EFFECT OF SEEDBED PREPARATION METHODS AND SOYBEAN [*Glycine max* (L.) Merr.] RESIDUE ON NET NITROGEN MINERALIZATION AND SORGHUM [*Sorghum bicolor* (L.) Moench] GROWTH.

by

MANFREY LYSON MLOTHA

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Approved by:
John L. Havlin
Major Professor

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INTRODUCTION

In recent years farmers in the United States have been shifting from tillage intensive to reduced tillage systems to conserve soil, water, and energy. Crop residues have also been increasingly put to alternative uses such as livestock feed and bedding, thereby reducing the quantity of residue returned to the soil.

Returning crop residues to the soil favorably influences soil organic matter levels, soil structure, and storage and movement of water and air. However, when tillage and management systems are changed the physical, chemical, and biological soil properties are also changed. This may in turn greatly influence residue decomposition, hence, nitrogen mineralization rate. A more complete understanding of residue management effects on nitrogen mineralization is vital if crop yields are to be optimized.

The objectives of this experiment were to determine the effect of seedbed preparation and soybean residue level on the amount of nitrogen mineralized from soil organic matter and soybean residue utilizing field and laboratory methods, and sorghum growth.

LITERATURE REVIEW

Legumes are often credited with supplying large amounts of N to succeeding nonleguminous crops. The rate of N mineralization from crop residue largely dictates the crop residue N availability to the succeeding crop.

Tillage method and crop residue level and type influence the rate of organic N mineralization. Many farmers are shifting from conventional (CT) to reduced (RT) or no-tillage (NT) crop management practices with concern for soil and energy conservation (8). Crop residue placement is the significant difference between CT and NT systems. In CT, crop residues are incorporated uniformly into the surface soil using a moldboard plow, while in NT they are left scattered on the soil surface or as standing stubble. This may greatly modify the soil biological environment and may influence N mineralization and denitrification rates (1). Some of the differences in soil environment between NT and CT soils, both related to surface mulch, are the tendency for the NT soil to be both wetter and colder (35). The wetter surface is thought to be due both to reduced evaporation and often to an improved water infiltration. The cooler soil temperatures are related to the insulating effect of the mulch, the greater path of diffusion of water vapor through the mulch and the change in surface albedo which tends to reflect radiation rather than to absorb it.

Several studies comparing microbial populations of RT and CT soils demonstrated that greater numbers of aerobic microorganisms were often associated with the surface 0 to 15 cm of RT soils (12, 16, 33). More recently, Barber and Standell (2), and, Doran (10) found that microbial numbers, dehydrogenase activities, and respiration in the surface of NT soils were significantly greater than those in CT soils. However, at soil depths below 5 to 7.5 cm these indices of microbial activity were often greater in CT soils. Most researchers have concluded that the increased microbial activity observed in the surface 7.5 cm layer of RT or NT soils is related to greater organic carbon (C) and water contents resulting from the maintenance of crop residues on the soil surface (8, 20). Similarly, lower microbial numbers and activities at 7.5 to 15 cm in NT soils have been considered a reflection of the lower levels of organic C and N at this depth.

Linn and Doran (20, 21) reported that aerobic and anaerobic microorganisms in the 0 to 7.5 cm soil depth increment of NT soils averaged 1.35 to 1.41 and 1.27 to 1.31 times greater, respectively, than in CT soils. In this study, volumetric water content, water-filled pore space, water soluble C, and organic C and N were greater for surface NT soils compared to CT soils. In contrast, aerobic microbial populations were significantly greater in CT soils at the 7.5 to 15 cm depth; however, at depths greater than 15 cm the numbers of aerobic microorganisms were similar between tillage treatments. In NT soils these organisms comprised a greater proportion of the total bacterial population than in CT soils. Denitrification activity, after irrigation with 15 mm of water, was substantially greater in the surface 0 to 7.5 cm of NT than CT soils. At the 7.5 to 15 cm soil depth, however, the denitrifying activity in CT soils was the same or higher than that of NT soils. These results indicate the presence of less aerobic conditions in NT soils. This condition appeared to result from greater soil bulk densities and/or water contents in NT soils, which increase water-filled pore space and the potential for water to reduce oxygen diffusion through the soil profile.

Thomas et al (34) reported that the behavior of N under NT is modified somewhat compared to CT due to the differences in soil environment. The N mineralization rate in NT tends to be lower because the the soil is not disturbed and the organic residues remain on the surface where decomposition is slower. Hence, especially in the spring, there is usually less nitrate in the soil in unfertilized NT soil than similar tilled soil.

The work of Dick (8) showed that NT resulted in significantly higher organic C and N concentrations in the 0 to 15 cm soil increment of a Hoytville silt clay loam (fine, illitic, mesic Mollic Ochraqualf) soil, but significantly lower concentrations in the 15 to 30 cm soil increment. For the Wooster silt loam (fine, mixed, mesic Typic Fragiudalf) soil, no tillage resulted in higher concentrations in the 0 to 7.5 cm soil increment. No significant differences were observed among tillage treatments below 7.5 cm. Comparison of organic C in the plow layer (0 to 22.5 cm) of the soils at the beginning of this long-term tillage experiment and after 19 years showed a 11% decrease or remained constant under NT in the Wooster and Hoytville soils,respectively. Organic C concentrations in the Hoytville soil were decreased 12 to 14% by long-term RT or CT while a 23 to 25% decrease was observed for the Wooster soil. A higher C:N ratio was observed under NT than RT or CT in the surface soil increments. Tillage intensity, however, had little effect on the ratios averaged over the entire 0 to 30 cm profile. Soil pH was 0.1 to 0.3 units lower under NT in all soil increments except in the 22.5 to 30 cm increment of Wooster soil.

Soil enzyme activities are often used as indices of microbial activity (6, 14). In addition, soil enzymes play an important role in the cycling of C, N, phosphorus (P), and sulfur (S). Soil urease, acid phosphatase and protease activities in the 0 to 10 cm surface increment (18) and acid phosphatase and dehydrogenase activities in the 0 to 7.5 cm surface increment (10) were found to be higher in NT than CT fields. Similar results were reported by Dick (9).

Research in western Nebraska demonstrated lower NO_3-N levels with RT and NT than CT systems (13), which may have accounted for lower yields than expected with RT and NT systems. Broder <u>et al</u> (4) observed that lower populations of nitrifiers and higher populations of denitrifiers were paralleled by lower NO_3-N levels in the NT compared with CT soils. Compared to plowed soils, levels of potentially mineralizable N in the surface 0 to 15 cm layer of NT and RT soils averaged 20 and 12% higher, respectively. Doran (10) found the amount of potentially mineralizable N in the surface 7.5 cm of NT soils averaged 35% greater than in plowed soils indicating a greater conservation of organic N.

