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Notes on Prairie Species in Iowa. II. Establishment by Sod and Seedling Transplants

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Abstract. Success in establishment of prairie species was measured using sod and seedling transplants. Sod transplants, 25 cm in diameter and 10-20 cm in depth, were successful for 42 species. Fourteen species present in sod transplants set in both annual weeds and *Bromus inermis* sod illustrated the effect of competition on vigor. After two years, in the weedy plot, all species were present, 11 had flowered and 5 had spread. In the *Bromus* plot, 9 species had died, 2 had flowered and none had spread.

Seedling transplants of 48 of 52 prairie species were present after overwintering. One-quart plastic bags and 3″ and 4″ peat pots were used. Of 16 species set into *Poa pratensis* sod, after 2 years, 15 species were present and 7 had flowered.

INTRODUCTION

Both sod and seedling transplants have often been used to introduce prairie species into flower beds and gardens. Transplanting has also been done on a large scale in some prairie reconstruction. Two examples are the Curtis Prairie in the University of Wisconsin Arboretum at Madison, Wisconsin (Curtis and Partch 1948) and the Morton Arboretum, Lisle, Illinois. At the Arboretum thousands of seedling transplants have been set out each spring for several years. With careful hand weeding several times during the season a vigorous growth of prairie is produced in one or two growing seasons (personal communication, Raymond Schulenburg). However, data are not available on sucess of individual species.

Fragments of prairie sod have shown their ability to withstand transplanting in a number of studies. McMillan (1964) used sod fragments transplanted into a common garden to measure ecotypic variation in prairie grasses. Weaver and Darland (1947) measured vigor in range grasses using sods.

In a study at the Iowa Lakeside Laboratory, Milford, Iowa, 12 species of prairie plants were transplanted in July, 1941, into an area dominated by *Bromus intermis*[3] and *Agropyron repens* (Anderson 1946). Two years later 5 species were still present. No recent relocation of these transplants has been made.

The study outlined in this report includes the transplanting of prairie sods and seedlings of prairie species. The major emphasis in the research was to identify prairie species, especially forbs, which could be successfully transplanted.

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[3] Nomenclature mostly according to Gleason and Cronquist (1963).

Methods and Materials

Sod Transplants

Sods 25 cm in diameter and 10 to 15 cm in depth were removed from intact prairie relicts by means of a power cutter slightly modified from a design of Stransky and Bilan (1964) (Figure 1). The only departure from their design was the substitution of a

Fig. 1. Sod cutter and sod. Sod is 25cm in diameter.

sharpened, undulating cutting edge for the saw-tooth edge of their cutter. The cutter was attached to the drive chuck of a tractor-powered post hole digger. The weight of the apparatus was sufficient to force it into the sod when the cutter was rotating. Sods were extracted from the cutter by forcing out by hand or by means of a wooden plate mounted within the cutter.

Donor sites of sod transplants were the Boone Prairie described by Freckman (1966) and the Chicago and Northwestern Railroad right-of-way 2 miles south of Ames, Iowa.

In 1965 duplicate sets of 26 sods were set out in a plot dominated by *Bromus inermis* and in a cultivated plot seeded to winter wheat in the Ash Avenue Experimental Plots, Ames, Iowa. No manipulation of either site was made following placement of the

sods. Sods were cut and set on 7 and 8 May, 1965. Holes to receive the sods were dug using the power cutter. Final shaping was done using a hand spade to assure maximum contact of the sod transplant with bottom and sides of the hole. The sods were pressed firmly into place and marked with a 12″ pot label. A record was kept of species present and flowering in each sod.

In the fall of 1965 and spring of 1966 sods were cut at the above locations and set into *Bromus inermis* sod at the Ash Avenue plots. Sixty-five sods were transplanted in November, 1965, and the same number were transplanted in late April and early May, 1966. Sods were set out in a grid pattern approximately 1.5 m apart.

Approximately one-half of the sods received treatment to relieve competition from the surrounding vegetation. The treatment consisted of a shallow cultivated band around the sod and trimming of the surrounding vegetation to 30-40 cm in height in a 0.5 m perimeter band around each sod. Cultivation and trimming were carried out several times during the growing season. Measurement included presence, height and flowering in each transplant.

