Interrill Erodibility Affected by Cropping Systems and Initial Soil Water Content

F. Ghidey, E. E. Alberts

Abstract. *The effects of continuous soybean and continuous corn cropping systems and initial water content (IWC) of the soil on runoff, soil loss, and interrill erodibility were studied in the laboratory. Samples of a Mexico silt loam (Udollic Ochraqualf) were packed in 0.3-m-wide × 1.0-m-long soil beds and subjected to a series of simulated rainfall events. Differences in measured runoff and soil loss between the cropping systems were less than 1.0%. The IWC did not affect soil loss during the initial event, but it had a significant effect ($p < 0.05$) during the following event where an increase in mean IWC from 4 to 15% decreased mean soil loss from 12.9 to 10.7 g min^{-1} m^{-2}. Cropping did not influence interrill erodibility (K_i) calculated from a power relationship with rainfall intensity. There was a negative linear relationship between K_i and IWC. Calculating K_i from rainfall intensity and runoff rate improved the relationship between K_i and IWC. Our results indicate that interrill soil losses and erodibility are sensitive to IWC and need to be considered in interrill erosion research and modeling, particularly for silt loam soils. Our results also indicate that including a runoff rate term in the equation used to predict interrill erosion will improve its prediction accuracy.*

Keywords. *Runoff, Soil loss, Interrill erosion.*

Interrill erosion is defined as a process of soil detachment by raindrops and transport in thin sheet flow (Foster et al., 1977). Interrill erosion is affected by many factors including rainfall intensity (Meyer, 1981; Park et al., 1983), infiltration and runoff (Bradford et al., 1987), slope (Lattanzi et al., 1974; Singer and Blackard, 1982; Watson and Laflen, 1986; Meyer and Harmon, 1989), and residue cover (Lattanzi et al., 1974). Interrill erosion is also affected by soil properties including soil texture, organic-matter content, aggregate stability, and residual effects of crops and management practices. Most interrill erosion studies have focused on evaluating differences among soils. For example, Young and Onstad (1982) studied three soils and found that textural properties and aggregate stability were important determinants of both interrill and rill erodibility. Meyer and Harmon (1984) found textural and chemical properties were both related to interrill erosion rate.

While much important research has been conducted on the factors affecting interrill erosion, few studies have focused on understanding antecedent cropping and management effects on runoff and soil loss. Results from research conducted on natural rainfall erosion plots to evaluate cropping effects have been conflicting. Laflen and Moldenhauer (1979) found that annual soil loss from corn following soybeans was higher ($p < 0.10$) than that from corn following corn. Most of the annual difference occurred during the rough fallow and rapid growth periods. Alberts et al. (1985) did not find any difference in soil loss during the seedbed period between continuous soybean and continuous corn that were conventionally tilled. Field-scale rainfall simulation has also been used to evaluate the effect of prior soybean cropping on soil loss. Results have ranged from those that have found a prior cropping effect (Oschwald and Siemens, 1976) to those that have not found an effect (Laflen and Colvin, 1981; Colvin and Laflen, 1981). Erosion losses under field conditions are affected by many factors including prior cropping effects, surface residue cover, dead root biomass, soil roughness, and the size and stability of soil aggregates. To more carefully elucidate the influence of antecedent cropping on soil aggregate size, stability, and detachment resistance, a more controlled laboratory study is needed whereby all casual factors other than that related to the soil factor itself are eliminated.

Soil properties such as aggregate stability and porosity also change temporally within and among years in response to changing soil management and temporal variation in climate (Lehrsch et al., 1991). For instance, the wet stability of an aggregate, when tested in the laboratory, has been found to be significantly affected by soil water content (Lehrsch and Jolley, 1992). Many studies of interrill erosion have focused on evaluating differences among soils when tested in an unconsolidated or tilled state (Meyer and Harmon, 1984; Bradford et al., 1987; Laflen et al., 1991). However, the range of erodibility variation from cropping, management, and environmental factors within most soils is as large or larger than differences in erodibility from one soil to another when tested in a standard unconsolidated or tilled state (Alberts, 1991). Thus, further research is needed to characterize the effects of cropping and management, time of sample collection, and initial soil water content on interrill erodibility.

