EFFECTS OF CLIMACTIC FACTORS ON SOIL EROSION AND MOISTURE CONTENT ON VARIOUS PARTS OF THE TOPOGRAPHY

Soil erosion through weathering is largely affected by climactic factors such as precipitation, wind, and temperature. These meteorological variables have the potential to drastically change the appearance and properties of soil such as soil moisture content and magnitude of erosion. Measuring the direct effects of these variables in the field is tedious given the chaotic nature of weather phenomena. Given this added complexity, this study is conducted as a controlled experiment with attention paid particularly to the effects of precipitation duration and magnitude on soil erosion and weathering. Various soil textures (silty clay, clay, and clay loam) in northeastern Kansas will react differently to erosion due to precipitation because surface runoff is largely a factor of the amount of rainfall infiltrated into the soil. The fundamental questions in this study are 1) How do different soil textures react to erosion due to precipitation and 2) What is the soil moisture content measured at various parts of the landscape (i.e., summit, backslope, and floodplain) after a rain event. As discussed above, "precipitation" will be induced in a controlled experiment with altered intensity and duration for each soil texture.

Daniel Hirmas 9/25/11 5:47 AM
Comment [1]: Does 'factors' need to be in the title. Consider changing this to just 'climate.'

Daniel Hirmas 9/25/11 5:45 AM
Comment [2]: Doesn't this imply that topography is a factor that will be examined? "The Topography"? Do you mean the "Landscape"? Consider changing t ... [1]

Daniel Hirmas 9/25/11 5:49 AM
Comment [3]: How is soil erosion a ... [2]

Daniel Hirmas 9/25/11 5:53 AM
Comment [4]: Isn't this a change of ... [3]

Daniel Hirmas 9/25/11 5:55 AM
Comment [5]: This is already a dyn ... [4]

Daniel Hirmas 9/25/11 6:01 AM
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Daniel Hirmas 9/25/11 6:03 AM
Comment [6]: Add a sentence or a ... [6]

Daniel Hirmas 9/25/11 6:00 AM
Comment [7]: What complexity?

Daniel Hirmas 9/25/11 5:59 AM
Comment [8]: What was added? N ... [7]

Daniel Hirmas 9/25/11 6:04 AM
Comment [9]: Possibly remove this ... [8]

Daniel Hirmas 9/25/11 6:08 AM
Comment [10]: Will you actually b ... [9]

Daniel Hirmas 9/25/11 6:07 AM
Comment [11]: Awkward. Try sta ... [10]

Daniel Hirmas 9/25/11 6:09 AM
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Daniel Hirmas 9/25/11 6:13 AM
Comment [12]: Do you already kn ... [12]

Daniel Hirmas 9/25/11 6:14 AM
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Daniel Hirmas 9/25/11 6:14 AM
Comment [13]: Awkward. Do you ... [13]

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Daniel Hirmas 9/25/11 6:23 AM
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Comment [16]: Its not clear in thi ... [16]

Daniel Hirmas 9/25/11 6:21 AM
Comment [17]: How will landscap ... [17]

Page 1: [1] Comment [2]	Daniel Hirmas	9/25/11 5:45 AM

Doesn't this imply that topography is a factor that will be examined? "The Topography"? Do you mean the "Landscape"? Consider changing the title to "Effects of topography and climate on soil erosion and moisture content."

Page 1: [2] Comment [3]	Daniel Hirmas	9/25/11 5:49 AM

How is soil erosion affected by weathering over the time scale that climactic factors operate? Shouldn't this just read, "Soil erosion is largely affected by climactic factors…".

Page 1: [3] Comment [4]	Daniel Hirmas	9/25/11 5:53 AM

Isn't this a change of time scale compared to climate? Could you use 'climatological variables' instead for consistency with the previous statement and title?

Page 1: [4] Comment [5]	Daniel Hirmas	9/25/11 5:55 AM

This is already a dynamic property of the soil; why is it being examined directly?

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It is somewhat tedious to

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Page 1: [5] Deleted	Daniel Hirmas	9/25/11 6:01 AM

It is somewhat tedious to

Page 1: [6] Comment [6]	Daniel Hirmas	9/25/11 6:03 AM

Add a sentence or a statement to this sentence explaining why this is tedious. It is not obvious from the chaotic nature of weather phenomena.

Page 1: [7] Comment [8]	Daniel Hirmas	9/25/11 5:59 AM

What was added? Not clear.

Page 1: [8] Comment [9]	Daniel Hirmas	9/25/11 6:04 AM

Possibly remove this statement.

Page 1: [9] Comment [10]	Daniel Hirmas	9/25/11 6:08 AM

Will you actually be studying weathering?

Page 1: [10] Comment [11]	Daniel Hirmas	9/25/11 6:07 AM

Awkward. Try starting this sentence off with a more direct statement such as, "The goal of this project is to study the effects of …".

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Page 1: [12] Comment [12]	Daniel Hirmas	9/25/11 6:13 AM

Do you already know this? If this is a hypothesis then state it plainly. If this is known from the literature, then remove the word 'will.'

Page 1: [13] Comment [13]	Daniel Hirmas	9/25/11 6:14 AM

Awkward. Do you mean “water erosion?"

Page 1: [14] Comment [14]	Daniel Hirmas	9/25/11 6:18 AM

Consider breaking this statement up. The idea here is that soil texture affects infiltration rate which, in turn, affects the amount of water available for runoff.

Page 1: [15] Comment [15]	Daniel Hirmas	9/25/11 6:23 AM

Under different rainfall intensities? Need to be clear on what you mean by 'due to precipitation.'

Page 1: [16] Comment [16]	Daniel Hirmas	9/25/11 6:26 AM

Its not clear in this writeup why measuring this is important or relevant to soil erosion. What depths will be measured here. Are you interested in subsurface water redistribution along a hillslope? That seems like a separate question from soil erosion.

Page 1: [17] Comment [17]	Daniel Hirmas	9/25/11 6:21 AM

How will landscape position be controlled? Will this be somehow done in a lab? Need to briefly fill in some details.

EFFECTS OF TOPOGRAPHY AND LAND USE ON INFILTRATION RATES AT THE UNIVERSITY OF KANSAS FIELD STATION

Soil water infiltration rate is the speed at which water enters soil. Infiltration rate depends on soil texture and structure; these properties determine how easily water can move into and redistribute within the pore space. For example, a sandy soil will have a higher infiltration rate than a compact clayey soil due to the difference of porosity between these two samples. Infiltration rates also vary among locations on the topography as the summit, backslope and flood plain regions will have different infiltration rates mainly due to the differing properties of soil in these regions. This study was conducted at the University of Kansas Field Station north of Lawrence, KS, in two sites; a cultivated field and an adjacent non-cultivated area. Infiltration rate was determined using a minidisk infiltrometer (Decagon Devices, Inc., Pullman, WA) at several locations along a hillslope transect within the two fields. Surface samples were taken in conjunction with each infiltration rate measurement and processed in the lab to determine bulk density, field moisture content, and porosity.

Daniel Hirmas 10/23/11 11:27 PM
Comment [1]: Perhaps too obvious? Try relating infiltration rate to runoff, erosion, potential for ponding, etc. in this first sentence.

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Daniel Hirmas 10/23/11 11:29 PM
Comment [2]: Remember that this is an abstract, not the introduction section. No reason to go into a lot of detail. Remove this sentence.

