A P P L I C A T I O N

The Effects of Seeding Time on Emergence and Growth
of Prairie Grasses, Sedges, Legumes and Forbs

1. Name of applicant University of Northern Iowa

   Name of contact person Daryl Smith

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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:_____

4. Proposed beginning and ending dates of the project (if applicable):

Beginning date Nov. 1, 2009 Ending date Dec. 31, 2010

5. Provide a ***detailed*** concept statement for the project on a separate sheet of paper.

a. If applying for **roadside inventory**, **gateway landscaping/roadside enhancement**, **planting/maintenance materials/labor**, or **demonstration/education** funding, include the following information:

- Why is this project being proposed?
- What are the project goals?
- How will project goals be accomplished and evaluated?
- Who will be involved (organizations, etc.)?

If the project involves landscaping or roadside enhancement, applications must also include:

- A readable and detailed map of the area, noting project location, adjacent land use, and size of proposed planting area. Be sure to indicate the width of the roadside (from edge of traveled surface to right-of-way line), if applicable.
- Location of tree or shrub plantings, in feet, from the edge of traveled surfaces.
- A list of all plant species to be used in the project, arranged alphabetically by scientific name. Format the list using the following column headings:

Scientific name	**Common name**	**Lbs.**	**Oz.**	**No. of live plants**

b. If applying for **research** funding, include the following sections:

- Project title
- Proposed research
  Detail project objectives, methodologies and timeline. Note issues that require special consideration, and possible limitations of the study. Include pertinent literature citations.
- Budget
  Detail costs for the project, including salary(ies), capital equipment expenses, indirect fees (maximum 8%), and other expenses. Include a list of matching sources of funds.
- Curriculum vitae (If a vitae has been provided in previous applications to the LRTF, this section may be waived.)

c. If applying for **equipment** funding, include the following information:

- Product specifications.
- An explanation of why the equipment is needed and how it will be used.
- Approximate number of acres of native vegetation to be planted or managed with the equipment.

6. Actual funds requested:

On a separate sheet of paper, provide an ***itemized list*** of estimated expenditures for the project. (Chemicals must be listed by complete name and manufacturer.)

Note: If matching funds or in-kind contributions are to be used for the project, you must provide a list of the source(s), a description of the funds/contributions and the dollar value(s) on a separate page.

Total funds needed for the project	$ 30696
Less the amount of matching funds and/or in-kind contributions to be used for the project*	$ 7796
Total funds requested from the LRTF	$ 22900

* Funds/contributions that have been used on a regular basis for vegetation management in previous years are not to be considered as matching funds or in-kind contributions.

7. If applicable, please indicate the type of right-of-way in which you will be planting (check all that apply):

State or Federal highways _____ County roads _____ City streets _____

8. Signature of applicant:

_____

Project Director — Date
Daryl Smith

_____

Grants and Contracts Administrator — Date
Edward Ebert

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Proposed Research

This research project compares the effect of different seeding times (mid fall, mid-winter, mid-spring, and mid-summer) on the emergence and establishment of native plants. The results will provide information on the most appropriate time to seed for optimal establishment of native grasses, sedges, legumes and forbs and will be useful in developing recommendations for seeding times in prairie reconstruction projects.

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

Introduction

A primary goal in prairie reconstruction is to maximize establishment of species included in the seeding mixture. It is important to plant the seed at a time that is optimal for seed germination and growth of as many species as possible. In the past, when seed mixes contained only a few species of warm-season grasses, researchers and resource managers recommended planting these species in late spring and early summer (Meyer and Gaynor 2002, Packard and Mutel 1997).

Today, prairie seed mixes may have in excess of 40 species. Species such as cool-season and warm-season grasses, sedges, legumes and forbs differ in phenology. Environmental conditions for optimum germination and growth among these groups and individual species can vary (Greene and Curtis 1950). Cool-season grass and sedge species germinate in early spring or early fall when soil temperatures are between 39^{o} to 45^{o} whereas warm-season grass species germinate in late spring and early summer when soil temperatures reach 50^{o} to 56^{o} (Smith and Smith 1998). Seeding cool-season grasses in early spring or in late summer to early fall can improve establishment, whereas seeding warm-season grasses during this time can result in poor establishment (Meyer and Gaynor 2002). Optimal seeding time can vary greatly with legumes and other forbs. Early spring seeding can maximize emergence of butterfly milkweed (*Asclepias tuberosa*) and round-headed bush clover (*Lespedeza capitata*) whereas fall seeding can maximize emergence of black samson (*Echinacea angustifolia*) and large-flowered beardtongue (*Penstemon grandiflorus*) (Salac and Traeger 1982). Maximizing native plant establishment may reduce the chance of weed invasion and increase native species biodiversity (Tilman 1997, Ries et al. 2001).