The objectives of this study were to:

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- Evaluate the effects of antecedent soybean and corn cropping, time of soil sample collection relative to the growing season, and initial soil water content on runoff, soil loss, and interrill soil erodibility parameters for a Mexico silt loam soil.
- Test various equations that describe interrill erosion.

Materials and Methods

The soil for this study was collected from plots located at the University of Missouri Midwest Claypan Experimental Farm near Kingdom City, Missouri. The soil is a Mexico silt loam (fine, montmorillonitic, mesic, Udollic Ochraqualf) with sand, silt, and clay contents of 5, 69, and 26%, respectively. The soil is located within and is considered representative of soils located in Major Land Resource Area 113, an area of about 4 m ha.

For the antecedent cropping study, a 1-ha field, which had been in mixed cropping, was divided into two experimental units in 1979. One unit was planted to continuous corn and the other to continuous soybeans for six years. In the spring of 1985, 26 plot pairs were established up-and-down slope near the center line of the field. Each plot pair was comprised of one soybean plot and one corn plot separated by about 3 m. Each plot in a pair was 3 m across slope × 3.5 m. In early September, the soil was lightly tilled with a rototiller, and soil samples to a depth of 75 mm were immediately collected from 10 randomly selected pair plots. Soil samples were air dried, then sieved through a 9-mm sieve and packed in the soil boxes.

For the water content effect study, soil was collected from four replications of continuous corn and continuous soybean plots immediately after planting, 7 weeks after planting, and 17 weeks after planting. The soil was lightly tilled with a rototiller as a secondary tillage operation prior to sample collection. At each sampling period about 200 kg of soil from the 0 to 75 mm depth was collected from each plot. Half the soil collected was air dried prior to rainfall simulation; the remainder was tested in the field-moist state.

Each erodibility study was conducted in a laboratory using soil boxes and a rainfall simulator. The soil boxes were 100 cm long and 30 cm wide. Soil depth was 10 cm overlaying 5 cm of sand. One end wall in these boxes was provided with a V-shaped collector to catch runoff. A vertical extension, 20-cm tall, was attached to the side walls and other end wall to contain splash during rainfall. Two perforated tubes in the bottom of each box allowed for air venting and drainage.

The soil was firmly packed to an average bulk density of 1.03 g/cc using a vibrational packing device. The soil box was placed in a supporting stand at slopes of 9 and 4% for the cropping and initial water content studies, respectively. Rain was applied with a multiple intensity rainfall simulator, similar to that described by Meyer and Harmon (1979) with a single 80150 v-jet nozzle. Mean waterdrop diameter was 3.0 mm falling from a height of 2.5 m.

To each box, rainfall of 64 mm h^{-1} intensity was applied for 1 h during the first day. On the second day, a 30-min run of constant intensity (64 mm h^{-1}) was applied. This was done to standardize the water content of the soil. On day 2, the 30-min constant intensity event was followed by four 15-min storms at intensities of 13, 38, 76, and 114 mm h^{-1} for the cropping effect study, and 25, 50, 75, and 100 mm h^{-1} for the initial soil water content study. During each rainstorm, surface runoff was measured and sampled for sediment analysis. After runoff began, samples were collected at 2- and 3-min intervals in the first 5 min, and at 5-min intervals thereafter.

Interrill detachment was described as being proportional to the power of rainfall intensity and slope factor (Meyer, 1981):

$$D_i = K_i I^b S_f \tag{1}$$

where D_i is the interrill erosion rate (kg m^{-2} s^{-1}), K_i is the interrill erodibility parameter of the soil (kg s m^{-4}), I is the rainfall intensity (m s^{-1}), b is the exponent related to soil clay content (Meyer and Harmon, 1984), and S_f is the slope factor defined by Liebenow et al. (1990):

$$S_f = 1.05 - 0.85 \exp^{[-4\sin(\theta)]} \tag{2}$$

where θ is the slope angle.

The average erosion rates obtained from the 15-min variable intensity storms were used to evaluate equation 1. To fit equation 1 to the data using a linear relationship, both the erosion rate (D) and rainfall intensity (I) data were transformed into logarithms. The transformed data were then plotted and the resultant intercept and slope values were used to predict K_i and b of equation 1, respectively.

