	.296	.161	.263	30.8
10	9	ST	96.5	16.2	10715	2.80	.289	.173	.234	31.4
11	18	ST	99.7	15.8	11898	2.84	.305	.179	.241	35.0
12	27	ST	99.3	16.9	10648	2.81	.299	.184	.256	33.9
13	36	ST	101.1	16.4	10624	2.82	.304	.189	.257	34.6
14	9	BI	104.0	15.7	10064	2.83	.295	.144	.312	32.9
15	18	BI	98.9	16.0	10711	2.82	.299	.140	.234	28.1
16	27	BI	97.8	15.2	10962	2.75	.290	.166	.284	33.7
17	36	BI	102.5	15.3	12054	2.73	.302	.168	.233	33.6
		PR>F	.8795	.2589	.3602	.8125	.9002	.3153	.3794	.4436
		LSD(0.05)	NS	1.5	1627	NS	NS	NS	.066	8.1
		C.V.	6.6	6.7	10.4	3.6	6.7	18.5	18.7	17.4

Table 2B. Replication effects, site 8740.

REP								
1	103.0	16.8	10883	2.77	.289	.162	.254	32.4
2	99.2	16.6	10659	2.83	.294	.168	.258	32.5
3	102.0	16.1	12148	2.83	.298	.179	.250	36.2
4	98.6	15.6	10687	2.80	.303	.169	.241	31.1
PR>F	.1803	.0154	.0009	.3216	.2345	.4437	.7394	.0759
LSD (0.05)	NS	0.8	814	NS	NS	NS	NS	3.9
C.V.	6.6	6.7	10.4	3.6	6.7	18.5	18.7	17.4

Table 3. Site 8740 - Analysis by method, P rate and interactions.

Table 3A.

METHOD	YIELD (BU/A)	MOISTURE %	DRY MATTER (LB/A)	LEAF P %	STOVER P %	GRAIN P %	APPARENT P RECOVERY % GRAIN	STOVER	TOTAL
BR	101.5	16.3	11564	.298	.174	.239	4.9	8.7	14.4
ST	99.2	16.3	10971	.299	.181	.247	7.0	11.7	18.7
KN	102.2	16.7	11029	.294	.168	.253	11.4	1.4	12.8
BI	100.8	15.5	10948	.296	.154	.266	24.2	0	11.7
PR> F	.6072	.0591	.4847	.9110	.1583	.3954	.1561	.3489	.9824
LSD (0.05)	NS	0.8	NS	NS	.024	NS	NS	NS	NS
C.V.	6.4	7.4	11.5	7.0	19.7	17.5	212.4	1730.7	369.7

Table 3B.

P RATE (Kg/ha)									
9	99.8	16.4	10847	.296	.152	.246	20.3	0	5.1
18	100.8	16.0	11318	.295	.170	.245	10.0	10.0	20.0
27	101.2	16.2	11251	.297	.181	.268	12.2	10.5	22.8
36	101.8	16.2	11096	.299	.174	.246	5.0	3.9	9.4
PR> F	.8613	.8413	.7352	.9610	.1206	.4045	.3659	.2545	.7379
LSD (0.05)	NS	NS	NS	NS	.024	NS	NS	NS	NS
C.V.	6.4	7.4	11.5	7.0	19.7	17.5	212.4	1730.7	369.7

Table 3C.

INTERACTION PR> F									
REP* P RATE	.6469	.8267	.7163	.8401	.6843	.2094	.8877	.9782	.9142
REP* METHOD	.1686	.8934	.9400	.8032	.5568	.5235	.4845	.5902	.4033
METHOD * P RATE	.6531	.8325	.3789	.7864	.8518	.1824	.0366	.9391	.7475

Treatment and replication means for site 8741 are given in Tables 4A and 4B. At this site, there were significant differences among treatments and replications in grain yield. The unfertilized check yield was 55 bu/A. Application of P by all methods significantly increased yield. Phosphorus also decreased grain moisture at harvest, increased total dry matter production, and increased leaf tissue P content. There was a significant replication effect, with yield and leaf tissue P increasing as the replications proceeded down slope, which also corresponded with increasing soil P levels.

Table 4A. Treatment effects, site 8741.

TRT	P RATE (kg/ha)	P METHOD	YIELD (BU/A)	MOISTURE %	DRY MATTER (LB/A)	LEAF N %	LEAF P %	STOVER P %	GRAIN P %	TOTAL P UPTAKE (LB/A)
1	0	--	55.0	18.6	7304	2.72	.221	.109	.192	14.2
2	9	BR	62.6	15.7	6562	2.77	.269	.120	.183	14.2
3	18	BR	78.6	15.5	8899	2.62	.284	.135	.223	21.9
4	27	BR	84.0	14.5	8822	2.64	.285	.138	.254	24.2
5	36	BR	84.3	14.4	10966	2.85	.307	.164	.258	29.8
6	9	KN	85.1	15.9	9893	2.73	.304	.142	.220	24.7
7	18	KN	86.2	15.2	10549	2.60	.274	.149	.228	26.8
8	27	KN	84.0	14.5	9248	2.79	.302	.126	.253	23.6
9	36	KN	87.9	16.4	9969	2.74	.312	.152	.217	26.7
10	9	ST	61.3	15.1	8465	2.60	.253	.145	.229	19.9
11	18	ST	86.7	15.4	8699	2.78	.300	.152	.250	27.3
12	27	ST	80.0	14.9	9872	2.73	.277	.128	.235	24.0
13	36	ST	87.0	14.3	10509	2.85	.310	.130	.244	25.4
14	9	BI	81.6	14.9	7609	2.82	.290	.155	.262	24.1
15	18	BI	86.5	13.9	9423	2.82	.307	.159	.253	27.2
16	27	BI	83.3	14.8	10570	2.87	.285	.156	.217	27.3
17	36	BI	80.5	14.9	9175	2.76	.298	.125	.236	22.0
		PR> F	.1182	.0008	.0266	.8740	.0534	.8927	.7498	.5591
		LSD (0.05)	19.3	1.6	2343	NS	.049	NS	NS	11.1
		C.V.	17.1	6.4	15.5	7.3	10.2	25.7	19.7	32.9

Table 4B. Replication effects, site 8741.

REP								
1	71.8	15.8	8791	2.72	.286	.143	.248	23.2
2	72.6	15.2	9244	2.62	.263	.133	.216	21.2
3	94.6	14.7	9588	2.90	.311	.146	.233	26.6
PR> F	.0001	.0112	.2790	.0014	.0002	.5487	.1424	.1378
LSD (0.05)	9.4	0.7	NS	0.14	.021	NS	NS	NS
C.V.	17.1	6.4	15.5	7.3	10.2	25.7	19.7	32.9

Tables 5A, 5B and 5C contain method, P rate and interaction effects for site 8741. There was a trend towards increased grain yield with the knife and band-incorporated treatments over the broadcast and starter treatments. This effect was most evident at the lowest P rate of 9 kg ha^{-1} (Figure 1). At the 18 kg P ha^{-1} rate, yield was maximized for all application methods except for the broadcast method, which required 27 kg P ha^{-1} to achieve the same yield that the knife and band-incorporated treatments achieved at 9 kg P ha^{-1}.

Apparent P recoveries calculated for application methods appear quite high, with trends towards greater recovery with the KN and BI treatments, with BR treatments recovering less fertilizer P, and intermediate recovery for ST treatments. Even though there is almost a two-fold difference in total apparent P recovery between the BR and KN methods, this difference was not significant at the 5% level due to high C.V. values. Apparent P recovery at different fertilizer P rates follows the expected trend of decreasing P recovery with increasing fertilizer P rate.

Table 5. Site 8741 - Analysis by method, P rate and interactions.

