THE INFLUENCE OF SOIL EROSION ON CROP PRODUCTIVITY AND SURFACE SOIL CHARACTERISTICS FOR FIVE SELECTED OKLAHOMA SOILS SOWN TO WINTER WHEAT

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PREFATORY STATEMENT

The body of this dissertation was written according to the standards set forth in the 1976 edition of the "Handbook and Style Manual for ASA, CSSA, and SSSA Publications", and later amendments as published by the Soil Science Society of America.

ABSTRACT

The objectives of this study were two-fold; One, to determine, under actual field conditions, the differences between soil productivity of eroded and noneroded soil sown to winter wheat, and Two, to measure the soil property differences that appear to be associated with soil productivity differences. Five cooperative research locations were selected in south west-central Garfield Co., Oklahoma. At each location, 2 sites of equal dimensions were established on eroded and noneroded phases, of the same soil series. Four of the five eroded phases were estimated to have sustained 43 to 72% loss of the "original" A horizon as compared to their respective noneroded phases. At the fifth location, (E), the loss was greater than 75%. Four plots per site were randomly chosen to estimate yield using a coordinate grid and random number table. Three random 76 cm rowlengths per plot, were used to estimate yield components. Nine surface soil samples were collected and combined for analysis. Conventional 2X4 factorial analyses of variance, and T-tests were used to evaluate yield, yield components, and soil properties.

At location C, yield and soil property differences between eroded and noneroded plots were not solely the result of erosion. Supplemental conversation with the commercial producer, confirmed extensive landforming had occurred. Analyses of variance for yield performed without locations C and E, (location E was not harvested), strongly suggested (Prob. ‘.001) that erosion by location interaction was not present and that the yield differences between eroded and noneroded plots at each location was 677 $Kg \cdot Ha^{-1}$. Analyses and tests performed on yield components showed differences present due to locations for tiller number/plant and kernels/spike. No consistent trends of differences were indicated for stand, kernel weight, and 1000 kernel weight. Differences for percent very fine sand, clay, and silt were ascribed to the mixing of B horizon material with A horizon during cultivation at locations A, C, and E. At the other locations, mixing was thought to have occurred but went undetected because there was either no Bt horizon (location D) or a thick A horizon (location B). Percent organic carbon was greatest within a location for the noneroded soils at three of the four harvested locations and location E. The occurrence of pH, CEC, and % base saturation differences was similar at locations C and E only. Other differences were either judged nonpractical or statistically insignificant.

Additional index words: Yield comopnents, *Triticum aestivum*, physical and chemical soil properties.

INTRODUCTION AND LITERATURE REVIEW

Rainfall erosion is a serious problem on farmland over a large part of the world. According to the Oklahoma Conservation Needs Inventory (18), erosion is the dominant hazard limiting land use on 60 percent of the total acreage in Oklahoma. Thirty-two percent of this acreage has erosion problems that make it expensive to keep in production.

With the settlement of the Great Plains, there came an increase in agricultural and non-agricultural activity. Because of this activity, the rate of erosion on many of the soils of this region increased.

Accelerated erosion has been defined as soil movement under conditions where modern man's activities have disturbed the natural vegetative cover (3). Accelerated erosion was first widely recognized as a problem in the 1930's. During this time, languishing crop productivity and successive years of crop failure combined to force many farmers out of business (11). Consequently, some of the eroded land was removed from production. Today, much eroded land is still being used for crop production.

In Oklahoma, specific research concerning erosion and its influence on crop production is lacking. This lack of data presents problems for those extension workers and Soil Conservation Service personnel who advise producers on the best use and management of their land. These needs are only partially addressed by the tables of expected yields that the National Cooperative Soil Survey includes in every county soil survey. Expected yields for major crops are given for each Soil Mapping Unit (including eroded phases). These expected yields are generally not taken from actual data, but are estimated based on the past experience of Soil Survey personnel and local farmers.

In 1980, the Soil Erosion - Soil Productivity Research Planning Committee (27) was appointed in an effort to develop a suitable soil erosion - soil productivity relationship. In March 1981 the committee summarized four important effects that erosion has on productivity. The first effect is the loss of plant available water. Available soil water may be reduced by changing the characteristics of the rootzone. If subsoils have high strength, poor aeration or are toxic to roots the rootzone and/or water supplying capacity becomes reduced.

Secondly, erosion can contribute to nutrient losses from the soil. Soil particles detached and transported through erosion carry attached nutrients with them.

Third, erosion may reduce productivity by degrading soil structure. Degradation of soil structure increases erodibility, surface sealing and crusting, and leads to poorer seed beds.

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Lastly, erosion can reduce productivity by creating nonuniformity across a producers field. For example, if portions of the field are differentially able to sustain tillage equipment then inconsistent seed beds are created along with subsequent variable emergence.

In addition, the Planning Committee concluded that the relationship between soil erosion and soil productivity is not adequately defined and until such a relationship is adequately developed, selecting management strategies to maximize long-term crop production will be impossible. It is the choice of proper management strategies, which will determine whether or not a grower's long-term crop production will be maximized.

Most research information concerning possible soil erosion - crop productivity relationships has come from: 1) land leveling and desurfacing studies where the subsoil is artificially exposed, and from 2) pot culture comparisons in modified environments (8,15,17, 22,24). Studies such as these, suggest indirectly that erosion will lower productivity, although the time scale of removal is different in most cases, i.e. instantaneous for mechanical soil removal and slow for erosion. Results can be expected to vary with soil profile characteristics, and in some cases the subsoil may be a productive medium because it is composed of buried topsoil.

Other erosion-productivity research has been conducted investigating the erosion-productivity relationship under actual field conditions. Studies of this nature are few and involve measuring crop yield on soils subjected to differing degrees of erosion. The erosion is not simulated, but is that which took place through farm operations.

In Wisconsin, Hays et al. (10) located areas of severe and moderate erosion in the same field. The soil was a Fayette silt loam with a slight clay accumulation in the B horizon. The main difference between the A and B horizons was in the Nitrogen and organic matter contents. The productivity of the severely eroded soils was restored with proper fertilization. They conceded the response would not have been as favorable with a finer textured subsoil. Both Adams (1) and Langdale et al. (14) used corn (_Zea mays_ L.) as a test crop to compare yields from moderately eroded soil and severely eroded soil. Cecil was the soil used in both studies. It is a Typic Hapludult, characterized by a subsurface argillic horizon. In both instances, corn yields were significantly greater on moderate eroded soil.

In Kentucky, (W.W. Frye, S.A. Ebelhar, L.S. Murdock, and R.L. Blevins. 1982. Soil erosion effects on properties and productivity of two soils in Kentucky. Agron. Abstracts p. 248.), an effort was made to identify the yield-limiting effects of soil erosion and to quantify losses in soil productivity. Soil samples were taken from field experiments with corn (Zea mays L.) on two sites where the silt loam surface soils were known to vary in degree of past erosion from none-to-slight to moderate. The samples were analyzed to determine the effects of moderate erosion on certain physical and chemical properties. Clay content of the surface layer of soil was the most reliable indicator of degree of past erosion. Comparison of results on uneroded and moderately eroded soils generally showed the following effects of erosion: higher clay content and higher bulk density in the Ap horizon, tendency for lower organic matter content although differences were small, lower plant available water holding capacity, lower pH, lower soil-test P, and lower yields. Lower plant available water holding capacity associated with higher clay content was thought to be a major yield-limiting property of eroded soils.