Daniel Hirmas 10/23/11 11:31 PM
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Daniel Hirmas 10/23/11 11:34 PM
Comment [3]: Not sure what you mean by this.

Daniel Hirmas 10/23/11 11:32 PM
Comment [4]: These are landscape positions not simply topography.

Daniel Hirmas 10/23/11 11:33 PM
Comment [5]: These are hillslope components. Why is "regions" mentioned here?

Daniel Hirmas 10/23/11 11:34 PM
Comment [6]: Isn't this just a function of slope and upslope contributing area?

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EFFECTS OF TOPOGRAPHY AND LAND USE ON INFILTRATION RATES AT THE UNIVERSITY OF KANSAS FIELD STATION

INTRODUCTION

Soil infiltration rate is influenced by many properties of the soil such as bulk density, porosity, and soil texture (Guzman and Al-Kaisi, 2011). For example, a sandy soil will have a higher infiltration rate than a compact clayey soil due to the difference of porosity between these two samples. Also, the backslope of the landscape is expected have lower soil infiltration rates due to runoff from the slope of the hillside (Guzman and Al-Kaisi, 2011). Disk infiltrometers can be utilized to measure the rate of infiltration in the field at various locations along the hillslope. The value of soil hydraulic conductivity obtained in the lab often fails to describe that measured in the field, so the need of a minidisk infiltrometer is necessary to get a more accurate representation of soil infiltration rate (Dusek et al., 2009). Cultivated versus non-cultivated areas show robust differences in the rate of infiltration as cultivated regions will produce more surface runoff leading to erosion especially along the backslope (Arriaga et al., 2010). The objective of this study is to use the minidisk infiltrometer to look at the effects of land-use practices and landscape locations on soil infiltration rates, and then compare these results to soil properties such as bulk density, soil water content, and porosity in the lab.

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Comment [1]: This doesn't follow from the earlier statement. There are other ways of getting infiltration rate in the field besides disk infiltrometry.

Daniel Hirmas 11/8/11 3:26 PM
Comment [2]: Whats a robust difference?

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Daniel Hirmas 11/8/11 3:28 PM
Comment [3]: Spend some time discussing why this is the case. Perhaps break this paragraph up into three paragraphs.

REFERENCES

Arriaga, F.J. et al., 2010. Conservation tillage improves soil physical properties on different landscape positions of a coastal plain soil. In Endale, D.M., and Iversen, K.V., editors. Proceedings of the 32nd Southern Conservation Agricultural Systems Conference, July 20-22, 2010, Jackson, Tennessee. CDROM.

Dusek, J., Dohnal, M., Volgel, T., 2009. Numerical Analysis of Ponded Infiltration Experiment under Different Experimental Conditions. Soil and Water Resources 2, S22-S27.

Guzman, J.G, Al-Kaisi, M.M., 2011. Landscape position effect on selected soil physical properties of reconstructed prairies in southcentral Iowa. Journal of Soil and Water Conservation 66(3), 183-191.

Daniel Hirmas 11/8/11 3:24 PM
Comment [4]: Cannot use "et al." in the references section

EFFECTS OF TOPOGRAPHY AND LAND USE ON INFILTRATION RATES AT THE UNIVERSITY OF KANSAS FIELD STATION

INTRODUCTION

Soil infiltration rate is influenced by many properties of the soil such as bulk density, porosity, and soil texture (Guzman and Al-Kaisi, 2011). For example, a sandy soil will have a higher infiltration rate than a compact clayey soil due to the difference of porosity between the two samples. Also, a backslope position on the landscape is expected have lower soil infiltration rates due to runoff (Guzman and Al-Kaisi, 2011). Disk infiltrometers can be utilized to measure the rate of infiltration in the field at various locations along the hillslope. A minidisk infiltrometer can get a more accurate representation of soil hydraulic conductivity as it is measured in the field rather than in the lab (Dusek et al., 2009).

Infiltration rates are a factor of land use, soil type, bulk density, and are influenced by both topography and climate (Abdelkadir and Yimer, 2011). Cultivated versus non-cultivated areas prove to have differences in the rate of infiltration as cultivated regions will produce more surface runoff leading to erosion especially along the backslope (Arriaga et al., 2010). Cultivated regions have been found to have a lower cumulative infiltration amount due to soil compaction and higher bulk densities (Abdelkadir and Yimer, 2011). Cultivation practices show to have a large effect on infiltration rates due to these parameters, and measurements from a disk infiltrometer can help determine soil hydraulic properties from measurements made in the field (Schwartz and Evett, 2002).

Daniel Hirmas 12/11/11 10:29 PM
Comment [1]: Need an abstract first. The abstract does not need to be titled as such but comes before the introduction. Look carefully at the General Final Project Instructions.

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Comment [4]: Compared to what?

Daniel Hirmas 12/11/11 10:35 PM
Comment [5]: Not sure that infiltration rates are a factor of land use…land use affects infiltration rate only through the physical and chemical changes to soil properties it brings about. Need to reword for clarity.

Daniel Hirmas 12/11/11 10:37 PM
Comment [6]: ?? Need to go through the final draft and check for grammatical mistakes.

The objectives of this study are to use the minidisk infiltrometer to examine the effects of land-use practice and landscape position on soil infiltration rates and compare these results to soil properties such as bulk density, soil water content, particle-size distribution, and porosity. All these soil parameters and soil hydraulic conductivity will be found for both cultivated and non-cultivated areas of the University of Kansas Field Station in Lawrence, KS. The effects of cultivation are felt for quite some time, so the impacts of agriculture will be seen when comparing the cultivated and non-cultivated areas of the study (Homburg and Sandor, 2011). The main questions looked at here are 1) Are there major differences in soil infiltration rates in the cultivated and non-cultivated samples? 2) Do bulk density, particle size distribution, soil water content or other environmental factors explain the infiltration rates seen at these sites?

METHEDOLOGY

This study was performed at the University of Kansas Field Station at two adjacent tall grass prairies in the Rockefeller Experimental Tract; one area that was cultivated last in the 1950's and another that has been left undisturbed. All measurements were taken at random locations along the hillslope to cover the effects of hillslope sections on hydraulic properties of the soil. The native (unplowed) prairie is periodically burned to conserve the local biodiversity in the field. Measurements were taken on November 5, 2011, two days after a precipitation event of about a quarter of an inch of total rain.

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Comment [7]: Why is this an objective? How do you compare infiltration rates to bulk density, water content, PSD, and porosity? Does that even make sense? This introduction lacks continuity. Need to reread the four elements of a good introduction in the General Final Project Instructions. There is no real reason to deviate from that advice.

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Comment [8]: These soil hydraulic conductivity?

Daniel Hirmas 12/11/11 10:43 PM
Comment [9]: This is more like it. Direct questions that are clearly stated. The whole introduction should be coherently moving to these questions.

Infiltration measurements were taken at five random locations in both the native tall grass prairie and the cultivated prairie using a minidisk infiltrometer (Decagon Devices, Pullman, WA). The infiltration rates at each location were conducted for a total of four minutes using a tension of -1 centimeters. The infiltrometer measurements were taken every 10 seconds for the first minute, and subsequently every 20 seconds. Once the infiltration rates were obtained, the cumulative infiltration could be plotted versus time and hydraulic conductivity at each of the 10 locations can be calculated.

