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USE OF GREENHOUSE PROPAGATED WETLAND PLANTS VERSUS LIVE TRANSPLANTS TO VEGETATE CONSTRUCTED OR CREATED WETLANDS

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ABSTRACT

Seeds of *Carex nebrascensis*, *Juncus balticus*, *Eleocharis palustris*, *Scirpus acutus*, *Scirpus pungens*, and *Scirpus maritimus* were collected in 1991 from native stands. These seeds were stratified and planted in the greenhouse in 1992. Greenhouse plugs were transferred into two created wetland ponds with different water regimes. In 1992, live plants were collected from the same areas as the seed, transported, and planted into two other created wetland ponds. All plants were monitored and evaluated in 1992 and 1993 for survival, spread, and flowering. Survival of SCPU3 greenhouse propagated plants was significantly greater than wild transplants. The opposite was true of SCMA and CANE2. Rhizomatous spread of CANE2, JUBA and SCPU3 was significantly greater in greenhouse grown plants versus wild transplants. Other species showed no significant difference in spread. Flowering was greater in wild transplants versus greenhouse plants for JUBA and ELPA3. SCAC and SCPU3 was the opposite. Other species showed no significant difference.

INTRODUCTION

Degradation of wetlands is widespread over the United States (Tiner 1984, Dahl 1990, Dahl and Johnson 1991, and Brady and Flather 1994, among others). Numerous opportunities for the restoration, revegetation, improvement, and creation of wetlands exist nationwide. Wetlands perform several functions important to plant and animal life, as well as water quality.

1) Wetlands are significant in food chain production, general habitat, and nesting, spawning, rearing, and resting sites for aquatic and terrestrial species (Feierabend 1989). 2) Their destruction or alteration detrimentally affects natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, and water current patterns (Belt 1975). 3) They also serve as shields for other adjacent areas that could be damaged by wave action, erosion or storms. 4) They serve as valuable storage areas for storm and flood waters (Belt 1975, Novitzki 1979, Verry and Boelter 1979). 5) Wetlands are prime natural recharge areas where surface and ground water are directly interconnected (Weller 1991). 6) Wetlands serve as water quality improvement sites that use natural purification functions to remove a variety of chemicals, heavy metals, agricultural products, and other contaminants (Hammer and Bastion 1989).

However, availability of wetland plants or seed on a commercial basis is extremely limited, especially in the arid and semiarid west. Selected ecotypes of wetland plants with proven performance traits for establishment and production are not available. Cultural techniques for both seed and wild transplants on a commercial production scale of certain species of wetland plants are neither documented nor clearly understood.

The Interagency Riparian/Wetland Plant Development Project is charged with developing cultural propagation techniques for the following wetland plant species typically found in many wetlands in the arid and semi-arid west:

Nebraska Sedge, *Carex nebrascensis* (CANE2)
Creeping Spikerush, *Eleocharis palustris* (ELPA3)
Baltic Rush, *Juncus balticus* (JUBA)
Threesquare Bulrush, *Scirpus pungens* (SCPU3)
Alkali Bulrush, *Scirpus maritimus* (SCMA)
Hardstem Bulrush, *Scirpus acutus* (SCAC)

One of the Interagency Riparian/Wetland Plant Development Project goals is to release performance tested ecotypes to the commercial market and to have private growers produce the plants for sale to the public. In order to accomplish this goal, propagation and transplant procedures must be developed and perfected. For the purpose of this paper accessional data is not discussed.

METHODS AND MATERIALS

Created Wetland Ponds

In 1991, eleven 18 X 21 meter (60 X 70 ft) wetland ponds were created at the Plant Materials Center. Six ponds were lined with a 22 mil impervious liner to prevent water leakage and five were unlined. Five of the lined ponds were used in this study. These ponds were constructed on a silt loam soil in former cropland. There was no evidence of prior wetland conditions (e.g. hydric soils, hydrology, biota) in the immediate area. The ponds receive an average of 22.4 cm (8.8 inches) of total annual precipitation in addition to supplemental water from an irrigation system that originates at the Snake River.

The six test species were split up into two different water regimes: 1) the "moist group" which was composed of *Carex nebrascensis*, *Eleocharis palustris*, and *Juncus balticus* and 2) the "standing water group" which was composed of *Scirpus pungens*, *Scirpus maritimus*, and *Scirpus acutus*. The "moist group" ponds were watered to a depth of 7 cm. Matric potential in the "moist groups" was measured with tensiometers. The water level in these ponds was allowed to drop until there was a 10% reduction from full field saturation before they were irrigated again. The water level in the "standing water group" ponds was maintained at 15 cm. Two ponds were dedicated to each water regime group; one pond was planted with greenhouse propagated transplants and one was planted with wild collected transplants.

Greenhouse Propagation

In 1991, a total of 106 collections of the six selected wetland plant species were made throughout the Interagency Riparian/Wetland Plant Development Project 5 state service area (Figure 1). Collection windows, procedures, and amounts of bulk seed necessary for useable amounts of clean seed were documented. Each collection was assigned an individual accession number and the seed cleaned. Cleaned seed was stored in the PMC seed storage building until they could be stratified. The temperature in the storage facility was maintained between 1°and 12°C with humidity at less than 10%.