In an incubation study, Rice and Smith (30) reported slower nitrification rates in CT than NT soil cores even though an attempt was made to maintain similar moisture levels in both CT and NT soils. Rapid water evaporation from CT soil, due to the absence of surface mulch, resulted in greater variation in soil moisture and was suggested as a probable cause for the slower nitrification rate. Cabrera and Kissel (5) found no N mineralization differences between soil with sorghum residue and residue removal treatment. They attributed the lack of difference to the long time between treatment application and measurement of N mineralization.

The quantity of residue needed to maintain soil productivity varies with climate, topography, soil, and management systems. Linstrom et al (22) estimated that in the Great Plains of the United States only 21% of crop residues could be removed without seriously increasing soil erosion potential. The specific quantities of the residue that could be safely removed varied with tillage practices, with greater amounts retained under NT than CT. Where crop residues are continuously removed, soil organic matter levels decrease until a new steady state is reached. Organic matter levels of CT soil cropped to corn in Indiana and Iowa decreased 10 to 30% within 10 to 12 years when crop residues were removed (3, 19). Larson et al (19) demonstrated that, with plowing, 4.5 t ha^{-1} of corn residues were needed to maintain soil organic matter levels. Janssen and Whitney (17) estimated a 100 kg ha^{-1}

loss through annual removal of crop residues within 7 years in a wheat-grain sorghum rotation in eastern Kansas. Doran _et al_ (11) reported that complete crop residue removal after harvest lowered corn and soybean grain and residue yields by 22 to 24%, respectively, compared to no residue removal over a 3 year period. Removal of 50% or addition of 50% surface crop residue (150%) had little or no effect on corn yields compared to no removal (100 %). It was further indicated that sorghum yields were unaffected by residue removal, but stands were significantly less at the 150% residue rate. Yield reductions for corn and soybean were primarily attributed to decreased water storage and higher surface soil temperatures where residues were completely removed. Sorghum tolerates of temperature and water stress better than other crops. Maintenance of surface crop residue has several potential limitations related to phytotoxicities, plant disease, and weed control problems (7).

In a 3 year study with 0, 1, 2, 4, 8, and 12 t ha^{-1} wheat mulch rates in Texas, Unger (36) reported that increasing mulch rates delayed the time that soil reached favorable temperatures for sorghum germination and growth. However, temperatures were near optimum before normal planting dates and, therefore, mulches did not affect sorghum germination and only slightly delayed emergence.

Since temperatures with high mulch rarely, if ever, reached the optimum for sorghum growth, plants on these plots grew slower early in the season than those on plots with low mulch rates. Later in the season, when soil water limited growth, plants on high mulch rate plots grew faster than on other plots because of higher water contents. Increased mulch rates decreased average soil temperature during all seasons of fallow from wheat harvest to sorghum planting. However, when temperature of bare soil approached or fell below 0°C, the temperature effect was reversed. The change in temperature for each tonne ha^{-1} of mulch compared with bare soil was greatest for the 1 t ha^{-1} rate and generally decreased as mulch rates increased.

Yaacob and Blair (37) reported 14.7, 14.6, and 16.8% N mineralized from ^{15}N labeled soybean residues from soils cropped to one, three, and six previous soybean crops, respectively. On the other hand, Power _et al_ (26) reported that almost all N in soybean residue was mineralized and available to the following crop. Studies on crop N uptake have shown higher tissue N concentration in crops grown in rotation with soybean than those monocropped. Work by Gakale and Clegg (15) showed that unfertilized sorghum rotated with soybean contained more than twice as much N as did continuous sorghum at the vegetative stage, and this amount was equivalent to the amount in plants fertilized with 56 kg N ha^{-1}. As the crop developed further, there was evidence that N from soybean residue supplemented fertilizer N; as shown by high concentrations of N in the sorghum rotated with soybean than continuous sorghum receiving 112 kg N ha^{-1} or less. This happened even though sorghum rotated with soybean produced more biomass that should have diluted tissue N.

MATERIALS AND METHODS

A field study was conducted in 1988 at the Ashland Agronomy Farm near Manhattan, Kansas, to evaluate nitrogen (N) mineralization rate of soil organic matter and soybean residue under three seedbed preparation methods in a grain sorghum-soybean rotation. The soil was a Muir silt loam (cumulic Haplustoll, fine-silty, mixed, mesic) with an average pH of about 6.0 containing about 2% organic matter in the surface 30 cm layer.

A split plot experimental design with four replicates was used. The main plots consisted of three seedbed preparation methods as main plots with three soybean residue levels as subplots. The main plots were 18.3 cm long and 6.1 cm wide giving three 6.1 m^2 subplots. The methods of seedbed preparation were chemical, mechanical, and a combination of chemical and mechanical. These seedbed preparation methods had been imposed on the same plots since 1975 in a long-term conservation tillage grain sorghum-soybean rotation experiment (25). The mechanical and chemical/mechanical treatments were first plowed 24 June 1987, to incorporate residue, chiseled on 22 October 1987 and again cultivated on 22 April 1988. Glyphosate [N-(phosphonomethyl) glysine] plus Paraquat [1, 1′-dimethyl-4,4′-bipyridium ion] were applied in the chemical plots on 25 April 1988 to control weeds. Spring tooth cultivation was done in the mechanical and chemical/mechanical plots on 11 May 1988. Sorghum variety "Pioneer 8686" was planted on 26 May 1988. Lasso [2-chloro-2′, 6′-diethyl-N-(methoxymethyl) acetanilide (2-chloro-N-(2,6-diethylephenyl)-N-methoxymethylacetamide)] plus Atrazine [2- chloro-4(ethylamino)-6-(isopropylamino)-s-triazine] were applied immediately after planting to all plots. All plots were tilled 2 weeks after planting. Soybean residue yield was estimated just before soybean harvest. A 1 m row section of soybean plants was sampled from each replicate, including ground residue, giving a total residue yield of 1172 kg ha^{-1} (excluding seed) containing 4% N. The chemical, mechanical, and chemical/mechanical treatments yielded 2809, 2903, and 3079 kg ha^{-1} of soybean grain, respectively, at harvest containing about 7% N. The soybean residue treatments were applied on 9 October 1987. The residue treatments were residue removed (by soil surface raking), normal residue, and twice the normal residue level (achieved by evenly hand spreading the residue from the residue removal treatment). Grain sorghum variety variety "Pioneer 8686" was planted on 26 May 1988 at a 0.76 m row spacing giving 8 rows per plot.

Soils were sampled 5 days before sorghum planting and

28 days after harvest. Each plot was sampled to a depth of 120 cm in the following increments: 0 to 7.5, 7.5 to 15, 15 to 30, 30 to 60, 60 to 90, and 90 to 120 cm. The 30 to 60, 60 to 90, and 90 to 120 cm depth samples were taken at three locations along the middle of each subplot using a hydraulic probe. Six soil cores were sampled for each of the 0 to 7.5, 7.5 to 15, and 15 to 30 cm depths around each of the deep sample holes and a composite sample made for each of the surface sample depths. Each subplot, hence, ended up with 18 soil samples for inorganic N determination. Each deep sample hole was flagged to guide later soil and plant sampling. All soil samples were oven dried at 35^{o}C and ground to pass a 2 mm sieve. Soil nitrate and ammonium N were determined in 2 M KCl extracts using a flow injection auto-analyzer (27, 29). In this method of analysis nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. Total nitrite (reduced nitrate plus original nitrite) is then determined by diazoting with sulfanilamide followed by coupling with N-1-naphthylethylenediamine dihydrochloride. The resulting water soluble die exhibits a magenta color which is read at 520 nm. On the other hand, when ammonia is heated with salicylate and hypochlorite in an alkaline phosphate buffer, an emerald green color is produced which is proportional to the ammonia concentration. The presence

of tartrate in the buffer prevents precipitation of calcium and magnesium. The color is intensified by adding sodium nitroprusside.

