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Survivorship of Introduced Prairie Plant Species in a Degraded Weedy Meadow Under Plant Removal and Non-Plant Removal Conditions

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ABSTRACT

This two-year study addressed the survival of four prairie species, big bluestem (*Andropogon gerardi* Vitman, Poaceae), prairie cord grass (*Spartina pectinata* Link, Poaceae), wild bergamot (*Monarda fistulosa* L., Lamiaceae), and prairie dock (*Silphium terebinthinaceum* Jacq., Asteraceae) planted one meter apart under plant removal and non-plant removal conditions in a degraded weedy meadow. The study site was divided into 1 m^2 plots. Four hundred and thirty-eight seedlings were planted. The plant removal treatment consisted of eliminating visible plant material from an area of 314 cm^2 (radius=10cm) and to a depth of 5 cm for one-half of the total seedlings. Approximately one-half of the plants for each species received the plant removal treatment and one-half received no plant treatment. The seedlings receiving these two different treatments were planted in alternate and adjacent plots. Statistical analyses indicate that there is no significant difference ($p>0.05$) in the planting treatment of the prairie seedlings after the first two growing seasons. It does not appear advantageous to remove adjacent existing weedy plants when planting these four prairie plant species into old field meadows. Planting these prairie plant seedlings directly into weedy old field areas may be advantageous to establish low quality prairie in areas that are small, steeply inclined, or otherwise unsuitable for conventional soil preparation methods such as plowing, discing, and roto-tilling. This planting method can also be used to establish buffer areas surrounding pristine prairie remnants.

INTRODUCTION

Weed competition with prairie plants during the first year following prairie re-establishment is commonly considered to be a major problem. Removal of weeds by tilling beginning at least six months prior to sowing or planting seedlings is the standard obviating method (Schramm 1970 and 1978, Schulenberg,1970). However, prairie re-establishment programs with limited funds, narrow strips of abandoned land, steep embankments, or other small areas often make tilling impractical.

Several non-traditional experimental techniques have been developed as alternatives to the removal of pre-existing plants in prairie enrichment and/or re-establishment projects. Schramm (1978) tried to enrich a prairie restoration with various forb species by cutting holes in existing prairie sod and planting seedlings. Due to grazing by deer and rabbits and competition from existing plants, there was considerable seedling mortality. Warkins and Howell (1983) introduced forb species in established *Andropogon gerardi* and *Sorghastrum nutans* sod at the Fermilab Prairie restoration site using nine different treatments. The most successful treatment was the roto-till/seedling, with the least successful being the sod removal/seedling. Warkins (1988) introduced forb seedlings of five prairie species using roto-till and mow treatments at Fermilab. The results showed little difference between these treatments. At the North Branch Prairie Project, Packard raked prairie seeds into exotic grass turf and, along with fire and time, produced "successional restoration" (Nelson, 1987). Although the above studies have offered alternative methods to large scale tilling in re-establishing and/or enriching a prairie, quantitative analyses of their success are lacking.

This study evaluates the practice of non-plant removal, i.e., planting seedlings of four native prairie species into a weedy old field with scattered recently bulldozed sites. The native prairie plants chosen for re-establishing prairie in this plot were big bluestem (*Andropogon gerardi* Vitman, Poaceae), wild bergamot (*Monarda fistulosa* L., Lamiaceae), prairie dock (*Silphium terebinthinaceum* Jacq., Asteracae), and prairie cord grass (*Spartina pectinata* Link, Poaceae).

SITE LOCATION AND DESCRIPTION OF STUDY AREA

The study site was a weedy old field area on the northeast corner of a marsh located on the campus of College of DuPage. The legal description of College of DuPage property is as follows: SW of NE Quarter, Sections 26 and 27, Township 39, Range 10 in DuPage County, Illinois. The trapezoid-shaped study area is approximately 500 m^2. It is bordered by a thick stand of cattails, *Typha latifolia* L., and *T. angustifolia* L., and sandbar willow, *Salix interior* Rowlee, on the south and west ends. Lawn grass borders the study area on the east and north ends.

Prior to 1965, the study area was farmed. Then between 1965 and 6 June, 1987 the area remained fallow except for some scattered bulldozed scapings from construction activities during 1985. Plant species found in the

study site at the time of seedling transplantation of the four prairie species are listed in Table 1. Soil, chemical, and structural characteristics of the site are given in Table 2.