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A best-fit quadratic line was fit to each of the cumulative infiltration plots. The shape of the best-fit line should be concave or else a negative hydraulic conductivity would be calculated. A convex best-fit quadratic was found in the majority of the cumulative infiltration plots, most likely due to precipitation two days prior to taking the measurements. The precipitation would cause the infiltration rates in the first couple measurements to be slower than what would occur in a drier soil. A negative hydraulic conductivity is impossible, so in order to move forward with the study, another method had to be substituted. In this case, a best-fit linear line was fit to the data from the first minute on. Data from the first 60 seconds was eliminated because infiltration rate during this time period is fastest. A best-fit quadratic line would be ideal when incorporating the first 60 seconds, but this could not be used due to the convex shape of most of the parabolas. A linear line omitting the first minute had a higher R^2 value than that including the first 60 seconds. The slope of the best-fit linear line was implemented in the rest of the equations to find the hydraulic conductivity of the 10 sample sites.

In this study, two methods are looked at to determine the hydraulic conductivity of the soil samples. The first method uses a look-up table to find the van Genuchten parameters based on 12 textural classes (Carsel and Parrish, 1988). This method involved determining soil texture based on the “feel method”. The second method invokes Rosetta pedotranfer function (PTF) model that converts basic soil information to hydraulic properties (Schaap et al., 2001). This model specifically uses particle size distribution and bulk density to find the van Genuchten parameters.

Daniel Hirmas 12/11/11 10:49 PM
Comment [10]: Does this make sense? Why not just say uses if that's what you mean. Need to go through the whole document and change these kinds of word usages.

Particle size distribution was found in the lab using a hydrometer. A large sample was taken from each of the fields to determine the particle size distribution for each study site. The results given are a generalization of the particle size distribution for the two fields and do not include an averaging between multiple random samples. The resulting general field percentages of sand, silt, and clay are incorporated into the PTF along with bulk density to determine the van Genuchten parameters for each field.

Both methods to find hydraulic conductivity of the soil employ a set of equations suggested by Zhang (1997). These equations are:

$$I = C_1 t + C_2 \sqrt{t} \qquad \text{[Equation 1]}$$

Where C_1 and C_2 are the parameters in the equation for the best-fit line. C_1 relates to the soils hydraulic conductivity, and C_2 relates to the soils sorptivity. The hydraulic conductivity, K, can then be found using Equation 2.

$$K = {C_1}/{A} \qquad \text{[Equation 2]}$$

Where

$$A = \frac{11.65*(n^{0.1}-1)*\exp[2.92(n-1.9)\alpha h_0]}{(\alpha r_0)^{0.91}} \text{ if } n \geq 1.9 \qquad \text{[Equation 3]}$$

$$A = \frac{11.65*(n^{0.1}-1)*\exp[7.5(n-1.9)\alpha h_0]}{(\alpha r_0)^{0.91}} \text{ if } n < 1.9. \qquad \text{[Equation 4]}$$

Where n and α are the van Genuchten parameters for the soil, r_0 is the disk radius, (2.25 cm.) and h_0 is the suction at the disk surface (-1 cm. for all samples).

Three random soil samples were taken from each of the sites to determine the bulk density and particle size distribution. The values from each site will be averaged to help determine the hydraulic properties at the 10 infiltration measurement locations. Once the hydraulic properties were determined, comparisons between the native (non-cultivated) field and the cultivated field are made. A discussion on the differences between the two hydraulic conductivity methods will also be conducted as the two methods proved to give varying results.

Gravimetric and volumetric water content were also measured at each location to examine the differences between moisture availability in the soil at each site location.

RESULTS

Total soil infiltration for each of the five sample locations in the non-cultivated tall grass prairie is shown in Figure 1. This figure shows data from the first minute to four minutes for reasons stated above. The slope of the best-fit line for each sample is relatively close and the R^2 values are all very high indicating a good representation from the linear fit. The cumulative infiltration varies across the five samples as the highest total infiltration is around 0.41 cm and the lowest is only

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about 0.19 cm. The average cumulative infiltration across all five samples in the native prairie is 29.2 cm.

Figure 2 shows the cumulative infiltration for the five samples in the cultivated tall grass prairie. The slopes in these plots are also similar to each other but slightly larger than the slopes found for the non-cultivated field. The main difference between the two study sites, however, is the total amount of infiltration achieved. In this case the highest infiltration amount is 0.32 cm. and the lowest is about 0.21 cm. The cumulative infiltration average between all five samples in the cultivated field is 27.4 cm.; about two centimeters lower than the native prairie.

The results from Figure 1 and Figure 2 show that compaction due to cultivation decreases the amount of water that infiltrates the soil. Compaction on cultivated ground can be caused by numerous things, but most commonly through heavy traffic. Compaction can lead to increased surface runoff and limited water availability throughout the soil profile due to the reduced infiltration (Abdelkadir and Yimer, 2011). Infiltration is governed largely by the macropores, so when there is some compaction in cultivated fields, the macropores are being reduced to micropores and infiltration rates become smaller (Logsdon and Jaynes, 1996). It is therefore not surprising that total infiltration was lower for the cultivated field. Cultivation in the field likely led to macropores evolving into micropores, which caused a reduction in infiltration in the field.

Gravimetric water content, volumetric water content, and bulk densities for both the cultivated and non-cultivated study areas are shown in Table 1. As stated above, three samples were taken in the field at each location. These values were averaged across the three samples to show the differences between these parameters in the two fields. As noted in the previous section, there was a total of about a quarter of an inch of rain two days prior to the sampling period. This would account for the large water content amounts. The values obtained from this sampling time are therefore more saturated than what would be expected. The cultivated field had higher values for each of the parameters, but the biggest difference between the two sample sites was the volumetric water content results. In this case, there was a 37.4% difference between the two sites.

Higher water content in the cultivated soil proves to be an odd result given then surface runoff is more prevalent in compact cultivated soil. Also, there was reduced infiltration observed in the cultivated field samples, which would also lead one to believe there would be less water within a soil sample. Higher bulk density is expected in the cultivated field mainly due to compaction. There is less space in between soil particles in a compact cultivated soil, so the bulk density would therefore be large. In contrast, the native prairie has much bigger spaces between soil particles, so it's bulk density should be low. These conclusions are consistent with the results from the bulk density sampling done here, but they are not consistent regarding the moisture content results.

Table 2 shows the particle size distribution for the cultivated and non-cultivated study areas that will help determine the hydraulic conductivity of the soil at both fields. The cultivated field has lower sand and clay content in its soil than in the non-cultivated field, while the non-cultivated field has higher silt content. From Table 2, we can conclude that the soil texture type based on the textural triangle is silt loam for both of the study areas. The texture of the cultivated area is very close to being a silt clay loam while the non-cultivated field is close to being a silt soil, but in the end they are still classified as the same class. This must mean that soil texture type is not a dominant factor when comparing the hydraulic properties of the cultivated and non-cultivated prairies. It is most likely more related to the distribution of micro- and macropores and the bulk density of the soil.

Results from the hydrometer and bulk density measurements were incorporated into finding the hydraulic conductivity of the two sample sites shown in Table 3. The hydraulic conductivity measured using the Rosetta PTF is in the second column, and hydraulic conductivity measured using a look-up table using soil texture provided in Carsel and Parish (1988) is in the third column. Finally, the percent difference between the two methods is in the fourth column. The percent difference between the cultivated and non-cultivated fields for each method is also shown in the last row. All hydraulic conductivity measurements used Equation 4 as $n<1.9$ in every case.