It is difficult to find agreement on an optimal time to plant a prairie reconstruction as there are a variety of opinions. Consequently, specific recommendations for the best time to plant a diverse prairie seed mix may depend upon whom you ask. Current agency recommendations for planting encompass a wide range of times: fall seeding, frost seeding in the winter, spring seeding, and even summer seeding (Iowa DOT 2007, Iowa NRCS 2003). Clearly, there is the need to determine an optimal time to plant a diverse prairie seed mix.

Objectives

1. Which seeding time(s) result in maximum total native plant emergence and establishment?
2. Which seeding time(s) result in maximum warm and cool-season grasses emergence and establishment?
3. Does seeding time affect emergence and establishment of individual grass species.
4. Which seeding time(s) result in maximum total forb emergence and establishment?
5. Does seeding time affect emergence and establishment of individual forb species?
6. Which seeding time(s) result in maximum total legume emergence and

establishment?

7. Does seeding time affect emergence and establishment of individual legume species?
8. Does seeding time affect native plant growth in first or second growing season?
9. Does seeding time affect weed growth in first or second growing season?
10. Does seeding time affect native plant mortality over winter?

Methods

The 1.5 acre research site is located on the University of Northern Iowa campus south of Tallgrass Prairie Center in Cedar Falls, Iowa. Previously the area was a brome/alfalfa hayfield. It was sprayed with glyphosate in July 2008 and disked 2-3 times during the remainder of summer to prepare the area for planting. The experiment uses a two block randomized design. Each block consists of 12 (10m x 10m) plots. The four seeding time treatments; mid-winter, mid-spring, mid-summer, and mid-fall which are replicated 6 times in the experiment. Due to the close proximity to Iowa Ecotype Project (IEP) foundation fields, source-identified Iowa Ecotype seed from the appropriate zone is being used for the experiment. The seed mix consists of 7 warm-season grasses, 2 cool-season grasses, 1 sedge, 4 legumes, and 17 forb species (Table 1). Seed will be planted at the appropriate times (see timeline) by hand broadcasting followed by cultipacking. The plots will be mowed to maintain a 4"- 6" high in the first growing season to aid in weed control and allow light to reach the soil surface. Vegetation will be sampled in September and early October 2009 and in June and Sept. in 2010. Fifteen randomly placed ¼ m^2 quadrats will be sampled in each plot. Native seedlings in each quadrat will be identified and counted. Presence of weed species in each quadrat will be noted. In addition, four grayheaded coneflowers will be randomly sampled in each plot and measurements taken for root and shoot length and biomass. The data will be analyzed using a 2-way ANOVA and a Tukey's protected test for pairwise comparisons of means among seeding time treatments. Weather conditions from an area weather station will collected for the duration of the experiment.

Table 1. Seed mix (Iowa yellow tag-zone 2 seed preferred) for 0.6 ac seeding time experiment 2008.

Grasses & Sedges		**phenology**	**Seeds/ sq ft**
Andropogon gerardii	Big Bluestem	warm-season	2
Bouteloua curtipendula	Side-oats Grama	warm-season	2
Bromus kalmii	Prairie Brome	cool-season	2
Carex bebbii	Bebbs sedge	cool-season	2
Elymus canadensis	Canada Wildrye	cool-season	2
Panicum virgatum	Switchgrass	warm-season	2
Schizachyrium scoparius	Little Bluestem	warm-season	2
Sorghastrum nutans	Indian Grass	warm-season	2
Sporobolus asper	Tall Dropseed	warm-season	2
Sporobolus heterolepis	Prairie Dropseed	warm-season	2
			20.0
Forbs			
Amorpha canescens	Leadplant	legume	1
Artemisia ludoviciana	Prairie Sage	forb	1
Aster laevis	Smooth Blue Aster	forb	1