MATERIALS AND METHODS

A. gerardi, *M. fistulosa*, *S. terebinthinaceum*, and *S. pectinata* were selected for this research because they are common tallgrass prairie natives. The first three species can tolerate degraded/disturbed soils and are among the most hardy prairie plants. *A. gerardi* was the dominant grass of tallgrass prairie that once covered a large part of the Chicago region. It is now restricted to prairie remnants and often is the only prairie species surviving after disturbance of a prairie. *M. fistulosa* and *S. terebinthinaceum* thrive in mesic to hydric prairie but can survive severe degradation (Swink and Wilhelm, 1979). *S. pectinata* was formerly one of the dominant grasses of the tall grass prairie but now survives largely along roadsides, in ditches, and on wet ground (Pohl, 1968).

Seeds for these prairie plants were collected during Fall, 1986, from sources within a radius of 10 miles to ensure local genotypes. All seeds were kept in cold damp storage until 17 February, 1987. They were then stratified with fine damp sand and refrigerated at 4°C in an attempt to duplicate winter conditions.

On 25 March, 1987, the seeds were planted in the College of DuPage greenhouse into a 50-50 mixture of sterilized black soil and "Jiffy Mix Plus" from Ball Seed Company. From 2 May to 20 May, 1987, the seedlings were transplanted to individual jiffy pots and then after one week acclimatized outside in a semi-shaded area. Following acclimatization, the seedlings were transplanted to the study site from 5 June to 12 June, 1987.

The study site was divided into 438 one m^2 plots. Before planting the seedlings, the study site area was mowed to a height of 11 cm, which was the approximate seedling height of the four prairie species. Four hundred and thirty-eight seedlings were planted at a density of one per plot. Seedlings were watered at the time of planting.

The "plant removal" treatment consisted of eliminating visible plant material from an area of 314 cm^2 (radius = 10 cm) and to a depth of 5 cm before transplanting one-half of the seedlings. The remaining one-half were transplanted without removal of any surrounding plant material. Treatments were planted one meter apart in alternate and adjacent plots (Figure 1).

Rainfall data was obtained from the 1987 Climatological Data Annual Survey. The planted seedlings presence was monitored every two weeks from 6 June, 1987 to 30 August, 1987. The seedlings were again monitored on 29 and 30 September, 1988. Seedling survival of *A. gerardi*, *M. fistulosa*, *S. terebinthinaceum*, and *S. pectinata* seedlings between the "plant removal" and "non-plant removal" treatments were compared using the Chi-square analysis of contingency tables (Zar, 1984).

RESULTS AND DISCUSSION

Survivorship of the four prairie species seedlings planted is summarized in Figure 2. Mortalities for all prairie seedlings were greatest during the first two week interval after plantings from 6 June to 20 June, 1987. These early mortalities could be attributed to lower than normal rainfall. When combining both treatment and non-treatment plants, *A. gerardi* had the highest survival (64.3%), followed by *M. fistulosa*, (48.2%), *S. terebinthinaceum* (34.9%), and *S. pectinata* (26.2%).

No significant difference ($p > 0.05$) in seedling survivorship was found between the planting treatments for all species (Table 3). The lack of significance in survivorship suggests that removal of adjacent plant material at least from an area of 314 cm^2 and to a depth of 5 cm when transplanting seedlings of *A. gerardi*, *M. fistulosa*, *S. terebinthinaceum*, and *S. pectinata* in weedy and degraded old field areas is not necessary.

CONCLUSION

Our study found that *A. gerardi, M. fistulosa, S. terebinthinaceum,* and *S. pectinata* seedlings survive for two years with 26.2 to 64.3% survival when planted directly into a weedy old field area. We found no advantage to removing existing plant material for a circular area of 314 cm^2 and to a depth of 5 cm when planting these seedlings.

Planting prairie seedlings directly into weedy old field areas may be advantageous in establishing low quality prairie in areas which are small, steeply inclined, or otherwise unsuitable for conventional soil preparation methods such as plowing, discing, and roto-tilling. If this technique applies to other species, other applications include enriching existing prairie restoration sites or establishing buffer areas surrounding pristine prairie remnants without causing major soil disturbance.

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Table 1. Plant species present in old field meadow study area.

The following symbols are used to suggest each plant's role in the context of this specific project (Schulenberg, 1970). Nomenclature is from Swink and Wilhelm (1979).

p = Members of some kind of Chicago-region prairie community. Multiple p's suggest greater fidelity to prairie habitats.

w = weeds, e.g., plants not considered legitimate members of the prairie community. Many of these are true weeds in the sense that they are extremely aggressive in their manner of growth; others are merely "plants out of place." Multiple w's indicate greater aggressiveness and persistence.