Interrill erosion or detachment has been approximately proportional to the square of rainfall intensity and the slope factor (Meyer and Harmon, 1984; Watson and Laflen, 1986):

$$D_i = K_i I^2 S_f \tag{3}$$

Interrill erosion has also been assumed to be a function of rainfall intensity and runoff rate:

$$D_i = K_i I\, R\, S_f \tag{4}$$

where R is the runoff rate (m s^{-1}). Erosion rates from constant intensity runs (60 and 30 min of rainfall events at 64 mm h^{-1} intensity) were used to evaluate equations 3 and 4.

Results and Discussion

Cropping System Effects on Runoff and Soil Loss

Runoff and soil losses for continuous soybean and corn cropping systems measured from constant intensity rainfall simulations are shown in table 1. Data were collected from the first day 60-min run at 64 mm h^{-1} intensity (dry run), and second day 30-min run at 64 mm h^{-1} intensity (wet run). The differences in runoff rate between the cropping conditions varied from –2.86 to 2.88 mm h^{-1} for the dry run and –2.51 to 4.23 mm h^{-1} for the wet run. Although there were differences in runoff rates between some of the paired plots, their mean values were not significantly different ($p \leq 0.10$). Mean runoff rates for the soybean and corn cropping systems were 52.06 and

Table 1. Runoff and soil losses from continuous soybean and corn cropping systems measured in the laboratory on a 9% slope

Pair Plot	Runoff Rate (mm h^{-1})						Soil Loss (g $min^{-1}m^{-2}$)					
	Dry Run*			Wet Run†			Dry Run			Wet Run		
(No.)	SB	Corn	Diff.	SB	Corn	Diff.	SB	Corn	Diff.	SB	Corn	Diff.
1	50.81	48.78	2.03	55.34	54.15	1.19	13.46	13.57	–0.11	10.63	11.87	–1.23
2	52.28	53.43	–1.15	54.49	55.98	–1.50	13.99	19.63	–5.63	10.32	13.77	–3.45
3	49.96	50.78	–0.82	53.82	55.01	–1.19	12.28	8.44	3.85	11.19	12.76	–1.57
4	48.26	51.12	–2.86	53.66	56.17	–2.51	11.91	10.96	0.95	9.28	10.16	–0.88
5	54.59	52.91	1.68	56.74	56.33	–0.40	20.49	18.04	2.45	14.25	12.29	1.95
6	51.89	50.27	1.62	54.34	55.15	–0.81	18.64	11.73	6.91	13.56	8.87	4.69
7	52.18	52.87	–0.69	56.45	57.62	–1.17	14.78	12.20	2.59	11.01	9.99	1.03
8	53.43	51.14	2.29	58.86	57.91	0.95	13.26	14.49	–1.23	11.94	12.66	–0.72
9	52.01	51.80	0.21	59.05	54.82	4.23	14.62	17.37	–2.75	14.39	14.48	–0.10
10	55.10	52.22	2.88	55.90	55.83	0.07	12.98	13.01	–0.03	8.74	9.36	–0.62
Mean	52.06	51.54	0.52	55.87	55.90	–0.03	14.63	13.93	0.69	11.53	11.62	–0.09

* Dry run – 60-min of rain at 64 mm h^{-1} on the first day of simulation.

† Wet run – 30-min of rain at 64 mm h^{-1} on the second day of simulation.

51.54 mm h^{-1} for the dry run, and 55.87 and 55.90 mm h^{-1} for the wet run, respectively. In both cases, the difference in runoff rates between soybean and corn cropping was less than 1.0%.

Soil losses between some of the paired plots were significant. However, the difference between their mean values was not significant ($p \leq 0.10$). Mean soil losses for the soybean and corn cropping systems were 14.63 and 13.93 g min^{-1} m^{-2} for the dry run, and 11.53 and 11.62 g min^{-1} m^{-2} for the wet run, respectively. This study, thus, showed that antecedent cropping had virtually no effect on runoff and soil loss. Influences of these cropping systems on factors such as microbial populations, amount of decomposed residue and roots, and amount of dead roots on soil resistance to sealing and detachment by raindrops could not be detected. The soil used in these studies was passed through a 9-mm sieve. Distinguishable residue was removed during sieving. Also, the soil did not contain clods greater than 9 mm. We focused on the effect of these treatments on natural soil aggregation rather than including larger clods likely formed during moldboard plowing and disking.