Here we notice that the cultivated field has lower hydraulic conductivity using the Rosetta PTF, but a higher hydraulic conductivity using the look-up table. Based on previous results, the conclusions from Rosetta PTF seem to be the most accurate way to determine hydraulic conductivity of these soils. Also, there was such a large percent difference between the two methods that one must be more correct. Gupta et al. (2006) emphasizes the importance of macropores in determining ease of water flow in a soil, so hydraulic conductivity of the cultivated prairie should be lower than the non-cultivated field. As stated earlier, the particle size distribution isn't the main element contributing to hydraulic properties of the soil, but bulk density and the effects of compaction may be the key in this study.

Rosetta PTF also calculates the saturated hydraulic conductivity (K_s) of soils based on particle size distribution and bulk density. K_s in the cultivated area is 7.39 X 10^{-4} and K_s in the non-cultivated field is 7.22 X 10^{-4} . K_s in the cultivated field is therefore slightly larger than that of the non-cultivated field. Assouline (2006) notes that saturated hydraulic conductivity of a soil is also largely determined by the macropores, so compacted cultivated soils should have a lower K_s value than non-cultivated soils, as is the case for hydraulic conductivity. This was not the case here, but the values of K_s vary only by 2.4%. Although results of K_s are unexpected, the unsaturated hydraulic conductivity proved to be vastly different in each of the sample sites. This proves that indeed infiltration and water flow in soil differs between cultivated and non-cultivated fields.

DISCUSSION

Hydraulic conductivity measures how easily water can flow through a soil. The results from field sampling give expected results for what would be anticipated in cultivated and non-cultivated native prairies. Bulk density was higher and hydraulic conductivity was lower for the cultivated area most likely due to the macropores being converted to micropores due to compaction. This would essentially lead to less water infiltration. Consistent results were found across the sampling sites as infiltration rates were high in the non-cultivated field and lower in the cultivated field. Therefore, water most easily flowed through the non-cultivated native land and was more restricted in the cultivated field.

Two odd results came when comparing the moisture content and saturated hydraulic conductivity of the two fields. The opposite of the results is what would be expected, but there is other evidence that supports lower values of these parameters in the cultivated field.

Errors may occur when considering it rained a fair amount two days before the study, as this may have influenced the soil properties. The precipitation most likely affected the shape of the quadratic best-fit line. Some errors in calculating the hydraulic conductivity may occur because a linear best-fit line was used in substitution for a quadratic best-fit line and only for the last three minutes. It was a necessary substitution given that a negative hydraulic conductivity calculated from the quadratic best-fit line is physically impossible. The errors in using a linear line are most likely far less extensive than using a negative C_1 value to calculate K.

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CONCLUSIONS

This study showed that cultivated and non-cultivated tall grass prairies have very different properties that affect hydraulic properties of the soil. Even though cultivation in the non-cultivated area ended in the late 1950's, its impacts on the soil are still felt today. Total infiltration was smaller in the cultivated sample sites and bulk density was higher. These results are consistent with compacted soil that has less macropores than its non-cultivated neighbor in that infiltration rates are affected by pore size.

Random sampling of each measurement covered a variety of hillslope locations to get a general idea of the properties of the soil for each field. Some results were consistent with general assumptions regarding hydraulic properties of compact and native soils, but there were some interesting results that may be a surprise. The saturated hydraulic conductivity values, and water content for samples in the two fields did not provide expected results. Overall though, there was immense support for lower infiltration rates in cultivated versus non-cultivated fields.

Further research could include further sampling in the region, longer infiltration measurement times, and possibly look at different locations around the Midwest to see the consistency of these results. Overall, this study proved that cultivation that occurred more than 50 years ago still affects the water infiltration and hydraulic properties of soil mainly because of bulk density and the effects of compaction. Runoff and soil water properties will be impacted for several more decades because of this.

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Table 1
Water content and bulk density measurements

Sample	Mass W.C (g/g)	Bulk Density (g/cm^3)	Vol. W.C. (cm^3/cm^3)
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% Difference	**26.41%**	**10.16%**	**37.40%**

Table 2
Particle size distribution

	% Silt	% Clay	% Sand
Cultivated Sample	77.99%	11.99%	10.12%
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Hydraulic conductivity measurements

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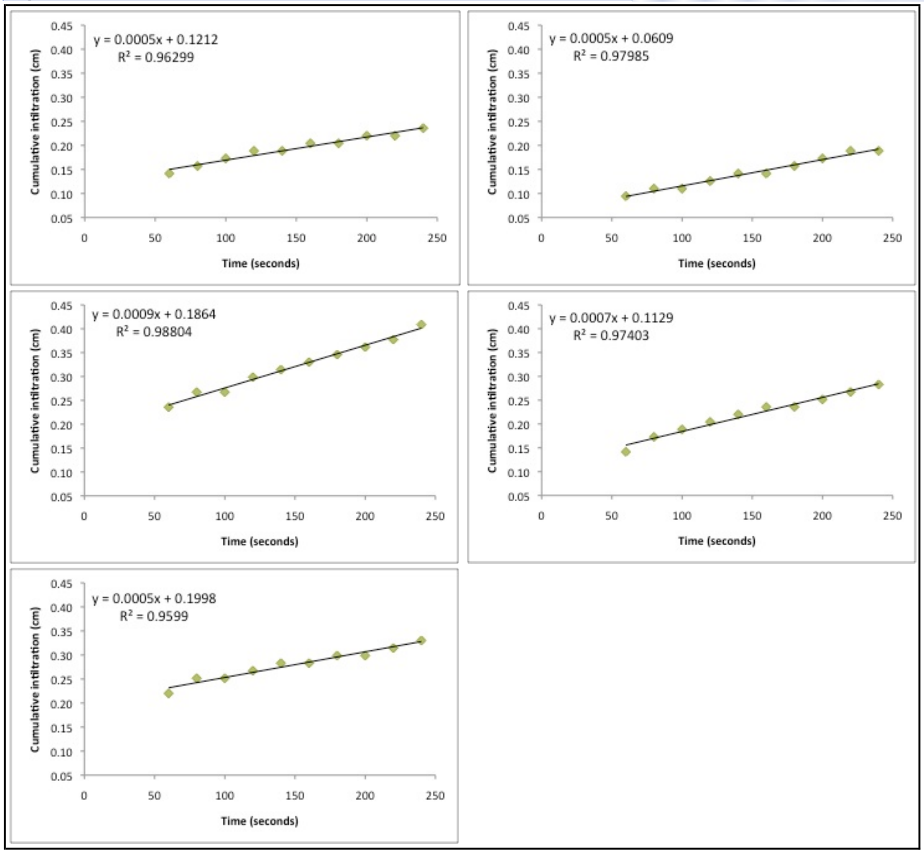
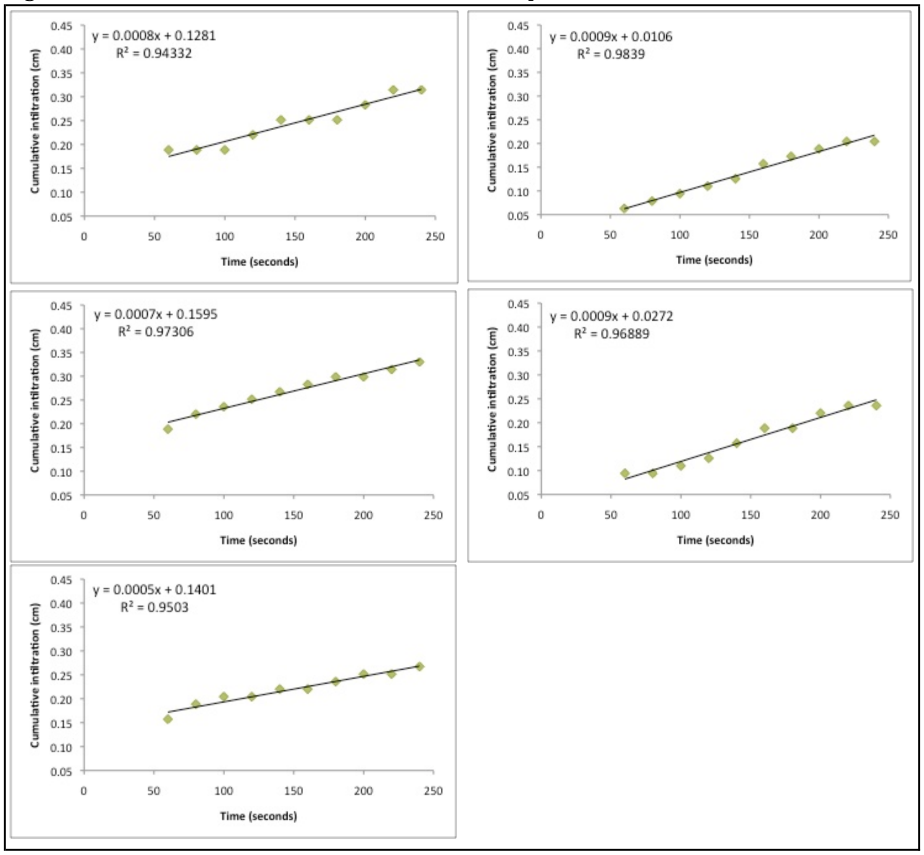
Figure 1. Non-cultivated field cumulative infiltration plots



