

MEDIA COMPOSITION INFLUENCES GREEN ROOF PLANT VIABILITY IN THE OZARK HIGHLANDS

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ABSTRACT

*Plant selection and establishment are critical components for green roof health and success. Plant palettes (sets of plant species selected for specific conditions) for green roofs vary in their ability to confer benefits depending on the species make-up and their adaptation to particular environments and climates. The response of various species to climatic factors on rooftops is unknown for the Ozark Highlands region. The objective of this study was to compare plant survival and spread in three growing medium treatments (course and fine texture with compost and fine texture with no compost) installed as part of a green roof system. The study was performed on a green roof system at the University of Arkansas in Fayetteville over 3 years. Data were collected on 13 species installed in September of 2006 and surveyed on three dates thereafter: April 30, 2007; May 19, 2009; September 10, 2009. The treatments with added compost had statistically greater vegetated cover (from 73 to 87%) compared to the fine medium without compost (36 to 43%). In most cases the spread of individual plants was not significantly different between treatments. Results indicated that rooting medium containing compost increased survival and overall vegetated roof coverage, and identified various potential green roof plant species for the Ozark Highland environment. Two species, *Sedum middendorffianum* var. *diffusum* and *Sedum spurium* 'Roseum', did particularly well in all treatments. One species, *Sedum kamschaticum*, did well only in the treatments with compost.*

KEYWORDS

Green roof, Sedum, Extensive green roof

INTRODUCTION

Green roof plants including low-growing sedums, succulents, and other drought-tolerant plants are widely used in the United States. Tests have been carried out to identify native species for use on green roofs in the U.S. with some success (Carter and Butler 2008). Grasses and forbs are also popular green roof plants. Effective green roof plants can benefit the building

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operation, the environment, and people. For example, vegetative cover buffers the building from temperature extremes, retards fire, and prolongs roof membrane longevity. A diverse plant community provides habitat for birds and insects and filters atmospheric and rain contaminants. People benefit directly from the visual aesthetics and noise reduction (Oberndorfer et al. 2007; Sonne 2006; Dunnett and Kingsbury 2004; Clark 2005 Moran 2004). While many plants can be generally utilized in green roofs throughout the U.S., empirical studies completed for a region to ascertain which genus and species are appropriate for a given locale are essential for successful green roof application.

There is no empirical information on non-irrigated green roof plant selection related to the location of this study: Hardiness Zone 6b (USDA), Ozark Highlands Ecoregion 39a, Level IV, (USEPA). With extreme climatic variations across the zone producing an average of 56 days of temperature highs above 32°C (90°F) and 105 days below 0°C (32°F) annually, plants must be cold hardy and heat tolerant. Annual precipitation is 1168 mm (46 in), with May and June being the wettest at over 127 mm (5 in) each, and January and February the driest, each below 63.5 mm (2.5 in) on average (NOAA 2009). The site is in Fayetteville, AR on the University of Arkansas campus at The Gatehouse to The Gardens (GPS 36° 36'30.81" N 94° 10'45.59" W).

One objective of this study was to compare plant species for suitability for green roof use under environmental conditions typical of the Ozark Highlands. The second objective was to determine species responses to differences in the composition of the growing medium in a non-irrigated green roof system.

MATERIALS AND METHODS

Three green roof plots were installed on two newly constructed buildings. Buildings were enclosed and had environmental controls. Roof slope was 2% and had typical roof drains. One building was approximately twice as large as the other and therefore was subdivided into two treatments. Buildings had a parapet of approximately 1 m in height encompassing the entire roof. Each treatment plot was approximately 38 m². The waterproof roofing membranes (Siplast modified bitumen) were installed by the roofing contractor over the top of typical sub-roofing and rigid insulation. The treatment for each roof was selected at random. Roofs were fitted with a donated J-DRain GRS green roof drainage layer, (JDR Enterprises Incorporated, Alpharetta, GA) immediately above the waterproofing membrane. The drainage layers consisted of root barrier, plastic corrugated drainage material, and filter fabric with incorporated root inhibitor, which was then covered with a light-weight aggregate growing medium donated by Chandler Materials, Inc. (Tulsa, OK), who also provided data on the material texture. The coarse medium had particles with more than 80% between 4.75 mm (0.19 in) and 10 mm (0.39 in), and the remaining particles were generally greater than 1.18 mm (0.05 in). The fine medium had all particles passing through a 4.75 mm (0.19 in) sieve, and more than 50% were between 1.18 mm (0.05 in) and 2.36 mm (0.09 in); 25% of the particles were less than 1.18 mm (0.05 in) but greater than 600 µm (0.02 in), with the rest being finer than 600 µm (0.02 in) (Table 1).