Table 5A.

METHOD	YIELD (BU/A)	MOISTURE %	DRY MATTER (LB/A)	LEAF P %	STOVER P %	GRAIN P %	APPARENT P RECOVERY % GRAIN	STOVER	TOTAL
BR	77.4	15.0	8812	.286	.139	.230	20.7	17.3	38.0
ST	78.7	15.0	9386	.285	.139	.240	29.1	31.1	60.2
KN	85.8	15.5	9915	.298	.142	.230	34.8	40.3	75.0
BI	83.0	14.6	9194	.295	.149	.242	39.3	34.7	74.0
PR>F	.2992	.1704	.3378	.6652	.8975	.8827	.3197	.2439	.2275
LSD (0.05)	9.6	0.8	NS	NS	NS	NS	NS	NS	NS
C.V.	14.4	15.01	15.6	10.4	25.6	20.8	80.1	89.2	76.8

Table 5B.

P RATE (Kg/ha)									
9	72.6	15.4	8132	.279	.141	.224	46.0	41.7	87.7
18	84.5	15.0	9393	.291	.149	.239	36.6	38.7	75.4
27	82.8	14.7	9628	.287	.137	.240	23.8	22.2	46.0
36	84.9	15.0	10155	.307	.143	.239	17.5	20.8	38.2
PR> F	.0606	.3192	.0204	.1895	.8756	.8239	.0483	.1690	.0609
LSD (0.05)	9.6	NS	1189	NS	NS	NS	20.3	NS	38.9
C.V.	14.4	15.01	15.6	10.4	25.6	20.8	80.1	89.2	76.8

Table 5C.

INTERACTION PR> F									
REP* P RATE	.0604	.6094	.3583	.3596	.5335	.6427	.0215	.1516	.0525
REP* METHOD	.2614	.3359	.5575	.6454	.3151	.5627	.3411	.2570	.3390
METHOD* P RATE	.5314	.2302	.2483	.6208	.8047	.6906	.2469	.3099	.3294

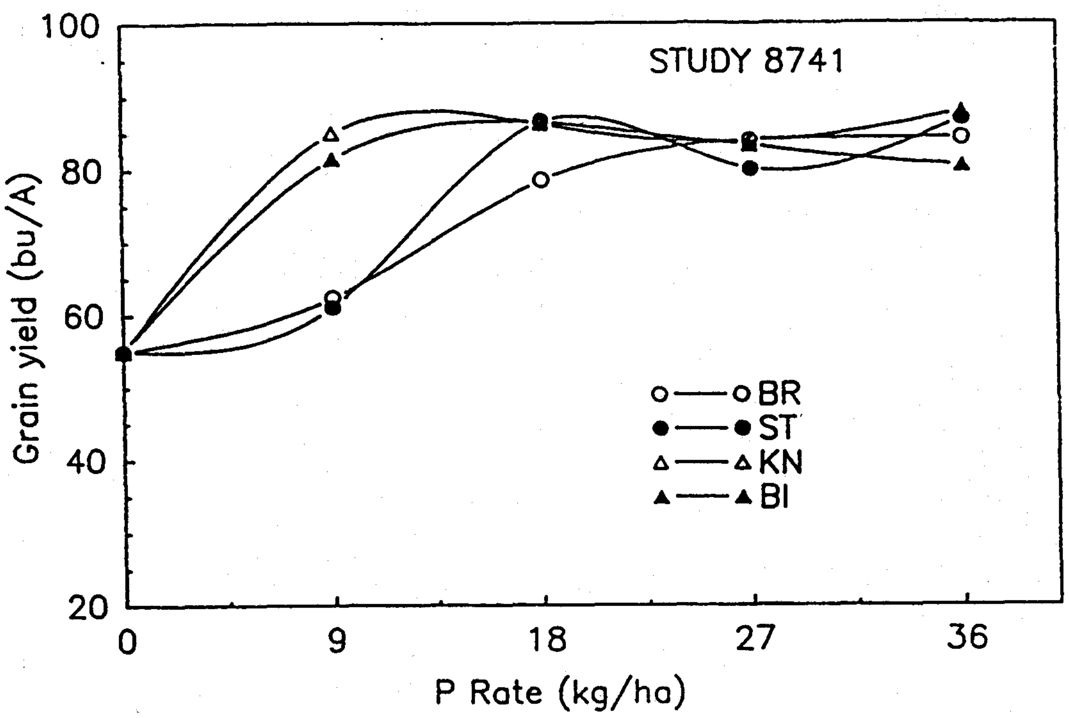


Figure 1. Site 8741, grain yield with different application methods.

Summary

Results from 1987 indicate that the KN and BI application methods appear to be more efficient than the BR and ST methods - optimizing yield at lower P rates and increasing the fertilizer use efficiency of the applied P. These responses were seen at site 8741, which responded to P fertilization. At site 8740, there was no yield response to P fertilization, and thus no effect of application method.

Soil samples taken from both sites across fertilizer bands are currently being analyzed. Preliminary data indicates that the fertilizer bands can be detected in this manner at both locations. A supplementary report will be provided when soils analysis is complete.

Plans for 1988 are to continue the study at two sites. The study will be repeated at the Bladen location (8741), again on grain sorghum, and at another site yet to be selected.

Progress Report on the B-K-R Demonstration Farm

Gary W. Hergert, Dennis Bauer, and Don Sander

During 1987 three fertilizer experiments were conducted on the B-K-R Demonstration Farm. The first was the continuation of a liming study that began in 1985. The second study was a soil test lab comparison experiment and the third was a rate and method of phosphorus experiment on corn.

I. Liming Study

Objectives:

1. To evaluate the effect of various lime sources and rates on crop yield on a acid sandy soil.
2. To demonstrate the economics of liming with various lime sources.

Procedure:

The experiment was established in 1985 on a Valentine Boelus fine sand. Soil analysis in the spring of 1985 showed a pH of 5.6, 1% Organic Matter, 34 ppm Bray 1P, 138 ppm K, and 0.8 ppm sulfur. The liming recommendation was 1,000 pounds of ag lime/acre. Four treatments including a check, broadcast and incorporated ag lime, broadcast and incorporated pelleted lime, and row applied pelleted lime were used. The broadcast pelleted lime rate was selected by spending the same dollar amount as was spent for the ag lime. Ag lime was broadcast April 18 and incorporated by a single disking. Treatments were laid out in replicated strips which ranged in width from 20 to 50 feet wide the length of the pivot. Four replications were used.

The plot area was sampled again by treatments in the spring of 1986 (Table 1). No difference in soil pH for the various treatments was shown and based on the soil tests 3000 pounds of ag lime was recommended. In 1986 the ag lime plot from 1985 was split. Half received no additional lime while the other half received the 3000 pounds of ag lime. The broadcast pelleted lime treatment was also split. Half did not receive any additional lime and the other half received a broadcast application of 1250 pounds of pelleted lime per acre. The liming rates in both 1985 and 1986 for the pelleted lime were based on spending the same amount of money for ag lime. All broadcast lime treatments were incorporated by single disking. Soybeans were planted in 1986.

In 1987 no additional treatments were applied and corn was planted following the soybeans. The pH values of the various treatments over time show an interesting effect (Table 1). Following the year of corn in 1985 the soil pH levels in 1986 had declined by about half a pH unit. In 1987 following the year of soybeans the pH had increased to its initial level at the start of the experiment. The reason for this change in pH is most likely the lime that is applied in the irrigation water during the growing season and the lack of nitrogen fertilizer. During years following corn production the pH is expected to drop because of the use of nitrogen fertilizer. The effects of the liming, however, were beginning to show significant results in 1987 even following the soybeans. There was a range in soil pH of one unit. The plots will be sampled in the spring of 1988.

