A P P L I C A T I O N

Comparison of Water Interception and Infiltration
by Selected Grass Dominated Communities

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   Sponsoring agency or department (if applicable):

   State (Agency)_____ County (Name & no.) _____

   City _____ College/University _____

   Note:
   If private citizens or groups are proposing a roadside enhancement project, a letter of support from the agency maintaining the right-of-way must be attached.

2. Purpose of application: (Choose most appropriate, or if multipurpose, please rank—with 1 being the highest priority.)

   Roadside inventory _____

   Gateway landscaping/Roadside enhancement _____

   Research, demonstration, and education __X___

   Equipment _____

   Other (list below) _____

   _____

   _____

3. Maintenance of roadside, gateway, or other project site (if applicable):

   Person Responsible: _____ Phone Number:_____

   Maintenance of equipment(if applicable):

   Person Responsible: _____ Phone Number:_____

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Proposed Research

We propose comparing water interception and infiltration of various types of grassland stands of similar age and the same soil type. Grass dominated stands to be compared in the 2-year project include: a monoculture stand of a cool-season grass (control), a mixed stand of two cool-season grasses, a mixed stand of 2 cool-season grasses and 5 warm-season grasses, and a mixed stand of 5 warm-season grasses and 2 cool-season grasses and 33 forbs.

This research will provide information on the species composition of stands that maximize water interception and infiltration to reduce storm water runoff. These results will be useful in designing seed mixes in roadsides and watersheds to minimize storm water runoff and erosion.

This is a two-year project. The proposal is for the second year of the project.

Introduction

Storm water runoff is a growing concern. The Iowa record floods of June 2008 graphically demonstrated the need to address this concern. Vegetation can significantly influence storm water runoff in two ways. First is a process called interception, the amount of rainfall that is retained by plant foliage. Research has shown that plants with greater canopy cover will intercept more water (Wang et al. 2005). Clark (1940) determined that an acre of big bluestem (*Andropogon gerardii*) can intercept and hold up to 53 tons of rainfall as compared to 28 tons for smaller, less dense buffalo grass (*Buchloe dactyloides*). Fifty-three tons of water per acre is equivalent to a 1" rainfall event in an hour. Clearly, reducing the amount of storm water runoff can be achieved by selecting plant species that provide good canopy cover and high levels of adsorption. The second process that can reduce storm water runoff is infiltration. Rainfall that reaches the soil surface and is absorbed (infiltrates) into the soil. Vegetation has a significant role in water infiltration (USDA-NRCS 1998). Dee et al. (1966) found that water infiltration in a stand of silver bluestem (*Andropogon saccharoides*) was three times greater than in a stand of buffalo grass. Thus, reduction of storm water runoff may also be achieved by selecting plant species that maximize water infiltration. Therefore, vegetation that increases water interception and infiltration should be planted to reduce storm water runoff and curtail flooding.

It is well documented that non-native grasses such as smooth brome (*Bromus inermis*), and Kentucky bluegrass (*Poa pratensis*) produce much less above ground vegetative growth and more shallow roots than native, prairie grasses like big bluestem, switchgrass (*Panicum virgatum*) and indiangrass (*Sorghastrum nutans*) (Weaver 1949). Due to their more extensive above ground vegetative growth and more extensive root systems, one would expect greater water interception and infiltration by stands of these native grasses than the non-natives. However, a recent study by Al-Kaisi (2005), indicated that water infiltration did not significantly differ among stands of Kentucky bluegrass, smooth brome, reconstructed tallgrass prairies and prairie remnants. He concluded that the engineered soils (Orthents soils) from roadway construction and the variability of plant composition of the reconstructed and native prairie communities may have contributed to these questionable results (Al-Kaisi 2005). No tests of water interception were conducted in this study.

Objectives

This project is designed to answer the following questions:

1. Does species composition a grass dominated stand affect water interception?
2. Does above ground biomass of a grass dominated stand affect water interception?
3. Does species composition of a grass dominated stand affect water infiltration?
4. Does species composition of a grass dominated stand affect root biomass?