Initial Water Content (IWC) Effect on Runoff and Soil Loss

Results from previous subsection indicated that runoff and soil losses were not affected by continuous soybean and corn cropping. Soil samples for the initial soil water content study were collected from four plot replications of continuous soybean and continuous corn. The data were initially analyzed to test the hypothesis that these cropping systems did not affect runoff and soil loss. The hypothesis was accepted, thus the soybean and corn data were combined into one data set for additional analyses. Values presented in figure 1 and table 2 are means of eight observations.

The average soil water contents for the air-dry and field-moist samples were 4.2 and 17.6% for sampling date 1 (6 May), 4.1 and 11.7% for sampling date 2 (26 June), and 4.3 and 15.4% for sampling date 3 (3 September). Table 2 presents runoff and soil losses measured for the three sampling dates based on the dry and wet runs. Runoff measured from the dry run was substantially affected by IWC of the soil. Runoff rates measured from the field-moist soils for the dry run for the three sampling dates were 25, 11, and 16% higher than those from the air-dry soils. For the dry run, there was a linear relationship between runoff and IWC:

$$RO = 44.30 + 0.71\ IWC$$

$$r^2 = 0.82 \qquad (5)$$

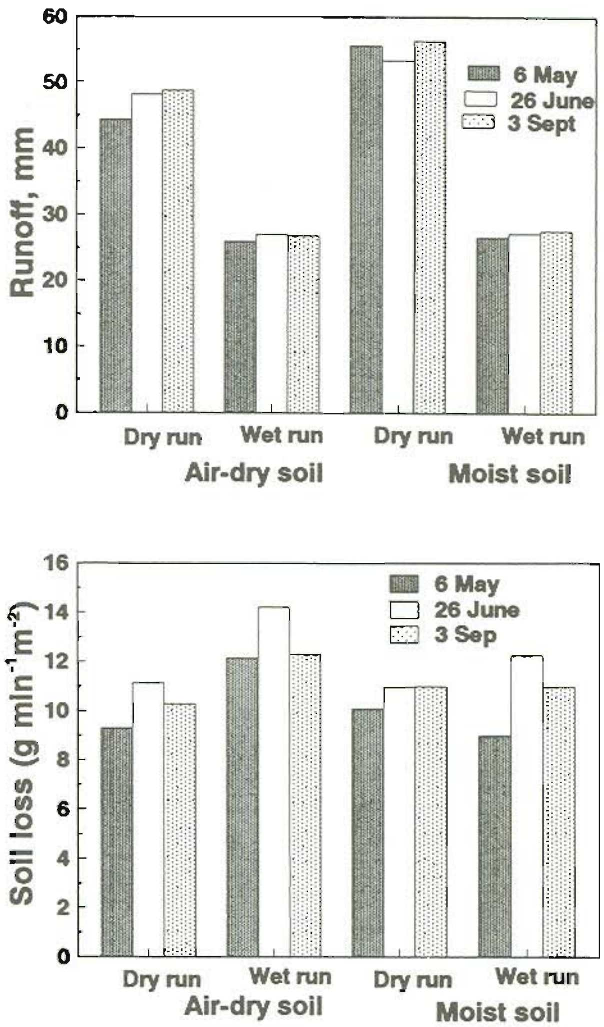

Figure 1–Temporal variation in runoff and soil loss.

Table 2. Effect of initial gravimetric water content on runoff and soil losses measured in the laboratory on a 4% slope*

Date	Soil Moisture Condi-tion	Initial Moisture Content (%)	Runoff Rate (mm h^{-1})		Soil Loss (g min^{-1} m^{-2})	
			Dry Run†	Wet Run‡	Dry Run	Wet Run
6 May	air-dry	4.20	44.29 de	51.70 c	9.27 ed	12.13 bc
	moist	17.60	55.54 ab	53.14 bc	10.07 ed	8.95 e
26 June	air-dry	4.10	48.10 d	53.80 abc	11.11 bcd	14.20 a
	moist	11.70	53.35 bc	54.36 ab	10.94 bcd	12.25 b
3 Sept.	air-dry	4.30	48.67 d	53.47 bc	10.25 cde	12.30 ab
	moist	15.40	56.25 a	55.22 ab	10.79 bcd	10.95 cd

* Values containing the same letter are not significantly different at 5% level.

† 60-min of rain at 64 mm h^{-1} on the first day of simulation.

‡ 30-min of rain at 64 mm h^{-1} on the second day of simulation.

where RO is runoff rate in mm h^{-1}, and IWC is given as a percentage.