Soybeans will be grown in 1988. There was a significant liming effect on soybean yield in 1986 (Table 2). The highest rate of lime produced a significantly better soybean yield than the check. Other treatments were intermediate. During both 1985 and 1987 no significant lime effect was shown for corn. Yields were lower in 1985 due to a mid-season hail storm. In 1987 the poor performance of the row applied lime cannot be explained. Stand counts were not taken, however, the application of the pelleted lime with the seed for corn may have reduced the stand and the yield potential. This treatment did yield significantly less than the other treatments.

Based on previous work liming on sandy soils may not be beneficial for corn until soil pH levels decline to less than pH 5.2. Liming did increase soybean yields in 1986. If the payback in a corn-soybean rotation is sufficient over a 5 to 8 year period liming can be recommended.

II. Soil Test Lab Comparison Experiment

A soil test lab comparison study conducted by the University of Nebraska for a number of years showed a wide range in fertilizer recommendations between a number of laboratories. These experiments did confirm the accuracy of the laboratories' analytical techniques. However, there was a wide variation in the recommendations. Most of these experiments were conducted on silt loam soils that were high to medium fertility.

The B-K-R demonstration farm provided an opportunity to select a site that had a very low fertility level to see if differences in recommendations still existed and if those recommendations performed differently on an infertile sandy soil. A second objective of this experiment was to determine if University fertilizer recommendations are indeed adequate to produce optimum economic yields. The University has a major responsibility to provide research information upon which fertilizer recommendations are made to commercial soil testing labs. These experiments provide a check on the University recommendations. This experiment was originated to enhance the value of soil testing which eventually benefits the entire agricultural community. It is fully expected that commercial soil testing laboratories will continue to handle a major portion of the soil testing business as the University Lab only tests about 5% of the soil samples in the state at this time.

Procedure: A composite soil sample was taken out of the four replications for a given laboratory and sent to that laboratory under a farmer's name. The four laboratories selected were A&L Laboratories, Harris, Servi-Tech, and UNL. The actual soil test results are shown in Table 3. There was fairly good agreement between the different soil test levels and the analysis did show that the site was low in most nutrient levels. The biggest variation in analytical values for sulfur. UNL uses a 0.1 N HCL test whereas commercial labs use DTPA.

Laboratories were provided with information on soil type, suggesting a yield goal of 165 bushel corn. The actual fertilizer recommended by the different laboratories is shown in Table 4. Corn variety Horizon 4112 was planted April 30, 1987 and harvested October 13. To provide for the best nitrogen management between laboratories all of the nutrients plus 40 pounds of nitrogen was applied preplant to each of the plots. The remaining amount of nitrogen was applied as a sidedress application of ammonium nitrate when the corn was approximately 2 feet tall. This method of fertilizer application allowed incorporation of broadcast phosphorus, sulfur, zinc, and other micronutrients or secondary nutrients. It also provided a split application for the nitrogen to best utilize the nitrogen that was recommended by the laboratories.

Table 5 shows the fertilizer costs that were used to compute the costs in Table 4. The total cost ranged from $61.65 to $121.10 (Table 4). The University recommendations were not the lowest as shown in Table 4. Fertilizer sources used are shown in Table 6. The yields attained (183 bu/A) were excellent and exceeded the yield goal (165 bu/A) (Table 7). There was no significant difference between any of the laboratories.

The results from this one year study are not different than those attained over the 15 year history of soil test lab comparison experiments previously conducted by UNL. The information shows that the laboratories are doing a good job of providing analytical results although differences in recommendations remain. Two laboratories (UNL and Servi-Tech) are recommending on a deficiency correction basis and both produced very good yields. The results confirm that the deficiency correction approach does not limit yields if the yield attained is above the specified yield goal. If this were not true, the higher N, P, K, and S rates of A&L and Harris would or should have produced a higher yield. The Servi-Tech Laboratory actually produced the yield at a lower cost than UNL. The other two laboratories' costs were increased by larger additions of nitrogen, potassium, sulfur, micronutrients and secondary nutrients. Past research on Nebraska soils show that many of these nutrients often do not provide economic yield increases.

III. Phosphorus Rate and Method Experiment

What is the best method to apply phosphorus for corn grown on sandy soils? Does the initial soil test level influence the method and rate that are required for maximum production? These two questions were the primary guides in designing a phosphorus experiment at the B-K-R Demo Farm.

Phosphorus was applied to 80' by 80' blocks in the spring of 1986. The phosphate rate applied was 0, 40, or 80 lbs/P_2O_5/A. A corn crop was grown on this area in 1986. In the spring of 1987 soil samples were taken from this area and showed that the check area had a soil test level of about 5 ppm P, the area fertilized with 40 pounds of phosphate had a soil test level of about 9 ppm and the area receiving 80 had a soil test level of 13 ppm P. A phosphorus rate by method experiment was designed for this area and fertilizer was applied in the spring of 1987. The phosphorus application methods used included broadcast, deep banded or knifed in and row application at planting time. 10-34-0 was the phosphorus fertilizer used for each method. Nitrogen rates were balanced by inclusion of nitrogen solution so nitrogen was balanced between all treatments. Phosphorus rates were 0, 15, 30, 45, 60, and 75 pounds of phosphate/A.

The preliminary results (Table 8) show that at all initial soil test phosphorus levels the row application was significantly better than the broadcast or the deep band. Since this soil test is very low in phosphorus the 75 pounds phosphorus rate may not have been sufficient to maximize yield but the range of rates used encompassed the responsive range and allowed separation of method effectiveness.

Since there was not a significant initial phosphorus level by method by rate interaction, data was averaged over initial soil test levels to show the phosphorus response of the different methods. This information is shown in Figure 1 and compares row applied against the average of deep banded and broadcast phosphorus. The curves are visual extrapolations as the regressions have not been completed yet. This experiment will be continued in 1988.

Table 1. pH values in the 0-8 inch depth before planting and lime application.

	1985	1986	1987
Check	5.6	5.1	5.7
Ag Lime - 85	5.6	5.1	6.0
Ag Lime - 85 & 86	5.6	5.1	6.3
Pelleted - 85	5.6	5.1	5.9
Pelleted - 85 & 86	5.6	5.1	6.1
Row-applied	5.6	5.0	5.7

Table 2. Yields for the B-K-R liming experiment in bu/A.

	Corn 1985	Soybeans 1986	Corn 1987
	bu/A		
Check	115 a*	45.9 b	154 ab
Ag Lime - 85	118 a	47.7 ab	158 a
Ag Lime - 85 & 86	---	51.4 a	154 ab
Pelleted - 85	114 a	46.1 b	151 ab
Pelleted - 85 & 86	---	45.4 b	152 ab
Row-applied	117 a	47.6 ab	142 a
CV	4%	6%	7%

*Values followed by the same letter are not significantly different at the 10% level of probability.

Table 3. Soil test results for the B-K-R soil tst lab comparison, 1987.

Laboratory	pH	O.M.	P	K	Zn	S
			ppm			
A&L	5.9	1.8%	7	98	0.8	9
Harris	6.0	1.7%	4	107	0.8	2
Servi-Tech	6.2	1.7%	5	146	0.8	6
UNL	6.0	1.5%	5	125	2.7	1

Table 4. Fertilizer recommended for 165 bushel corn.