5. Does the root biomass of a grass dominated stand affect water infiltration?

Methods

This research experiment will be conducted on the campus prairie and adjacent areas at the University of Northern Iowa in Cedar Falls, Iowa. As indicated by soil maps and samples, the soil type of the research site is Saude Loam. The site was a brome/clover hayfield prior to seeding with warm-season grasses in 1973. Transplants of a number of forbs were added to a portion of the grassland in 1982 as a part of a plant rescue mission. In 1998 and 2003, thirty-three species of forbs were seeded into to a another portion of the site. Water interception and infiltration will be compared in four distinctly different grassland stands of similar ages within a single soil type. Grass stand treatments consists of: monoculture stand of Kentucky bluegrass (control), a mixed stand of Kentucky bluegrass and smooth brome, a mixed stand the previous two grasses and 5 additional warm-season grasses, and a mixed stand of the seven previous grasses plus an additional 33 forbs species. Measurements will be taken at six random locations within each vegetation type. Water infiltration will be measured with a Cornell Sprinkle Infiltrometer (Odgen et al. 1997). A technique developed by Clark (1940) will be used to measure water interception within the various stands. This method involves placing pans under vegetation in the plot. The vegetation acts as a screen over the pan during rainfall events catching any water not intercepted by the vegetation above. The amount of water in the pan under the vegetation will be compared to the total amount of rainfall as measured from a pan not obstructed by vegetation.

Timeline

Year 1	
Burn research sites	May 2009
Interception/infiltration sampling	June, Sept. 2009
Interim LRTF Report	May 2009
Year 2	
Burn research sites	Fall 2009
Interception/infiltration sampling	June and Sept. 2010
Final LRTF Report	December 2010

Progress to date

Soil samples were taken from each plot in October of 2008 and dried for analysis in the summer of 2009. Research plots were burned in May of 2009 and then they were measured, boundaries laid-out, and flagged. Each plot is triangular in shape and is 15x16x14m in dimension. The sprinkle infiltrometer was ordered and received from Cornell in April of 2009. Materials needed to construct pans have been obtained and the next step will be to build pans. Sampling of both infiltration and interception will occur in mid and late summer. Initial vegetation sampling will be done in early June.

Education and Outreach

An important aspect of this project is to promote prairie restoration and reconstruction to practitioners and to the public. The proposed research site is located on campus at the University of Northern Iowa. Due to its proximity to the Tallgrass Prairie Center (TPC), the research site will be an excellent demonstration site for workshops, conferences and field trips for the general public to observe differences in species composition of grass dominated stands and the effect of these difference on water interception and infiltration.

At the completion of this project, a summary report will be submitted to the LRTF committee and the results will be presented at the 22nd North American Prairie Conference, 2011 Iowa Prairie Conference, Iowa Academy of Science, and Iowa Roadside Conference.

Budget

	LRTF	TPC
Personnel		
Research Administrator		
Salary	$ 2,700	
Fringe Benefits	$ 1,004	
Graduate student stipend	$ 8,392	
Student salaries	$ 6,608	
Tuition		$7596
Supplies & Services	$ 2,000	
Travel	$ 700	
Total Direct Cost	$21,404	
Indirect Costs (8%)	$ 1,712	
Total LRTF Request	**$23,116**	
Match	$ 7,596	
Total Project Cost	$30,712	

Literature Cited

Al-Kaisi M. 2005. Infiltration rates for native and reconstructed prairies across Iowa. Report. Iowa Department of Transportation-Living Roadway Trust Fund. Ames, Ia. http://www.iowalivingroadway.com/researchreports.

Clark O. 1940. Interception of rainfall by prairie grasses, weeds, and certain crop plants. Ecological Monographs. 10: 243-277.

Dee R, Thadis B, Robertson E. 1966. Influence of grass vegetation on water intake of Pullman Silty Clay Loam. Journal of Range Management. 19(2): 77-79.