For the dry run, there was no correlation between soil loss and IWC. Soil loss from field-moist soils during the dry run was 9% higher for sampling date 1, 2% lower for sampling date 2, and 5% higher for sampling date 3, than from air-dry soils.

On day 2 of simulation (wet run), there was no significant difference ($p < 0.05$) in runoff between initial soil water conditions. Runoff rates from the field-moist soils for the three sampling dates were 3, 1, and 3% higher than those measured from air-dry soils. For the wet run, soil loss was significantly ($p < 0.05$) affected by IWC. Soil losses from field-moist soils for the three sampling dates were 26, 14, and 11% lower than those from the air-dry soils. There was a linear relationship between soil loss and IWC:

$$SL = 13.91 - 0.22\ IWC$$

$$r^2 = 0.52 \qquad (6)$$

where SL is soil loss in g min^{-1} m^{-2}, and IWC is given as percentage.

It appears that IWC did affect the amount of soil disruption, but that soil drainage and surface drying during the 24-h period between the 60- and 30-min events were required to increase the erosion response. Because soil water content had no effect on runoff during the wet runs, the variation in soil loss is not influenced by infiltration or runoff, but related more to the sediment concentration of the runoff.

Temporal Variation in Runoff and Soil Loss

Mean runoff and soil loss observed from the constant intensity dry run (day 1) and wet run (day 2) for the three sampling dates and two soil conditions are shown in figure 1. Generally, differences in runoff, soil loss, and interrill erodibility among the sampling dates were not significant ($p < 0.05$), particularly for the air-dry soil. There was a slight variation in soil loss among the sampling dates for the moist soil runs, which could be attributed to the differences in soil water content. It was felt that growing plant roots and changes in soil water and temperature might have an effect on soil resistance to interrill erosion as measured from disturbed soil. Fortunately, these factors were not found to be important. Temporal changes in interrill erodibility undoubtedly occur in the field, but the primary factors are probably soil consolidation and strength as related to tillage, soil wetting and drying, and freezing and thawing.

Slope Effect on Runoff and Soil Loss

As previously mentioned, the cropping effect study was conducted on a 9% slope, while a 4% slope was used for the initial water effect study. Because the 9% slope data of the cropping study was collected from air-dry soils, data from only the air-dry portion of the water content study on a 4% slope was used to evaluate the effect of slope on runoff and soil loss. As expected, slope had a significant effect on runoff rate (fig. 2). Runoff from the 9% slope was higher by almost 10% for the dry run and 5% for the wet run. Mean soil loss from the 9% slope was 40% higher than that from the 4% slope for the dry run. However, for the wet run, soil loss from the 4% slope was higher by 10% than that from the 9% slope. Thus, slope has affected runoff during both the dry and wet runs but only influenced soil loss during the dry run.