Seedling Transplants

Seedlings for transplanting studies were obtained from germination flats in early summer and transplanted individually to pots or plastic bags. They were allowed to become established while in the greenhouse, and set out in mid-summer or fall.

In the 1965 experiment seedlings of 16 species were transplanted into one quart plastic bags filled with steam-treated greenhouse soil. After transplanting the seedlings into the bags, the bags were placed in flats in the greenhouse. Aluminum foil was wrapped around the contents of each flat to discourage algal growth within the containers.

Seedlings were set out at the Littlefield Biological Research Area, 1½ miles south of Ames, Iowa. Planting times varied with development of seedlings and opportunity for transplanting. Thirteen species were set out between 24 June and 7 July, 1965. The remaining three species were set out in September, 1965.

The site was dominated by *Poa pratensis* with many weedy species present including *Verbena stricta* and *Taraxacum officinale*. The site sloped gently toward the south-west. Measurements included presence and flowering in September, 1965, October, 1966, and May, 1967.

Two groups of seedlings were transplanted in 1966. In late May seedlings of 50 species were transplanted into 3″ round peat pots using steam-treated greenhouse soil. Transplants were transferred to a greenhouse bench until early September, 1966.

These transplants were set out on 3 and 4 September, 1966, in

Bromus inermis sod on a creek terrace. The location was SE¼, SW¼, Sec. 11, T-97N, R-18W, Mitchell County, Iowa. Before setting out, the existing cover was clipped to 7 to 10 cm in height and clippings were removed. Transplants were watered when set out, the following day, and two weeks later. Presence of each transplant was noted in May, 1967.

The second group of seedlings were transplanted from germination flats to 4″ round peat pots in late August. The transplants were transferred to a greenhouse bench until late September when they were set out. At this time the transplants were set out in *Bromus* and *Poa* sod at the Littlefield Biological Research Area. The site was near the top of a ridge and sloped slightly to the west. Transplants were watered when set out and at 3 day intervals for 2 weeks. Presence of each transplant was noted in May, 1967.

Table 1. Presence, height, and flowering of prairie species in sod transplants set in cultivated and *Bromus* plots in 1965.

Species	1965[a] Cultivated	1965[a] *Bromus*	1966 Cultivated	1966 *Bromus*	1967[a] Cultivated	1967[a] *Bromus*
Andropogon gerardi	X[b]	X*	181*		X	
Andropogon scoparious	X	X*	91*	22	X	
Elymus canadensis	X	X*	157*		X	
Panicum virgatum	X	X*	53*	X	X	X
Sorghastrum nutans	X	X*	156*		X	
Spartina pectinata	X	X*	68*	170	X	
Sporobolus heterolepis	X	X	80		X	
Stipa spartea	X*	X	132*	24	X	X
Anemone canadensis	X*	X	46*		X	
Anemone cylindrica				34*		
Aster ericoides			89*		X	
Cicuta maculata	X		179*		X	
Helianthus grosseserratus	X	X*	205*	185*	X	X
Helianthus laetiflorus	X	X	165*	157	X	
Lithospermum canescens	X		32*		X	
Phlox pilosa				44		
Pycnanthemum virginianum			67*		X	
Ratibida pinnata	X		127*		X	
Rosa suffulta			X		X	
Silphium laciniatum	X	X	69	101	X	X
Solidago rigida	X	X	141*	94*	X	X
Viola pedatifida	X	X	X	26	X	
Zizia aurea		X		86*		X*

[a]Height measurements not made.
[b] X denotes presence.
*Flowering

Results

Sod Transplants

Spring, 1965. Twenty-three prairie species were established from sod transplants set out in spring, 1965. Measurements of presence, height and flowering for 1965 and 1966 and overwintering 1967 are presented in Table 1.

Because of accidental mowing, data from 1965 is not comparable between those sods set in a cultivated plot and those in *Bromus inermis.*

Eight grass species established were *Andropogon gerardi, A. scoparius, Elymus canadensis, Panicum virgatum, Sorghastrum nutans, Spartina pectinata, Sporobolus heterolepis,* and *Stipa spartea.* Compositae included *Aster ericoides, Helianthus grosseserratus, H. laetiflorus, Ratibida pinnata, Silphium laciniatum,* and *Solidago rigida.* Nine other species also were established.