Soil bulk density was measured 46 days after grain sorghum harvest using a hydraulic probe and similar depth increments as the soil samples for N determination along subplot border rows where compaction had been minimal.

Dry matter was determined from plant samples (excluding roots) taken from a 1 m inner row section on both sides of the subplot 25 and 57 days after planting. Plant population and plant height were determined 25 days after planting. Days to 50% flowering were also recorded. At physiological maturity, 100 days after planting, shoot dry weight, number of productive heads, stover and grain yield, grain test weight and moisture content were determined. Grain yield was corrected to 12.5% moisture. A 1 m section of total shoot dry matter, including heads, was harvested from each of four subplot rows close to the soil sample locations. Root dry weight was estimated at 21% of total plant dry weight as suggested by Myers (24). Sorghum dry matter samples taken 57 days after planting, and stover and grain sampled at physiological maturity were analyzed for N using the flow injection auto-analyzer (28). Root N was estimated at 7.5% of total plant N as suggested by Myers (24).

Net N mineralization (Nm) in the field soils during the growing season was estimated as:

Nm = Inorganic after harvest + Plant N uptake - Inorganic N before planting.

Where: Inorganic N after harvest = NO_3-N plus NH_4-N in the soil profile at the end of the measurement period,

Inorganic N before planting = NO_3-N plus NH_4-N in the soil profile at the beginning of the measurement period,

Plant N uptake = Total N uptake at physiological maturity including estimated root N.

Soil samples for the laboratory incubation study were taken on 18 March 1989, 196 days after grain sorghum harvest. Two intact soil cores were collected from the surface 10 cm of each subplot using a steel corer fitted with an inner plastic syringe 13 cm long and 2.5 cm inside diameter (23, 30). The cores were incubated at 35^{o}C and 85% relative humidity after leaching with 100 mL 0.01 M $CaCl_2$ to remove initial mineral N (33). NO_3-N and NH_4-N were leached with 100 mL 0.01 M $CaCl_2$ using a motor driven vacuum extractor after 14, 35, 49, and 77 days of incubation. NO_3-N and NH_4-N were determined in the leachate using the flow injection auto-analyzer (27, 29).

All data were statistically analyzed using the General

Linear Models procedure in SAS (31). One replicate was excluded in the analysis of the field study because of high variability.

RESULTS AND DISCUSSION

Soil inorganic N in the 0 to 30 cm layer was significantly higher in the residue removal treatment before sorghum planting (Tables 1, 2). There were no significant differences in initial inorganic N among seedbed preparation methods, however, within the chemical and mechanical treatments the inorganic N level decreased with increased residue. Thomas et al (34) suggested that N mineralization rate in NT tends to be lower because the soil is not disturbed and the organic residues remain on the surface where decomposition is slower. They further indicated that there is usually less nitrate in the unfertilized NT soil than in similar tilled soils, especially in spring when soils are cooler under NT due to surface mulch. The cooler atmospheric temperatures earlier in spring (Table 3) possibly led to lower soil temperatures in the chemical treatment where there was surface residue leading into reduced microbial activity and N mineralization compared with residue removal plots.

Sorghum dry matter yield and plant height significantly increased with decreased soybean residue level 25 days after planting. This could possibly be due to higher soil inorganic N in the surface layer of the residue removal treatment (Table 1). Unger (36) attributed the slower growth of the sorghum early in the season in plots with higher mulch rates to the below optimum soil temperatures for sorghum growth in these plots. Residue level had no significant effect on dry matter 57 days after planting. However, 43 days later the double residue treatment had significantly higher dry matter than the other two treatments. This suggests a significant recovery in plant growth in the residue treated plots. Among seedbed preparation methods the mechanical treatment had significantly shorter plants 25 days after planting and significantly lower dry matter 32 days later. Residue incorporation probably resulted into immobilization of some of the inorganic N by soil microbes. The lack of significant differences in plant population suggests that dry matter yield differences among treatments were affected by factors other than plant population (Table 4). Doubling residue significantly delayed flowering (Table 4) resulting in significantly higher N uptake as reflected in sorghum head N content within this treatment at 57 days after planting (Table 6). Seedbed preparation methods had no significant effect on number of sorghum productive heads, grain and stover yield, grain moisture content and test weight (Table 5). Among residue treatments doubling residue significantly increased grain yield. Seedbed preparation methods had no significant effect on sorghum stover and head N at flowering (57 days after planting), grain and stover N at physiological maturity (Table 6), while doubling residue significantly increased sorghum head N 57 days after planting and grain N at harvest with no significant effect on stover N. The higher N uptake was possibly due to the longer plant growth period in the double residue treatment.

The tilling of all plots 2 weeks after sorghum planting possibly narrowed differences among seedbed preparation methods such that their impact on sorghum growth was similar. On the other hand, tillage operations in the mechanical and chemical/mechanical treatments were the same except for the herbicide application in the chemical/mechanical treatment earlier in the year which probably resulted in little differences on sorghum growth and yield since there was little weed pressure during the season.

Soil inorganic N after physiological maturity did not differ significantly among treatments except for the normal residue treatment which had significantly higher inorganic N ($p = 0.09$) in the surface 30 cm soil layer (Table 7). Within the 0 to 120 cm depth increments the chemical treatment had the highest inorganic N in the surface 0 to 7.5 cm layer (Table 8). With a significant interaction between seedbed preparation methods and soybean residue level (p = 0.08), comparisons within the mechanical and chemical/mechanical treatments indicated that the normal residue treatment had significantly higher inorganic N than the residue removal and 2 x normal treatments, while within the chemical treatment the normal residue treatment had the lowest inorganic N (Table 8). Among seedbed preparation treatments the chemical treatment had significantly higher inorganic N than the chemical/mechanical and mechanical treatments over the residue removal and double residue treatments, but had significantly lower inorganic N than the mechanical treatment over the normal residue treatment. These N differences may either reflect differences in mineralization or in plant N uptake or both.

There was significant interaction between seedbed preparation methods and residue on net N mineralization (Nm) (Table 9). Doubling residue significantly increased Nm over the normal residue treatment within the chemical treatment. The residue removal treatment had significantly lower Nm than the normal residue treatment within the mechanical, chemical, and chemical/mechanical treatments as would be expected. The lack of significant differences in Nm between the residue removal and the double residue treatments within the chemical treatment cannot be easily explained. Comparison of seedbed preparation methods over individual residue treatments suggests the chemical treatment had significantly higher Nm than the chemical/mechanical treatment over all residue levels while with the mechanical treatment, Nm was higher over the residue removal and 2 x normal residue levels.