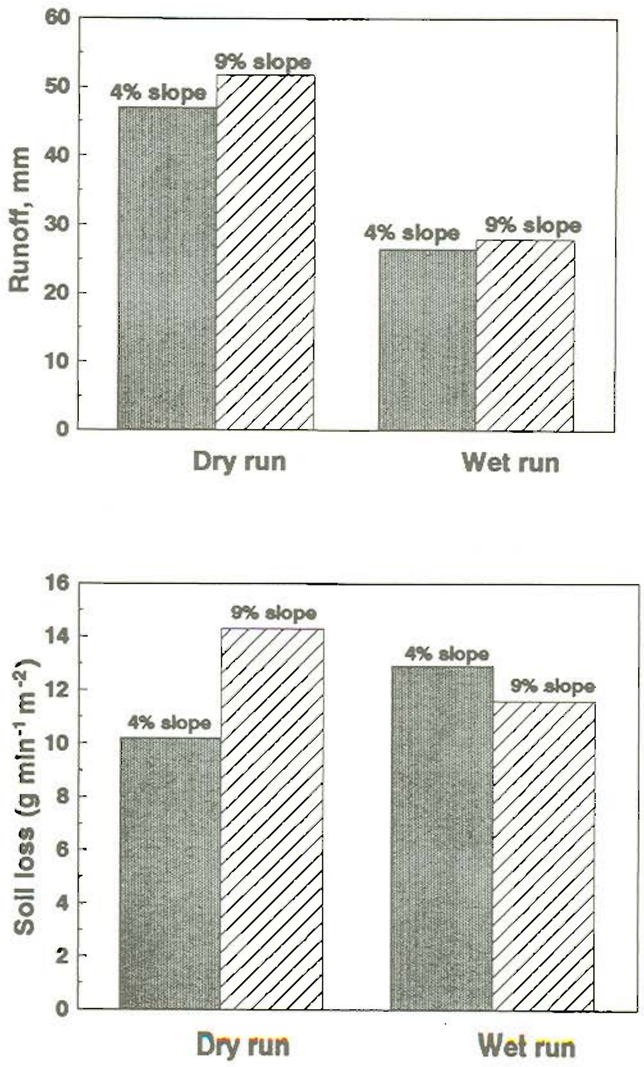

Figure 2–Slope effect on runoff and soil loss.

Table 3. Interrill parameter, K_i, and exponent b for continuous soybean and corn cropping systems measured from variable intensity rainfall

Pair Plot (No.)	$K_i \times 10^{-6}$ SB	$K_i \times 10^{-6}$ Corn	$K_i \times 10^{-6}$ Diff.	b SB	b Corn	b Diff.
1	1.51	1.59	-0.08	1.79	2.01	-0.22
2	1.49	1.93	-0.44	1.65	1.61	0.04
3	1.52	1.57	-0.05	1.90	2.05	-0.15
4	1.33	1.18	0.15	1.68	1.81	-0.13
5	1.65	1.57	0.08	1.55	1.48	0.07
6	1.55	1.11	0.44	1.58	1.94	-0.36
7	1.15	1.02	0.13	2.31	1.87	0.44
8	1.32	1.57	-0.25	1.73	1.60	0.13
9	1.70	1.85	-0.15	1.69	1.46	0.23
10	1.10	1.12	-0.02	2.19	2.02	0.17
Mean	1.44	1.45	0.01	1.81	1.78	0.03

Note: K_i units are kg s m^{-4}.

Effect of Cropping Systems on Interrill Erodibility, K_i

Erosion rates measured from the 15-min variable intensity storms (13, 38, 78, and 114 mm h^{-1}) were used to evaluate the K_i and b values given in equation 1. The K_i values ($\times 10^{-6}$) varied from 1.10 to 1.70 kg s m^{-4} for the soybean cropping system, and from 1.02 to 1.93 kg s m^{-4} for the corn cropping system (table 3). Values for b varied from 1.55 to 2.31 for the soybean cropping system, and from 1.46 to 2.05 for the corn cropping system. Although there were significant differences in K_i and b values between some of the paired plots, their mean values were not significantly different ($p < 0.05$). The mean K_i ($\times 10^{-6}$) and b values were 1.44 kg s m^{-4} and 1.81 for soybean and 1.45 kg s m^{-4} and 1.78 for corn. In this study, the exponent b (eq. 1) for a silt loam soil was close to 2.0. This agrees with previous studies that found interrill erosion to be proportional to the square of rainfall intensity (Meyer and Harmon, 1984; Watson and Laflen, 1986).

Erosion rates measured from the 60- and 30-min constant intensity storms (dry and wet runs) were used to evaluate equations 3 and 4 and to estimate soil K_i. Mean K_i values ($\times 10^{-6}$) calculated from the square power relationship (eq. 3) for continuous soybean and corn were 1.26 and 1.19 kg s m^{-4} for the dry run, and 1.92 and 1.97 kg s m^{-4} for the wet run, respectively (table 4). Mean K_i values ($\times 10^{-6}$) calculated from equation 4 were 1.42 and 1.37 kg s m^{-4} for the dry run and 2.22 and 2.32 kg s m^{-4} for the wet run, respectively.

There were no significant differences ($p \leq 0.10$) between the calculated mean K_i values for the soybean and corn cropping systems. Rather large differences existed among interrill erosion and erodibility values for each crop within a plot pair (tables 3 and 4). Coefficients of variation averaged about 18% for all erosion variables. Even with 10 K_i observations for continuous corn (table 3), the 95% confidence interval around the mean of 1.45 kg s m^{-4} was ± 0.19.