Daniel Hirmas 12/11/11 11:03 PM

Comment [12]: Need another figure that graphically shows the infiltration rate determined by these plots and compares it to bulk density, psd, and porosity. This could be a simple bar graph with two groups: cultivated and non-cultivated with the mean of infiltration rate, ksat, bulk density, psd, and porosity side-by-side in each group. You could bring in the replication through standard deviation bars over the mean. Otherwise, this is very hard to follow.

Figure 2. Cultivated field cumulative infiltration plots



RERERENCES

Abdelkadir, A, Yimer, F, 2011. Soil water property variations in three adjacent land use types in the Rift Valley area of Ethiopia. Journal of Arid Environments 75, 1067-1071.

Arriaga, F.J., Biscaro, A.S., Balkcom, K.S., Shaw, J.N., van Santen, E., Kornecki, T., 2010. Conservation tillage improves soil physical properties on different landscape positions of a coastal plain soil. In Endale, D.M., and Iversen, K.V., editors. Proceedings of the 32nd Southern Conservation Agricultural Systems Conference, July 20-22, 2010, Jackson, Tennessee. CDROM.

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Schwartz, R.C., Evett, S.R., 2002. Estimating hydraulic properties of a fine-textured soil using a disc infiltrometer. Soil Science of America Journal 66,1409-1423.

Zhang, R., 1997. Determination of soil sorptivity and hydraulic conductivity from the disk infiltrometer. Soil Science Society of America Journal 61, 1024-1030.

EFFECTS OF TOPOGRAPHY AND LAND USE ON INFILTRATION RATES AT THE UNIVERSITY OF KANSAS FIELD STATION

ABSTRACT

This study investigates the effects of cultivation on cumulative water infiltration. Several samples were taken at the University of Kansas Field Station in north Lawrence at two sites, one that was cultivated last in the 1950's and the other that is in a native, non-cultivated field. Tests on particle size distribution, soil moisture content, bulk density, and hydraulic conductivity for each of the fields are conducted to determine which parameters affect cumulative infiltration the most. The infiltration rates were measured using a minidisk infiltrometer with five measurements taken at random locations in each field. Results showed that cultivated areas are more compact and have higher bulk densities than the native, non-cultivated field. Bulk density from compaction and hydraulic conductivity were the main parameters that seemed to impact the amount of water that infiltrated the soil. Reduced macropores and an increase in micropores from compaction proved to affect cumulative infiltration more than soil texture. Overall, the effects of compaction from cultivation and agricultural practices are felt for sometime due to an increase in bulk density and decrease in hydraulic conductivity.

INTRODUCTION

Soil infiltration rate is influenced by many properties of the soil such as bulk density, land-use, and soil texture (Guzman and Al-Kaisi, 2011). For example, a sandy soil will have a higher infiltration rate and bulk density than a clayey soil due to the difference of porosity between the two samples. Guzman and Al-Kaisi (2011) found that infiltration rates and bulk density are highly correlated as water flow is largely determined by the pore sizes throughout the soil.

Cultivation and compaction from agricultural practices increases the bulk density of a soil (Abdelkadir and Yimer, 2011). Cultivated versus non-cultivated areas prove to have differences in the rate of infiltration as cultivated regions will produce more surface runoff leading to erosion especially along the backslope (Arriaga et al., 2010). Abdelkadir and Yimer (2011) found cultivated regions had smaller cumulative infiltration amounts and lower soil moisture content than non-cultivated areas. They attributed these results to soil compaction and higher bulk densities in cultivated fields.

Disk infiltrometers are a relatively simple and effective way to examine the effects of cultivation practices on infiltration rates because they can measure the infiltration rates in the field at many locations along the hillslope. Disk infiltrometers help derive parameters like saturated hydraulic conductivity, and are crucial to understanding water flow in soils (Schwartz and Evett, 2002). Hydraulic conductivity measured in the lab often fails to represent what would be found in the field, so a minidisk infiltrometer is used to get a more accurate representation of the hydraulic conductivity of the soil at many locations in the field (Dusek et al., 2009).

The objective of this study is to use the minidisk infiltrometer and examine the effects of land-use practices and landscape positions on soil infiltration rates for both cultivated and non-cultivated areas of the University of Kansas Field Station in Lawrence, KS. The effects of cultivation are felt for quite some time, so the impacts of agricultural practices will be seen when comparing the cultivated and non-cultivated areas of the study area (Homburg and Sandor, 2011). The main questions looked at in this study are 1) Are there major differences in soil infiltration rates in the cultivated and non-cultivated samples? 2) Do bulk density, particle size distribution, soil water content or other environmental factors explain the infiltration rates seen at these sites?

METHEDOLOGY

This study was performed at the University of Kansas Field Station at two adjacent tall grass prairies in the Rockefeller Experimental Tract; one area that was cultivated last in the 1950's and another that has been left undisturbed. All measurements were taken at random locations along the hillslope to cover the effects of hillslope sections on hydraulic properties of the soil. The native (unplowed) prairie is periodically burned to conserve the local biodiversity in the field. Measurements were taken on November 5, 2011, two days after a precipitation event dropped about 0.25 inches of rain.