One roof was filled with 7.62 cm (3 in) of 100% fine growing medium without compost (*fn*). Another roof was filled with a 7.62 cm (3 in) mixture of 85% fine growing medium and 15% mushroom compost (*fc*). The third roof was filled with a 7.62 cm (3 in) mixture of 85% coarse growing medium and 15% mushroom compost (*cc*). The mushroom compost was

TABLE 1. Growing Matrix Material Data Sheet.

pH 8.8 (AASHTO T 289, 5-10) (The pH becomes neutral with rainfall)		
Cationic exchange capacity 10.9 (1/8"), 8.0 (3/8")		
Insoluble residue 98% insoluble (OHD L-25) (ASTM D 3042)		
AASHTO— <i>American Association of State Highway and Transportation Officials</i>		
ASTM— <i>American Society for Testing and Materials</i>		
OHD— <i>Office of Hydrologic Development</i>		
% retained on each sieve	Coarse	Fines
12.7 mm	0	0
9.53 mm	3	0
7.94 mm	0	0
4.75 mm	78	0
2.36 mm	15	25
1.18 mm	2	32
600 µm	0	25
300 µm	0	12
150 µm	0	4
Pan	2	2
X-Ray Diffraction Mineralogical Analysis of fine size		
Mineral Constituents	Formula	Relative Abundance, %
Quartz	SiO ₂	35
Plagioclase Feldspar	(Na,Ca)AlSi ₃ O ₈	2
K-Feldspar	(K,Na)AlSi ₃ O ₈	3
Calcite	CaCO ₃	1
Dolomite	(Ca, Mg)CO ₃	2
Magnetite	alpha-Fe ₃ O ₄	trace
Hematite	alpha-Fe ₂ O ₃	2
Anatase	TiO ₂	trace
Amorphous (non-crystallized glassy structure)		55
Total		100%

Data Provided by Chandler Materials Tulsa OK.

donated by Professional Landscaping, Inc. (Springdale, AR) and is a mixture of straw, cow manure and chicken litter. The mushroom compost was used in one rotation of mushroom production, removed from the facility, steamed, and trucked to the compost distributor (personal communication, Nitron Industries).

Emory Knoll Farm (Street, MD) donated eighteen species of plants in plug form. The species provided were selected by the nursery and were considered potentially tolerant of green roof conditions of limited water depth and rooting zone while being cold hardy in USDA zone 6b. The species list (Table 2) shows several species of sedums and other species with similar physiologic characteristics. Plants were installed on 15.2 cm (6 in) centers in

TABLE 2. Plant list of plants randomly planted on three different media treatments.

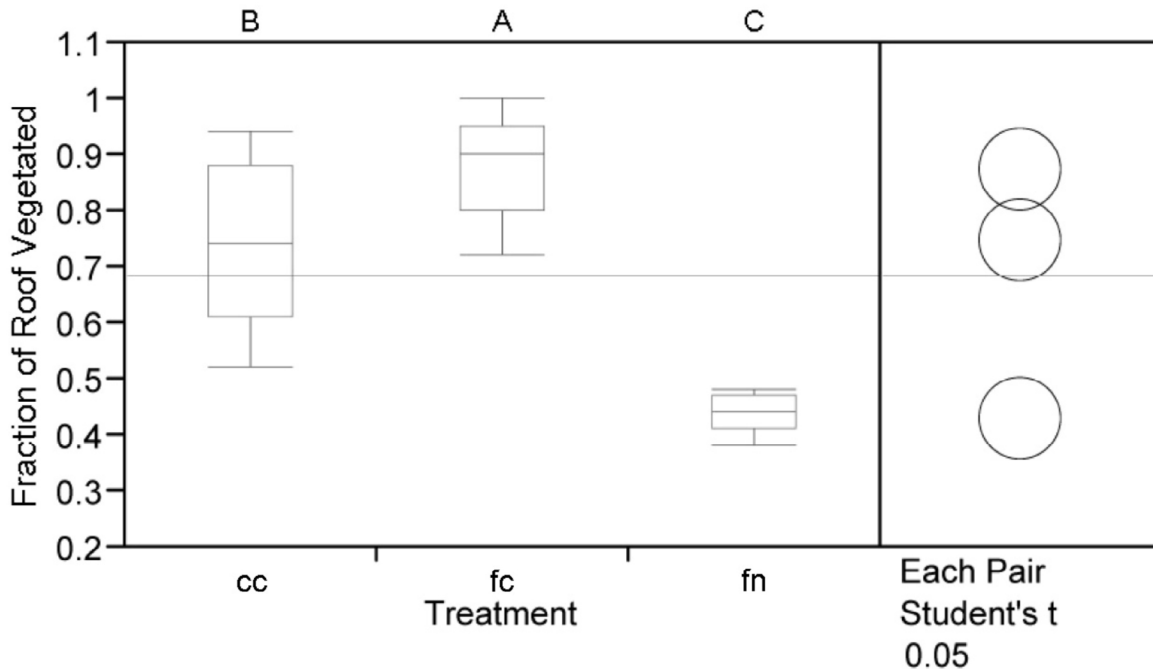
Scientific name	Common Name
<i>Allium schoenoprasum</i>	chives
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	ice plant
<i>Delosperma nubigenum</i> 'Basutoland'	ice plant
<i>Delosperma</i> 'Tiffindell Magenta'	ice plant
<i>Sedum album</i>	jellybean sedum
<i>Sedum kamtschaticum</i>	Russian stonecrop
<i>Sedum kamtschaticum</i> var. <i>floriferum</i> 'Weihenstephaner Gold'	stonecrop
<i>Sedum lineare</i> 'Variegatum'	variegated sedum
<i>Sedum middendorffianum</i> var. <i>diffusum</i>	'Diffusum' stonecrop
<i>Sedum reflexum</i> 'Angelina'	Angelina stonecrop
<i>Sedum reflexum</i> 'Blue Spruce'	spruce-leaved stonecrop
<i>Sedum sexangulare</i>	six-sided sedum
<i>Sedum spurium</i> 'John Creech'	John Creech sedum
<i>Sedum spurium</i> 'Dragon's Blood'	Dragon's Blood sedum
<i>Sedum spurium</i> 'Roseum'	Roseum sedum
<i>Sedum spurium</i> 'White Form'	White Form sedum
<i>Talinum calycinum</i>	large-flowered farnflower
<i>Talinum parviflorum</i>	sunbright