In North Carolina, (J. Stone, R. Daniels, J. Gilliam, J. Kleiss and K. Cassel. 1982. Relationships among corn yields, surface horizon color and slope form in some clayey North Carolina Piedmont soils. Agron. Abstr. p. 257.) data collected from five commercial fields indicated a strong relationship exists between corn yields and Munsell hue of the plow layer. In general, the plow layers with 7.5YR hues had the highest mean yields and those with 5YR hues the lowest.

Plow layers with 10YR hues were either intermediate or not significantly different from those with 7.5YR hues. Within a Munsell hue, the shape of the slope, concave, convex or straight, also was significantly related to yield in the fields tested. The plow layer Munsell hue was closely related to the amount of BA and B2 horizon incorporated within the plow layer which in turn is related to the amount of erosion or deposition at the site.

The objectives of this study were two-fold; One to determine under actual field conditions the differences between soil productivity of eroded and noneroded soil sown to winter wheat, and Two, to measure the physical and chemical soil property differences that appear to be associated with soil productivity differences.

MATERIALS AND METHODS

Physical and chemical soil properties and, soil productivity were measured on the soils of five commercial wheat production fields (Table 1) located in south west-central Garfield Co., Oklahoma (Fig.1). Garfield County has been dominated by agricultural activity since it's settlement in 1893. The average annual precipitation is approximately 80 cm with about 65 percent of that occurring from March to November (16). The quick runoff from thunder storms can result in crop loss, flooding, and soil erosion from April to October.

The wheat production season of 1981-1982 was one of the wettest in this century (Fig.2). General rains that fell throughout most of October prevented sowing at that time. The only moisture stress of consequence may have been in April during stem elongation. Rains occurring in May effectively eliminated any severe drought effects for this study (13).

Experimental Layout

The research was designed, conducted and analyzed as a 2 x 4 factorial sampling experiment with erosion and locations as the two classifications. Research locations were established using three criteria: 1) eroded and noneroded phases of the same soil type (Table 1) were adjacent to one another; 2) cooperators used the same management and cultural techniques (Table 2) on each phase; and 3) all locations were close together to facilitate field work, and keep climatic differences to a minimum. At each location, 2 sites of equal dimensions were established (Fig. 4-8), one in the eroded phase and the other in the noneroded phase. Eroded sites had sustained in each case between 43 and 72 percent loss of the original A horizon except for location E which had lost in excess of 75 percent. Three random subplots were selected within each plot for estimating yield components. Alternate random plots were available for use in the event that anomalous conditions were encountered.

Plot dimensions varied from location to location because of row spacing differences. Plot areas were 9.3m² at location A, C, D, and E, and 8.2m² at location B. Each subplot consisted of a 76 cm row-length. At maturity, subplots were harvested by removing whole plants and bundling them. Plots were subsequently hand harvested and bundled using sickles, paper bags and twine. Bundles were threshed with a Vogel nursery thresher.

Yield Components

Stand, tiller number/plant, kernels/spike and kernel weight were measured on each subplot. The mean yield component estimates of plots were calculated by averaging their corresponding subplot measurement.

Stand

Stand was determined by washing the plant roots free of soil and counting the separated plants. Stand was converted to a per-hectare basis for statistical analyses and tests.

Tiller Number/Plant

Tiller number/plant was expressed as the number of spikes divided by the stand count.

Kernels/spike

The number of kernels/spike was calculated using all spikes taken from a subplot. The spikes were threshed by hand, using corrogated rubbing boards, and the kernels were counted to determine the mean number of kernels/spike.

Kernel Weight

Kernel weight was determined from all spikes taken from each subplot. The kernel weight of each subplot was divided by the number of kernels produced and was recorded in g/kernel.

Soil Analyses

Nine surface soil samples, to the 15 cm depth, were collected from each plot using an Oakley soil sampling tool. Samples were collected after the plants had emerged at equally spaced points along plot diagonals. Soil samples from each plot were then mixed and prepared for analysis as described in method 1B1 and 1B1a of Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples (19).

Physical Properties

Particle size analysis was done by method 3A1 except a hydrometer was used to determine the clay fraction. Bulk density was done according to method 4A3. Munsell colors were determined using crushed samples.

Chemical Properties

Percent organic carbon was determined by method 6A1A, and percent base saturation by methods 5C3. Electrical conductivity, extractable acidity, soil reaction, cation exchange capacity and extractable bases were done by methods 8A1, 6H1, 8C1a, 5A2a, and 5B1, respectively.

Extractable bases, Ca^{++} and Mg^{++} were measured according to method 7 in Agric. Handb. No. 60 (25). Nitrate nitrogen was determined using a nitrate ion electrode method for a 2.4 to 1 water to soil ratio (as developed by Agronomic Services, Oklahoma State University). Available phosphorous was determined using the Bray-I procedure where 1 g soil was extracted with 20 ml of .025 N HCL and .03 N NH_3Fl for 5 min (4).

Statistical Analyses

Standard analyses of variance were conducted on the mentioned soil properties and productivity variables to detect significant differences among erosion levels (eroded vs. noneroded), locations, and the presence or absence of erosion by location interaction for the combined locations. If erosion by location interaction was present and significant differences were indicated between eroded and noneroded sites over all locations, then separate T-tests (23) were conducted to test for differences between eroded and noneroded variable means within each location. Standard errors and coefficients of variation (C.V.) of selected variables were also calculated.

RESULTS AND DISCUSSION

Soil test measurements for nitrate nitrogen showed no regular trends or patterns among or within locations. This was not surprising, since soils could not be sampled until the crop was established, thus allowing NO_3-N to be converted to other N-forms or crop use. Available phosphorous and potassium was judged sufficient on all plots based on the latest sufficiency index (12).

Yield

Analysis of variance mean squares and their attendant F-test significance levels for yield are shown in Table 4. The analysis for yield showed tests of erosion and locations significant ($P < .0001$). Interaction was not thought to be present at the .155 level.

When mean yields of eroded and noneroded sites are displayed graphically (Fig. 3), an interaction appears to exist. It was not detected, however, by the analysis of variance (Table 4). We feel the statistical evidence is insufficient ($OSL < .155$) to strongly rule out the presence of interaction. If the true yield differences due to erosion are similar (i.e. no interaction), then the plot lines representing the different locations would be parallel. The means at location C, however do not conform to the hypothesis of no interaction. A subsequent analysis of variance performed without location C (Table 5) strongly suggests that interaction is not present ($Prob < .61$) and that the response of yield to erosion does indeed seem to be similar from location to location. Since there was evidence in Table 4 for the absence of interaction and strong evidence in Table 5, it appears that the large difference between means at location C may not be solely due to the removal of A horizon through erosion. After the analyses were completed, the cooperating farmer at location C was asked about the history of the soil at the eroded research site on his land. He indicated that, "in 1948, gullies large enough to hide trucks" were filled in and smoothed over with a bulldozer. The surface soil outside of the eroded site within the eroded phase (Fig. 6) was used to form a diversion terrace to protect the gullied area.