Laboratory	N	P	K	S	Fertilizer Bill-NPKS
	--------------lbs/A------------				
A&L	220	110	140	25	$87.00
Harris	195	135	125	35	$90.30
Servi-Tech	165	95	25	15	$57.60
UNL	170	100	40	20	$62.70

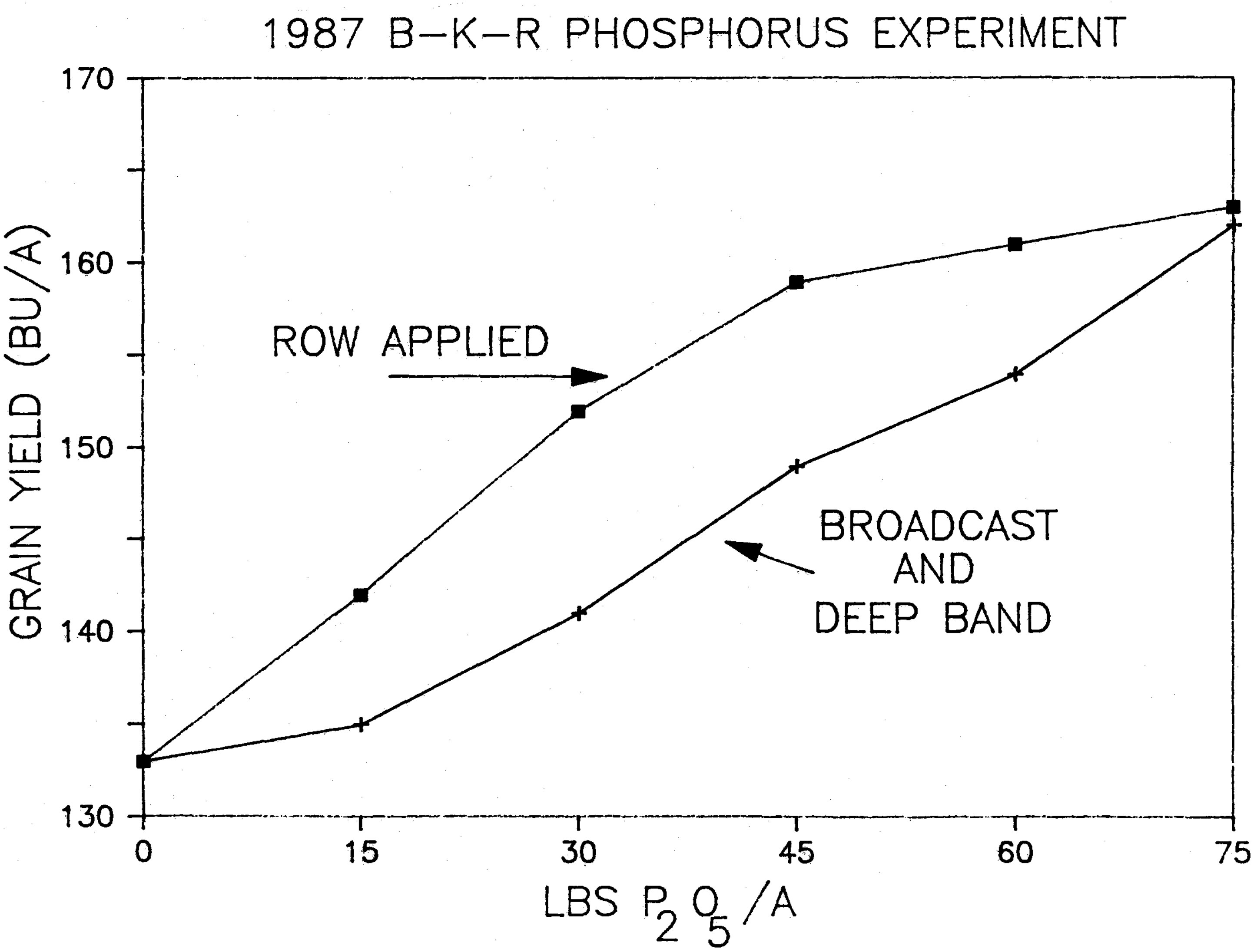
	Mg	Zn	B	Cu	Mn	Total Bill
	-------------------lbs/A-----------------					
A&L	22	5	1.0	1.5	3.5	$109.11
Harris	20	10	1.5	2.3	5.5	$121.10
Servi-Tech	0	3	0.5	0	0	$ 61.65
UNL	0	3	0	0	0	$ 65.40

Table 5. Fertilizer costs used for the B-K-R soil lab comparison experiment.

Element	Cost/lb
N	$0.15
P	0.28
K	0.13
Mg	0.38
S	0.20
Zn	0.90
Mn	0.80
Cu	2.50
B	2.70

Table 6. Fertilizer sources used in the B-K-R soil lab comparison experiment.

Ammonium nitrate	34-0-0
TSP	0-46-0
KCL	0-0-60
S	21-0-0
Zn	$ZnSO_4$ H_2O
Mg	$MgSO_4$ $7H_2O$
Cu	$CuSO_4$ $5H_2O$
B	SOLU B
Mn	$MnSO_4$ $3H_2O$



1987 B-K-R PHOSPHORUS EXPERIMENT
170
160
150
140
130
GRAIN YIELD (BU/A)
ROW APPLIED
BROADCAST
AND
DEEP BAND
0
15
30
45
60
75
LBS P2O5/A

DYNAMICS OF WATER IN RIGID AND SWELLING SOILS

D. Swartzendruber

Objective:

The general objective of this report is to analyze and quantify the processes by which water flows into and through porous media and soils under both saturated and unsaturated conditions. Swelling and nonswelling soils are considered.

Procedure:

As far as reasonably possible, each flow process is approached as a mathematical boundary-value problem to be solved by classical mathematical means or by computer if necessary. Experiments are conducted in the laboratory with vertical flow columns on which measurements of water content and soil bulk density are obtained by the attenuation of dual-energy gamma radiation. Other flow measurements are taken as needed.

Results and Discussion:

Eleven different forms of published infiltration equations have been compared with each other by means of dimensionless variables in time and in quantity of water infiltrated. All equations agree with each other in the limit of both very small and very large times. At intermediate times, however, the discrepancy between equations reaches as high as on the order of 55%. Nonetheless, seven of the eleven equations fall within a band of ± 10% of each other. One of the familiar equations falling outside this band is that of Green and Ampt.

Even for the equations with the largest discrepancies between each other, a 3-parameter dimensionless infiltration equation, derived exactly from a quasi solution of Richards' equation, will serve as a universal form (within ± 0.31% error) for all eleven of the previously published equations. If the universal equation is expressed in simplest form (1 parameter dimensionless or 3 parameters dimensional), the agreement is still within ± 2.5% for nine of the eleven equations. Hence, this 3-parameter form has been proposed as a theoretically based equation of broad capability for describing the infiltration process quantitatively in both laboratory and field. Further theoretical work confirms the utility of this 3-parameter form.

Analysis has continued on the very extensive laboratory data obtained for water infiltration into upward swelling columns of an equal-part mixture of Wyoming bentonite and quartz silt. A mathematical solution has been sought in terms of the material coordinate and a specially modified diffusivity function. Other characterizing functions have also been introduced, and appear to have merit and promise.

HIGH YIELD CORN - SOYBEAN- WHEAT ROTATION STUDY

W. R. Peterson, D. T. Walters, and R. A. Olson

Objectives: To examine the response of corn yield as a result of being in a corn-soybean-wheat rotation with all crops irrigated as required on a Sharpsburg sicl. To evaluate the energy efficiency of a corn-soybean-wheat rotation and monoculture corn as influenced by nutritional requirements.

Procedure: Plots were established in 1981-82 using a corn-soybean-wheat rotation and continuous corn. Design was such that every crop is produced every year. Rotation was designated as the whole plot factor. Nine fertility treatments are applied as the subplot factor. These include a check, three rates of N, two rates of P and K with singular rates of manure, S, Zn, Cu and B. Highest rates of nitrogen are employed for corn while 1/2 and 1/4 the corn nitrogen rate are applied to wheat and soybeans respectively.