During the second (1966) growing season most species in the cultivated plot flowered while only 4 species flowered in the *Bromus* plot. Also, all species in the cultivated plot were taller than in the *Bromus* plot except *Spartina pectinata* and *Silphium laciniatum.*

Observations in the spring of 1967 showed a continuation of the trend for species to persist in the cultivated plot and to die out in the *Bromus* plot. During the two years in place several species had

Table 2. Prairie species established in sod transplants set in 1966.

Andropogon gerardi
Andropogon scoparius
Panicum virgatum
Sorghastrum nutans
Spartina pectinata
Sporobolus asper
Sporobolus heterolepis
Stipa spartea

Achillea millefolium
Aster ericoides
Aster laevis
Cirsium altissimum
Coreopsis palmata
Echinacea pallida
Helianthus grosseserratus
Helianthus laetiflorus
Liatris aspera
Ratibida pinnata
Rudbeckia hirta
Solidago rigida
Parthenium integrifolium
Anemone cylindrica
Asclepias syriaca
Asclepias tuberosa
Cicuta maculata
Eleocharis compressa
Euphrobia corollata
Fragaria virginiana
Galuim obtusum
Hypoxis hirsuta
Lespedeza capitata
Lithospermum canescens
Oxalis violacea
Petalostemon purpureum
Phlox pilosa
Physalis heterophylla
Pycnanthemum virginianum
Rosa suffulta
Sisyrinchium campestre
Viola papilionacea
Zizia aurea

spread by rhizomes beyond the confines of the original transplants in the cultivated plot. These were *Aster ericoides, Helianthus grosseserratus, H. laetiflorus, Panicum virgatum, Spartina pectinata,* and *Anemone canadensis.*

Transplanting, 1966. Forty-one prairie species were established in 130 sod transplants set out in the fall of 1965 and spring of 1966. Thirty-four species were established from the Boone site while 22 species were established from the Ames site. In sods receiving no cultivation 34 species were present while 35 were present in sods receiving cultivation. Sods set in late fall yielded 36 species while 26 species were present in sods set in spring (Table 2).

Flowering was observed in 26 species; 21 in fall transplants, 16 in spring; 18 in uncultivated transplants, 20 with cultivation.

Where comparisons of height could be made between fall and spring transplantings, the taller plants appeared to be in fall transplants about 75% of the time. Comparisons between cultivated and non-cultivated transplants showed taller plants in cultivated transplants about 60% of the time (Christiansen 1967).

Most species survived the winter of 1967 with little or no loss. Losses were evenly distributed between cultivated and uncultivated transplants. Of the 18 transplants containing plants flowering in mid-May, 1967, 14 were in the cultivated treatment and four were uncultivated.

Seedling Transplants

Summer transplant, 1965. Of the 16 species transplanted into sod of *Poa pratensis* in summer, 1965, almost all survived except for *Liatris aspera* in which 7 of 10 plants were dead by fall (Table 3). At the time of observation in the fall of 1966 all plants of *Liatris aspera* and several individuals of *Asclepias verticillata* and *Eryngium yuccifolium* had died. Most other species had more than 75% of the plants still living.

Flowering was observed in one species, *Aster ericoides,* in 1965. In 1966 *Elymus canadensis, Aster ericoides, Ratibida pinnata,* and *Solidago rigida* flowered in 75% or more of the plants present. Also flowering but at lower levels were *Sporobolus asper, Echinacea pallida,* and *Anemone cylindrica.*

Most species suffered some losses during the winter of 1966, and *Liatris aspera* was eliminated. Ten of 15 species present in the fall of 1966 survived the winter of 1967 without losses.

Fall transplants, 1966. Seedling transplants in three inch peat pots, in Mitchell County included 20 species in the Compositae, 11 species in the Leguminosae, and 12 other species for a total of 44 species and 113 plants (Table 4).

Table 3. Persistence and flowering of seedlings transplanted in 1965.