In the incubation study cumulative Nm after 77 days of incubation was significantly higher with the chemical than with the mechanical treatment ($p = 0.09$) (Table 10 and Fig. 1). No significant differences in Nm were observed among residue treatments (Table 10 and Fig. 2) probably because by soil sampling time all residue may have been degraded.

Further research is needed to evaluate long-term seedbed preparation and soybean residue level effects on Nm.

CONCLUSION

Doubling residue significantly delayed sorghum flowering, increased grain and dry matter yield , and grain N at physiological maturity. Seedbed preparation methods and residue level had a significant combined effect on Nm. Doubling residue within the chemical treatment resulted in the highest Nm over all treatment combinations. In the laboratory incubation study Nm was significantly higher with the chemical seedbed compared to other two methods. No significant differences in Nm were observed among residue treatments.

The lack of overall significant differences among the seedbed preparation and residue treatments suggests the need for further research.

Table 1. Effect of seedbed preparation and soybean residue on soil inorganic N before grain sorghum planting in the 0 to 30 (N1a) and 0 to 120 cm (N1b) depths and bulk density (BD) in the 0 to 120 cm depth.

Seedbed Preparation	Residue	N1a	N1b	BD
		kg N ha^{-1}		g cm^{-3}
Chemical	Removed	54.4	130	1.37
Chemical	Normal	53.2	139	1.40
Chemical	2 x Normal	51.4	127	1.38
Chemical/mechanical	Removed	53.6	133	1.33
Chemical/mechanical	Normal	47.8	126	1.36
Chemical/mechanical	2 x Normal	51.2	138	1.40
Mechanical	Removed	59.4	137	1.41
Mechanical	Normal	47.9	134	1.36
Mechanical	2 x Normal	46.2	121	1.36
<u>Seedbed Preparation Means.</u>				
Chemical		53.0	131	1.39
Chemical/mechanical		50.8	133	1.36
Mechanical		51.1	131	1.38
LSD (0.05)		NS	NS	NS
Prob. > F		0.87	0.99	0.80
<u>Residue Means</u>				
Removed		55.8	133	1.37
Normal		49.6	133	1.37
2 x Normal		49.6	128	1.38
LSD (0.05)		4.10	NS	NS
Prob. > F		0.0086	0.60	0.90
<u>Seedbed x Residue Interaction</u>		NS	NS	NS
Prob. > F		0.12	0.23	0.31
C.V. %		15.2	17.3	8.97

Table 2. Effect of seedbed preparation and soybean residue on soil inorganic N before sorghum planting (N1) in the 0 to 120 cm depth increments and soil bulk density (BD).

Treatment	Depth	N1[1]	BD
	cm	kg N ha^{-1}	g cm^{-3}
Seedbed Prep.			
Chemical	0 to 7.5	20.3	1.41
	7.5 to 15	13.0	1.48
	15 to 30	19.8	1.38
	30 to 60	31.3	1.34
	60 to 90	25.6	1.36
	90 to 120	21.4	1.37
Chem/mechanical	0 to 7.5	17.0	1.23
	7.5 to 15	13.5	1.50
	15 to 30	20.4	1.35
	30 to 60	32.4	1.35
	60 to 90	25.4	1.39
	90 to 120	23.7	1.37
Mechanical	0 to 7.5	17.4	1.36
	7.5 to 15	13.5	1.48
	15 to 30	20.2	1.42
	30 to 60	32.5	1.32
	60 to 90	25.5	1.35
	90 to 120	22.0	1.34
Seedbed x Depth Interaction.			
Prob. > F		0.76	0.31
Residue			
Removed	0 to 7.5	18.7	1.31
	7.5 to 15	14.6	1.47
	15 to 30	22.6	1.41
	30 to 60	31.6	1.35
	60 to 90	22.5	1.34
	90 to 120	23.5	1.34
Normal	0 to 7.5	17.6	1.35
	7.5 to 15	13.1	1.51
	15 to 30	18.9	1.33
	30 to 60	33.1	1.32
	60 to 90	26.2	1.35
	90 to 120	24.0	1.40

Cont.

Table 2 cont.

2 x Normal	0 to 7.5	18.4	1.34
	7.5 to 15	12.4	1.48
	15 to 30	18.8	1.41
	30 to 60	31.4	1.34
	60 to 90	27.8	1.40
	90 to 120	19.7	1.33
Residue x Depth Interaction.			
Prob. > F		0.02	0.77
C.V. %		17.3	8.97

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[1] kg N ha^{-1} in each depth increment.

Table 3. Temperature and precipitation for Ashland Research Farm, 1988.

Month	Temperature		Precipitation
	Min.	Max.	
	----- °C ------		mm
February	-7.9	10.3	Trace
March	-1.9	15.6	31.75
April	1.9	19.9	93.22
May	11.4	27.1	46.74
June	16.3	33.4	35.81
July	18.4	34.3	77.47
August	18.3	35.3	20.07
September	12.4	27.9	75.69
October	4.1	21.2	28.45

Table 4. Effect of seedbed preparation and soybean residue on sorghum shoot dry matter 25, 57, and 100 days after planting, plant population and height 25 days after planting, and days to 50% flowering.

Seedbed Prep.	Residue	Dry Matter			Population	Height	Flower
		25	57	100			
		-- t ha^{-1} --			x10^{5} ha^{-1}	cm	days
Chemical	Removed	0.72	7.47	10.7	1.73	13.7	49
Chemical	Normal	0.64	8.23	11.8	1.73	14.0	50
Chemical	2 x Nor.	0.54	7.00	12.8	1.78	12.7	51
Chem/Mech.	Removed	0.69	7.50	11.0	1.78	13.7	48
Chem/Mech.	Normal	0.59	7.53	9.7	1.82	12.7	50
Chem/Mech.	2 x Nor.	0.49	7.27	12.1	1.91	12.3	51
Mechanical	Removed	0.61	6.53	10.3	1.82	13.0	48
Mechanical	Normal	0.51	6.97	11.5	1.64	12.0	51
Mechanical	2 x Nor.	0.44	6.87	12.0	1.73	12.0	51
Seedbed Prep. Means.							
Chemical		0.63	7.57	11.8	1.75	13.4	50
Chemical/Mechan.		0.59	7.43	10.9	1.84	12.9	50
Mechanical		0.52	6.79	11.3	1.73	12.3	50
LSD (0.05)		NS	NS	NS	NS	0.62	NS
LSD (0.10)		NS	0.59	NS	NS	0.47	NS
Prob. > F		0.35	0.09	0.66	0.40	0.02	0.9
Residue Means							
Removed		0.67	7.17	10.7	1.78	13.4	48
Normal		0.58	7.58	11.0	1.73	12.9	50
2 x Normal		0.49	7.04	12.3	1.81	12.3	51
LSD (0.05)		0.07	NS	0.80	NS	0.89	2.0
Prob. > F		0.0007	0.37	0.0002	0.54	0.05	0.01
Seedbed x Residue Interaction		NS	NS	S	NS	NS	NS
Prob. > F		0.99	0.72	0.09	0.59	0.58	0.92
C.V. %		12.4	11.1	6.89	7.83	6.68	2.94
1 df contrasts				Prob.>F			
Mech. vs chem/mech. over Normal				0.02			

Table 5. Effect of seedbed preparation and soybean residue on grain sorghum head, stover and grain yield, moisture, and, test weight.