Results: The growing season for 1987 was favorable although yields of corn and soybeans were less for 1987 than for 1986. Wheat yields in 1987 were near normal. Limited irrigation was required for corn and soybeans in 1987. Corn was irrigated three times and soybeans were irrigated twice.

Table 1 gives crop yield response of corn, soybeans and wheat for the various treatments. Only soybeans failed to give a yield response to added fertilizer. The check treatment yield for soybeans was not significantly different from the remainder of the treatments. The manure treatment is a consistent performer in terms of producing one of the top yields for all crops. In 1987 only continuous corn required additional nitrogen above that provided by manure to produce maximum yield.

The result of analysis of variance is given in Table 2. The rotation effect was highly significant in 1987. Corn grown in rotation with wheat and soybeans consistently outyielded corn grown continuously (Table 1).

The energy yield per hectare of corn, wheat and soybeans is given in Table 3. Corn grown in rotation produced the greatest amount of energy, consistently outproducing corn grown continuously. Soybeans produced less energy per hectare than corn but greater amounts than wheat.

Wheat is a low energy output crop but also does not require large amounts of energy to produce a crop (Table 4). The energy efficiency for wheat is also given in Table 4. Wheat responded to fertilizer in terms of both additional grain yield and increased energy efficiency. The manure treatment produced the highest grain yield and the greatest energy efficiency for wheat in 1987.

Soybeans did not respond to fertilizer in 1987 (Table 1). As a result, the check treatment produced the highest energy efficiency for soybeans in 1987 and the 1985-1987 average (Table 5). Soybeans have consistently failed to respond to added fertilizer. No statistically significant yield increase has resulted from additional fertilizer in the years 1985, 1986, or 1987 for soybeans.

Table 6 gives the energy use and efficiency for corn grown continuously and corn grown in rotation. There was a definite advantage for corn grown in rotation versus corn grown continuously in 1987, both in terms of yield and energy efficiency. The check plot for rotation corn yielded very well in 1987 and has performed much better than the check plot for corn grown continuously. The difference in yield between rotation corn and continuous corn tends to decrease with greater amounts of added fertilizer (Table 1).

The overall energy efficiency of a corn-woybean-wheat rotation versus continuous corn is presented in Table 7. There is a definite advantage for the rotation in terms of efficiency. Corn grown continuously was able to produce more total energy per hectare but the efficiency of energy production was lower than for the corn-soybean-wheat rotation.

Table 1. Grain yields in high yield rotation experiment, 1987. Mead field lab on Sharpsburg sicl.

Treatment[1] lb/A	Average grain yields bu/a[2] Rotation Corn	Rotation Soybeans	Rotation Wheat	Continuous Corn
1. Control	129b	44a	24c	51c
2. 20T manure[3]	165a	44a	45a	100b
3. 80+0+0	148ab	47a	26c	101b
4. 160+0+0	159a	46a	31bc	128a
5. 160+40+0	152ab	49a	43a	122a
6. 160+40+40	149ab	45a	31bc	124a
7. 160+40+30+20S+10Zn+1B+0.5Cu	140ab	46a	37ab	133a
8. 320+80+80	150ab	49a	45a	134a
9. 160+40+40+20T manure[3]	177ab	49a	40ab	128a

[1] Wheat receives one-half the N rate of corn, soybeans one-fourth.
[2] Means followed by the same letter within a column are not significantly different at the 5% level.
[3] 20T manure applied in alternate years.

Table 2. Analysis of variance for the comparison of continuous vs. rotated corn yields, 1987.

Sources	Prob. $\geq$ F
Rotation	0.0010
Treatment (T)	0.0001
R x T	0.0001

Table 3. Energy yields of corn, wheat, soybean rotation versus continuous corn, 1987. Mead Field Lab on Sharpsburg sicl.

Treatment	Yield Mcal/ha			
	Rotation			
	Wheat	Soybeans	Corn	Continuous Corn
1	5311	11920	28032	11169
2	9958	11920	36135	21900
4	6860	12462	34821	28032
8	9958	13275	32850	29346
9	8851	13275	31755	28032

Table 4. Energy use and efficiency for wheat Mcal/ha

Treatment	1	2	4	8	9
Machinery			360.18		
Gasoline			374.74		
Diesel			519.34		
Electricity			42.43		
Nitrogen	0	0	1300.00	2600.00	1300.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Seed			12.74		
Herbicide			223.71		
Transportation			41.39		
Total	1574.53	2854.63	2874.53	4592.72	4093.72
Yield (1987)bu/A	24	45	31	45	40
Kcal output/ Kcal input	3.4	3.9	2.4	2.2	2.2
Avg. yield (85-86)	31	49	32	42	44
Kcal output/ Kcal input	4.4	4.2	2.5	2.0	2.4

Table 5. Energy use and efficiency for irrigated soybeans Mcal/ha.

Treatment	1	2	4	8	9
Machinery			210.42		
Gasoline			242.62		
Diesel			616.35		
Irrig. Diesel			301.71		
Irrigation (2")			472.24		
Nitrogen	0	0	650.00	1300.00	650.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Herbicide			307.73		
Seed			585.60		
Transportation			38.29		
Total	2774.96	3785.06	3424.96	4493.15	4644.15
Yield 1987	44	44	46	49	49
Kcal output/ Kcal input	4.3	3.1	3.6	3.0	2.9
Avg. yield 85-87	49	52	53	57	57
Kcal output/ Kcal input	4.9	3.8	4.3	3.5	3.3

Table 6. Energy use and efficiency for irrigated corn Mcal/ha.

Treatment	1	2	4	8	9
Machinery			990.00		
Gasoline			267.79		
Natural Gas			16.54		
Electricity			869.81		
Nitrogen	0	0	2600.00	5400.00	2600.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Seed			504.50		
Irrigation			472.24		
Diesel			981.60		
Irrig. Diesel (8")			1185.00		
Insecticides			439.97		
Herbicides			174.84		
Transportation			49.40		
Total	5951.69	6961.79	8551.69	11769.88	9770.88
1987 yield continuous corn	51	100	128	134	128
Kcal output/ Kcal input	1.9	3.1	3.3	2.5	2.9
Rotated corn	129	165	159	150	145
Kcal output/ Kcal input	4.7	5.2	4.1	2.8	3.3
Avg. Yield (85-87)					
Continuous corn	76	139	159	154	165
Kcal output/ Kcal input	2.8	4.4	4.1	2.9	3.7
Rotated corn	143	177	185	195	175
Kcal output/ Kcal input	5.3	5.6	4.7	3.6	3.9

Table 7. Corn-soybean-wheat rotation energy yield per acre and energy efficiency of corn-soybean-wheat rotation versus continuous corn, 1987.

Treatment	Energy Yield Mcal/yr/ha		Energy Efficiency Mcal produced/Mcal consumed	
	Rotation corn-soybean-wheat	cont. corn	Rotation corn-soybean-wheat	cont. corn
1	13,088	11,169	4.4	1.9
2	19,338	21,900	4.4	3.1
4	18,048	28,032	3.6	2.3
8	18,694	29,346	2.7	2.5
9	17,960	28,032	2.9	2.9

INFLUENCE OF LANDSCAPE POSITION ON CROP PRODUCTION AND PROFITABILITY

A. J. Jones, L. N. Mielke, C. A. Bartles and C. A. Miller

Objectives: to auqntify topsoil thickness, nutrient status and crop produc tivity of several landscape positions within an eroded field.