Aster novae-angliae	New England Aster	forb	1
Astragalus canadensis	Milk Vetch	legume	1
Coreopsis palmata	Prairie Coreopsis	forb	1
Dalea purpurea	Purple Prairie Clover	forb	1
Desmodium canadense	Showy Tick Trefoil	legume	1
Echinacea pallida	Pale Purple Coneflower	forb	1
Erynigium yuccifolium	Rattlesnake Master	forb	1
Heliopsis helianthoides	Ox-eye Sunflower	forb	1
Lespedeza capitata	Roundheaded Bush Clover	legume	1
Liatris aspera	Rough Blazingstar	forb	1
Monarda fistulosa	Wild Bergamot	forb	1
Parthenium integrifolium	Wild Quinine	forb	1
Penstemon digitalis	Foxglove Beardtongue	forb	1
Pycnanthemum virginianum	Common Mt. Mint	forb	1
Ratibida pinnata	Yellow Coneflower	forb	1
Ruellia humilis	Wild Petunia	forb	1
Solidago rigida	Stiff Goldenrod	forb	1
Zizia aurea	Golden Alexanders	forb	1
		TOTAL forb	21
		TOTALgrass	20
		TOTAL	41

Timeline

Sprayed with glyphosate	July 2008
Disked (4 times)	July – September 2008
Picked rock	September 2008
Seed/cultipack (mid-winter plots)	Week of February 09, 2009
Planting for seedling identification	Week of May 11, 2009
Seed/cultipack (mid-spring plots)	Week of May 18, 2009
Seed/cultipack (mid-summer plots)	Week of August 10, 2009
Seed/cultipack (mid-fall plots)	Week of November 16, 2009
Sample vegetation	Early September and early October 2009
Interim LRTF Report	March 2009
Sample vegetation	Early July and September 2009
Final LRTF Report	December 2009

Activities to date

Originally, this research project was designed with a mid-fall planting during the week of November 10, 2008. However, as the grant did not take effect until after Nov. 1, 2009, seed could not be purchased and delivered by the 10th. Consequently, the research design was modified to began with a mid-winter planting instead of a mid-fall planting. The site was prepared for seeding by spraying the plots with glyphosate in July of 2008. Next, they were disked four times from July to September of 2008 to reduce weeds and prepare the seedbed. This resulted in a very loose seedbed with numerous exposed large rocks. The rocks were picked up and the site cultipacked to firm the seedbed in September of 2008. As indicated in the methods section, the research design called for two replicate blocks with twelve plots. The plots

were planned to be 15m x 15m, however, the site would not accommodate 12 plots of that size so they were reduced to 10m x 10m and were laid-out in February of 2009. Seed for each of the 12 plots was mixed on February 05, 2009, and stored in a seed cooler until the appropriate seeding date. The mid-winter seeding was done on February 09,2009. Seed was hand broadcast and the plots cultipacked to increase the seed-to-soil contact. On May 11, 2009, extra seeds were planted in conetainers to grow in the greenhouse for future reference in seedling identification during vegetative sampling. The mid-spring planting was done during the week of May 18, 2009 with the previously described methods of hand broadcasting and cultipacking.

Education and Outreach

An important aspect of this project is to provide prairie restoration and reconstruction information to practitioners and to the public. This research is located near the University of Northern Iowa Tallgrass prairie Center (TPC). The TPC would use this research site as a demonstration site (showing differences in seeding times) for workshops, conferences and field trips for the general public. 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, Iowa Prairie Conference, Iowa Academy of Science, and Iowa Roadside Conference.

Budget

	SOURCE OF FUNDS	
	LRTF	TPC-UNI
Personnel		
Research Project Manager		
Salary	$ 2,700	
Fringe Benefits	$ 1,004	
Graduate student stipend	$ 8,392	
Graduate tuition		$ 7,596
Student wages	$ 7,408	
Sub-Total	$19,504	
Supplies & Services	$ 1,000	
Weed Control (for Canada thistle)		$ 200
Travel	$ 700	
Sub-Total	$ 1,700	$ 7,796
Direct Cost	$21,204	
Indirect Cost (8%)	$ 1,696	
Total LRTF Request	$22,900	
Total In Kind	$ 7,796	
Total Project Cost	**$30,696**	

Literature Cited

Greene H, Curtis J. 1950. Germination studies of Wisconsin prairie plants. American Midland