The quantity and types of significant differences between mean soil properties and yield measurement differences associated with locations A, B, and D, and those associated with location C, seem to confirm the events related by the farmer. For example, at location C highly significant differences occurred for pH, CEC, Extr. Mg, Na, H, and percent base saturation (Table 13). Such differences were not evident at the other harvested locations. The average of mean differences between eroded and noneroded sites for locations A, B, and D was calculated to be 677 $Kg \cdot Ha^{-1}$. On the other hand, the mean difference at location C was 1743 $Kg \cdot Ha^{-1}$ (Table 8).

Yield Components

The analyses for tillers/plant and kernels/spike (Table 6) indicated differences present (OSL <.0001 and, <.04, respectively) due to locations. Evidence of interaction and differences due to erosion was not indicated for these variables. The protected LSD comparison of location means of tillers/plant showed that location A was significantly larger than any of the other locations. It was concluded that the low seeding rate at location A (Table 2) contributed to the size of this component. Similar examination of the location means for kernels per spike showed location B significantly greater than means at either location A or D.

Analyses in Table 6 for stand, kernel weight, and 1000 kernel weight showed the presence of interaction (OSL $<.0008$, $<.05$, and $<.03$, respectively). This suggests that these yield components responded differently to erosion from location to location. T-test for differences between mean stand and 1000 kernel weight values from eroded and non-eroded sites (Table 7) showed a difference for stand (OSL $<.01$) at location B, and for 1000 kernel weight (OSL $<.05$) at location C. No apparent reason was immediately clear as to why stand means were different at location B. It is thought that perhaps the slope associated with the eroded sites could have increased water runoff sufficiently to cause seed loss and germination stress through soil wash and slow infiltration.

The low kernel weight at location B (Table 8) is consistent with the other yield component values at this location. High stand values lead to lower tiller numbers per plant; and high counts of kernels per spike tend to lower kernel weight. At the other locations, yield components also seemed to exhibit similar interdependence.

Soil Properties

Physical Properties

AOV's associated with fine earth particle sizes less than .10 mm in mean diameter are shown in Table 9. AOV's for those size fractions greater than .1 mm and for bulk density measurements are not given because these analyses indicated no significant differences among locations or erosion levels, and the absence of interaction.

Analyses for percent clay, percent silt, and percent very fine sand (VFS) indicated the presence of erosion by location interaction at the .01, .01, and .10 significance levels, respectively.

T-tests performed on all three variables within a location showed a statistically significant (OSL $<$ .05) difference between eroded and noneroded sites at location C for all variables and at location E for percent clay and percent silt at the .05 and .01 significance levels, respectively as shown in Table 10.

These physical property results are not unusual when one considers the soil profile descriptions in Table 3. At locations A, C, and E the subsurface horizon of clay accumulation (Bt) in the noneroded phase begins at approximately 25-30 cm. In the surface soil of the eroded phases the A horizon is not as thick, and can become mixed with portions of the Bt horizon during cultivation. At location D, the B horizon has probably been similarly mixed with the A horizon but did not show up in the analysis as an increase in clay content because the B horizon is weakly developed and would therefore, have only a minimum amount of illuvial clay. At location B, the A horizon is thick enough that the Bt horizon has not yet started to be mixed into the plow layer of the eroded soil.

Differences in silt percentage can be, in part, caused by the clay content differences that exist. Since silt percentage values are partially dependent on the relative amounts of the other soil separates, an increase in clay content would correlate with a relative decrease in silt content. On the other hand, silt and silt-size aggregates are the most easily detached by water of all the size fractions in soils. This fact alone may have accounted for the differences detected. The range in values for CV's in Table 14 are consistent with those found by Wilding and Drees (26) for soil particle size determinations at the soil mapping unit level.

Mean dry and moist Munsell color value and chroma measurements (Table 11) were either the same or slightly greater for eroded soils than for the noneroded.

Chemical Properties

Analyses (Table 12) performed on the chemical properties showed a significant (OSL $< .01$) presence of interaction for all measured properties except extractable potassium (K) and electrical conductivity (EC). The analysis for exchangeable potassium indicated the presence of interaction at the .05 level. The analysis for EC showed relatively weak evidence for the absence of interaction at the .15 level. Differences due to erosion and location were detected at the .05 and .01 levels, respectively. Such statistical evidence might suggest that differences between eroded and noneroded sites are similar and that differences are present due to locations. These results are similar to those encountered in the analyses performed on yield data. They are, however, insignificant if viewed in a practical sense. The largest mean value of EC was 1130 umho/cm as shown in Table 14. This value is approximately 3.1 times less than the threshold value at which soluble salt content may be considered detrimental to normal crop productivity

The results from T-tests performed on all chemical variables except potassium are found in Table 13. T-tests for potassium were not performed because statistical differences due to erosion effects were not indicated attendant to the presence of erosion by location interaction.

Tests for percent organic carbon content (%OC) showed significant differences between erosion at four of the five locations: locations A and E at the .10 level and at locations C and D at the .01 level.

Organic carbon content may be reported as organic matter by multiplying the organic carbon figure by 1.724. Other conversion factors have also been used. Broadbent (5) suggests that the factor for converting organic carbon to organic matter in surface soils is better if the figure 1.9 is used, and that the figure for subsoils should be about 2.5. Since variations exist in the carbon-to-organic matter ratio among horizons and pedons (2), the % organic carbon results were reported and analyzed as such.

Since percent organic carbon reflects in varying degrees the amount of organic matter in the soil, its reduction must be considered one of the soil properties which contributes most to the differences in crop productivity which were noticed. Organic matter is responsible for desirable soil structure, soil porosity, CEC and good soil water and air relations. Chemically, organic matter is also the "soil origin source" of nearly all nitrogen and 5 to 60 percent of the phosphorous (7).

Other T-tests performed on the remaining variables showed, with few exceptions, that differences were confined mainly to location C and E. Variables, H and cation exchange capacity (CEC) showed differences (OSL $< .01$) at locations C and E. T-tests for extractable calcium (Ca) indicated a difference at location C (OSL $< .05$) and for extractable magnesium (Mg) differences were exhibited (OSL $< .01$) at locations C, D, and E. Exchangeable sodium (Na) was statistically different at location C and E at the .01 and .10 significance levels, respectively. Differences (OSL $< .01$) were indicated at locations B, C, and E for extractable acidity (H), and for percent base saturation at the .05, .01, and .05 levels, respectively.

Those differences excluding % OC at locations C and E which appear to have practical significance are pH, CEC, and percent base saturation. These particular differences suggest that the eroded phases have perhaps experienced greater than 75 percent A horizon removal. If location E had been harvested, it too might have had yield differences as great as those seen at location C.

SUMMARY AND CONCLUSIONS

With the assistance of five cooperative winter wheat growers, productivity and soil properties were studied as they exist under actual field conditions on eroded and noneroded phases of five selected soils in south west-central Garfield Co., Oklahoma.