Table 5. Soil K_i and b values for the soil water effect study measured from variable intensity rainfall

Date	Soil Moisture Condition	Initial Moisture Content (%)	$K_i \times 10^{-6}$	b	r^2
6 May	air-dry	4.2	2.62	2.22	0.97
	moist	17.6	1.72	2.07	0.92
26 June	air-dry	4.1	2.87	2.19	0.98
	moist	11.7	2.33	2.14	0.99
3 Sept.	air-dry	4.3	2.66	2.17	0.89
	moist	15.4	2.10	1.97	0.98

Note: K_i units are kg s m^{-4}.

Effect of IWC on Interrill Erodibility

Interrill erodibility was significantly affected by the IWC of the soil (table 5). Average K_i values ($\times 10^{-6}$) and b values from the three sampling dates were 2.72 kg s m^{-4} and 2.19 for the air-dry soil, and 2.05 kg s m^{-4} and 2.06 for the field-moist soil, respectively. Thus, soil K_i values from air-dry soils were 25% higher than those from field-moist soils. The difference in the exponent, b, between the air-dry and field-moist conditions was about 5%, and the value was close to 2.

Soil K_i values calculated from equations 3 and 4 are given in table 6. For the dry run, there was no correlation between IWC and K_i calculated from equation 3. However, K_i values from the wet run decreased substantially as IWC increased. Moreover, there was a linear relationship between K_i and IWC:

Table 4. Soil K_i values for continuous soybean and corn cropping conditions computed from the relationships $D_i = K_i I^2 S_f$ and $D_i = K_i I R S_f$, using constant intensity rainfall data

Pair Plot (no.)	$K_i \times 10^{-6}$ ($D_i = K_i I^2 S_f$) Dry Run SB	Dry Run Corn	Dry Run Diff.	Wet Run SB	Wet Run Corn	Wet Run Diff.	$K_i \times 10^{-6}$ ($D_i = K_i IRS_f$) Dry Run SB	Dry Run Corn	Dry Run Diff.	Wet Run SB	Wet Run Corn	Wet Run Diff.
1	1.14	1.14	0.00	1.79	2.00	-0.21	1.33	1.38	-0.05	2.10	2.40	-0.30
2	1.20	1.73	-0.54	1.71	2.35	-0.63	1.35	1.93	-0.58	2.03	2.76	-0.73
3	1.04	0.73	0.31	1.86	2.15	-0.29	1.23	0.85	0.38	2.22	2.58	0.35
4	1.03	0.91	0.12	1.56	1.71	-0.15	1.26	1.04	0.22	1.90	1.97	-0.07
5	1.77	1.56	0.20	2.39	2.05	0.34	1.91	1.75	0.17	2.73	2.34	0.39
6	1.63	0.99	0.64	2.14	1.49	0.64	1.86	1.17	0.69	2.54	1.79	0.75
7	1.26	1.05	0.21	1.84	1.66	0.18	1.42	1.16	0.25	2.12	1.86	0.26
8	1.13	1.23	-0.10	1.99	2.16	-0.17	1.25	1.42	-0.17	2.19	2.43	-0.25
9	1.27	1.52	-0.25	2.46	2.56	-0.11	1.44	1.73	-0.29	2.71	3.18	-0.47
10	1.10	1.10	0.00	1.42	1.56	-0.14	1.18	1.24	-0.06	1.64	1.80	-0.16
Mean	1.26	1.19	0.07	1.92	1.97	0.05	1.42	1.37	0.05	2.22	2.32	-0.10

Note: K_i units are kg s m^{-4}.

Table 6. Soil K_i values for the soil moisture effect study computed from the relationships $D_i = K_i I^2 S_f$, and $D_i = K_i I R S_f$ using constant intensity rainfall data*

Date	Soil Moisture Condition	Initial Moisture Content (%)	$K_i \times 10^{-6}$ ($D_i = K_i I^2 S_f$) Dry Run	Wet Run	$K_i \times 10^{-6}$ ($D_i = K_i IRS_f$) Dry Run	Wet Run
6 May	air-dry	4.2	1.29 d	2.91 b	1.90 ef	3.64 b
	moist	17.6	1.34 d	2.11 c	1.53 f	2.58 d
26 June	air-dry	4.1	1.51 d	3.37 a	2.10 e	4.10 a
	moist	11.7	1.48 d	2.89 b	1.78 ef	3.44 b
3 Sept.	air-dry	4.3	1.40 d	2.91 b	1.86 ef	3.51 b
	moist	15.4	1.43 d	2.58 b	1.64 ef	3.02 c

* Values containing the same letter are not significantly different at 5% level. K_i units are kg s m^{-4}.

$$K_i = 3.31 - 0.054 \text{ IWC}$$

$$r^2 = 0.54 \quad (7)$$

where K_i is in Kg s m^{-4}, and IWC is given as a percentage.