Procedures:

Experimental sites were established on five farm fields in southeastern Nebraska in the spring of 1985. Soil and crop information was obtained from six different landscape positions on each field in 1985 and 1986. The positions include upper interfluve (UL), lower interfluve(LI), shoulder (S), upper linear (UL), lower linear (LL) and foot (F) slopes (Fig. 1). For each landscape position topsoil thickness, slope gradient and length, nutrient status and crop yields were evaluated. Combinations of crop sequence over a two-year period for the experimental sites include continuous sorghum, corn-soybeans and soybeans-sorghum.

Results and Discussion:

Topsoil Thickness

Topsoil thickness among the landscape positions of the experimental sites ranged from 0 to 18 inches (Table 1). These values were compared to the topsoil thickness of the noneroded phase of the soil type as designed in the SOILS-5 data base and are expressed as a percentage of topsoil remaining. From 0 to almost 60% of the potential topsoil was present on the hillslopes monitored. Topsoil thickness was not highly correlated with slope gradient or slope length. There did exist, however, a general tendency for the percentage of topsoil remaining to decrease with increaseing slope gradient. A general ranking of landscape positions illustrates that the UI, LI and F slopes had the greatest percentage of topsoil remaining while the UL and LL slopes have the lowest percentage of topsoil remaining.

Nutrient Status

Evaluation of several soil chemical properties indicate that little reduction in nutrient supplying capacity has been lost in the erosion process. This is indicated by the small variation and lack of a strong trend in each property across landscape positions (Table 2). Nutrient levels, except nitrate-nitrogen (NO_3-N) are considered to be adequate for crop production according to university soil test recommendations. The adequacy of NO_3-N is dependent upon the crop to be grown and nitrate content of the lower soil profile.

Crop response

Crop yields were highly variable across experimental sites thus, demonstrating the impact of local climatic conditions, soil type and management practices on productivity. However, variation in yield among landscape positions with average field yield, corn, soybeans and sorghum generally showed yield above average for corn on LI and F slopes, for soybeans on LI, S and F slopes, and for sorghum on UI and LI slopes (Fig. 2). Upper and lower linear landscape positions were associated with poorest production for all three crops.

Table 1. Characteristics of topsoil thickness and topography for six landscape positions within experimental fields.

Site/Characteristic	Landscape Position[3/]					
	UI	LI	S	UL	LL	F
Crete						
Topsoil thickness (in)	14	8	5	5	4	15
Topsoil remaining (%)	39	22	14	14	11	42
Slope gradient (%)	3	4	3	4	5	2
Slope length (ft)	150	325	250	300	300	75
Hastings						
Topsoil thickness (in)	7	7	5	0	0	18
Topsoil remaining (%)	13	13	10	0	0	35
Slope gradient (%)	4	4	9	18	16	5
Slope length (ft)	170	220	250	180	210	40
Moody						
Topsoil thickness (in)	4	16	8	0	0	18
Topsoil remaining (%)	20	80	40	0	0	90
Slope gradient (%)	1	2	4	5	6	1
Slope length (ft)	80	360	560	100	200	100
Sharpsburg						
Topsoil thickness (in)	7	7	8	4	6	10
Topsoil remaining (%)	29	29	33	17	25	42
Slope gradient (%)	2	2	6	9	9	2
Slope length (ft)	70	100	50	90	130	175
Wymore						
Topsoil thickness (in)	14	14	10	8	6	13
Topsoil remaining (%)	58	58	42	33	25	54
Slope gradient (%)	1	1	2	3	4	4
Slope length (ft)	45	150	390	465	30	50

[3/] Abbreviations for landscape positions are UI-upper interfluve; LI-lower interfluve; S-shoulder; UL-upper linear; LL-lower linear; F-foot slope.

Table 2. Nutrient status for six landscape positions averaged over five experimental fields.

Nutrient	Landscape Position [4/]					
	UI	LI	S	UL	LL	F
pH	5.6	5.5	5.5	5.4	5.6	5.6
Organic matter (%)	2.4	2.2	2.4	2.5	2.2	2.3
NO_3-N (ppm)	22.4	19.0	26.0	24.6	18.3	15.6
Phosphorus (ppm)	23.7	20.5	26.1	39.5	35.7	37.9
Potassium (ppm)	358.	365.	370.	494.	392.	340.
Zinc (ppm)	4.0	4.6	4.1	5.6	5.5	5.1

[4/] Abbreviations for landscape positions are UI-upper interfluve; LI-lower interfluve; S-shoulder; UL-upper linear; LL-lower linear; F-foot slope.

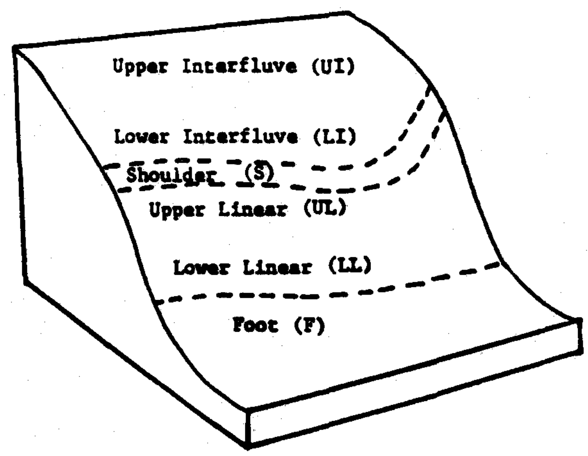


Fig. 1. Generalized physiographic representation of landscape positions.

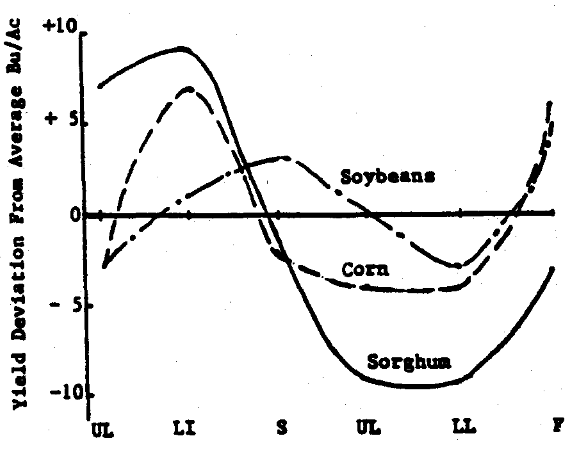


Fig. 2. Average deviation in crop yield based on field average for each crop-location year.

MICROBIAL ACTIVITY AND AVAILABLE SOIL N AS REGULATED BY SOIL WATER-FILLED PORE SPACE

John Doran and Lloyd Mielke

OBJECTIVE

The present study was initiated to evaluate the utility of soil water-filled pore space as a practical index of aerobic and anaerobic microbial processes and N transformations across a range of soils varying in texture, organic matter status, and previous management. Water-filled pore space was chosen as a practical index of soil aeration status since it integrates the effects of tillage on both soil porosity and water content, requires only measurement of soil bulk density and water content, and thus can be utilized by a greater number of researchers and farmers.

PROCEDURES

Eighteen soils for experimentation were collected from surface soil A horizons of benchmark sites in Major Land Resource Areas in the USA and represented 9 of 10 taxonomic soil orders. The soils varied in texture, organic matter content, and management history with respect to cropping, native vegetation, and soil cultivation (Table 1). To reestablish soil biological activity after collection and storage, soils were pre-conditioned before experimentation by cropping to oats (*Avena sativa* L.) and, where necessary, were limed to achieve a pH of 6.5 to 7.0 and amended with N or P to narrow factors limiting plant and microbial growth to those of primary interest-namely soil aeration and water content.