Species	No. of transplants	Fall 1965		Fall 1966		Spring 1967
		Presence	Flowering	Presence	Flowering	Presence
Andropogon gerardi	5	5/5	0/5	5/5	0/5	4/5
Elymus canadensis	10	10/10	0/10	9/10	9/9	9/9
Sorghastrum nutans	8	8/8	0/8	3/8	0/3	3/3
Sporobolus asper	10	9/10	0/9	7/9	1/7	5/7
Sporobolus heterolepis	9	9/9	0/9	7/9	0/7	4/7
Stipa spartea	10	9/10	0/9	6/9	0/6	5/6
Aster ericoides	10	10/10	2/10	10/10	8/10	10/10
Echinacea pallida	10	8/10	0/8	7/8	2/7	7/7
Liatris aspera	10	3/10	0/3	0/3	—	—
Liatris pycnostachya	10	7/10	0/7	7/7	0/7	7/7
Ratibida pinnata	10	8/10	0/8	8/8	6/8	8/8
Silphium laciniatum	10	8/10	0/8	8/8	0/8	8/8
Solidago rigida	10	7/10	0/7	6/7	6/7	5/6
Anemone cylindrica	8	8/8	0/8	6/8	2/6	6/6
Asclepias verticillata	10	10/10	0/10	4/10	0/4	4/4
Eryngium yuccifolium	10	8/10	0/8	3/8	0/3	3/3

Ninety-two percent of the transplants survived the winter of 1967. Of the 44 species present, 35 suffered no losses.

Transplants, mostly in four inch peat pots, set out at the Littlefield Biological Area, Story County, numbered 158 plants of 32 species (Table 4). There were 17 species in the Compositae, 8 species in the Leguminosae, and 7 other species.

Survival over the winter of 1967 was about 87%. No losses were noted for 20 species and almost one-half of the plants which died were in two legume species, *Desmodium illinoense* and *Lespedeza capitata*. One transplant of *Geum triflorum* flowered in May, 1967.

Discussion and Conclusions

Sod Transplants

It appears that a large number of prairie species can be successfully transplanted using sods as described above. The thirty-four species established from the Boone site in 1966 represent approximately 37% of the flora of that site (Freckman 1966). This is rather remarkable when one considers that only about 3.3m² of sod out of 7 acres was transplanted.

Based mostly on data from the 1965 transplants, placing sods in cultivated plots is much less strenuous on the prairie species than in *Bromus* sod. The contrast in plant height and flowering between the two sites in 1966 and survival of the winter of 1967 (Table 1)

Table 4. Overwinter survival of seedling transplants set out in 1966.

Species	Mitchell County	Story County	Species	Mitchell County	Story County
Aster ericoides	4/4	1/1	*Astragalus Canadensis*	4/4	1/1
Aster laevis	3/3	0/1	*Astragalus crassicarpus*	2/3	—
Aster sericeus	3/3	6/8	*Baptisia leucophaea*	4/4	1/1
Cirsium flodmanii	4/4	8/8	*Desmodium canadense*	3/3	1/1
Echinacea pallida	4/4	8/8	*Desmodium illinoense*	2/4	0/3
Helianthus grosseserratus	1/2	8/8	*Glycyrrhiza lepidota*	1/1	—
Helianthus laetiflorus	4/4	8/8	*Lathyrus venosus*	1/1	—
Heliopsis helianthoides	4/4	8/8	*Lespedeza capitata*	—	0/5
Hieracium umbellatum	4/4	8/9	*Petalostemon candidum*	2/2	1/1
Kuhnia eupatorioides	3/3	8/9	*Petalostemon purpureum*	3/3	1/2
Liatris aspera	4/4	8/8	*Anemone canadensis*	1/1	—
Liatris pycnostachya	0/1	—	*Anemone cylindrica*	1/1	—
Parthenium integrifolium	3/3	3/3	*Asclepias sullivantii*	3/3	2/3
Ratibida pinnata	4/4	8/8	*Asclepias tuberosa*	4/5	—
Rudbeckia hirta	4/4	—	*Eryngium yuccifolium*	4/4	—
Rudbeckia subtomentosa	2/2	1/1	*Euphorbia corollata*	0/1	0/2
Silphium integrifolium	4/4	8/8	*Geum triflorum*	4/4	3/3
Silphium laciniatum	3/3	10/11	*Monarda fistulosa*	3/4	7/7
Solidago canadensis	4/4	—	*Onosmodium occidentale*	1/1	—
Solidago rigida	4/4	8/8	*Phlox pilosa*	4/4	5/5
Amorpha fruticosa	1/2	2/4	*Thalictrum dasycarpum*	3/3	3/3
Astragalus agrestis	4/4	—	*Zizia aurea*	3/3	3/3