Naturalist 43(1): 186-194.
Iowa Department of Transportation. 2007. Standard specifications for highway and bridge construction. Highway Division. Specification section. Ames, Iowa.
Iowa Natural Resources and Conservation Services. 2003. Conservation cover. Practice code 327. http://www.ia.nrcs.usda.gov.
Meyer M, Gaynor V. 2002. Effect of seeding dates on establishment of native grasses. Native Plants Journal Fall: 132-138.
Packard S, Mutel C. 1997. The tallgrass restoration handbook for prairies, savannas, and woodlands. Island Press. Washington, D.C. 463p.
Salac S, Traeger J. 1982. Seeding dates and field establishment of wildflowers. Hortscience. 17(5): 805-806.
Smith Jr. R, Smith S, (eds.) 1998. Native grass seed production manual. United States Department of Agriculture. Natural Resources Conservation Service. Bismark, North Dakota. 155p.

The Effects of Seeding Time on Emergence and Growth of Prairie Grasses, Sedges, Legumes and Forbs

Rebekah McKay

Living Roadway Trust Fund Interim Report

Project Objectives

1. Does seeding time affect emergence among selected warm and cool-season grasses, legumes, and other forbs?
2. Does seeding time affect native plant growth in early establishment?
3. Does seeding time affect native plant mortality overwinter?
4. Does seeding time affect weed growth in early establishment?

Research Completed To-Date

The seeding of all the treatments is completed. During the week February 09, 2009, the mid-winter seeding mixture was hand broadcast and cultipacked to increase the seed-to-soil contact. On May 11, 2009, extra seeds of the mixture were planted in conetainers for reference in seedling identification during vegetative sampling. The mid-spring seeding was done during the week of May 19, 2009. Plots were roto-tilled before the mid-summer and mid-fall plantings to replicate previous seed bed preparation. All plots were mowed 5 times during the summer to increase establishment. The mid-summer seeding was done the week of August 17, 2009 using the previously described methods. Vegetation was sampled in early September 2009. Native seedlings were identified and counted in fourteen 1/10 m^2 quadrats along two randomly placed transects in each plot. In addition, weed species present in each quadrat were identified and recorded. Data was analyzed using a 2-way ANOVA and a Tukey's protected test for pairwise comparisons was used to compare means among seeding time treatments. A comparison of the results of the total seedling emerged is shown in Table 1 and is the comparison is broken down into grasses and forbs emerged in Tables 2 and 3. Preliminary results showed that there were significantly ($p=0.05$) more grass seedlings present in mid-summer seeded plots than plots seeded in mid-winter and mid-spring. In addition, 40% of all grass seedlings detected were Canada wildrye (*Elymus canadensis*). Red clover (*Trifolium pratense*) was present in nearly all quadrat samples. The fall seeding was done the week of November 16, 2009. During the summer of 2010, the mid-fall treatment will be initially sampled and the other treatments resampled. Additionally, four randomly selected plants of gray-headed coneflower per plot will be destructive sampling. Root and shoot length will be measured and above ground biomass weighed.