Soils were hand compacted to bulk densities representative of both natural reconsolidation values and those after a normal equipment load in the field (47.9 kPa) at a soil water tension of 10 kPa. Experimental treatments for each of the 18 soils consisted of five soil water content levels Approximating water-filled pore spaces of 30, 45, 60, 75, and 90%. Soil water-filled pore space, synonymous with relative saturation, was calculated from the quotient of soil volumetric water content divided by total soil porosity. Soil porosity was calculated from soil bulk density assuming a soil particle density of 2.65 g/cm^3.

Soil respiration from repacked soil cores, a measure of aerobic microbial activity, was estimated from carbon dioxide produced over a four week period. Anaerobic microbial activity was estimated from soil denitrification as determined by measurement of nitrous oxide produced over the second to third week periods in incubation chambers to which 10% acetylene was added to block reduction to N_2. Net mineralization of N was determined through comparison of initial and final ammonium and nitrate levels in 2*M* KCl soil extracts.

RESULTS

Soil respiration in repacked cores for 16 of the 18 soils tested responded in a similar manner to the proportion of soil pore space filled with water (Fig. 1). Soil respiration increased 20 to 60% with increasing water content attaining maximum values between 55 and 61% WFPS after which further increases of water to between 80 and 90% WFPS resulted in decreases in respiration of 20 to 60%. The respiration data presented in Fig. 1 were expressed as relative comparisons to the maximum carbon dioxide produced from each soil to normalize large differences in soil organic C and other chemical characterisics between soils and permit better evaluation of the direct effects of soil WFPS among soils. A quadratic model of WFPS with relative soil respiration within three soil groupings provided an excellent fit for the experimental data (R^2=0.58 to 0.87, $p<0.0001$). Response of coarse textured soils, having a sand content > 50%, varied somewhat from that of medium to fine textured soils and the WFPS for maximum respiration, as determined from the first derivative of the quadratic relationship, was somewhat lower than finer textured soils (54.1% versus 60.7%). Also, increases in relative respiration

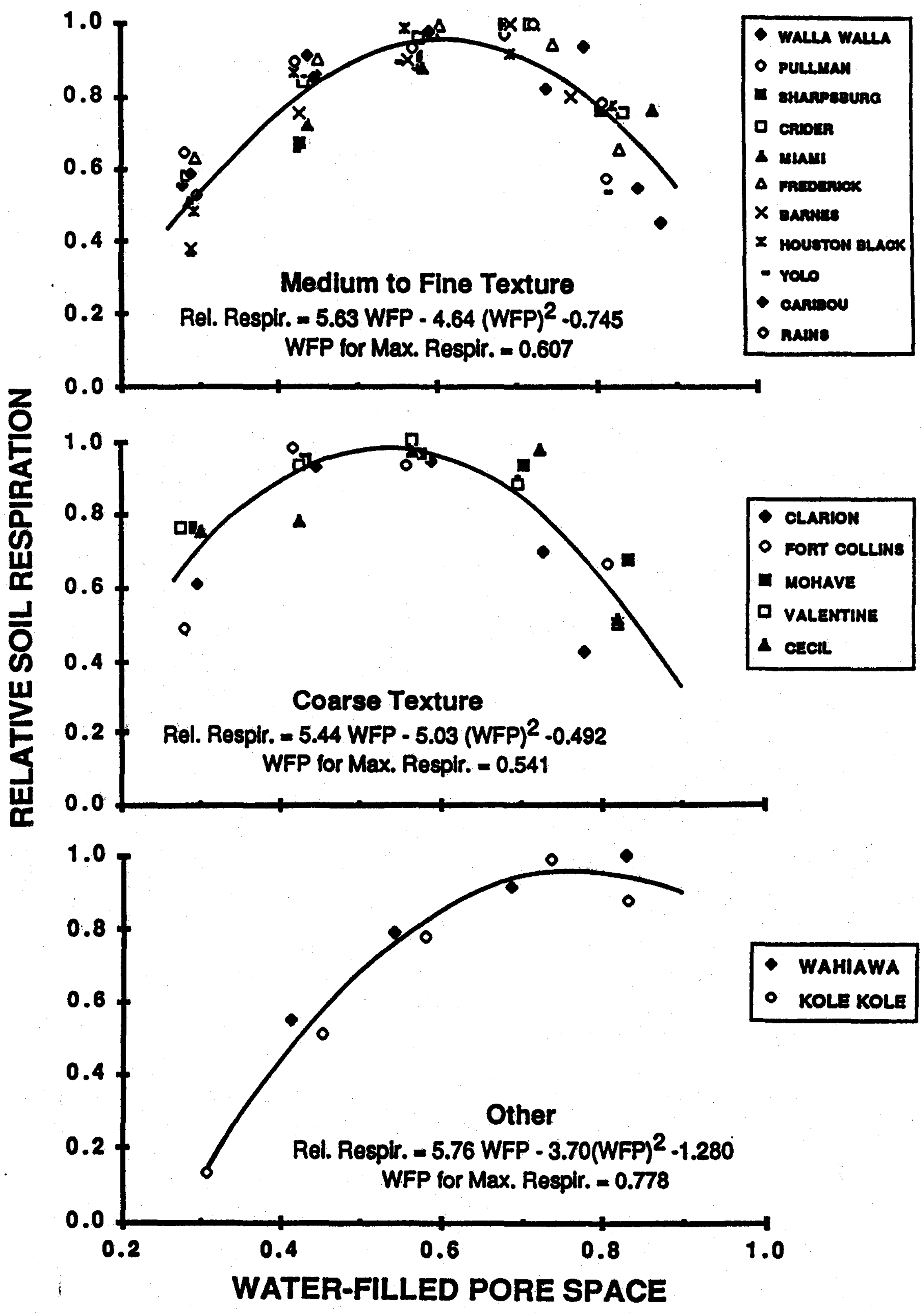


Fig. 1. Relationship between soil water-filled pore space and relative soil respiratic for repacked cores of 18 benchmark soils grouped by soil texture or structure.

for coarse textured soils with increasing water content were somewhat smaller at WFPS below the optimum for maximum respiration and decreases with increased water above the optimum were somewhat greater than those in medium to fine textured soils. Soil respiration differed in two highly weathered Hawaiian soils, which had a very fine granular structure, and increased until soil WFPS exceeded about 78%.

Changes in soil nitrate-N over the four week incubation period were related to to soil WFPS in a manner similar to those for soil respiration. Maximum accumulation of nitrate-N over the four week incubation occurred at WFPS of 56 to 72% for 16 soils and 74 and 83% for the two Hawaiian soils. Major losses of nitrate-N of from 7 to 90 mg N/kg soil for most soils occurred where WFPS exceeded 75%. These losses of nitrate-N, equivalent to 8 to 63% of the amounts accumulated under presumably more aerobic conditions at lower WFPS values, coincided with anaerobic microbial denitrification which increased exponentially when WFPS exceeded 70 to 75% (Fig. 2). Nitrate accumulation in the highly weathered Hawaiian soils increased with WFPS up to 74% for the Kole Kole loam and 83% for the Wahiawa clay with no significant denitrification losses of N from either soil at average WFPS values of 84 and 82%, respectively.

DISCUSSION

For a wide range of soils the percentage of soil pore space filled with water appears well correlated with aerobic and anerobic microbial activity and associated processes of respiration, mineralization, and denitrification. Results of this study agree with earlier findings with fewer soils that aerobic microbial activity increases in a linear manner with increasing water content between 30 and 60% WFPS and then declines above 60 to 70% WFPS, presumably a result of further water presenting a barrier for diffusion of oxygen to soil microorganisms.

In earlier research 80% WFPS was proposed as the point at which significant denitrification would occur in most soils, given adequate supply of available C and nitrate-N, and that at 60% WFPS little or no denitrification would occur. This postulation was confirmed in the present study for a wide range of soils in which denitrification was absent below 63% WFPS but increased exponentially at WFPS exceeding 70 to 75% in all but two Hawaiian soils which differed considerably in soil physical properties and presumably pore-size distributions.

