Evaluation of storm water runoff from a Midwest green roof system.

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ABSTRACT

Storm water runoff has become a serious environmental concern due to increased impervious surfaces in urban areas. Green roofs are a possible solution to this problem; however there is insufficient research in the United States regarding this tool. Due to the unique climate of the Midwest, data is needed to determine how much storm water will be retained by green roofs with varying media depths. My research includes thirty-two green roof models and four Green Roof Blocks™ located at the SIUE Environmental Science field site in Edwardsville, Illinois. The green roofs were placed in a completely randomized design with four replicates of each medium depth and four controls, on September 5, 2005. Storm water runoff is quantified from each green roof system after every rain event. The findings verify that green roof models with and without plants retain more storm water than control roofs. Green roof models with and without plants both retained the same quantity of storm water in this study period. The information found in my research can be used to evaluate the use of green roofs as a mitigating tool to reduce the quantity of storm water entering already overburdened storm water systems.

INTRODUCTION

Storm water runoff has become a serious environmental concern, not only in urban areas, but expanding suburban areas as well. As cornfields continue to turn into strip malls, the problem will only intensify. According to the EPA, a typical city block generates more than five times as much storm water runoff as a wood lot of the same size (USEPA 2003). Municipalities are struggling to keep up with the increase in storm water runoff as their communities grow.

Research has shown that green roofs decrease the quantity of storm water runoff by as much as seventy-five percent (Moran 2003). However, there is limited green roof data for the varied climatic conditions unique to the Midwest. Our cold winters and hot summers will be a challenge when searching for plants that can survive under these often harsh conditions. Various *Sedum* plant species have been successful in green roofs in Michigan (Monterusso et al. 2005). In order for green roofs to be a viable option in the Midwest, research data must be available to the building industry. The research that is currently being conducted in the United States lacks a sufficient number of replicates or focuses on only one aspect of green roofs, such as storm water runoff. My research has multiple replicates of each green roof depth. It also evaluates plants and monitors temperature differences of the roofing membrane. This study is long term, lasting through December, 2006, providing valuable green roof research data.

My research will determine which planting medium depth provides the greatest storm water retention. I am also evaluating the plants in order to determine which medium depth provides the best growing conditions. The plants in each green roof model are evaluated monthly to determine which soil depth provides the greatest growth, performance, and coverage. Temperature monitoring of the green roof models is also being conducted to determine if green roofs affect the roof membrane temperature, possibly reducing the energy demands of the building.

MATERIALS AND METHODS

Roof Model Setup: Green roof models were set up in a completely randomized design with four replications of 5, 10, 15, and 20 cm of growth media depth with plants, three replications of 5, 10, 15, and

20 cm of growth media without plants, 4 Green Roof Blocks™ with plants, and 4 control roofs. All 32 green roof models are 70 cm x 70 cm wood frames with wafer board substrates and adhered EPDM roofing membrane. The models have sheet metal edging to retain the growth media (Figure 1). Each roof system has a covered gutter connected to a water collection container.

Testing Models:

4 with 5 cm of growth media with plants
3 with 5 cm of growth media without plants
4 with 10 cm of growth media with plants
3 with 10 cm of growth media without plants
4 with 15 cm of growth media with plants
3 with 15 cm of growth media without plants
4 with 20 cm of growth media with plants
3 with 20 cm of growth media without plants
4 Green Roof Blocks™ with 10 cm of growth media with plants
4 control roofs with no growth media or plants

Plant Species: *Sedum hybridum immergrauch*

Fertilizer: Isobutylidene-diurea, IBDU Nitrogen, a condensed product of urea and isobutylaldehyde. 1,1-Diureidoisobutane

Growing medium: Fine Arkalite – expanded clay

Irrigation: By hand initially for the first two weeks as needed.

On September 5, 2005, eighty *Sedum immergrauch* plugs were planted into the sixteen model green roofs and four Green Roof Blocks™. Each planted green roof system contained five Sedum plugs randomly assigned to growth media depths of 5, 10, 15, or 20 cm.