Seedbed Prep.	Residue	Heads	Stover	Grain[1]	Moisture	Test Wt.
		x10^5 ha^{-1}	-- t ha^{-1} --		g kg^{-1}	kg m^{-3}
Chemical	Removed	1.97	5.42	5.27	0.091	717
Chemical	Normal	2.06	5.84	5.93	0.092	731
Chemical	2 x Norm.	2.01	5.01	7.87	0.091	734
Chem/Mec.	Removed	1.97	5.36	5.70	0.092	731
Chem/Mec.	Normal	1.94	4.55	5.20	0.089	721
Chem/Mec.	2 x Norm.	2.02	5.88	6.17	0.090	724
Mechan.	Removed	1.95	4.77	5.47	0.089	724
Mechan.	Normal	1.85	6.01	5.40	0.090	727
Mechan.	2 x Norm.	1.98	5.29	6.77	0.094	741
<u>Seedbed Prep. Means</u>						
Chemical		2.01	5.42	6.36	0.091	728
Chemical/Mechan.		1.98	5.26	5.69	0.090	725
Mechanical		1.93	5.37	5.88	0.091	731
LSD (0.05)		NS	NS	NS	NS	NS
Prob. > F		0.15	0.97	0.69	0.72	0.86
<u>Residue Means</u>						
Removed		1.96	5.18	5.48	0.091	724
Normal		1.95	5.49	5.51	0.090	726
2 x Normal		2.00	5.39	6.93	0.092	733
LSD (0.05)		NS	NS	0.70	NS	NS
Prob. > F		0.54	0.70	0.0008	0.67	0.2
Seedbed Prep. x Residue <u>Interaction</u>		NS		NS	NS	NS
Prob. > F		0.48	0.10	0.18	0.28	0.2
C.V. %		5.20	14.3	11.3	3.32	1.5
<u>1 df contrasts</u>			Prob.> F			
Normal vs 2xNormal in Mechan.			0.056			
Remove vs Norm. in Chem/mech.			0.060			
Mech. vs Chem/chem over Norm.			0.033			

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[1] Adjusted to 12.5% moisture.

Table 6. Effect of seedbed preparation method and soybean residue on grain sorghum stover and head tissue N 57 days after planting, and, grain and stover tissue N at physiological maturity.

Seedbed Prep.	Residue	57 Days		Maturity	
		Stover	Heads	Grain	Stover
		kg N ha^{-1}			
Chemical	Removed	61.0	16.7	78.9	20.3
Chemical	Normal	65.4	18.1	78.5	21.1
Chemical	2 x Norm.	58.2	11.8	90.6	18.8
Chem/Mechan.	Removed	58.1	17.7	76.2	26.2
Chem/Mechan.	Normal	55.6	16.5	69.8	16.9
Chem/Mechan.	2 x Norm.	60.5	15.2	85.0	22.5
Mechanical	Removed	60.6	15.0	73.1	19.5
Mechanical	Normal	55.8	14.3	70.8	26.8
Mechanical	2 x Norm.	53.1	12.6	78.0	15.3
Seedbed Prep. Means.					
Chemical		61.5	15.5	82.6	20.3
Chemical/Mechanical		58.1	16.5	77.0	21.9
Mechanical		56.5	13.9	74.0	20.5
LSD (0.05)		NS	NS	NS	NS
Prob. > F		0.41	0.36	0.14	0.91
Residue Means.					
Removed		59.9	16.5	76.1	22.0
Normal		58.9	16.3	73.0	21.9
2 x Normal		57.3	13.2	84.5	18.9
LSD (0.05)		NS	2.68	6.49	NS
Prob. > F		0.62	0.03	0.01	0.52
Seedbed Prep. x Residue Interaction		NS	NS	NS	NS
Prob. > F		0.34	0.51	0.76	0.19
C.V. %		9.75	17.0	8.11	30.4

Table 7. Effect of seedbed preparation and soybean residue on soil inorganic N after sorghum physiological maturity in the 0 to 30 (N2a) and 0 to 120 cm (N2b) depths.

Seedbed Preparation	Residue	N2a	N2b
		------ kg ha^{-1}	-----
Chemical	Removed	64.3	158
Chemical	Normal	66.4	144
Chemical	2 x Normal	66.0	156
Chemical/mechanical	Removed	39.1	103
Chemical/mechanical	Normal	46.9	130
Chemical/mechanical	2 x Normal	43.1	117
Mechanical	Removed	48.6	117
Mechanical	Normal	60.7	148
Mechanical	2 x Normal	43.3	110
<u>Seedbed Preparation Means.</u>			
Chemical		65.6	152
Chemical/mechanical		43.1	116
Mechanical		50.9	125
LSD (0.05)		NS	NS
Prob.> F		0.28	0.31
<u>Residue Means</u>			
Removed		50.7	126
Normal		58.0	127
2 x Normal		50.8	127
LSD (0.05)		NS	NS
Prob.> F		0.09	0.12
<u>Seedbed x Residue Interaction</u>			
Prob.> F		0.35	0.08
C.V. %		27.5	11.90

<u>1 df Contrasts</u>	Prob.>F
Normal vs 2 x Normal in Chemical	0.379
Normal vs 2 x Normal in Chemical/Mechanical	0.011
Removed vs Normal in Mechanical	0.054
Removed vs Normal in Chemical/Mechanical	0.029
Chemical vs Chemical/Mechanical over Removed	0.008
Chemical vs Chemical/Mechanical over 2 x Normal	0.004
Chemical vs Mechanical over Removed	0.001
Chemical vs Mechanical over Normal	0.010
Chemical vs Mechanical over 2 x Normal	0.010

Table 8. Effect of seedbed preparation and soybean residue on soil inorganic N after sorghum physiological maturity (N2) in the 0 to 120 cm depth increments.