a randomly selected plant schedule on September 10, 2006 and received no supplemental watering after installation, and no fertilizer. The first survey was conducted on April 30, 2007 (Date 1) to determine which plants survived the first winter. The second survey was conducted after the third winter on May 19, 2009 (Date 2), and a third survey was conducted on Sept. 10, 2009 (Date 3) to determine which species were best adapted to the Ozark Highland summer conditions.

This project investigated three areas of response to green roof conditions per treatment (*fn*, *fc*, and *cc*). The first area of investigation was to determine how the plants responded as a whole to the growing conditions of each of the treatments. The first survey (Date 1) was conducted to determine which plants survived the first winter. Each plant was observed in the spring to determine if there was any emerging growth and recorded as living or non-living based on the presence or absence of vegetative growth. The second and third surveys (Date 2 and Date 3) were conducted by measuring several components of species/vegetative response.

A steel-wire grid quadrat was used for the second and third surveys (Date 2 and Date 3). The location of the quadrat sampling was determined by randomly selecting a row and column number on the planting plan which would designate where cell 1-1 (column and row) of the quadrat would be placed. The sampling quadrat consisted of a 5 cell × 5 cell grid of 14.8 cm × 14.8 cm (5.8 × 5.8 in) squares, for a total of 25 cells. The grid quadrat was randomly placed in 9 locations within each plot. Total vegetative coverage was determined by observing the quadrat by cell and recording through visual estimation, the percent of roof in each cell

FIGURE 1. Coverage Date 2; May 19, 2009 Average percent of roof covered by vegetation by treatment in Fayetteville, AR (third growing season). Letters at the top of the graph indicate significance; same letters shows no significant difference, and different letters show there is significant difference. Abbreviations: cc coarse with compost, fc fine with compost, fn fine without compost.



Box Plots: The box plot is made up of five components. First the line inside the rectangle represents the mean, and the box itself represents the middle 50% of the data points. The box above the mean is the upper quartile and below the mean line is the lower quartile. The whiskers represent outliers and extend no more than 1.5 standard deviations from the mean.