Location A, B, C and D had eroded phases which were classfied to have lost from 43 to 72% of the "original" A horizon with the eroded soil at location E having lost more than 75%. Soil productivity surface soil property differences, and cooperator questioning at location C however, suggested that the eroded phase experienced drastic landforming. The occurrance of physical and chemical property differences at location C were similar to those at location E.

Initial analyses of variance performed on yield for the four harvested locations A, B, C, and D indicated yield differences between soil phases within a location to be similar from location to location. Plots of eroded vs noneroded yield means suggested however, that the statistical evidence supporting the conclusion of a lack of interaction was weak. Analyses performed without location C gave correspondingly stronger evidence of no interaction. The mean difference between eroded and noneroded sites at locations A, B, and D was estimated to be 677 $Kg{\cdot}Ha^{-1}$ for yield. The eroded phase at location C had been subjected to landforming which had removed more than 75% of the original A horizon, and this in turn might explain why yield differences were larger than those associated with the other harvested locations.

Statistical analyses and tests performed on yield components showed no evidence of differences due to erosion or the presence of interaction for tiller number and kernels/spike. No consistent trends among locations for differences were indicated for stand, kernel weight and 1000 kernel weight.

Statistically significant differences for percent very fine sand, clay, and silt were ascribed to the mixing of B horizon material with A horizon material during cultivation. At locations with no such differences, the soil had either no Bt subsurface horizon or a thick A horizon. Mean dry and moist Munsell color value and chroma measurements for eroded soils were 0 to 2 units above those of noneroded soil sites.

T-tests performed on selected chemical property measurements showed differences in % organic carbon between eorded and noneroded soil phases at locations A, C, D, and E. These differences were considered as one of the soil properties most critical to difference observed in crop productivity. The occurrence of differences in pH, CEC, and % base saturation at location C and E seemed to indicate that more than 75% of the original A horizon on the eroded soils was indeed missing and that these particular measurements were indicative of substantial cultivation of B horizon material.

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Table 1. Land descriptions and soil classification at each location.

Location	Land Decription	Soil Classification†	Series	Slope	
				Eroded	Noneroded
A	E40,N½ of NW¼, Sec 20 T21N, R7W	Fine silty, mixed thermic Udic Argiustolls	Kingfisher	2-5%	1-3%
B	S½ of NW¼, Sec 11 T21N, R7W	Fine silty, mixed thermic Udic Argiustolls	Grant	5-8%	1-3%
C	E½ of SW¼, Sec 21 T21N, R6W	Fine silty, mixed thermic Udic Paleustolls	Norge	3-5%	1-3%
D	N80,NW¼ of SE¼, Sec 31 T21N, R6W	Coarse silty, mixed thermic Udic Haplustolls	Nash	5-8%	1-3%
E	SE40,N½ of SE¼, Sec 34 T21N, R6W	Fine, mixed thermic Udertic Paleustolls	Renfrow	3-5%	1-3%

† Soils were classified according to Soil Taxonomy (21).

Table 2. Selected cultural practises by location.

Cultural Practise [‡]	Location				
	A	B	C	D	E[†]
Planted	Sep. 19, 1981	Sep. 25, 1981	Sep. 26, 1981	Oct. 8, 1981	Sep. 29, 1981
Harvested	June 18,1982	June 18, 1982	June 19, 1982	June 17, 1982	
Seeding rate	50 lb/ A	100 lb/ A	70 lb/A	68 lb/ A	60 lb/ A
Drill Spacing	8 inches	7 inches	8 inches	10 inches	10 inches
Variety	TAM 101	Vona	TAM 101	TR 64	TAM 101
Grazed ?	NO	YES	NO	NO	YES
Fertilization (per acre basis)	100 lb N as Anhydrous NH_4	120 lb N as Anhydrous NH_4	65 lb N as Anhydrous NH_4 38 lb 18-46-0 in Spring	100 lb N as Anhydrous NH_4 40 lb 18-46-0 banded at planting	
Weed Control		2 years of burning straw	Stubble mulch and cultivation	none	
Years of continuous wheat [§]		5	4	unknown [¶]	
Yield history [§] last 5 years (Bu/ A)		40-45	35	26	

[†] This location was grazed completely, and no harvest was possible. [‡] Practises are listed as expressed by the commercial producer. [§] Pertinent information was not obtainable from the producer at location A. [¶] 1981-82 was the first year that the producer had farmed this land.

Table 3. Selected morphological and physical properties of the 5 soils studied.

Horizon‡	Depth	Munsell Color (moist)	Texture†	Structure†	Consistency† (moist)	Boundary†
	cm					
				Kingfisher-A		
A	0-25	7.5YR 3/2	sil	1fgr	fr	cs
BA	25-38	7.5YR 3/2	sicl	2fgr	fr	cs
Bt	38-74	2.5YR 3/4	sicl	2msbk	fi	gs
BC	74-122	2.5YR 3/6	sicl	2cbk	fi	
				Grant-B		
A1	0-16	5YR 3/4	sil	1mgr	fr	as
A2	16-41	5YR 3/4	sil	2mgr	fr	gs
Bt1	41-76	5YR 3/4	sil	2mgr	fr	gs
Bt2	76-109	5YR 3/6	sicl	2mgr	fr	gs
CB	109-140	2.5YR 4/6	sil	m	fr	
				Norge-C		
A	0-25	7.5YR 3/3	1	1fgr	fr	gs
BA	25-51	5YR 4/4	cl	2mgr	fr	gs
Bt	51-71	5YR 3/3	cl	2msbk	fi	gs
BC	71-107	5YR 4/3	cl	2msbk	fi	cs
C	107 +	5YR 4/6	cl	m	fr	
				Nash-D		
A	0-25	5YR 3/4	sil	1fgr	fr	gs
Bw	25-56	5yr 3/6	sil	1fgr	fr	gs
R	56 +					
				Renfrow-E		
A	0-18	5YR 3/3	sil	2fgr	fr	cs
AB	18-30	2.5YR 3/4	sil	2mgr	fi	cs
Bt	30-76	2.5YR 3/4	c	2cbk	vfi	gs
BC	76-107	2.5YR 3/6	c	m	vfi	cs
R	107+					

† Symbols are the same as given in the Soil Survey Manual, Agric. Handb. No. 18, USDA p. 139-140. ‡ Symbols are the same as given in the Soil Survey Manual, revised, May, 1981.

Table 4. Analysis of variance mean squares and their corresponding probabilities of greater F-values for yield measurements at locations A, B, C, and D.

Source	df	Yield	
		Mean Square	Pr > F
Erosion	1	7,124,172	.0001
Location	3	6,016,414	.0001
Interaction	3	652,180	.155
Error	24	341,338	

Table 5. Analysis of variance mean squares and their corresponding probabilities of greater F-values for yield measurements at locations A, B, and D.

Source	df	Yield	
		Mean Square	Pr > F
Erosion	1	2, 752,539	.004
Location	2	8,869,534	.0001
Interaction	2	126,906	.613
Error	18	252,352	

Table 6. Analyses of variance for yield component variables.

