

# Establishment of perennial alley cropping systems on riparian agricultural soils for biomass production and ecosystem services

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## Introduction

When planted in alley cropping systems, perennial biomass crops may provide feedstocks that support the development of alternative energy industries while also providing ecosystem services and creating sustainable agroecosystems. However, optimizing establishment and growth of these crops is essential to realizing highly productive agroecosystems and expanding possibilities for landowner adoption. The objective of this study is to determine establishment and yield parameters associated with the production of perennial biomass crops in an alley cropping system.

## Materials and methods

- Split plot, 2 x 4 full factorial design
- Established on three riparian sites in May 2010: Fairmont, Granada and Empire, Minnesota
- Poplar clone NM6 (*Populus maximowiczii* x *P. nigra*)
- Willow clone 9882-42 "Fish Creek" (*Salix purpurea* x *S. purpurea*)
- Switchgrass (*Panicum virgatum* L.)
- Prairie cordgrass (*Spartina pectinata* Bosc ex Link)
- Native tallgrass-forb-legume prairie polyculture
- Alfalfa (*Medicago sativa* L.) and 'Rush' intermediate wheatgrass (*Thinopyrum intermedium* (Host) Barkworth and Dewey) mixture

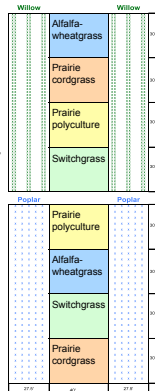


Figure 1. Full factorial, split plot experimental design

## Preliminary results

### Tree emergence and survival

First year survival was excellent for both willow and poplar clones across all three sites (Table 1). Data collected in May 2011 suggests that severe flooding resulted in little mortality overall, though some poplar mortality at the Granada site may be attributable to flood damage. Overall, trees at the Granada site had lower survival rates than trees at Fairmont and Empire. Willows exhibited greater survival than poplars across all three sites.

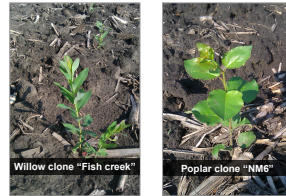


Table 1: First year tree survival

|                     | July 2010 (%) | August 2010 (%) | May 2011 (%) |
|---------------------|---------------|-----------------|--------------|
| <b>Granada*</b>     |               |                 |              |
| Willow              | 98.3          | 95.8            | 95.4         |
| Poplar              | 97.4          | 95.0            | 91.9         |
| <b>Fairmont**</b>   |               |                 |              |
| Willow              | 96.5          | 97.6            | 97.2         |
| Poplar              | 78.9          | 97.2            | 97.0         |
| <b>Empire*</b>      |               |                 |              |
| Willow              | 93.4          | 96.4            | 96.4         |
| Poplar              | 92.4          | 98.1            | 97.9         |
| <b>Across sites</b> |               |                 |              |
| Willow              | 96.0          | 96.6            | 96.3         |
| Poplar              | 89.5          | 96.8            | 95.6         |

\*willow n= 2,232, poplar n= 930; \*\*willow n=1,488, poplar n= 620



### Poplar stand characteristics

Poplars at the Empire site had greater mean height and number of stems per plant than those at other sites. Poplars at Granada had greater mean height, stem diameter per plant and basal area per plant than those at Fairmont. The results are summarized in Table 2.

Table 2: Poplar stand characteristics, December 2010

| Site       | Means        |                 |                              |                           |
|------------|--------------|-----------------|------------------------------|---------------------------|
|            | Height (cm)  | Stems per plant | Stem diameter per plant (cm) | Basal area per plant (mm) |
| Empire*    | 188.7 (45.1) | 1.6 (0.8)       | 17.7 (5.7)                   | 396.2 (197.3)             |
| Granada*   | 168.7 (63.1) | 1.2 (0.7)       | 15.7 (7.2)                   | 326.7 (230.4)             |
| Fairmont** | 131.2 (34.3) | 1.3 (0.7)       | 11.0 (3.6)                   | 139.2 (100.8)             |

\*n=384 \*\*n=256. Means are followed by standard deviations in parenthesis

### Herbaceous biomass yields

At Granada, the establishment year yields of prairie cordgrass were 133% less than the alfalfa-wheatgrass mixture, 100% less than the native prairie polyculture and 85% less than switchgrass (Figure 2). At Empire, herbaceous crops had similar yields which averaged about 2 tons ac<sup>-1</sup>.

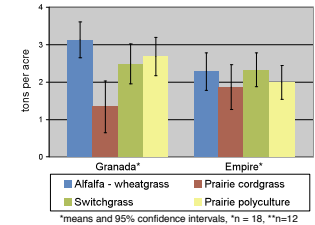


Figure 2. Seeding year herbaceous biomass yields by treatment and site.

## Summary

Preliminary observations suggest that these systems are suitable for riparian sites where frequent flooding occurs. First year tree survival was excellent. The alfalfa-wheatgrass mixture was the highest yielding herbaceous crop, while prairie cordgrass was the lowest. Data collection during the 2011 growing season will provide additional information about the establishment characteristics and yield parameters for these systems.

## Acknowledgments

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## For further information

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