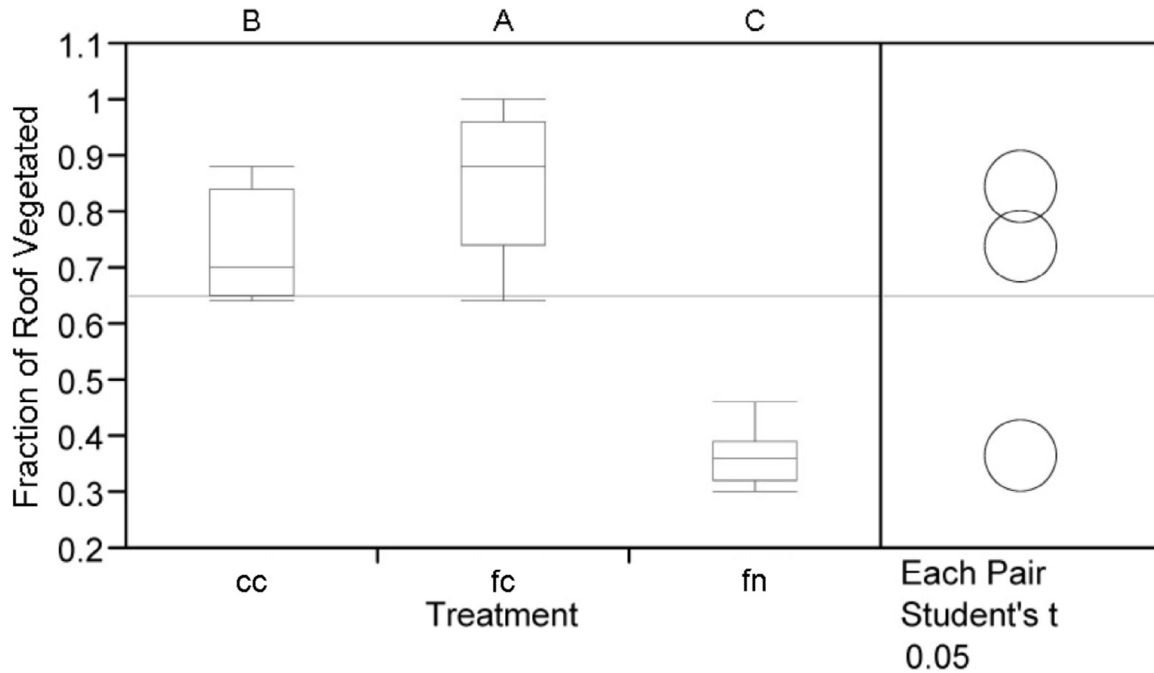
Each Pair Student's t Circles: The circles represent the data, the bigger the circle the more data points. The closer the circles are to overlapping, the closer the data to being statistically not different.

that was covered by vegetation regardless of species. Each cell was given a designation of 1, 0.5, or 0. When a cell was observed to have equal to or greater than 50% vegetated cover, that cell was given a (1). Where a cell was observed to have vegetated cover of less than 50% the cell was given a (0.5). If an observed cell had no visible vegetated coverage the cell was given a (0). The number designations for each cell were entered into a spreadsheet to determine averages per quadrat.

The same quadrat locations were used to determine how species were responding to the treatments with regard to species population. Each cell was observed and the species that occupied that cell were recorded. These cells could then be totaled to determine any species population gain or loss and overall species composition over time.

The third component observed in response to treatment was to determine vegetative spread by species. Eight plants per species within each treatment were randomly selected and measured in two directions perpendicular to each other crossing at center mass. By choosing to measure eight plants per species, we were able to maximize the number of species in the comparison due to the lack of surviving plants on the fine without compost treatment (*fn*). Due to dynamic nature of the green roof's plant composition, it was impossible to measure

FIGURE 2. Coverage Date 3; Sept 10, 2009 Average percent of green roof covered by vegetation by treatment in Fayetteville, AR (third growing season). Letters at the top of the graph indicate significance; same letters show no significant difference, and different letters show there is significant difference. Abbreviations: cc coarse with compost, fc fine with compost, fn fine without compost.



the same plants on Date 2 and Date 3. As a result, these plants were sampled randomly on each date by selecting a column and row and measuring the closest living plant to that point of the selected species.

Data Analysis

Using JMP 8 software (SAS Institute Inc., Cary, NC) data on roof coverage and spread by species were analyzed using a one-way analysis of variance (ANOVA) using the least significant difference (LSD) with α confidence level of 0.05 to determine statistical differences. The green roof coverage data were averaged per sampling cell where each cell was given a coverage score of (1) for a cell more than half covered by vegetation, (0.5) for cells half or less covered by vegetation, and (0) for cells with no vegetative cover. The coverage averages were subjected to ANOVA to test for statistical differences among treatments. The vegetated coverage was also analyzed for rooting matrix effects across time, through the summer months. The data for spread of individual species (area in cm^2) were log-transformed using the natural log (\ln) to minimize the influence of outliers before conducting the ANOVA. Mean values were derived by exponentiation of the \ln transformed data to retain the reduced influence of outliers.