		Variables									
Source	df	Stand †		Tillers/plant		Kernels/spike		Kernel wt. ‡		1000 Kernel wt.	
		Mean Square	Pr > F	Mean Square	Pr > F	Mean Square	Pr > F	Mean Square	Pr > F	Mean Square	Pr > F
Erosion	1	14.0171	.007	1.7	.50	36.1	.28	11.9	.04	57.04	.03
Location	3	34.3587	.0001	43.3	.0001	99.2	.04	5.0	.15	46.04	.016
Interaction	3	12.9610	.0008	4.0	.39	30.6	.40	7.6	.05	38.55	.03
Error	24	1.6387		3.8		30.0		2.6		10.88	

† mean square values are 10^{11} times greater than listed. ‡ mean square values are 10^{-5} times less than those listed.

Table 7. Results from T-tests performed on eroded and noneroded means of selected yield components by location.

Location	Eroded or Not	Variables	
		Stand	1000 Kernel wt.
A	E	726,538	29.7
	N	672,720	32.8
B	E	1,476,141	27.8
		**	
	N	3,009,896	25.3
C	E	1,463,839	27.8
			*
	N	1,512,275	36.0
D	E	1,274,401	29.3
	N	1,330,372	31.3

*, and ** significant at the .05 and .01 levels, respectively.

Table 8. Mean ($\bar{X}$), standard deviation of the mean ($S_{\bar{x}}$), and coefficient of variation (CV) for yield and yield component variables for locations A, B, C, and D.

			Variable				
Location	Eroded or Not	Statistic	Yield	Stand†	Tillers/ Plant	Kernels/Spike	Kernel Wt.
			Kg/Ha				g/seed
A	E	$\bar{x}$	2186	7.2654	7.3	15.8	.029
		$S_{\bar{x}}$	310	14.7941	2.4	.2	.0018
		CV	28.3	40.7	66.5	2.5	12.7
	N	$\bar{x}$	3132	6.72720	8.1	17.3	.032
		$S_{\bar{x}}$	198	8.4923	.8	.6	.0014
		CV	12.7	25.3	19.7	7.3	8.5
B	E	$\bar{x}$	3794	14.7614	3.8	24.4	.026
		$S_{\bar{x}}$	250	19.3719	.7	.9	.0009
		CV	13.2	26.3	34.7	7.1	7.0
	N	$\bar{x}$	4242	30.9990	2.3	23.6	.025
		$S_{\bar{x}}$	319	43.6764	.5	6.0	.0004
		CV	15.1	28.2	38.9	5	3.4
C	E	$\bar{x}$	1775	14.6384	2.2	23.9	.023
		$S_{\bar{x}}$	540	14.0339	.4	7.38	.0056
		CV	60.8	19.2	33.5	61.8	48.7
	N	$\bar{x}$	3518	15.1228	4.1	16.2	.036
		$S_{\bar{x}}$	114	14.8722	.3	.7	.0017
		CV	6.5	19.7	16.7	8.1	9.4
D	E	$\bar{x}$	1626	12.7440	2.6	17.3	.031
		$S_{\bar{x}}$	210	14.8978	.1	1.3	.0031
		CV	25.8	23.4	4.4	14.6	19.8
	N	$\bar{x}$	2264	13.3037	3.3	16.0	.031
		$S_{\bar{x}}$	186	7.9660	.2	1.3	.0009
		CV	16.4	12.0	12.2	16.6	5.6

† $\bar{x}$ and $S_{\bar{x}}$ values are respectively, 10,000 and 1000 times greater than indicated.

Table 9. Analyses of variance mean squares for selected fine earth particle sizes.

Source	df	Variables % Clay (<.002 mm)	 % Silt (.002-.04 mm)	 % VFS (.05-.10 mm)
Erosion	1	218. **	228. **	6.66 *
Location	4	54.6 **	73.2 *	21.6 **
Interaction	4	76.5 **	137. **	2.49 †
Error	30	7.61	10.3	1.04

†, *, **, significant at the .10, .05, and .01 levels, respectively.

Table 10. Results from T-tests performed on eroded and noneroded means of selected fine earth particle sizes by location.

Location	Eroded or Not	Variables		
		%Clay (<.002 mm)	%Silt (.002-.05 mm)	%VFS (.05-.10 mm)
A	E	21.8	67.3	9.35
		*	*	*
	N	19.1	71.8	8.01
B	E	17.3	76.2	.21
	N	16.7	76.9	.20
C	E	24.8	63.9	9.4
		**	**	**
	N	12.7	79.6	7.1
D	E	20.4	73.2	5.2
	N	22.6	67.1	4.3
E	E	29.0	64.6	5.9
		*	**	
	N	18.8	73.8	6.5

*, and **, significant at the .05 and .01 levels, respectively.

Table 11. Mean dry and moist Munsell color value and chroma measurements.

Location	Eroded or Not	Dry		Moist	
		Value	Chroma	Value	Chroma
A	E	4.50	5.00	4.00	2.75
	N	4.00	4.00	3.25	2.00
B	E	4.00	4.00	3.00	3.00
	N	4.00	4.00	3.00	3.00
C	E	5.00	6.00	3.00	3.00
	N	5.00	3.00	3.00	3.00
D	E	4.00	5.00	3.00	3.50
	N	4.00	4.50	3.25	3.25
E	E	4.25	4.00	3.25	4.00
	N	5.00	3.25	3.00	2.00

Table 12. Analyses of variance mean squares for selected chemical properties.

		Variables									
Source	df	% OC	pH	CEC	Ca	Mg	K	Na	H	EC	% Base Saturation
				--------------	------------	------------	Meq/100g	------------	--------------	µmho/cm	
Erosion	1	.234**	5.26**	308.3**	114.8**	25.1**	.0089	.329*	25.5**	753,777*	1556.0**
Location	4	.121**	3.08**	53.3**	136.0**	10.0**	.0484 †	.846**	9.6**	773,505**	763.1**
Interaction	4	.040**	2.69**	77.1**	20.7**	5.3**	.0839*	.250**	7.3**	257,274	682.8**
Error	30	.006	.191	7.59	28.1	7.8	.0234	.057	.9	141,133	41.6

†, *, **, significant at the .10, .05, and .01 levels, respectively.

Table 13. Results from T-tests performed on eroded and noneroded means of selected chemical properties by location.

		Variables								
Location	Eroded or Not	% OC	pH	CEC	Ca	Mg	Na	H	EC	% Base Saturation
				meq/100g					µmho/cm	
A	E	.68	6.23	19.4	6.7	4.3	0.0	3.9	186	75.1
		†								
	N	.90	5.90	20.2	7.3	3.7	0.0	4.1	181	74.1
B	E	.78	5.75	14.4	4.5	3.2	0.0	5.5	168	59.8
								**		*
	N	.73	5.58	14.0	4.5	3.2	0.0	6.8	154	54.5
C	E	.44	7.70	23.1	24.1	4.0	0.13	1.9	1102	92.9
		**	**	**	*	**	**	**		**
	N	.72	5.60	10.1	3.5	2.8	0.06	6.4	340	51.2
D	E	.79	6.95	21.2	10.5	5.6	0.0	3.5	531	81.5
		**				**				
	N	1.04	7.65	17.1	15.9	3.8	0.0	3.2	495	85.9
E	E	.67	7.40	25.9	8.3	8.1	1.1	2.7	1130	85.9
		†	**	**		**	†	**	**	*
	N	.74	5.68	14.9	5.9	3.8	0.3	5.1	674	67.1

†, *, ** significant at the .10, .05, .01 levels, respectively.