Infiltration measurements were taken at five random locations in both the native tall grass prairie and the cultivated prairie using a minidisk infiltrometer (Decagon Devices, Pullman, WA). The infiltration rates at each location were conducted for a total of four minutes using a tension of -1 centimeters. The infiltrometer measurements were taken every 10 seconds for the first minute, and subsequently every 20 seconds. Once the infiltration rates were obtained, the cumulative infiltration could be plotted versus time and hydraulic conductivity at each of the 10 locations can be calculated.

A best-fit quadratic line was fit to each of the cumulative infiltration plots. The shape of the best-fit line should be concave or else a negative hydraulic conductivity would be calculated. A convex best-fit quadratic was found in the majority of the cumulative infiltration plots, most likely due to precipitation two days prior to taking the measurements. The precipitation would cause the infiltration rates in the first couple measurements to be slower than what would occur in a drier soil. A negative hydraulic conductivity is impossible, so in order to move forward with the study, another method had to be substituted. In this case, a best-fit linear line was fit to the data from the first minute on. Data from the first 60 seconds was eliminated because infiltration rate during this time period is fastest. A linear line omitting the first minute had a higher R^2 value than a linear line including the first 60 seconds. The slope of the best-fit linear line was implemented in the rest of the equations to find the hydraulic conductivity of the 10 sample sites.

In this study, two methods are used to determine the hydraulic conductivity of the soil samples. The first method uses a look-up table to find the van Genuchten parameters based on 12 textural classes (Carsel and Parrish, 1988). This method involved determining soil texture based on the "feel method". The second method uses Rosetta pedotranfer function (PTF) model that converts basic soil information to hydraulic properties (Schaap et al., 2001). This model specifically uses particle size distribution and bulk density to find the van Genuchten parameters.

Particle size distribution was found in the lab using a hydrometer. A large sample was taken from each of the fields to determine the particle size distribution for each study site. The results given are a generalization of the particle size distribution for the two fields and do not include an averaging between multiple random samples. The resulting general field percentages of sand, silt, and clay are incorporated into the PTF along with bulk density to determine the van Genuchten parameters for each field.

Both methods to find hydraulic conductivity of the soil employ a set of equations suggested by Zhang (1997). These equations are:

$$I = C_1 t + C_2 \sqrt{t} \qquad \text{[Equation 1]}$$

Where C_1 and C_2 are the parameters in the equation for the best-fit line. C_1 relates to the soils hydraulic conductivity, and C_2 relates to the soils sorptivity. The hydraulic conductivity, K, can then be found using Equation 2.

$$K = {C_1}/{A} \qquad \text{[Equation 2]}$$

Where

$$A = \frac{11.65 * (n^{0.1} - 1) * \exp[2.92(n - 1.9)\alpha h_0]}{(\alpha r_0)^{0.91}} \text{ if n} \geq 1.9 \qquad \text{[Equation 3]}$$

$$A = \frac{11.65 * (n^{0.1} - 1) * \exp[7.5(n - 1.9)\alpha h_0]}{(\alpha r_0)^{0.91}} \text{ if n} < 1.9. \qquad \text{[Equation 4]}$$

Where n and α are the van Genuchten parameters for the soil, r_0 is the disk radius, (2.25 cm.) and h_0 is the suction at the disk surface (-1 cm. for all samples).

Three random soil samples were taken from each of the sites to determine the bulk density and particle size distribution. The values from each site will be averaged to help determine the hydraulic properties at the 10 infiltration measurement locations. Once the hydraulic properties were determined, comparisons between the native (non-cultivated) field and the cultivated field are made. The differences between the two hydraulic conductivity methods will also be discussed as the two methods proved to give varying results.

Gravimetric and volumetric water content were also measured at each location to examine the differences between moisture availability in the soil at each site location.

RESULTS

Figure 1 summarizes the total soil infiltration as it relates to particle size distribution, bulk density, and saturated hydraulic conductivity for both the cultivated and non-cultivated fields. These parameters and their effects on cumulative infiltration will be discussed in this section.

Total soil infiltration for each of the five sample locations in the non-cultivated tall grass prairie is shown in Figure 2. This figure shows data from the first minute to four minutes for reasons stated above. The slope of the best-fit line for each sample is relatively close and the R^2 values are all very high indicating that the linear fit adequately represents the data. The cumulative infiltration varies across the five samples as the highest total infiltration is around 0.41 cm and the lowest is only about 0.19 cm. The average cumulative infiltration across all five samples in the native prairie is 29.2 cm.

Figure 3 shows the cumulative infiltration for the five samples in the cultivated tall grass prairie. The slopes in these plots are also similar to each other but slightly larger than the slopes found for the non-cultivated field. The main difference between the two study sites, however, is the total amount of infiltration achieved. In this case the highest infiltration amount is 0.32 cm. and the lowest is about 0.21 cm. The cumulative infiltration average between all five samples in the cultivated field is 27.4 cm.; about two centimeters lower than the native prairie.

The results from Figures 1 through 3 show that compaction due to cultivation decreases the amount of water that infiltrates the soil. Compaction on cultivated ground can be caused by numerous things, but most commonly through heavy traffic. Compaction can lead to increased surface runoff and limited water availability throughout the soil profile due to the reduced infiltration (Abdelkadir and Yimer, 2011). Infiltration is governed largely by the macropores, so when there is some compaction in cultivated fields, the macropores are being reduced to micropores and infiltration rates become smaller (Logsdon and Jaynes, 1996). It is therefore not surprising that total infiltration was lower for the cultivated field. Cultivation in the field likely led to macropores evolving into micropores, which increased bulk density and caused a reduction in infiltration in the field.

Gravimetric water content, volumetric water content, and bulk densities for both the cultivated and non-cultivated study areas are shown in Table 1. As stated above, three samples were taken in the field at each location. These values were averaged across the three samples to show the differences between these parameters in the two fields. As noted in the previous section, there was about a quarter inch of rain two days prior to the sampling period. This would account for the large water content amounts. The values obtained from this sampling time are therefore more saturated than what would be expected. The cultivated field had higher values for each of the parameters, but the biggest difference between the two sample sites was the volumetric water content results. In this case, there was a 37.4% difference between the two sites.

Higher water content in the cultivated soil proves to be an odd result given that compact cultivated soils are prone to runoff. Also, there was reduced infiltration observed in the cultivated field samples, which would also lead one to believe there would be less water within a soil sample. Higher bulk density is expected in the cultivated field mainly due to compaction. There is less space in between soil particles in a compact cultivated soil, so the bulk density would therefore be large. In contrast, the native prairie has much bigger spaces between soil particles, so it's bulk density should be low. These conclusions are consistent with the results from the bulk density sampling done here, but they are not consistent regarding the moisture content results.

Table 2 shows the particle size distribution for the cultivated and non-cultivated study areas that will help determine the hydraulic conductivity of the soil at both fields. The cultivated field had lower sand and clay content and a higher amount of silt particles. From Table 2, we can conclude that the soil texture type based on the textural triangle is silt loam for both of the study areas. The texture of the cultivated area is very close to being a silt clay loam while the non-cultivated field is close to being a silt soil, but in the end they are still classified as the same class. This must mean that soil texture type is not a dominant factor when comparing the hydraulic properties of the cultivated and non-cultivated prairies. It is most likely more related to the distribution of micro- and macropores and the bulk density of the soil.