RESULTS AND DISCUSSION

Green roof total vegetative cover showed significant differences among all three treatments on two dates. The *fc* treatment had a vegetated cover greater than 84% on both days sampled (May and September of 2009). There was no statistically significant loss of cover between May

and September (Figure 3). As with the treatment of *fc*, there was no significant loss of cover in the summer months for the *cc* treatment. The *cc* treatment cover mean was 73% (Figure 4), more than 10 percentage points less than the coverage of the *fc* treatment (Figure 3). While the *fc* treatment had a greater vegetative cover, the *cc* had a greater number of species remaining (Tables 3 and 4). The cover means for treatments with compost (*cc* and *fc*) were significantly greater than the coverage of the *fn*. The *fn* cover means were 43% and 36% on the

FIGURE 3. Green roof plant average percent coverage for a fine growing medium with 15% (by volume) compost added (*fc*) in Fayetteville, AR (third growing season). [Date 2 (May 19), Date 3 (September 10); Probability > |t| .58 Confidence .95].

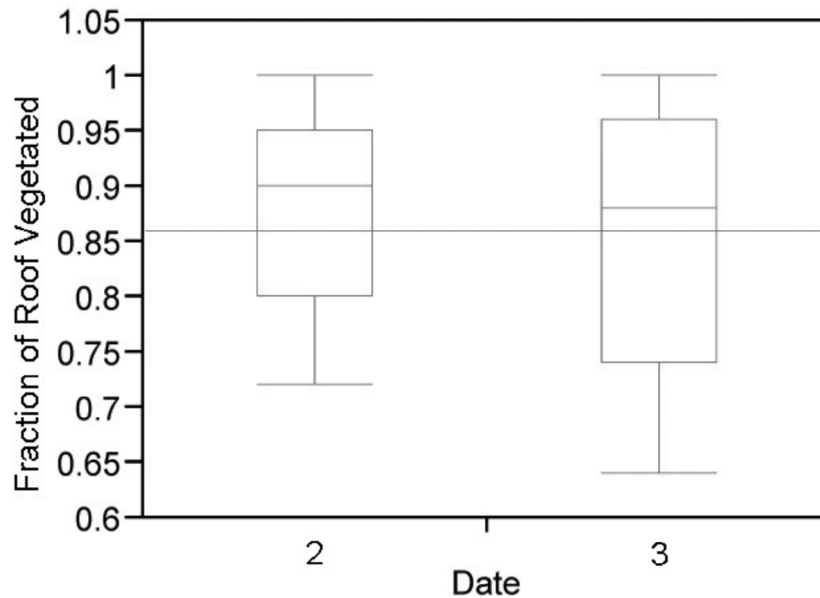


FIGURE 4. Green roof plant average percent coverage for a coarse growing medium with 15% (by volume) compost added (*cc*) in Fayetteville, AR (third growing season). [Date 2 (May 19), Date 3 (September 10); Probability > |t| .88 Confidence .95]