All of the seeds, except JUBA and CANE2 were stratified and then planted in late January 1992 in 352 cm^2 (21.5 in^3) Rootrainer Books™ with four cells each filled with a soil mix of 1 part sand, 1 part vermiculite, and 1 part peat moss. Enough time release fertilizer to last approximately 100 days was also added to the soil mix. Seeds were placed on the surface of the soil mix and not covered. To insure a strong viable plant, 20-25 seeds were planted in each cell. Rootrainer Books were then placed in specially constructed propagation tanks that could hold up to 30 cm of water. The water level in the propagation tanks was maintained at 15 cm which was enough to keep the soil surface moist throughout the growing period. Greenhouse temperatures were maintained between 30° and 37°C. Each tank was illuminated 24 hours a day with mercury vapor lights. The plants were then transplanted into the created wetland ponds in August and September.

Wild Transplant Collection Procedures

During the summer of 1992, the exact same sites were visited again and live transplants were collected. Non-destructive harvesting techniques were developed and documented. Data on temperature, area description, species condition, plants in association and any other information that would help in future collections were recorded.

Live plant collections were made by digging no more than 0.37 m^2 of plant material from any 1.1-1.5 m^2 area, so the native plants could spread back into the hole in one growing season (personal observation). The plants were dug down to a depth of about 15 cm which included a large percentage of the root mass. The above ground biomass was clipped off at a height of 25 cm to reduce root stress (Hollis Allen, WES, personal communication). Plants were transported in Styrofoam coolers. Enough water was added to the coolers to cover the root system. Temperatures were maintained at under 29°C (85°F). Ice was added to the coolers when external ambient temperatures were above 35°C (95°F).

Planting Procedures

Shovels were used to divide the 0.37 m^2 samples of wild collected plant material into five or six individual plugs. The plugs were 6 x 6 cm with healthy rhizomes and tops. Any weeds which were found in the plugs were removed by hand. Wild collected plants were transplanted in July and August. Greenhouse plants were transported to the ponds and planted in August and September. Every effort was made to keep the soil on the roots.

Four plugs (plants) from each collection site (accession) were planted 46 cm (18 inches) apart in a square called a "quad". Each "quad" was then randomly replicated 5 times. Each "quad" was 46 cm from a neighboring "quad". Border rows of the same species were planted between each species "block" so that potential interspecific root competition would not affect the test quads. Border rows were also planted around the outside of each "block" so all of the test plants would have the same amount of intraspecific competition on all sides to prevent the "edge effect". One pond was dedicated to the greenhouse grown "moist group", One to the wild collected "moist" group, one to the greenhouse grown "standing water group," and one to the wild collected "standing water" group.

Evaluation Procedures

Each accession of the six species tested were evaluated during September and October of 1993. Measurements were taken for height, shoot density (number of ramets contained within a 29.2 cm^2 hoop placed in the center of each quad), percent seed (percentage of ramets with seed heads in a given quad), and above ground biomass. Biomass measurements were made by centering each quad within a 63.5 X 63.5 cm (25 inch square) frame and then clipping and bagging all of the above ground biomass contained within it. The biomass samples were then air dried for 5 weeks and weighed to the nearest 5 grams. Each of the measured criteria for each species in a given treatment (greenhouse vs live transplants) were then averaged, and compared to the mean of the other treatment using the student t-test (Zar, 1984).

RESULTS AND DISCUSSION

Percent and rates of germination varied between accessions of the same species, as well as between species. This was probably due to ecotypic variation within a species and differences in germination requirements between species.

We considered washing the soil off the roots before transplanting the wild collected plants; the theory being that washing the soil off the roots would reduce the risk of noxious weed infestation. However, this procedure proved to be too time consuming and actually seemed to stress the plants which in turn increased the establishment time. It was decided to keep the soil on the roots to decrease this stress. We also believed the natural wetland soil could provide important microbes that would normally not occur in non-wetland, non-organic mineral soil used to construct wetlands on typical farm ground in the Intermountain West.

Our data for *Scirpus acutus* (Table 1) suggested that 1) there was no significant difference in height and shoot density (spread) between greenhouse propagated and wild transplants, 2) wild collected transplants had a higher percentage of shoots flower and set seed, and 3) greenhouse propagated transplants produced more above ground biomass (i.e. the plants were more robust) which may translate into an increase in nutrient uptake.

For *Scirpus maritimus* (Table 1), these data indicated that there was no significant difference between greenhouse propagated transplants and wild collected transplants. Neither greenhouse propagated transplants or wild collected transplants established well at first, but later filled in. Greenhouse propagated transplants were planted late (September) and were not trimmed. This seemed to stress the plants to the point that they all died. By the spring of 1994, apparently, all but 6-10 plants had died. By the end of the summer of 1994, the area was almost covered with ramets. These ramets must have come from the rhizomes of the plants we thought had died.