Treatment	Depth	N2
	cm	kg N ha^{-1}
<u>Seedbed Preparation</u>		
Chemical	0 to 7.5	32.6
	7.5 to 15	13.2
	15 to 30	19.8
	30 to 60	27.0
	60 to 90	30.8
	90 to 120	29.1
Chemical/Mechanical	0 to 7.5	17.1
	7.5 to 15	11.2
	15 to 30	14.7
	30 to 60	25.8
	60 to 90	23.6
	90 to 120	24.0
Mechanical	0 to 7.5	21.7
	7.5 to 15	13.9
	15 to 30	15.2
	30 to 60	23.9
	60 to 90	24.6
	90 to 120	25.5
<u>Seedbed x Depth Interaction</u>		
Prob. > F		0.001
<u>Residue</u>		
Removed	0 to 7.5	22.3
	7.5 to 15	12.2
	15 to 30	16.3
	30 to 60	23.6
	60 to 90	25.8
	90 to 120	25.4
Normal	0 to 7.5	26.5
	7.5 to 15	14.5
	15 to 30	17.1
	30 to 60	27.2
	60 to 90	26.5
	90 to 120	29.0

Cont.

Table 8 cont.

2 x Normal	0 to 7.5	22.8
	7.5 to 15	11.7
	15 to 30	16.3
	30 to 60	25.9
	60 to 90	26.7
	90 to 120	24.2
Residue x Depth Interaction		
Prob. > F		0.86

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[1] kg N ha^{-1} in each depth increment.

Table 9. Effect of seedbed preparation and soybean residue on net N mineralization.

Seedbed Prep.	Residue	Nm
		kg N ha^{-1}
Chemical	Removed	136
Chemical	Normal	114
Chemical	2 x Normal	148
Chem./Mechanical	Removed	80
Chem./Mechanical	Normal	98
Chem./Mechanical	2 x Normal	95
Mechanical	Removed	79
Mechanical	Normal	120
Mechanical	2 x Normal	90
<u>Seedbed Prep. Means</u>		
Chemical		132
Chemical/Mechanical		91
Mechanical		96
LSD (0.05)		NS
Prob. > F		0.35
<u>Residue Means.</u>		
Removed		98
Normal		110
2 x Normal		111
LSD (0.05)		NS
Prob. > F		0.29
<u>Seedbed x Residue Interaction</u>		
Prob. > F		0.06
C.V. %		17.2
<u>1 df Contrasts</u>		-------- Prob. > F --------
Normal vs 2 x Normal in Chemical		0.044
Removed vs Normal in Mechanical		0.260
Removed vs Normal in Chem/Mechanical		0.019
Normal vs 2 x Normal in Chem/Mechanical		0.070
Chemical vs Chem./Mechan. over Removed		0.003
Chemical vs Chem/Mechan. over 2 x Normal		0.002
Chemical vs Mechan. over Removed		0.003
Chemical vs Mechan. over Normal		0.004
Chemical vs Mechan. over 2 x Normal		0.004
Chem/Mechan. vs Mechan. over Normal		0.166

Table 10. Effect of seedbed preparation and soybean residue on N mineralization in the 0 to 10 cm depth in an 11 week incubation study for soil sampled 196 days after grain sorghum harvest.

Seedbed Prep.	Residue	Days Incubated					
		0	14	35	49	77	Total[1]
		---------- mg N kg^{-1} soil --------					
Chemical	Removed	11.1	16.4	20.3	9.3	15.7	61.7
Chemical	Normal	14.9	19.3	23.0	12.3	13.7	68.2
Chemical	2 x Norm.	29.6	19.4	21.6	10.3	14.3	65.7
Chem/Mechan.	Removed	9.4	13.4	16.7	7.3	10.0	47.2
Chem/Mechan.	Normal	16.2	14.0	17.3	8.7	15.7	59.0
Chem/Mechan.	2 x Norm.	17.2	16.7	26.3	12.0	13.0	68.0
Mechanical	Removed	8.8	14.3	18.0	9.7	9.7	54.7
Mechanical	Normal	17.3	14.7	18.6	9.0	10.3	55.7
Mechanical	2 x Norm.	12.1	16.0	19.6	10.7	11.3	57.0
<u>Seedbed Prep. Means.</u>							
Chemical		18.6	18.4	21.7	10.7	14.6	65.2
Chem/Mechan.		14.2	14.7	20.1	9.3	12.9	58.1
Mechanical		12.7	14.9	18.6	9.8	10.4	55.8
LSD (0.05)		NS	NS	NS	NS	NS	9.0
Prob. > F		0.13	0.15	0.15	0.57	0.13	0.09
<u>Residue Means.</u>							
Removed		9.8	14.7	18.3	8.8	11.8	54.5
Normal		16.1	15.9	19.7	10.0	13.2	61.0
2 x Normal		19.6	17.4	22.3	11.0	12.9	63.6
LSD (0.05)		5.17	NS	NS	NS	NS	NS
Prob. > F		0.01	0.38	0.27	0.37	0.65	0.34
Seedbed Prep. x Residue <u>Interaction</u>			NS	NS	NS	NS	NS
Prob. > F		0.08	0.96	0.40	0.59	0.43	0.74
C.V. %		36.7	24.5	25.1	32.5	27.0	21.7

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[1] Excludes initial extract (day = 0).

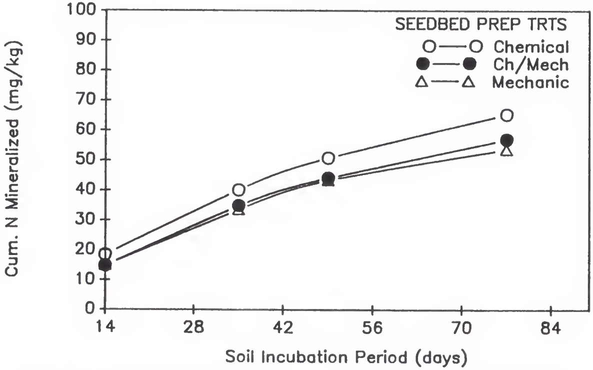


Figure 1. Seedbed preparation effect on cumulative mineralized N.

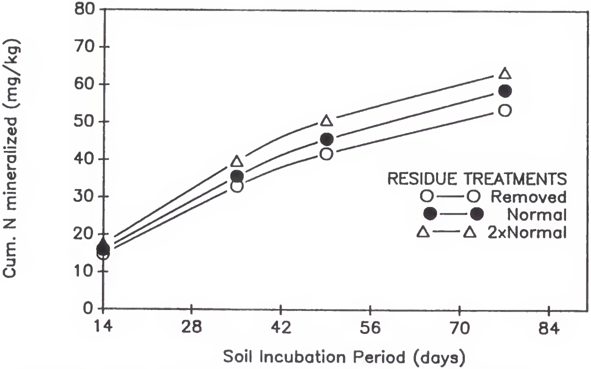


Figure 2. Soybean residue effect on cumulative mineralized N.

REFERENCES

1. Aulakh, M.S., D.A. Rennie, and E.A. Paul. 1984. Gaseous nitrogen losses from soils under zero-till as compared with conventional-till management systems. J. Environ. Qual.13:130-136.

2. Barber, D.A., and C.J. Standell. 1977. Preliminary observations on the effects of direct drilling on the microbial activity of the soil. p.58-60. In Agric. Res. Council 1976 Annual Report, Letcombe Lab., Wantage, England.