Table 14. Mean ($\bar{x}$), standard error of the mean ($S_{\bar{x}}$) and coefficient of variation (CV) for selected physical and chemical properties of the 5 soils studied.

Location	Eroded or Not	Statistic	Variables						
			%OC	%Clay	%Silt	%VFS	% Base Saturation	H	EC
								Meq/100g	μmho/cm
A	E	$\bar{x}$	.68	21.8	67.3	9.4	75.1	3.9	186
		$S_{\bar{x}}$	.1	.1	.8	.3	5.2	.8	12.4
		CV	28.9	.9	2.4	6.4	13.7	42.5	13.3
	N	$\bar{x}$	.9	19.1	71.8	8.0	74.1	4.1	181
		$S_{\bar{x}}$	.01	.8	1.0	.3	3.2	.5	17.2
		CV	21.3	8.7	2.7	7.8	8.6	23.1	19.0
B	E	$\bar{x}$	.78	17.34	76.20	6.13	59.8	5.5	168
		$S_{\bar{x}}$	.03	.6	.4	.4	.9	.1	18.6
		CV	6.7	7.4	1.1	12.7	3.0	4.6	22.2
	N	$\bar{x}$	.73	16.7	76.9	6.0	54.5	6.8	154
		$S_{\bar{x}}$	.02	.5	.6	.2	1.7	.20	17.1
		CV	5.4	5.6	1.6	7.4	6.2	5.8	22.3
C	E	$\bar{x}$	.44	24.8	63.9	9.4	92.9	1.9	1102
		$S_{\bar{x}}$	.01	1.6	1.1	.6	1.1	.1	531
		CV	6.6	12.2	3.3	11.9	2.4	10.4	96.3
	N	$\bar{x}$	.72	12.7	79.6	7.1	51.2	6.4	340
		$S_{\bar{x}}$	.03	.35	.55	.28	1.89	.50	56.0
		CV	9.7	5.4	1.4	8.0	7.4	15.6	32.9
D	E	$\bar{x}$	.79	20.4	73.2	5.2	81.5	3.5	531
		$S_{\bar{x}}$	.04	1.6	1.1	1.1	4.5	.6	91.4
		CV	9.2	15.7	3.6	43.7	11.0	36.4	34.5
	N	$\bar{x}$	1.04	22.6	67.1	4.3	85.9	3.2	495
		$S_{\bar{x}}$	.02	2.1	3.8	.33	2.7	.4	92
		CV	3.0	18.5	11.9	15.4	6.4	25.2	37.3
E	E	$\bar{x}$	.67	29.0	64.6	5.9	85.9	2.7	1130
		$S_{\bar{x}}$	.02	2.8	2.4	.6	4.9	.7	174
		CV	5.5	19.1	7.4	20.4	11.4	48.9	30.8
	N	$\bar{x}$	.74	18.8	73.8	6.5	67.1	5.1	674
		$S_{\bar{x}}$	.02	.9	1.0	.3	2.7	.14	141
		CV	6.5	9.0	2.6	8.5	7.9	5.5	49

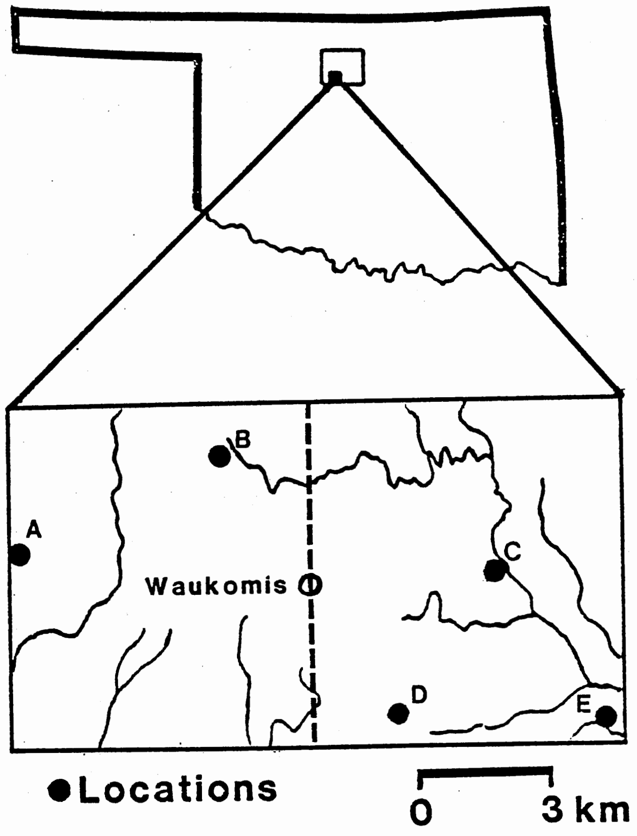


Fig. 1. Research locations in Oklahoma.