Storm water runoff is collected, weighed, and recorded after each precipitation event. The tare weight of the container is then subtracted from the total weight to determine net runoff. Once weighed, containers are emptied and reattached to the covered gutter system. Two rain gauges are located on table three to quantify rainfall at the site.

Figure 1. Green roof models with 5, 10, 15, and 20 cm growth medium depths at the Southern Illinois University Edwardsville Environmental Sciences Field Site.

DATA Analysis

All recorded data has been analyzed using SAS to determine whether or not there are differences in storm water retention among the different green roof systems (ANOVA for a completely randomized design, $\alpha < 0.05$).

RESULTS AND DISCUSSION

Storm Water Runoff: Green roof models with and without plants and Green Roof Blocks™ retain more storm water than control roofs (Figure 2, 3). Green roof models with and without plants retain the same quantity of storm water (Figure 2).

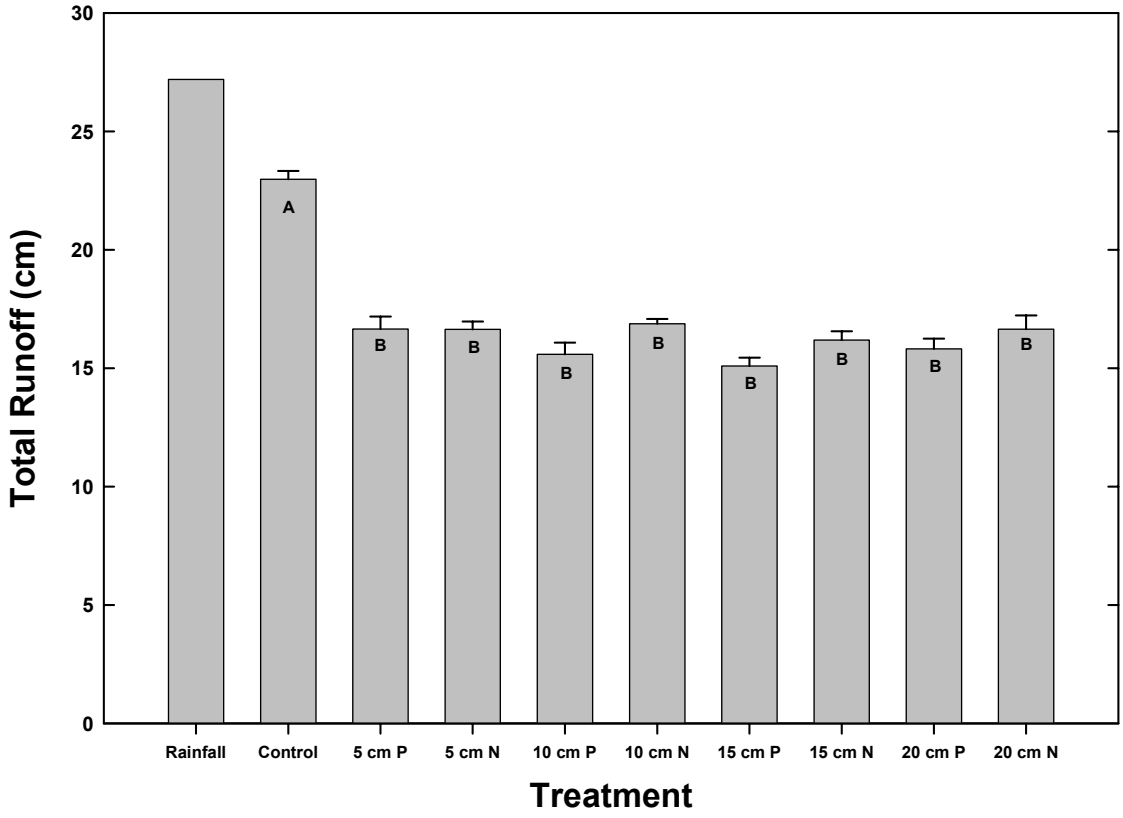

Figure 2. Storm water runoff between 9/5/05 and 12/26/05 from green roof systems with 5, 10, 15, and 20 cm medium depths. Bars containing the same letter are not significantly different ($\alpha<0.05$). (n=4 Control, n=4 Plants, n= 3 No plants). Error bars represent ± one standard error.