3. Barber, S.A. 1979. Corn residue management and soil organic matter. Agron. J. 71:625-627.

4. Broder, M.W., J.W. Doran, G.A. Peterson, and C.R. Fenster. 1984. Fallow tillage influence on spring populations of soil nitrifiers, denitrifiers, and available Nitrogen. Soil Sci. Soc. Am. J. 48 :1061-1067.

5. Cabrera, M.L., and D.E. Kissel. 1988b. Evaluation of a method to predict nitrogen mineralized from soil organic matter under field conditions. Soil Sci. Soc. Am. J. 52:1027-1031.

6. Casida, L.E., Jr. 1977. Microbial metabolic activity in soil as measured by dehydrogenase determinations. Appl. Environ. Microbiol. 34:630- 636.

7. Coock, R.J., M.G. Boosalis, and B. Doupnik. 1978. Inf-

luence of crop residues on plant diseases. p.147 164. In W.R. Oschwald (ed.) Crop residue management systems Am. Sci. Soc. of Agron. Spec. Publ. no. 31, Madison. W.I.

8. Dick, W.A. 1983. Organic carbon, nitrogen, and phosphorus concentrations and pH in soil profiles as affected by tillage intensities. Soil Sci. Soc. Am. J. 47:102-107.

9. Dick, W.A. 1984. Influence of long-term tillage and crop rotation combinations on soil enzyme activities. Soil Sci. Soc. Am. J. 48:569-575.

10. Dorn, J.W. 1980b. Soil microbial and biochemical changes associated with reduced tillage. Soil Sci. Soc. Am. J. 44:765-771.

11. Doran, J.W., W.W. Wilhelm, and J.F. Power. 1984. Crop residue removal and soil productivity with no-till corn, sorghum, and soybean. Soil Sci. Soc. Am. J. 641-645.

12. Dwason, R.C., V.T. Dwason, and T.M. McCalla. 1948. Distribution of microorganisms in the soil as affected by plowing and sub-tilling crop residues. Nebr. Agric. Exp. Stn. Res. Bull. 155.

13. Fenster, C.R., and G.A. Peterson. 1979. Effects of no-tillage fallow as compared to conventional tillage in a wheat-fallow system. Nebr. Agric. Exp.

Stn. Res. Bull. no. 289.

14. Frankenberger, W.T., Jr., and W.A. Dick. 1983. Relationships between enzyme activities and microbial growth and activity indicies in soil. Soil Sci. Soc. Am. J. 47:945-951.

15. Gakale, L.P., and M.D. Clegg. 1987. Nitrogen from soybean for dryland sorghum. Agron. J. 79:1057-1061

16. Gamble, S.J.R., T.W. Edminster, and F.S. Orcutt. 1952. Influence of double-cut plow mulch tillage on number and activity of microorganisms. Soil Sci. Soc. Am. Proc. 16:267-269.

17. Janssen, K.A., and D.A. Whitney. 1987. Crop residue removal and fertilizer management effects on soybeans wheat and grain sorghum in eastern Kansas. Kansas Fertilizer Research Report of Progress 531:98-103. Kansas State Univ., Manhattan. Ks.

18. Klein, T.M., and J.S. Koths. 1980. Urease, protease, and acid phosphatase in soil continuously cropped to corn by conventional or no-tillage methods. Soil Biol. Biochem. 12:293-294.

19. Larson, W.E., C.E. Clapp, W.H. Pierre, and Y.B. Morachan. 1972. Effects of increasing amounts of organic residues on continuous corn, organic carbon ,nitrogen, phosphorus, and sulfur. Agron. J.64:

204-208.

20. Linn, D.M., and J.W. Doran. 1984. Effect of water-filled pore space on CO_2 and NO_2 production in tilled and nontilled soils. Soil Sci. Soc. Am. J 48:1268-1272.

21. Linn, D.M., and J.W. Doran. 1984. Aerobic and anaerobic microbial populations in no-till and plowed soils. Soil Sci. Soc. Am. J. 48:795-799.

22. Linstrom, M.J., E.L. Skidmore, S.C. Gupta, and C.A. Onstad. 1979. Soil conservation limitations on removal of crop residues for energy production. J. Environ. Qual. 8:533-537.

23. Myers, R.G., C.W. Swallow, and D.E. Kissel. 1989. A method to secure, leach and incubate undisturbed soil cores. Soil Sci. Soc. Am. J. 53:467-471.

24. Myers, R.J.K. 1980. The root system of grain sorghum crop. Field Crops Res. 3:53-64.

25. Peterson, D.E. 1983. Crop production as affected by cropping sequence and method of seedbed preparation in conservation tillage. p.16-97. Master of Science Thesis. Dept. of Agron. Kansas State Univ. Manhattan. Kansas.

26. Power, J.F., J.W. Doran, and W.W. Wilhelm. 1986. Uptake of nitrogen from soil, fertilizer and crop

residues by no-till corn and soybean. Soil Sci. Soc. Am. J. 50:137-142.

27. QuickChem Systems. 1987. Ammonia in soil extracts. QuickChem Method no. 12-107-06-2-B. Operating Manual. Lachat Chemicals Inc.,Mequon, Wisconsin.

28. QuickChem Systems. 1987. Kjeldahl nitrogen or crude protein - Kjeldahl digest of feeds. QuickChem Method no. 15-107-28-3-A. Operating Manual. Lachat Chemicals Inc., Mequon, Wisconsin.

29. QuickChem Systems. 1987. Nitrate and nitrite in soil extracts. QuickChem Method no. 12- 107- 04-1-A. operating Manual. Lachat Chemicals Inc., Mequon, Wisconsin.

30. Rice, C.W., and M.S. Smith. 1983. Nitrification of fertilizer and mineralized ammonia in no-till plowed soil. Soil Sci. Soc. Am. J. 47:1125-1128.

31. SAS Institute Inc. 1982. SAS User's Guide: Statistics. SAS Institute Inc., Cary, North Carolina.

32. Schaller, F.W., and D.D. Evans. 1954. Some effects of mulch tillage. Agric. Eng. 35:731-734, 736.

33. Stanford, G., and S.J. Smith. 1972. Nitrogen Mineralization potentials of soils. Soil Sci. Soc.Am. J. Proc. 36:465-472.

34. Thomas, G.W., R.L. Blevins, R.E. Phillips, and M.A.

McMahon. 1973. Effect of a killed sod mulch on nitrate movement and corn yield. Agron. J. 65:736-739.

35. Thomas, G.W. and W.W. Frye. 1983. Fertilization and liming. p. 87-126. In R.E. Phillips and H.E. Phillips (ed.) No-Tillage Agriculture: Principles and Practices. Van Nostrand Reinhold Co. Inc,.

36. Unger, P.W. 1978. Straw mulch effects on soil temperatures and sorghum germination and growth. Agron. J. 70:

37. Yaacob, O., and G.J. Blair. 1980. Mineralization of ^{15}N-labeled legume residues in soils with different nitrogen contents and its uptake by Rhodes grass. Plant. Soil 57:237-248.