CONCLUSIONS

The proportion of soil pore space filled with water appears useful for simultaneously evaluating the effects of soil bulk density and water content on aeration-dependent microbial processes as related to tillage-induced changes in the soil physical environment. The consistency of relationship between soil WFPS and microbial activity for a wide range of soils enhances predictions of tillage management effects on aeration- dependent microbial processes over a range of climatic and soil drainage conditions. Of particular importance is the utility of WFPS to predict potential losses of soil and fertilizer nitrate-N through microbial denitrification. We are currently developing simplified equations for use by researchers and farmers to predict changes in available soil nitrate-N as related to soil WFPS. This information should greatly aid management decisions which improve fertilizer N use efficiency and reduce groundwater contamination by nitrate.

Table 1

Soil characteristics, experimental soil bulk density, and soil nitrate-N change in 4 weeks as influenced by % water-filled pore space (WFPS) for repacked cores of 18 surface soils.

Soil series	Organic C (%)	Soil particle size % sand	Soil particle size % clay	Bulk density (Mg/m3)	Maximum Nitrate-N Accumulation WFPS	Maximum Nitrate-N Accumulation mg/kg*	Maximum Nitrate-N Loss WFPS	Maximum Nitrate-N Loss mg/kg*
Walla Walla sil	1.14	16	16	1.10	58	23	86	36
Barnes l	2.34	39	23	1.20	70	9	77	22
Pullman sicl	0.96	18	30	1.10	60	15	82	22
Sharpsburg sicl	1.80	3	34	1.10	69	12	81	13
Houston Black sic	1.61	12	46	1.00	70	16	82	16
Crider sil	2.12	3	22	1.10	-	-	84	26
Miami sil	1.26	29	20	1.20	72	18	87	11
Yolo sil	1.33	22	24	1.20	68	17	82	9
Frederick sil	2.21	19	17	1.10	-	-	83	35
Rains sil	3.29	33	14	1.10	72	33	81	40
Caribou l	2.55	39	12	1.00	59	44	89	90
Clarion sc	1.40	53	18	1.20	59	12	78	27
Valentine s	0.90	90	3	1.35	57	5	82	29
Mohave scl	0.73	54	22	1.20	71	15	84	17
Fort Collins scl	0.81	55	26	1.20	56	12	81	7
Cecil sl	3.14	70	14	1.10	57	17	82	59
Kole Kole l	3.46	49	14	1.10	74	5	83	3
Wahiawa c	1.30	7.3	58	1.10	83	22	-	0

* mg/kg X 1.5 approximates pounds/acre 6 inches

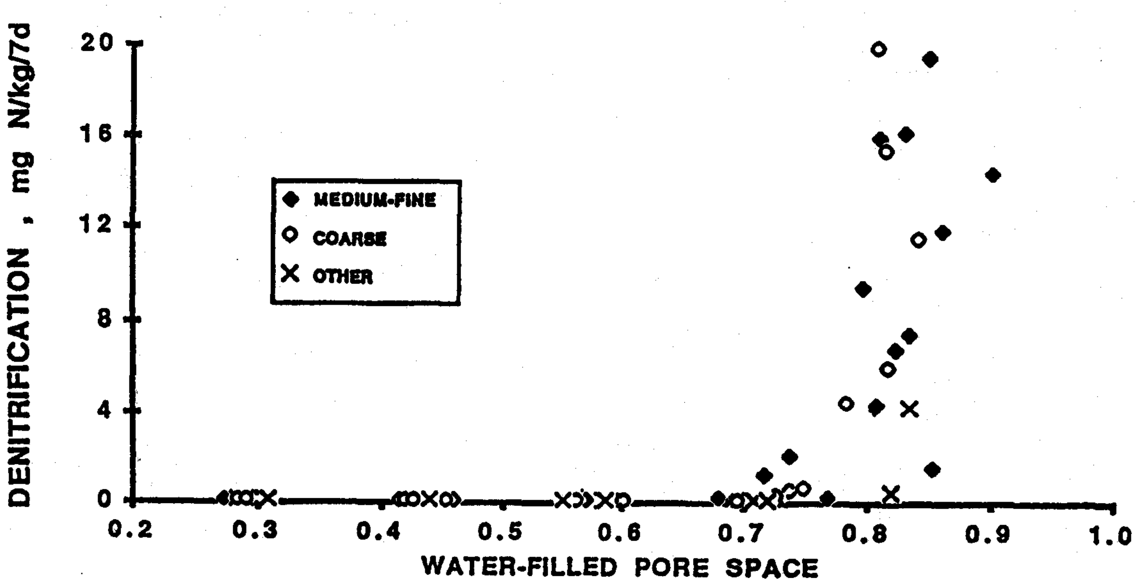


Fig. 2. Relationship between soil water-filled pore space and soil denitrification over 7 days for repacked cores of 18 benchmark soils grouped by soil texture or structure.

PRECIPITATION PROBABILITY MODELING

A. J. Jones, S. Samson and K. Hubbard

Objective: To develop a user friendly , PC-based computer model which will provide precipitation probability information in tabular and map form.

Procedures: Daily historical precipitation records from approximately 20 stations across Nebraska was retrieved from computerized data bases for use in modelling. A computer program was written to provide precipitation data, summary statistics and precipitation probabilities for each station on a daily, weekly monthly or annual basis based on user input.

Results: Computer software is supplied on two-5-1/2 inch floppy disks. Data from the 20 sites are stored on an additional 10 diskettes. Selected information is presented to illustrate the diversity of information which can be obtained.

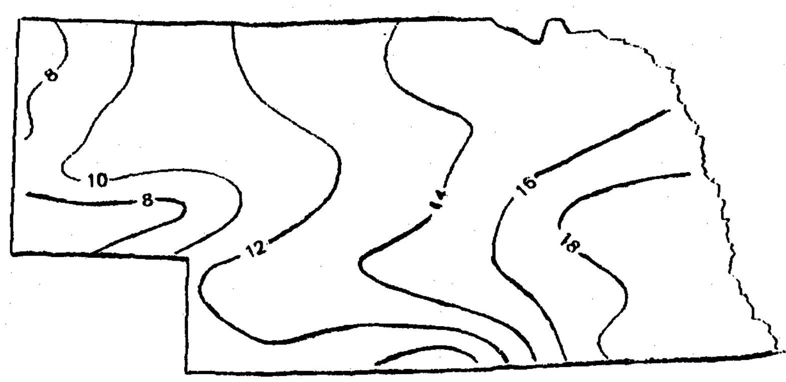
Table 1. Monthly precipitation for Halsey, NE. 1934-83.

	Average	50% Prob.
	--------- in.	---------
January	0.51	< 0.01
February	0.65	0.04
March	1.32	0.07
April	2.36	0.35
May	3.42	0.56
June	3.55	1.07
July	2.66	0.66
August	2.62	0.33
September	1.87	0.15
October	1.15	0.04
November	0.74	< 0.01
December	0.56	< 0.01

Table 2. Probability of receiving precipitation of 0.1 to 2.0 inches during 6 weeks of the year at 3 Nebraska stations.

Week	Gothenburg	Mitchell	Pawnee City
	-----------	% PROB	-----------
1 (1/1)	4	4	4
10 (3/7)	6	10	9
20 (5/16)	2	9	15
30 (7/25)	1	17	2
40 (10/3)	5	4	1
50 (12/12)	4	4	4

Figure 1. Probability of < 0.01 inches of precipitation occurring in Nebraska on April 1.



APR 1 Ppt $\leq$ .10"