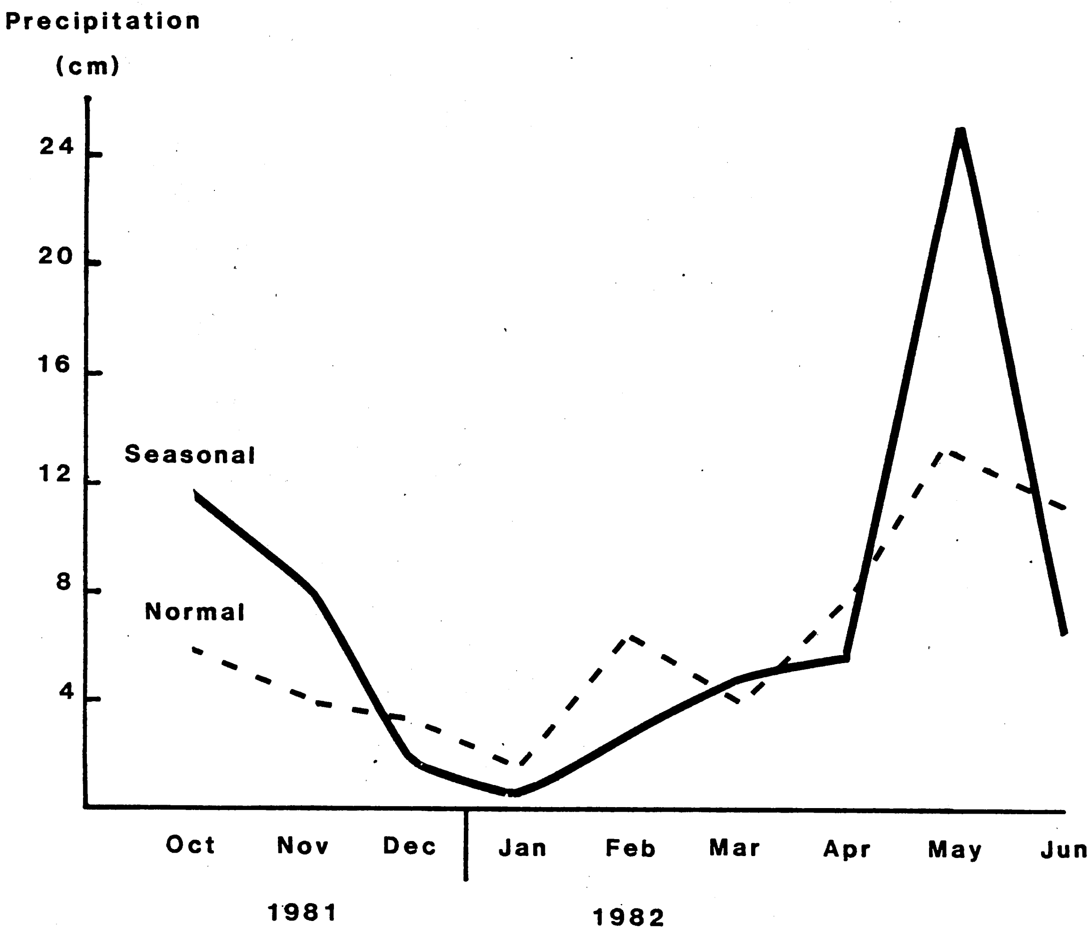


Fig. 2. Seasonal (1981-1982) and Normal precipitation at Enid, Oklahoma.

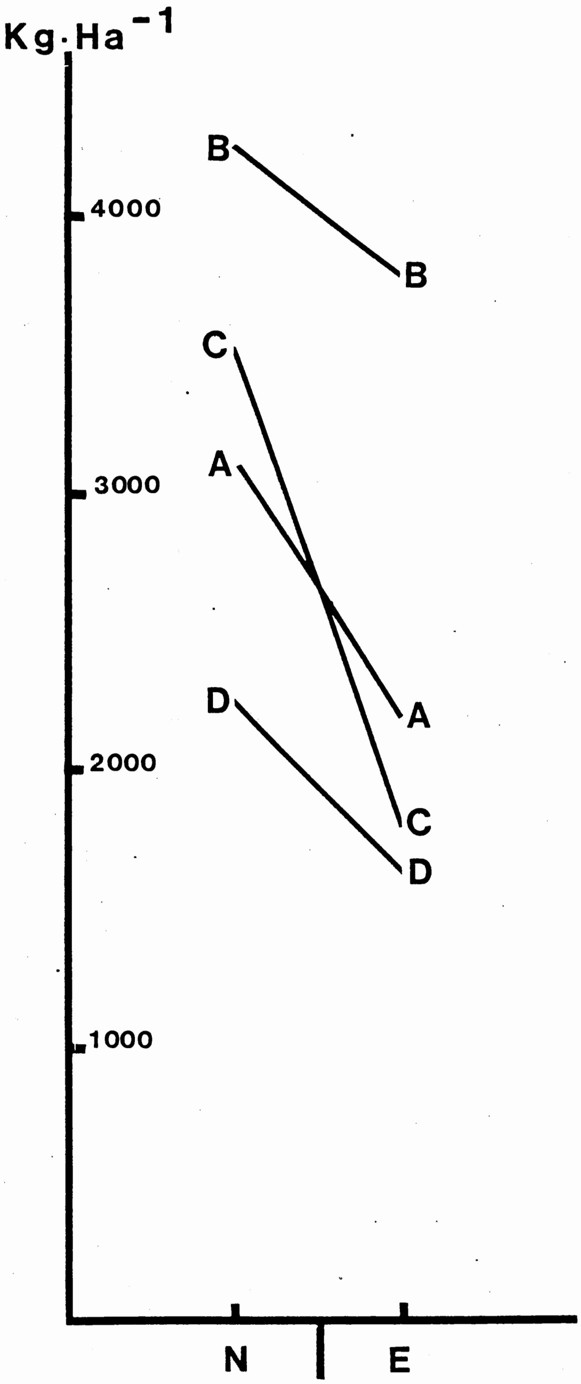


Figure 3. Plots of eroded (E) vs. non-eroded (N) yield means.

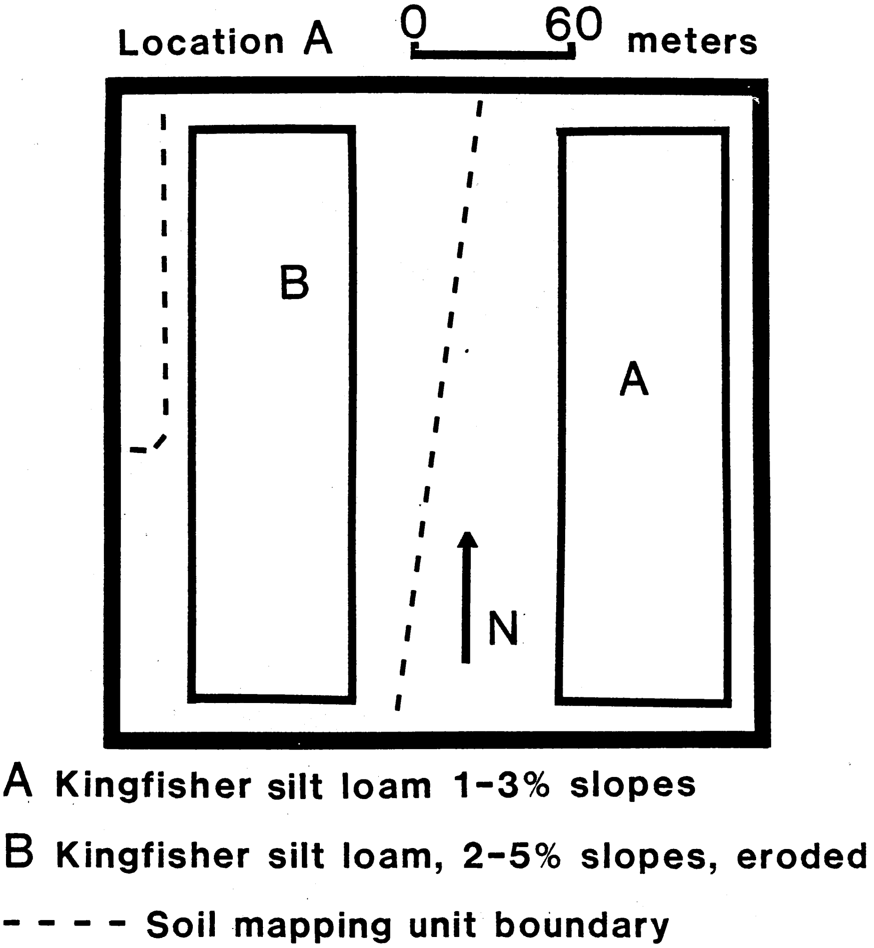


Fig. 4. Map of sites sampled at location A.