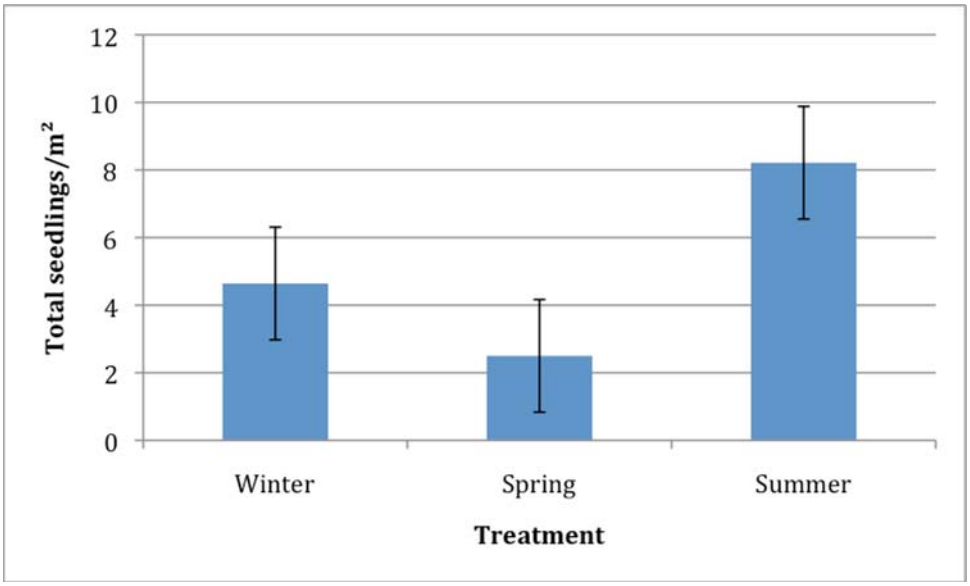

Table 1: Total seedlings/m^2 emerged per treatment

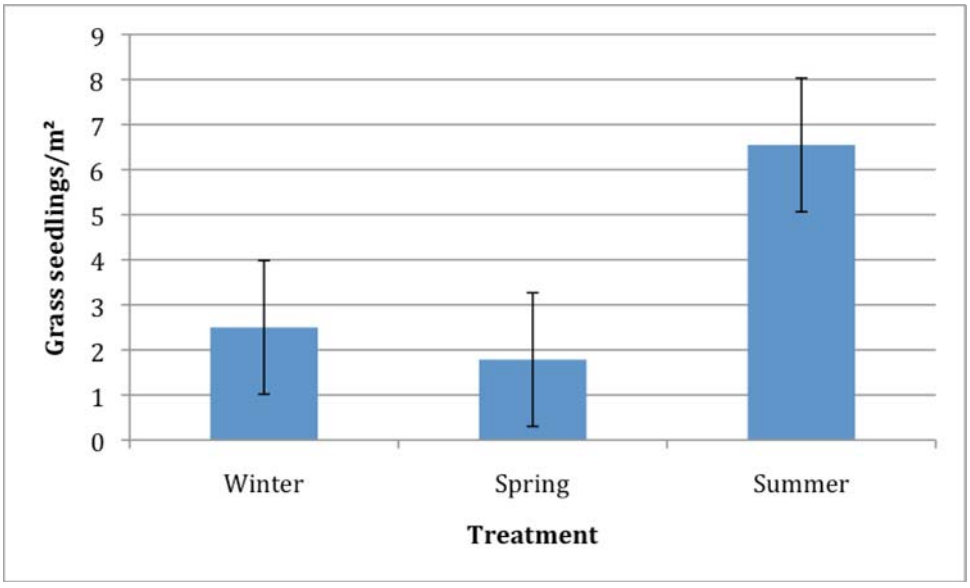

Table 2: Total grass seedlings/m² emerged per treatment

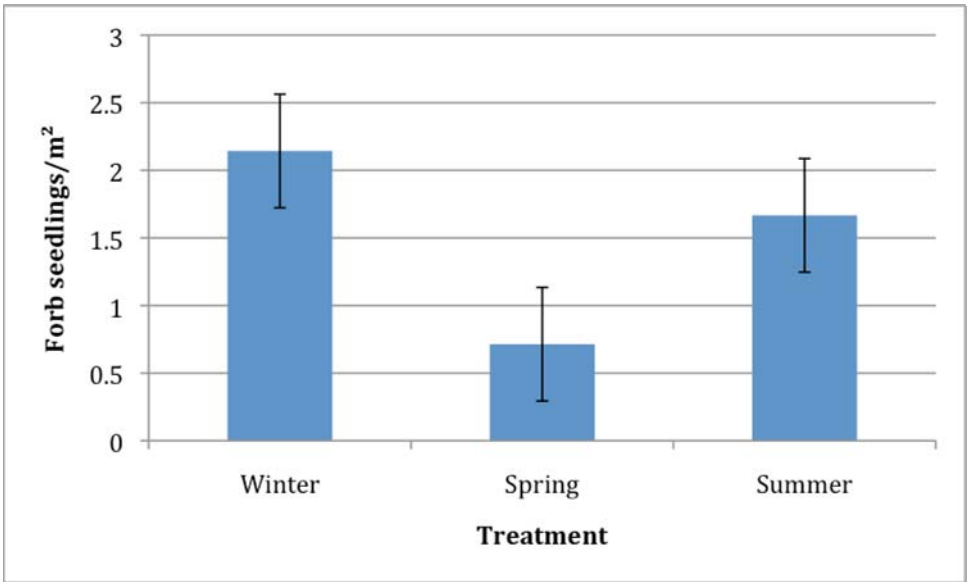

Table 3: Total forb seedlings/m² emerged per treatment