Green Roof Models and Green Roof Blocks™: Green roof models with plants retain more storm water than Green Roof Blocks™ at the 10 cm planting medium depth (Figure3).

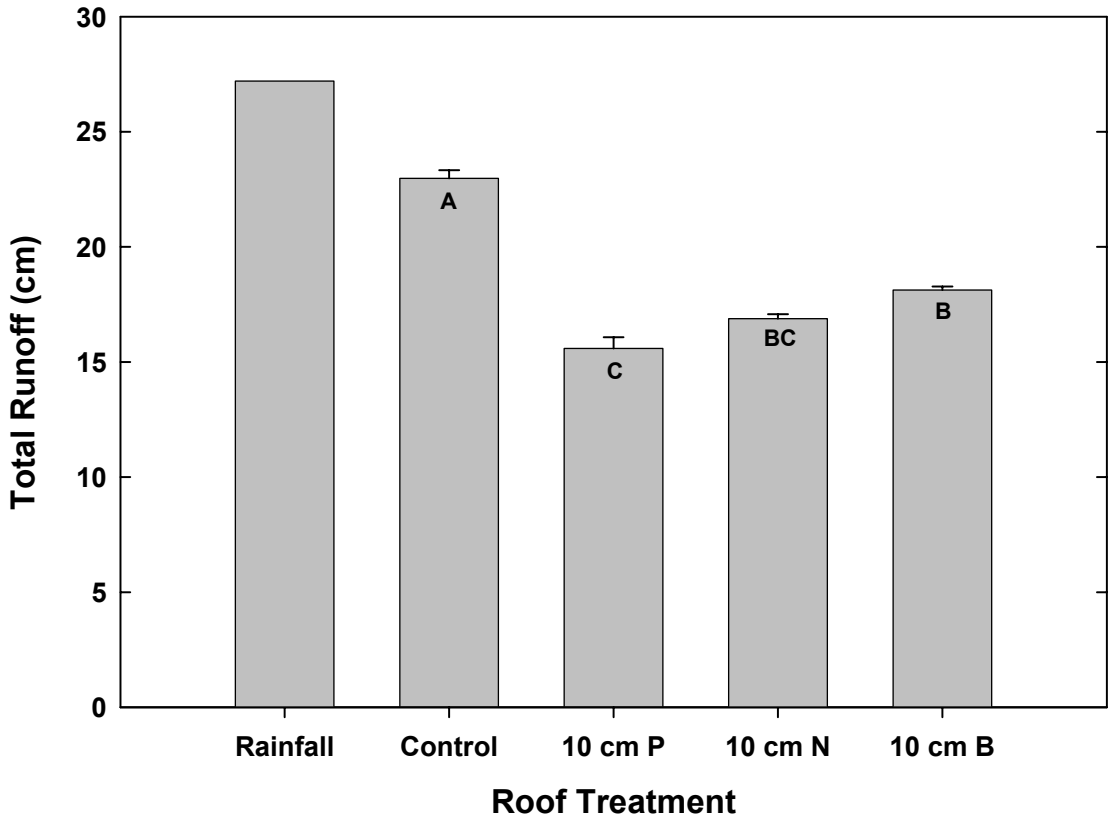

Figure 3. Storm water from 9/5/05 through 12/26/05 of 10 cm green roof models and 10 cm Green Roof Blocks™. Bars containing the same letter are not significantly different ($\alpha<0.05$). (n=4 Control, n=4 Plants, n= 3 No plants, n=4 Green Roof Blocks™). Error bars represent ± one standard error.

CONCLUSION:

The initial results indicate that green roof models retain more storm water than the control roofs. Green roof models with and without plants retain the same quantity of storm water. At the 10 cm depth, green roof models retain more storm water than Green Roof Blocks™, but both retain more than the control roofs. As the plants become more established, increasing roof coverage, the storm water retention capabilities may change as well.

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