Results from the hydrometer and bulk density measurements were incorporated into finding the hydraulic conductivity of the two sample sites shown in Table 3. The hydraulic conductivity measured using the Rosetta PTF is in the second column, and hydraulic conductivity measured using a look-up table using soil texture provided in Carsel and Parish (1988) is in the third column. Finally, the percent difference between the two methods is in the fourth column. The percent difference between the cultivated and non-cultivated fields for each method is also shown in the last row. All hydraulic conductivity measurements used Equation 4 as $n<1.9$ in every case.

Here we notice that the cultivated field has lower hydraulic conductivity using the Rosetta PTF, but a higher hydraulic conductivity using the look-up table. Based on previous results, the conclusions from Rosetta PTF seem to be the most accurate way to determine hydraulic conductivity of these soils. Gupta et al. (2006) emphasizes the importance of macropores in determining ease of water flow in a soil, so hydraulic conductivity of the cultivated prairie should be lower than the non-cultivated field. As stated earlier, the particle size distribution isn't the main element contributing to hydraulic properties of the soil, but bulk density and the effects of compaction may be the key in this study.

Rosetta PTF also calculates the saturated hydraulic conductivity (K_s) of soils based on particle size distribution and bulk density. K_s in the cultivated area is 7.39×10^{-4} and K_s in the non-cultivated field is 7.22×10^{-4}. K_s in the cultivated field is therefore slightly larger than that of the non-cultivated field. Assouline (2006) notes that saturated hydraulic conductivity of a soil is also largely determined by the macropores, so compacted cultivated soils should have a lower K_s value than non-cultivated soils, as is the case for hydraulic conductivity. This was not the case here, but the values of K_s vary only by 2.4%. Although results of K_s are unexpected, the unsaturated hydraulic conductivity proved to be vastly different in each of the sample sites. This proves that indeed infiltration and water flow in soil differs between cultivated and non-cultivated fields.

DISCUSSION

Hydraulic conductivity measures how easily water can flow through a soil. The results from field sampling give expected results for the cultivated and non-cultivated, native prairies. Bulk density was higher and hydraulic conductivity was lower for the cultivated area most likely due to the macropores being converted to micropores due to compaction. This would essentially lead to less water infiltration. Consistent results were found across the sampling sites as infiltration rates were high in the non-cultivated field and lower in the cultivated field. Therefore, water flowed easier through the non-cultivated native land and was more restricted in the cultivated field.

Moisture content and saturated hydraulic conductivity gave odd results when comparing the two fields. Although this was the case, there is other evidence that supports lower values of these parameters in the cultivated field. Bulk density, hydraulic conductivity, and cumulative infiltration all gave expected results for behavior of the two fields.

Errors may occur because it rained a fair amount two days before the study, as this may have influenced the soil properties. The precipitation most likely affected the shape of the quadratic best-fit line. Some errors in calculating the hydraulic conductivity may occur because a linear best-fit line was used in substitution for a quadratic best-fit line and only for the last three minutes. It was a necessary substitution given that a negative hydraulic conductivity calculated from the quadratic best-fit line is physically impossible. The errors in using a linear line are far less extensive than using a negative C_1 value to calculate K.

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CONCLUSIONS

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Future research would include further sampling in the region, longer infiltration measurement times, and possibly look at different locations around the Midwest to see the consistency of these results. Overall, this study proved that cultivation that occurred more than 50 years ago still affects the water infiltration and hydraulic properties of soil mainly because of bulk density and the effects of compaction. Runoff and soil water properties will be impacted for several more decades because of this.

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% Difference	**22.31%**	**20.33%**	

Figure 1. Reference plot for the parameters that influence cumulative infiltration for both the cultivated and non-cultivated fields