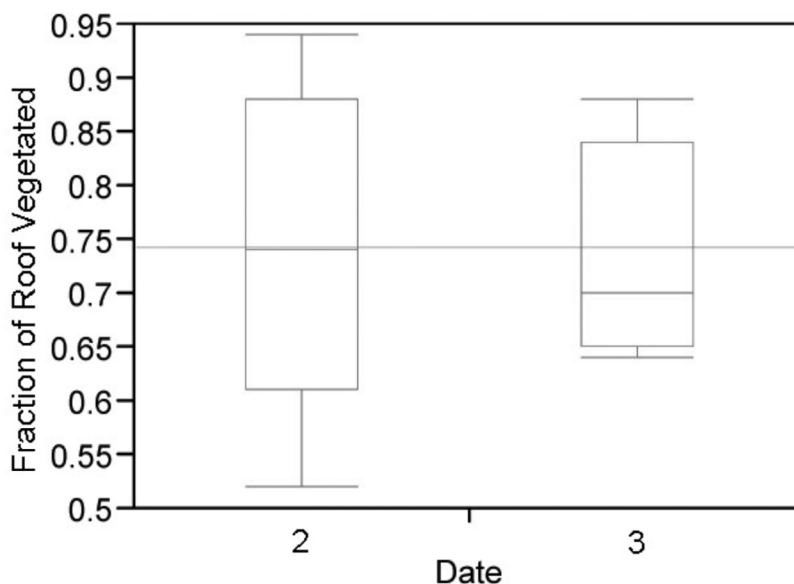


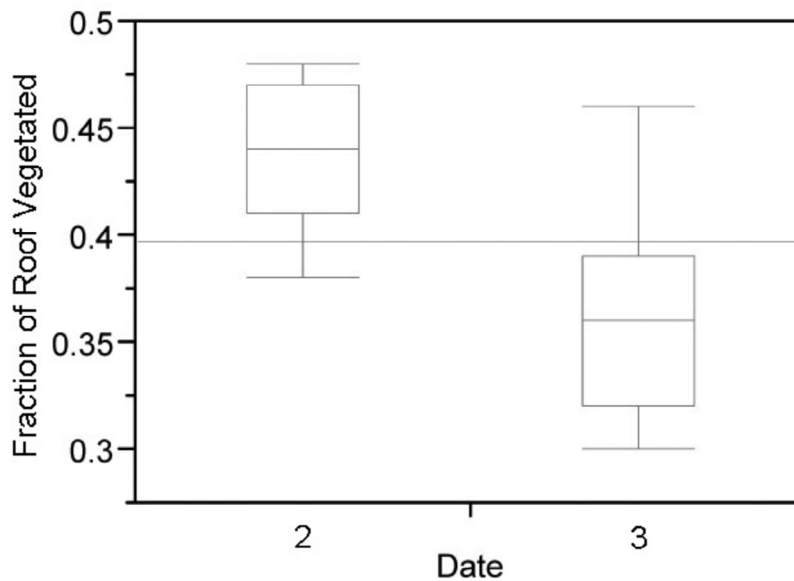
TABLE 3. Green roof plant quantities (*gain/loss*) by species in fine texture medium with compost added in Fayetteville, AR. [Planted Sept 10, 2006; Date 1 April 30, 2007; Date 2 May 19, 2009; Date 3 Sept 10, 2009]

Treatment Fine with Compost (fc)				
Species	Planted	Date 1	Date 2	Date 3
<i>Allium schoenoprasum</i>	8	8	7 (-1)	13 (+5)
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	12	3 (-9)	11 (-1)	1 (-11)
<i>S. kantschaticum</i>	8	7 (-1)	21 (+13)	49 (+41)
<i>S. lineare</i> 'Variegatum'	13	4 (-9)	2 (-11)	2 (-11)
<i>S. middendorffianum</i> var. <i>diffusum</i>	9	5 (-4)	8 (-1)	42 (+33)
<i>S. reflexum</i> 'Angelina'	15	15	8 (-7)	1 (-14)
<i>S. reflexum</i> 'Blue Spruce'	5	5	3 (-2)	2 (-3)
<i>S. sexangulare</i>	9	8 (-1)	9	5 (-4)
<i>S. spurium</i> 'John Creech'	16	15 (-1)	20 (+4)	16
<i>S. spurium</i> 'Dragon's Blood'	21	21	22 (+1)	8 (-13)
<i>S. spurium</i> 'Roseum'	11	10 (-1)	22 (+11)	18 (+7)
<i>S. spurium</i> 'White Form'	17	17	8 (-9)	8 (-9)
<i>Talinum calycinum</i>	3	3	24 (+21)	2 (-1)

TABLE 4. Green roof plant quantities (*gain/loss*) by species in coarse texture medium with compost added in Fayetteville, AR. [Planted Sept 10, 2006; Date 1 April 30, 2007; Date 2 May 19, 2009; Date 3 Sept 10, 2009]

Treatment Coarse with Compost (cc)				
Species	Planted	Date 1	Date 2	Date 3
<i>Allium schoenoprasum</i>	19	17 (-2)	13 (-6)	13 (-6)
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	8	2 (-6)	0	0
<i>S. kantschaticum</i>	9	7 (-2)	18 (+9)	18 (+9)
<i>S. lineare</i> 'Variegatum'	13	8 (-5)	2 (-11)	2 (-11)
<i>S. middendorffianum</i> var. <i>diffusum</i>	9	9	13 (+4)	11 (+2)
<i>S. reflexum</i> 'Angelina'	15	15	15	15
<i>S. reflexum</i> 'Blue Spruce'	9	9	17 (+8)	17 (+8)
<i>S. sexangulare</i>	5	5	13 (+8)	13 (+8)
<i>S. spurium</i> 'John Creech'	4	4	6 (+2)	6 (+2)
<i>S. spurium</i> 'Dragon's Blood'	21	21	24 (+3)	30 (+9)
<i>S. spurium</i> 'Roseum'	15	15	45 (+30)	48 (+33)
<i>S. spurium</i> 'White Form'	14	14	13 (-1)	12 (-2)
<i>Talinum calycinum</i>	5	4 (-1)	11 (+6)	12 (+7)

FIGURE 5. Green roof plant average percent coverage for a fine growing medium without compost (*fn*) in Fayetteville, AR (third growing season) [Date 2 (May 19), Date 3 (September 10); Probability > *t*l .02 Confidence .95].



sampled dates respectively (Figure 5). The *fn* treatment lost vegetated coverage through the summer months, unlike the treatments with compost (Figure 5).