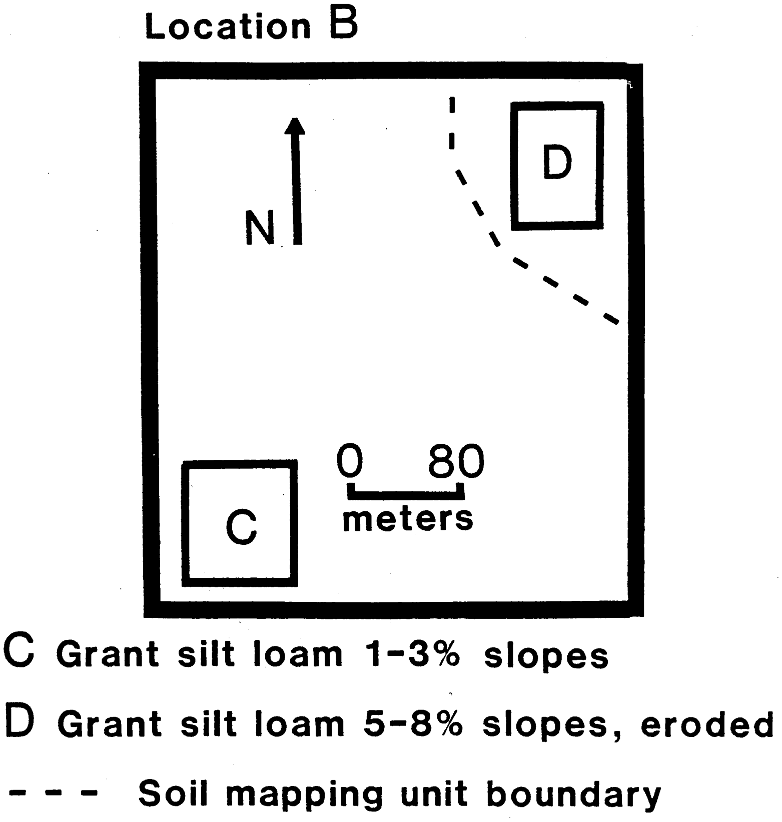


Fig. 5. Map of sites sampled at location B.

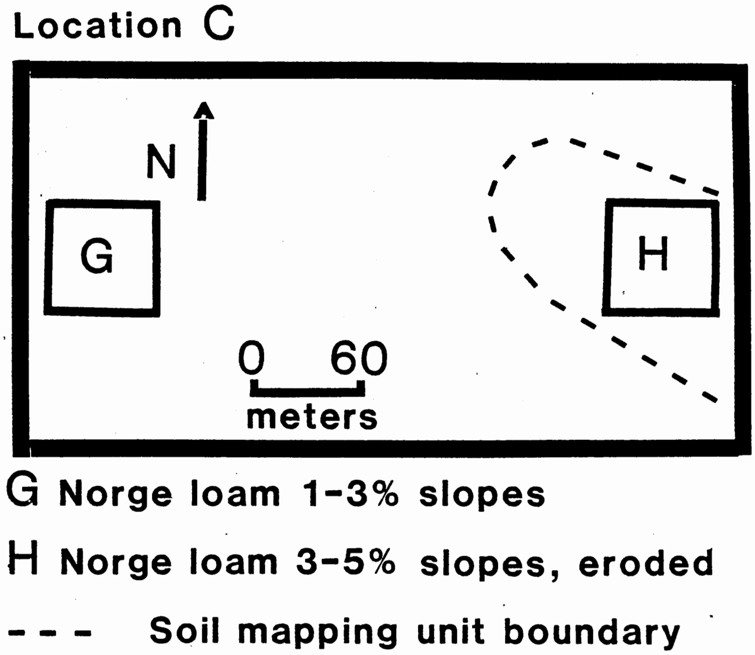


Fig. 6. Map of sites sampled at location C.

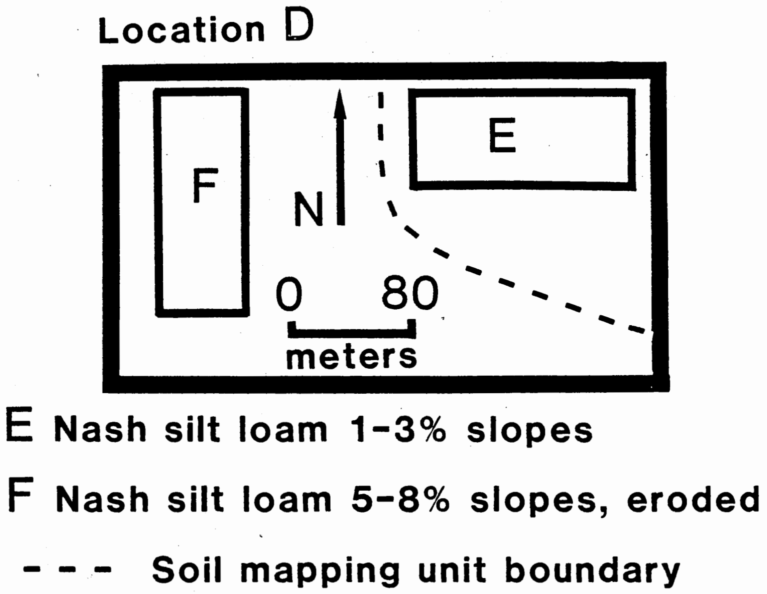
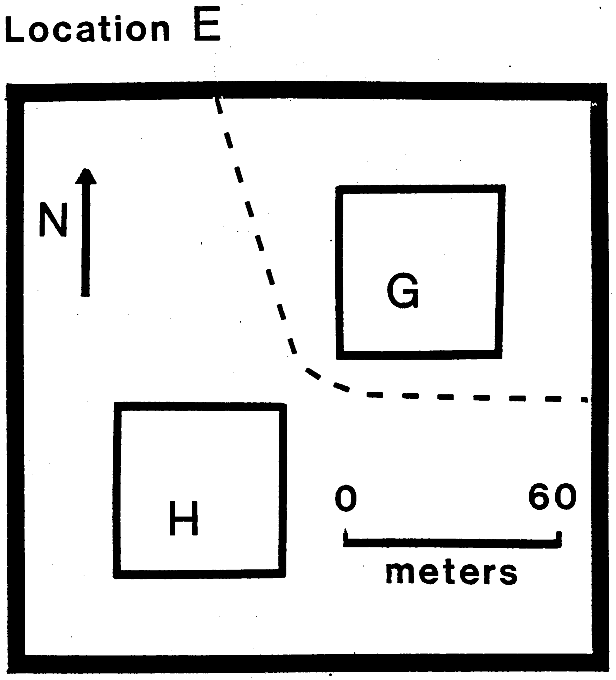


Fig. 7. Map of sites sampled at location D.



G Renfrow silt loam 1-3% slopes

H Renfrow silt loam 3-5% slopes, eroded

- - - - Soil mapping unit boundary

Fig. 8. Map of sites sampled at location E.

2

VITA

Gary Wayne Medlyn

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE INFLUENCE OF SOIL EROSION ON CROP PRODUCTIVITY AND SURFACE SOIL CHARACTERISTICS FOR FIVE SELECTED OKLAHOMA SOILS SOWN TO WINTER WHEAT

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