APPENDIX

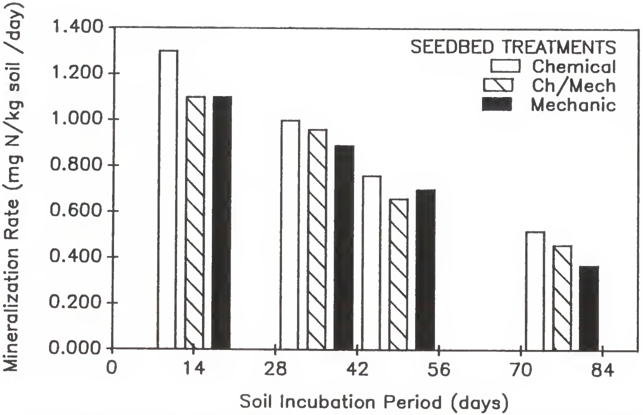
Appendix table 11. Effect of seedbed preparation and soybean residue on average soil NO_3-N and NH_4-N concentration in the 0 to 120 cm soil profile before sorghum planting and at physiological maturity.

Treatment	Depth	Before Planting		Maturity	
		NO_3	NH_4	NO_3	NH_4
	cm	------ mg N kg^{-1} soil			---------
<u>Seedbed Prep.</u>					
Chemical	0 to 7.5	13.9	5.3	20.0	10.8
	7.5 to 15	7.2	4.5	3.2	8.7
	15 to 30	6.2	3.5	1.1	8.7
	30 to 60	4.0	3.8	0.3	7.3
	60 to 90	2.4	3.9	0.3	7.3
	90 to 120	1.6	3.6	0.3	6.8
Chem/mechan.	0 to 7.5	11.9	6.6	11.9	7.2
	7.5 to 15	6.3	5.9	2.0	7.5
	15 to 30	5.2	5.0	0.8	6.4
	30 to 60	3.5	4.5	0.2	6.2
	60 to 90	1.8	4.3	0.0	5.7
	90 to 120	1.5	4.3	0.2	5.7
Mechanical	0 to 7.5	11.8	5.4	13.8	8.8
	7.5 to 15	7.2	5.0	3.4	9.3
	15 to 30	5.7	3.8	0.9	6.4
	30 to 60	4.2	4.1	0.2	6.1
	60 to 90	2.5	3.8	0.1	6.1
	90 to 120	1.8	3.7	0.3	6.3
<u>Seedbed x Depth Interaction</u> Prob. > F		0.19	0.33	0.01	0.07
<u>Residue</u> Removed	0 to 7.5	13.5	5.6	14.9	8.7
	7.5 to 15	7.8	5.4	2.8	8.3
	15 to 30	6.6	4.1	0.9	6.9
	30 to 60	4.1	3.9	0.2	6.7
	60 to 90	1.8	3.8	0.2	6.5
	90 to 120	1.7	4.1	0.3	6.2

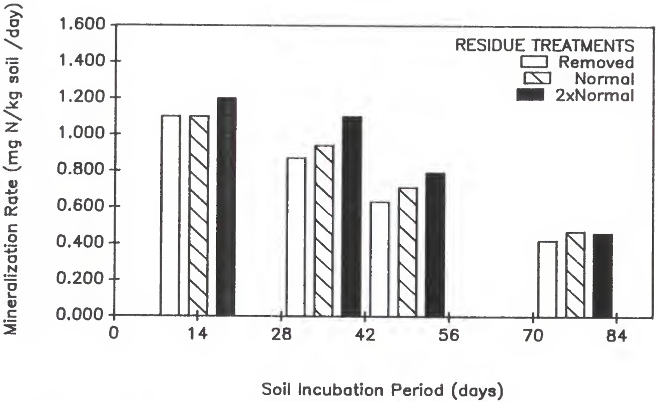
Cont.

Table 11 cont.

Normal	0 to 7.5	12.2	5.2	16.8	9.5
	7.5 to 15	6.9	4.7	3.9	9.0
	15 to 30	5.6	4.2	1.1	7.6
	30 to 60	4.0	4.3	0.4	6.5
	60 to 90	2.4	4.0	0.2	6.3
	90 to 120	1.8	3.9	0.4	6.6
2 x Normal	0 to 7.5	11.9	6.4	14.0	8.6
	7.5 to 15	6.0	5.2	2.0	8.3
	15 to 30	4.9	4.1	0.8	7.0
	30 to 60	3.6	4.2	0.1	6.4
	60 to 90	2.5	4.2	0.1	6.2
	90 to 120	1.3	3.6	0.1	6.0
Residue x Depth <u>Interaction.</u>					
Prob. > F		0.099	0.028	0.98	0.99



Appendix figure 3. Seedbed preparation effect on N mineralization rate.



Appendix figure 4. Soybean residue effect on N mineralization rate.

EFFECT OF SEEDBED PREPARATION METHODS AND SOYBEAN [*Glycine max.* (L.) Merr.] RESIDUE ON NET NITROGEN MINERALIZATION AND SORGHUM [*Sorghum bicolor* (L.) Moench] GROWTH.

by

MANFREY LYSON MLOTHA

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AN ABSTRACT OF A THESIS

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KANSAS STATE UNIVERSITY
Manhattan, Kansas

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ABSTRACT

Adoption of no-tillage management systems and utilization of residues has increased in the United States. This study was conducted to determine the effect of seedbed preparation methods and soybean residue level on net nitrogen (N) mineralization (Nm) from soil organic matter and soybean residue, and sorghum growth. Field and laboratory methods were used to determine Nm. The effects of removal or doubling normal soybean residue under chemical, mechanical, and a combination of chemical and mechanical seedbed preparation methods on Nm and sorghum growth were investigated at the Ashland Agronomy Farm near Manhattan, Kansas, in the summer of 1988 on a Muir silt loam (cumulic Haplustoll, fine-silty, mixed, mesic) soil. The study was conducted on a field where a long-term conservation tillage grain sorghum-soybean rotation study had been conducted since 1975. A split plot design with 4 replications was used with the seedbed preparation methods as main plots and soybean levels as subplots.

Sorghum variety "Pioneer 8686" was planted on 26 May, 1988. At 25 days after planting the residue removal, normal, and 2 x normal residue treatments resulted in dry matter yields of 0.67, 0.58, and 0.49 t ha^{-1}, respectively.

The 2 x normal residue treatment also had significantly shorter plants during the same period. The mechanical seedbed preparation method had significantly shorter plants 25 days after planting and the lowest dry matter yield 32 days later. Doubling residue significantly delayed flowering by 2 days over the residue removal treatment and produced significantly higher grain yield and N content at physiological maturity. The delay in sorghum maturity in the double residue treatment likely contributed to the higher N uptake.

Seedbed preparation methods and residue level had a significant combined effect on Nm. Doubling residue within the chemical treatment gave the highest Nm among all all treatment combinations. In the laboratory incubation study, the chemical treatment exhibited the highest Nm. No significant differences in Nm existed among residue treatments probably because most of the surface residue had been degraded by the time the soils were sampled.