Some species lost vegetation through the summer months, while others appeared to have emerged later with growth in late summer. Several species: *Allium schoenoprasum*, *Sedum reflexum* ‘Angelina’, *Sedum reflexum* ‘Blue Spruce’, *Sedum sexangulare*, *Sedum spurium* ‘John Creech’, and *Sedum spurium* ‘Roseum’ lost area through the summer (Table 6), most likely because of environmental conditions on the green roofs (i.e., water restricted, full sun, shallow rooting depth). There were two clear trends: 1) some species exhibited no differences in plant spread per treatment on selected dates. The species that followed this pattern were: *cc* treatment: *Sedum spurium* ‘John Creech’, *fc* treatment: *Sedum spurium* ‘White Foam’, and *fn* treatment: *Allium schoenoprasum* and *Delosperma ecklonis* var. *latifolia* (Table 6); 2) many of the observed species showed less plant coverage after the summer months (Table 6). Other than these trends, each plant had a different response to the green roof conditions and treatments at different times. *Sedum kamtschaticum* increased in area through the summer months, while *Talinum calycinum* emerged later than the other species on the roof. *Sedum spurium* ‘White Foam’ appeared to stay relatively steady across the summer with the average means for each treatment only slightly lower on September 10 than on May 19 (Table 6). *Sedum middendorffianum* var. *diffusum* had an anomalous dataset in that the species had spring emergence in treatments *cc* and *fn*, but showed no growth in *fc*. However, it appeared to have a late emergence in the *fc* treatment with extensive vegetative production, with a mean area close to that in *cc* during the spring. *Sedum spurium* ‘Dragon’s Blood’ had varied vegetation coverage by date. In treatment *cc*, it increased its vegetated cover through the summer, whereas in *fc* and *fn* it lost vegetated cover (Table 6). Three species, *Sedum kamtschaticum* var. *floriferum* ‘Weihestephaner Gold’, *Sedum lineare* ‘Variegatum’ and *Talinum parviflorum* did not survive

TABLE 5. Green roof plant quantities (*gain/loss*) by species in fine texture medium with no compost added in Fayetteville, AR. [Planted Sept 10, 2006; Date 1 April 30, 2007; Date 2 May 19, 2009; Date 3 Sept 10, 2009]

Treatment Fine without Compost (fn)				
Species	Planted	Date 1	Date 2	Date 3
<i>Allium schoenoprasum</i>	18	14 (-4)	0	0
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	12	7 (-5)	9 (-3)	15 (+3)
<i>S. kamtschaticum</i>	12	2 (-10)	0	1 (-11)
<i>S. lineare</i> 'Variegatum'	21	14 (-7)	0	0
<i>S. middendorffianum</i> var. <i>diffusum</i>	4	3 (-1)	9 (+5)	12 (+8)
<i>S. reflexum</i> 'Angelina'	19	16 (-3)	11 (-8)	12 (-7)
<i>S. reflexum</i> 'Blue Spruce'	13	13	22 (+9)	14 (+1)
<i>S. sexangulare</i>	5	5	19 (+14)	16 (+11)
<i>S. spurium</i> 'John Creech'	8	6 (-2)	4 (-4)	4 (-4)
<i>S. spurium</i> 'Dragon's Blood'	25	15 (-10)	27 (+2)	16 (-9)
<i>S. spurium</i> 'Roseum'	16	14 (-2)	23 (+7)	20 (+4)
<i>S. spurium</i> 'White Form'	25	19 (-6)	8 (-17)	8 (-17)
<i>Talinum calycinum</i>	4	3 (-1)	19 (+15)	15 (+11)

to the third growing season and were unable to be compared to other species and are therefore not considered appropriate selections for non-irrigated extensive green roof application this region.

CONCLUSIONS AND RECOMMENDATIONS

This study has provided valuable information on successful green roof plants in the Ozark Highlands. In addition to statistically significant findings, some interesting trends in species response to growing treatment may warrant further study to determine statistical significance. *Sedum middendorffianum* var. *diffusum*, *Sedum sexangulare*, and *Talinum calycinum* increased in population within the fine-without-compost treatment (*fn*) over the growing season (Table 5). *Sedum kamtschaticum*, *Sedum middendorffianum*, and *Sedum spurium* 'Roseum' increased population within the fine with compost (*fc*) treatment (Table 3). *Sedum kamtschaticum*, *Sedum reflexum* 'Blue Spruce', *Sedum sexangulare*, *Sedum spurium* 'John Creech', *Sedum spurium* 'Dragon's Blood', and *Sedum spurium* 'Roseum' increased population in the coarse-with-compost (*cc*) treatment (Table 4). A few species survived in the *fn* treatment (*Delosperma ecklonis* var. *latifolia*, *Sedum middendorffianum*, *Sedum sexangulare*, *Sedum spurium* 'Roseum', and *Talinum calycinum*) and started to multiply in this treatment (Table 5). These species did not experience the gains in coverage seen in treatments with compost, but did have increases every year (Figures 1 and 2).