Plant's Role	Plant
ww	Abutilon theophrasti, VELVET LEAF
w	Achillea millefolium, YARROW
*www	Agropyron repens, QUACK GRASS
ww	Agrostis alba, REDTOP
ww	Amaranthus retroflexus, ROUGH AMARANTH
*www	Ambrosia artemisiifolia elatior, COMMON RAGWEED
ww	Ambrosia trifida, GIANT RAGWEED
www	Asclepias syriaca, COMMON MILKWEED
p	Aster novae-angliae, NEW ENGLAND ASTER
*www	Aster pilosus, HAIRY ASTER
www	Barbarea vulgaris, YELLOW ROCKET
www	Brassica kaber pinnatifida, CHARLOCK
w	Bromus inermis, HUNGARIAN BROME
w	Chenopodium album, LAMB'S QUARTERS
ww	Cichorium intybus, CHICORY
www	Cirsium arvense, FIELD THISTLE
www	Cirsium vulgare, BULL THISTLE
w	Cornus stolonifera, RED-OSIER DOGWOOD
*www	Daucus carota, WILD CARROT
www	Erigeron annuus, ANNUAL FLEABANE
ww	Erigeron canadensis, HORSEWEED
p	Geum laciniatum trichocarpum, ROUGH AVENS
ww	Hordeum jubatum, SQUIRREL-TAIL GRASS
wwww	Melilotus alba, WHITE SWEET CLOVER
ww	Melilotus officinalis, YELLOW SWEET CLOVER
ww	Phalaris arundinacea, REED CANARY GRASS
www	Phleum pratense, TIMOTHY
w	Plantago major, COMMON PLANTAIN
ww	Plantago rugelii, RED-STALKED PLANTAIN
w	Poa annua, ANNUAL BLUEGRASS
*ww	Poa pratensis, KENTUCKY BLUEGRASS

Table 1. (Continued)

Plant's Role	Plant
www	Polygonum pensylvanicum laevigatum, PENNSYLVANIA KNOTWEED
ww	Rosa multiflora, MULTIFLORA ROSE
w	Rubus occidentalis, BLACK RASPBERRY
www	Rumex crispus, CURLY DOCK
ww	Salix interior, SANDBAR WILLOW
* ww	Setaria faberii, GIANT FOXTAIL
* ww	Setaria glauca, YELLOW FOXTAIL
ww	Setaria viridis, GREEN FOXTAIL
w	Solanum americanum, BLACK NIGHTSHADE
* ww	Solidago altissima, TALL GOLDENROD
www	Sonchus uliginosus, SMOOTH SOW THISTLE
ww	Taraxacum officinale, DANDELION
ww	Trifolium hybridum, ALSIKE CLOVER
ww	Trifolium repens, WHITE CLOVER

* dominant species

Table 2. Site soil characteristics.[1]

Soil pH	7.6		PPM
Organic Matter	5.5%	Zn	91.88
		B	41.00
Kg/ha		Mn	823.00
		Fe	28932
P	6.722	Cu	26.95
K	218.99	Al	29356
		Na	67.1

Cation Percent

P	0.07
K	0.52
Ca	1.03
Mg	0.87
S	0.06

[1]The soil data is a composite of two random samples. It was analyzed by Department of Soil Science, University of Wisconsin Extension, Madison, WI 53705-4364

Table 3. Chi-square analysis of contingency tables for plant removal and non-plant removal treatments for 1987-88. All were nonsignificant ($p>0.05$).

Species	1987	1988	1987-1988
Andropogon gerardi	0.9077	0.0299	0.2032
Monarda fistulosa	1.7199	0.1760	2.3098
Spartina pectinata	0.0050	0.0491	0.2375
Silphium terebinthinaceum	0.8416	0.6054	0.0109

Figure 1. Pattern of alternate and adjacent spacing of plant removal and non-plant removal treatments.

(1)	4	3	2	1	(4)	(3)
(2)	(1)	4	3	2	1	(4)
(3)	(2)	(1)	4	3	2	1
(4)	(3)	(2)	(1)	4	3	2
1	(4)	(3)	(2)	(1)	4	3
2	1	(4)	(3)	(2)	(1)	4
3	2	1	(4)	(3)	(2)	(1)
4	3	2	1	(4)	(3)	(2)

(1) = *Andropogon gerardi* treatment

(2) = *Monarda fistulosa* treatment

(3) = *Spartina pectinata* treatment

(4) = *Silphium terebinthinaceum* treatment

1 = *A. gerardi* non-treatment

2 = *M. fistulosa* non-treatment

3 = *S. pectinata* non-treatment

4 = *S. terebinthinaceum* non-treatment

Figure 2. Survivorship of *A. gerardi, M. fistulosa, S. pectinata,* and *S. terebinthinaceum* transplanted seedlings in a degraded weedy meadow from 6 June, 1987 to 30 September, 1988.