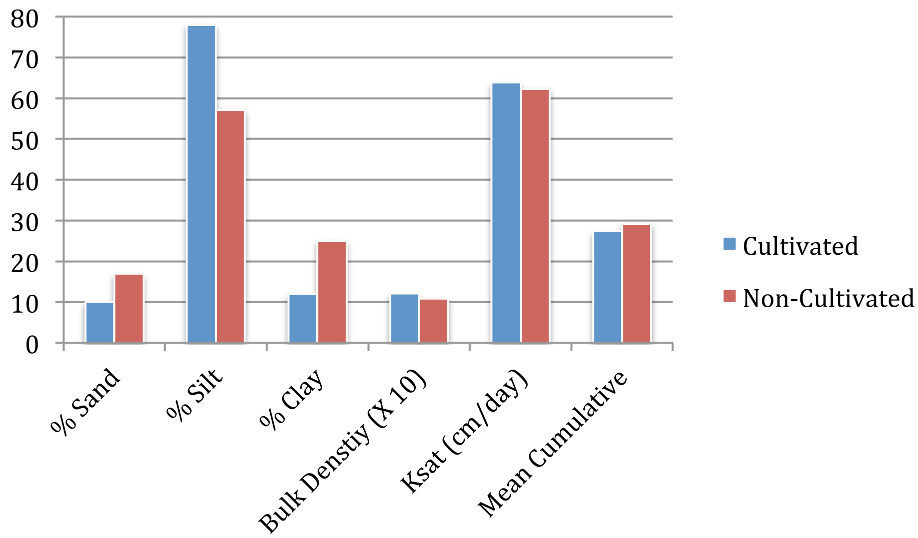


Figure 2. Non- cultivated field cumulative infiltration plots

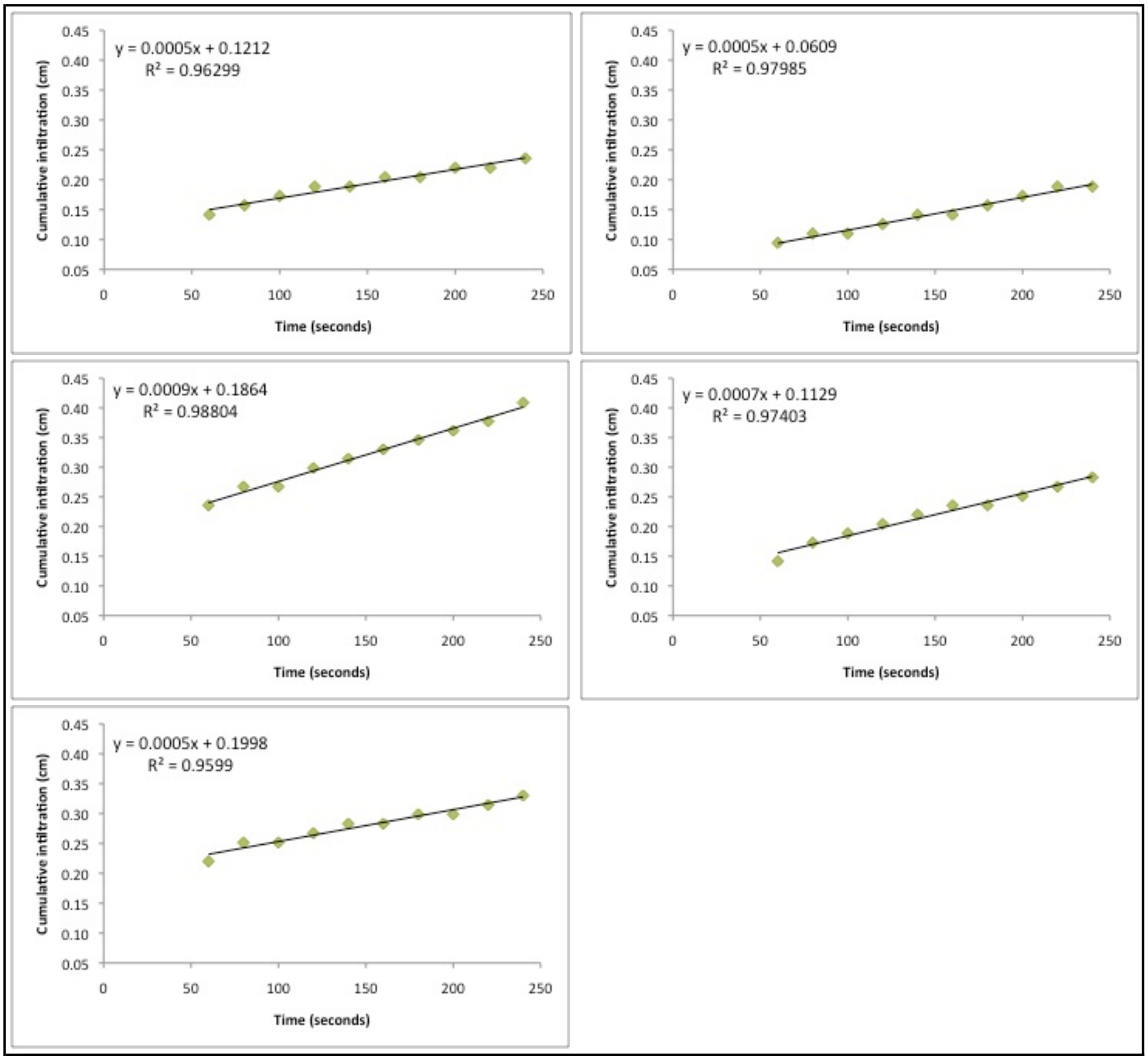
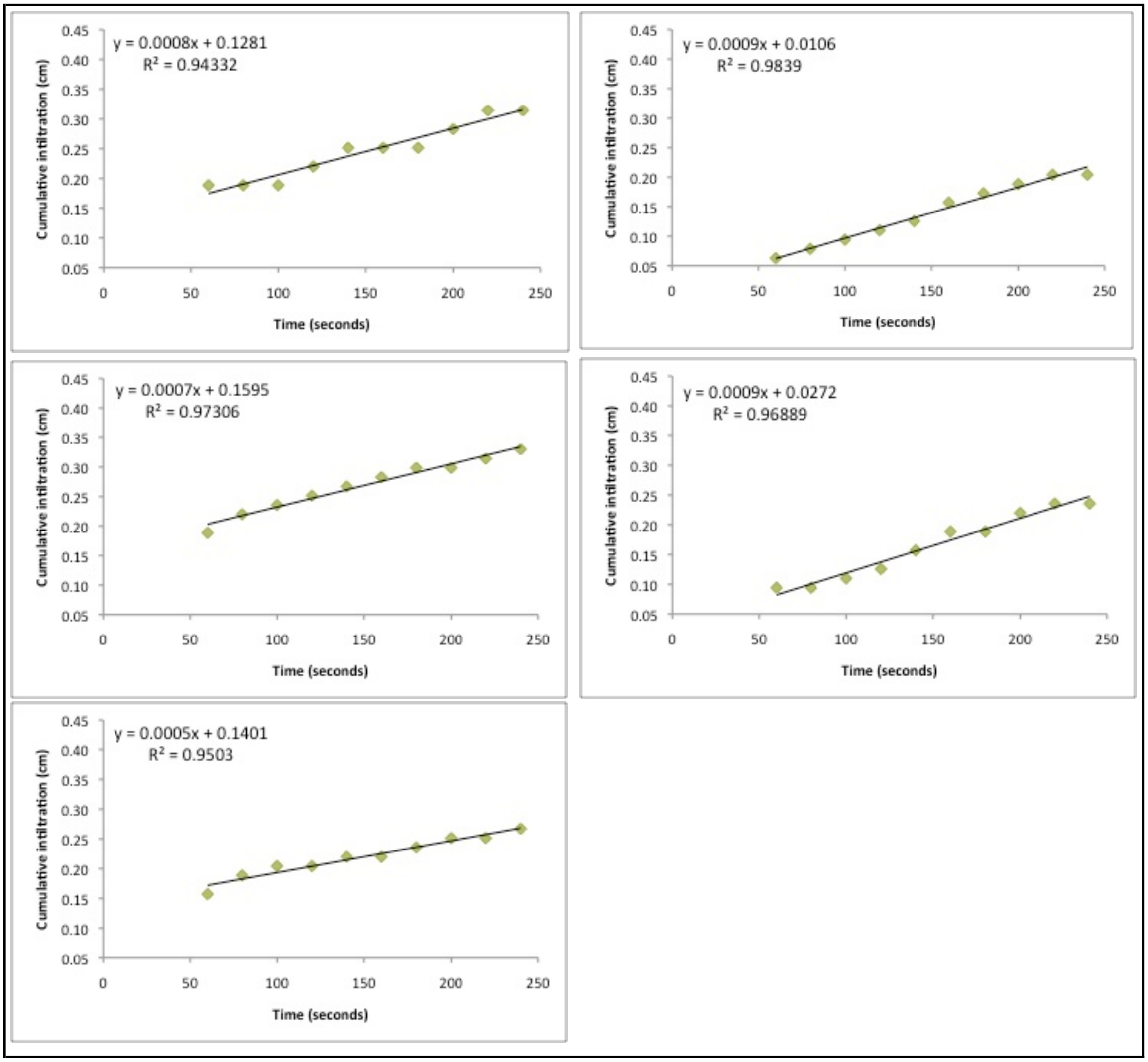


Figure 3. Cultivated field cumulative infiltration plots



RERERENCES

Abdelkadir, A, Yimer, F, 2011. Soil water property variations in three adjacent land use t types in the Rift Valley area of Ethiopia. Journal of Arid Environments 75, 1067-1071.

Arriaga, F.J., Biscaro, A.S., Balkcom, K.S., Shaw, J.N., van Santen, E., Kornecki, T., 2010. Conservation tillage improves soil physical properties on different landscape positions of a coastal plain soil. In Endale, D.M., and Iversen, K.V., editors. Proceedings of the 32nd Southern Conservation Agricultural Systems Conference, July 20-22, 2010, Jackson, Tennessee. CDROM.

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Logsdon, S.D., Jaynes, D.B., 1996. Spatial variability of hydraulic conductivity in a cultivated field at different times. Soil Science Socity of America Journal 60, 703–709.

Schaap, M.G., Leij, F.J., van Genuchten, M.T., 2001. Rosetta: a computer program for estimating soil hydraulic parameters with hierarchical pedotransfer functions. Journal of Hydrology 251, 163-176.

Schwartz, R.C., Evett, S.R., 2002. Estimating hydraulic properties of a fine-textured soil using a disc infiltrometer. Soil Science of America Journal 66,1409-1423.

Zhang, R., 1997. Determination of soil sorptivity and hydraulic conductivity from the disk infiltrometer. Soil Science Society of America Journal 61, 1024-1030.