There are several species that, given the proper conditions, can survive multiple growing seasons in a green roof system without outside inputs of water and fertilizer. In particular those species are *Sedum middendorffianum* var. *diffusum*, *Sedum spurium* 'Roseum', and *Sedum*

TABLE 6. Green roof species area of spread in Fayetteville, AR on two days in 2009 (third growing season). Abbreviations: cc coarse with compost, fc fine with compost, fn fine without compost; values within a row not connected with the same letter are statistically different LSD α .05.

Species	Plant Spread (cm ²)		
	cc	fc	fn
5/19/2009			
<i>Allium schoenoprasum</i>	36.1 ^B	95.5 ^A	0
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	12.5 ^A	64.1 ^A	74.8 ^A
<i>S. kamtschaticum</i>	61.6 ^B	278 ^A	0
<i>S. middendorffianum</i> var. <i>diffusum</i>	110 ^A	33.7 ^A	0
<i>S. reflexum</i> 'Angelina'	130 ^A	60.9 ^A	38.4 ^A
<i>S. reflexum</i> 'Blue Spruce'	174 ^A	82.2 ^A	68.4 ^A
<i>S. sexangulare</i>	214 ^A	110 ^B	122 ^{AB}
<i>S. spurium</i> 'John Creech'	53.3 ^{AB}	168 ^A	25.5 ^B
<i>S. spurium</i> 'Dragon's Blood'	43.4 ^A	82.4 ^A	99.5 ^A
<i>S. spurium</i> 'Roseum'	208 ^A	256 ^A	82.9 ^B
<i>S. spurium</i> 'White Form'	77 ^A	79.8 ^A	81.1 ^A
<i>Talinum calycinum</i>	0	0	0
9/10/2009			
<i>Allium schoenoprasum</i>	46.4 ^A	50.3 ^A	0
<i>Delosperma ecklonis</i> var. <i>latifolia</i>	50.1 ^A	46.1 ^A	67.4 ^A
<i>S. kamtschaticum</i>	297 ^A	348 ^A	33.9 ^B
<i>S. middendorffianum</i> var. <i>diffusum</i>	55.8 ^B	131 ^A	67.0 ^{AB}
<i>S. reflexum</i> 'Angelina'	45.6 ^A	0	28.5 ^A
<i>S. reflexum</i> 'Blue Spruce'	149 ^A	0	54.8 ^B
<i>S. sexangulare</i>	0	50.5 ^A	31.3 ^A
<i>S. spurium</i> 'John Creech'	58.8 ^A	95.1 ^A	18.5 ^B
<i>S. spurium</i> 'Dragon's Blood'	69.2 ^A	52.8 ^A	43.3 ^A
<i>S. spurium</i> 'Roseum'	249 ^A	127 ^B	48.9 ^C
<i>S. spurium</i> 'White Form'	107 ^A	84.8 ^A	46.0 ^B
<i>Talinum calycinum</i>	8.35 ^A	9.63 ^A	9.24 ^A

kamtschaticum. Depending on treatment type, species exhibiting green roof potential due to strong rates of plant spread are *Delosperma ecklonis* var. *latifolia*, *Sedum spurium* 'John Creech', & *Talinum calycinum*. *Sedum reflexum* 'Blue Spruce', *Sedum sexangulare*, & *Talinum calycinum* should also be considered for use on the basis of increases in overall plant numbers. It is also evident that the addition of compost can improve the chance of the success of the green roof plants. The success of the green roof plants should in turn enhance the stormwater mitigation properties through interception and transpiration of stormwater. However, findings also

indicate that some species can survive and spread even without the addition of organic compost. Future studies should seek to expand the plant palette for green roofs to provide greater biodiversity. Additionally, the quality and quantity of stormwater runoff should be examined to determine the potential impacts of green roof systems. While it is evident that compost has a positive impact on plant growth, there is a potential negative impact on stormwater runoff. This study also provides information about the success of plant species in coarse vs. fine growing media. The fine media had statistically greater vegetative coverage, however further investigation should be completed to include a treatment of coarse medium with no organic matter incorporation to determine the relative importance of particle size versus organic matter and further understand species response to the applied conditions.

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