The interrill erodibility parameter was highly correlated to IWC when interrill erosion was calculated based on intensity and runoff rate factors (eq. 4). The relationship between K_i and IWC for the dry run was:

$$K_i = 2.05 - 0.03 \text{ IWC}$$

$$r^2 = 0.67 \quad (8)$$

The relationship between K_i and IWC for the wet run was:

$$K_i = 4.07 - 0.07 \text{ IWC}$$

$$r^2 = 0.65 \quad (9)$$

These results show that interrill erosion for a silt loam soil can be better expressed as a function of rainfall intensity and runoff rate.

Comparison to the WEPP K_i Value

Elliot et al. (1989) measured on-site erodibility for several soils including the Mexico silt loam. Based on the data collected, K_i values ($\times 10^{-6}$) for the soils were determined using equation 3, and measured K_i for the Mexico silt loam soil was 2.97 Kg s m^{-4}. The K_i values obtained from this study were lower than WEPP K_i values. Mean K_i values ($\times 10^{-6}$) calculated from the square power relationship (eq. 3) for the dry and wet runs were 1.23 and 1.95 kg s m^{-4} from the 9% slope (cropping study, table 4), and 1.40 and 3.06 kg s m^{-4} for the 4% slope (soil water effect study, table 6), respectively. In WEPP, interrill erodibility was measured on a 51% landslope. Adjusting the measured WEPP K_i to a 9 or 4% slope results in even a higher value.

Kramer and Alberts (1993) sought to validate the WEPP Hillslope model using measured runoff and soil loss data from Kingdom City, Missouri. Initially they ran the model using the WEPP K_i value of 2.97, but found the predicted average annual soil loss to be much higher than that observed. They then optimized some of the erosion parameters, including the K_i value, so that the average annual soil loss would match the observed values. The optimized K_i value ($\times 10^{-6}$) was 1.00 kg s m^{-4}, which is much closer to the K_i values measured in this study than the value of 2.97 kg s m^{-4} reported by Elliot et al. (1989).

Summary and Conclusions

The effects of continuous corn and continuous soybean cropping systems, time of soil sample collection, and initial soil water content on interrill runoff and erosion for a silt loam soil were studied in the laboratory. We found that:

- Corn and soybean cropping had no effect on runoff or soil loss. Differences in runoff and soil loss between soybean and corn cropping systems were less than 1%.
- The IWC of the soil had a significant effect on runoff during the dry run but not during the succeeding wet run. The IWC had no effect on soil loss during the dry run, but had a significant effect ($p < 0.05$) during the wet run. There was a negative linear relationship between interrill erodibility parameter, K_i, and IWC. A viable explanation to this trend cannot be given. Perhaps it is related to differences in soil seal formation and soil strength. These results do have important implications for erosion scientists and modelers. More research is needed to determine mechanisms and factors influencing interrill erodibility as affected by initial soil water content. With time, erosion models like WEPP may be revised to include the effect of temporal changes in soil water content on the prediction of interrill erodibility.
- The time that samples were collected during a growing season did not generally have a statistically significant effect on runoff, soil loss, and interrill erodibility. The influence of changing cropping factors such as canopy cover, live root biomass, and soil water use did not change the erosion response of the Mexico soil when collected in a disturbed condition.
- Interrill erosion can apparently be well expressed as a function of rainfall intensity, runoff rate, and a slope factor. In the 1989 version of the WEPP Hillslope model, sediment delivery from interrill areas was predicted as a function of rainfall intensity, with the constant of proportionality being defined as the interrill erodibility value (eq. 3). One problem with this approach is that hydrologic and erosion processes are not separated because the equation does not contain a runoff term. This problem can lead to confounding of experimental results because it becomes impossible to separate the effects of soil sealing on infiltration, soil detachment, and sediment transport. Our results showed that adding a runoff term to the interrill equation (eq. 4) reduced the experimental error

making it more likely to detect the influence of study variables on interrill erodibility values.

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