Ogden C, van Es H, Schindelbeck R. 1997. Miniature rain simulator for measurement of infiltration and runoff. Soil Sci. Soc. Am. J. 56: 777-783.

United States Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS). 1998. Soil quality indicators: infiltration. Soil quality information sheet January 1998. http://www.soils.usda.gov.

Wang X, Li X, Zhang J, Zhang Z, Berndtsson R. 2005. Measurement of rainfall interception by xerophytic shrubs in re-vegetated sand dunes. Hydrological Sciences. 50(5): 897-910.

Weaver J. 1968. Prairie plants and their environment- A fifty-year study in the Midwest. University of Nebraska Press. Lincoln, Ne. 276pp.

Vita for research advisors provided with Year 1 Proposal

Comparison of Water Interception and Infiltration by Selected Grass Dominated Communities

Sarah Benedict

Living Roadside Trust Fund Interim Report

Project Progress:

After the first season of sampling, data has been collected for above-ground and root biomass, interception, and infiltration. After the plots were burned in late spring, above-ground biomass was taken when after revegetation occurred. Interception measurements were taken as soon as interception pans were placed in each of the plots randomly. Six interception pans were placed randomly throughout each plot underneath the vegetation.

Interception data was taken following seven rainfall events. Immediately following these rainfall events, the amount total amount of rainfall was determined and the amount of rainfall that was intercepted by the above ground biomass was also determined. The table below shows the interception rates for each rainfall event given as the percent of total rainfall intercepted by above ground biomass) from the first season of sampling for all plots (Table 1).

	Rainfall Event 1	Rainfall Event 2	Rainfall Event 3	Rainfall Event 4	Rainfall Event 5	Rainfall Event 6	Rainfall Event 7
Diverse Plot	36.3%	24.7%	58.6%	62.6%	31.7%	42%	29%
5 Warm Season Grasses	42.5%	38.4%	46.2%	74.4%	18.2%	47.1%	25.6%
2 Cool Season Grasses	28.4%	19.9%	23.3%	41.9%	16.7%	38%	14%
Kentucky Bluegrass	11.8%	6.1%	15.4%	28.4%	9.1%	20.8%	11.4%

Rainfall events varied in their duration and intensity from short heavy rainfall events such as event 7 in the table above, to long misty/light rain days such as events 3 and 4 in the table above.

Infiltration data was gathered three times from each plot in July/August using an infiltrometer. Infiltrometer readings were spaced out over a two week period in order to ensure that soil conditions were dry enough to collect correct readings. As recommended infiltration measurements were taken 3 days after a rainfall event so that the soil is dry enough to obtain an accurate measurement. The infiltrometer readings from the first season of sampling are shown in the table below (Table 2).

	Sample 1 (Week of July 6)	Sample 2 (week of July 29)	Sample 3 (week of August 4)
Diverse Plot	13mm/hr	15.4mm/hr	18.2mm/hr
5 Warm Season Grasses	18mm/hr	14.1mm/hr	13.6mm/hr
2 Cool Season Grasses	22.1mm/hr	19.2mm/hr	21.9mm/hr
Kentucky Bluegrass	24.9mm/hr	26mm/hr	20.3mm/hr

Soil samples were also taken to determine the amount of root biomass in each plot. The soil samples are currently being broken up and roots are removed from each sample. Once the roots are removed from each sample, the roots will be dried and weighed to determine root biomass. More soil samples will be taken in June of 2010 to obtain root biomass data for both seasons.

Next Season:

For the 2010 sampling season, plots will be burned in the spring. In the summer months, interception and infiltration data will be collected again. Interception data will be collected for 6-8 rainfall events throughout the summer. Infiltration measurements will be taken once a month starting in June and ending in September. Three measurements will be taken from each plot when soil conditions are dry (3 days after a rainfall event). Statistics will be run once all data is collected to determine whether any of the differences in data collected are significant.