is very striking. In 1966, all sod transplants were set in *Bromus* sod and the cultivation treatments were must less extensive than in the 1965 transplants. Accordingly, differences in height and flowering between sod and cultivation treatments were less definite than in 1965 transplants. Differences were more apparent in the spring of 1967 when flowering data rather than presence is considered,

showing 350% more flowering in the cultivated transplants. The use of presence (frequency) as an indication of change is less sensitive than other measure of dominance (Kucera and Koelling 1964). Therefore, flowering, a very sensitive measure of vigor (Braun-Blanquet 1932), seems appropriate as an index of response to various treatments.

When sod transplants were placed in cultivated soil the already established plants in the transplant are able to dominate the weedy species establishing from seed. When transplants are placed in competition with such vigorous perennial species as *Bromus inermis* the transplanted species with restricted root systems are at a distinct disadvantage. The spread of several species in the 1965 transplants placed in the cultivated plots vs. the absence of spread in the *Bromus* plot gives a striking comparison of the two treatments.

Species behavior in sod transplants can be associated with root system types (Weaver 1958). Those species which have spread extensively such as *Aster ericoides, Helianthus grosseserratus, H. laetiflorus,* and *Solidago rigida* are typified by producing rhizomes. *Echinacea pallida* and *Silphium laciniatum* both have deep unbranched root systems but apparently can survive transplanting due to water absorbing capacity in the upper part of the root system. *Lespedeza capitata* and *Petalostemon purpureum,* with little absorptive capacity near the soil surface, established only in two transplants. However, they were widely scattered on the donor sites, and this could also account for their lack of establishment.

Differences due to spring and fall transplanting are difficult to interpret because somewhat different areas were used as sources of plants in the two seasons. This was particularly true of the Boone site where most of the fall sods were taken from a low area and the spring sods were taken from an upland site. For this reason, the greater number of species established in the fall is probably more a reflection of site than of season. A comparison of plant height shows somewhat more vigorous plants in the fall transplants. *Helianthus laetiflorus* and *Phlox pilosa* flowered consistently in fall transplants but only occasionally in spring transplants.

This method of establishment of prairie species will find its greatest application where an existing prairie remnant is being destroyed. Removal of large numbers of sods from existing prairies would greatly increase the opportunity for introduced weedy species to become established. However, for large scale salvage of prairie remnants, sod strips cut with a tractor-mounted blade held several inches below the level of the ground such as a root pruner[4] used in nursery work would probably be satisfactory. In this case the strips could be cut into convenient lengths and loaded mechanically

[4] Howard C. Greene Mfg. Co., Portland, New York.

for transfer to the new site. Sod transplanting is most successful into cultivated soil. However, placing sods in plots seeded to prairie grasses the same or the previous year would probably be equally successful.

Seedling Transplants

Although labor requirements are high, the use of seedling transplants appears to be a feasible method of establishment of many prairie species. Even in competition with *Poa pratensis* and several weedy species, most prairie species persisted and several flowered in the 1965 transplants. Incidental observation of 1966 transplants in 1967 and 1968 indicate that persistence was much lower than in 1965 transplants. Undoubtably, at least part of this effect was due to the competitive nature of *Bromus*.

Each of the two types of containers was satisfactory for setting out seedlings. The use of plastic bags requires more space in the greenhouse and more labor in setting out, but provides a greater rooting depth. The advantages of the greater rooting depth cannot be tested in this study because different container types were confounded with time and location of transplanting.

It is probable that seedling transplants set into cultivated plots would behave much like sod transplants in having more growth and flowering than when set in sod. Incidental observations were made of several clumps of seedlings transplanted in late June, 1965, from germination flats into a cultivated plot seeded to winter wheat. All species transplanted including *Andropogon scoparius, Elymus canadensis, Aster ericoides, Echinacea pallida, Liatris aspera, L. pycnostachya, Ratibida pinnata, Solidago rigida,* and *Asclepias verticellata* flowered in 1966.

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