Data collected for *Scirpus pungens* (Table 1) indicates that 1) wild collected transplants were taller than greenhouse propagated transplants, and 2) greenhouse propagated transplants had greater shoot density and more flowering heads than wild collected transplants. Generally, we found that greenhouse propagated transplants had better survival, spread, and flowering than did the wild collected transplants. The greenhouse propagated transplants were planted in late September and were not trimmed after planting. Even with these problems, the greenhouse propagated transplants performed better than the wild collected transplants.

For *Juncus balticus* (Table 1), we found that 1) greenhouse propagated transplants were taller, more dense, and had higher biomass production than the wild collected transplants, and 2) wild collected transplants produced more seed than the greenhouse propagated transplants.

Our evaluations of *Carex nebrascensis*, indicated that greenhouse propagated transplants had significantly greater height, density, and above ground biomass production. Also, there was a trend towards greater seed production in the greenhouse propagated transplants.

Data on *Eleocharis palustris* (Table 1), suggested that wild collected transplants had significantly greater height, seed set, and biomass. There was a trend for the greenhouse propagated transplants to produce more shoots. Generally, wild collected transplants preformed better than greenhouse propagated transplants.

Some of the differences between the "greenhouse" and "wild" groups may be due to the differences in planting dates. Due to personnel constraints these groups were not planted at the same time which may have skewed the results. In addition, since the "greenhouse" and "wild" groups were in different ponds (which were not replicated), the statistical design was not balanced. These factors should be addressed in future research. We don't believe that the fertilizer which was originally added to the green house soil mix had any affect on the plants after they were transplanted to the ponds. The fertilizer was consumed in the greenhouse and the plants were beginning to show signs of fertilizer stress by the time they were transplanted to the ponds.

When planting a given species at the deeper end of its water tolerance, transplanting larger rhizomes, whether grown in the greenhouse or collected from the wild, may increase success (personal observation). This is most likely due to the larger carbohydrate stores found in the mature rhizomes.

CONCLUSION

With the exceptions of *Scirpus maritimus* and *Eleocharis palustris*, greenhouse propagated transplants performed better than wild collected transplants. Visually, all of the greenhouse propagated transplants appeared more vigorous than the wild collected. Greenhouse propagated plants may have performed better because the younger tissue is able to grow and spread more vigorously, thus, allowing them to colonize an area much quicker.

If you would like further Information Series technical papers or Technical Notes, write or call:

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Table 1: Average height, shoot density, percent seed, and above ground biomass for 6 different wetland species either grown in the greenhouse or live transplanted.[( ) = Standard Deviation, * = Statistically significant (P < 0.05)]

Scirpus acutus (SCAC)

	Average Height	**Shoot Density ($0.3m^2$)**	**Percent Seed**	**Above Ground Biomass ($g/0.64m^2$)**
Greenhouse	100.85 (22.29)	3.77 (3.24)	5.39 (8.35)	121.0 (61.24)*
Transplant	101.67 (18.72)	3.77 (2.97)	12.56 (18.14)*	87.08 (34.08)

***Scirpus maritimus* (SCMA)**

	Average Height	Shoot Density (0.3m^2)	Percent Seed	Above Ground Biomass (g/0.64m^2)
Greenhouse	27.00 (12.21)	2.80 (2.68)	0.00 (0.00)	NA
Transplant	42.60 (24.47)	5.00 (4.53)	6.97 (9.56)	NA

***Scirpus pungens* (SCPU3)**

	Average Height	Shoot Density (0.3m^2)	Percent Seed	Above Ground Biomass (g/0.64m^2)
Greenhouse	53.97(5.39)	23.80 (11.28)*	76.13 (18.83)*	NA
Transplant	60.60(7.09)*	14.60 (8.32)	23.20 (23.45)	NA

***Juncus balticus* (JUBA)**

	Average Height	Shoot Density (0.3m^2)	Percent Seed	Above Ground Biomass (g/0.64m^2)
Greenhouse	50.00 (10.95)*	84.97 (35.89)*	16.90 (16.31)	95.86 (42.37)
Transplant	46.39 (9.61)	21.71 (26.35)	58.36 (23.42)*	85.86 (51.25)

***Carex nebrascensis* (CANE2)**

	Average Height	Shoot Density (0.3m^2)	Percent Seed	Above Ground Biomass (g/0.64m^2)
Greenhouse	33.83(12.49)*	25.48 (8.56)*	2.93 (4.44)	70.53 (18.77)*
Transplant	30.11(9.75)	5.97 (4.60)	2.64 (3.14)	36.78 (21.67)

***Eleocharis palustris* (ELPA3)**

	Average Height	Shoot Density (0.3m^2)	Percent Seed	Above Ground Biomass (g/0.64m^2)
Greenhouse	23.18 (5.45)	137.96 (87.51)	8.0 (14.68)	19.72 (10.57)
Transplant	27.11 (6.25)*	129.37 (55.65)	44.09 (27.97)*	29.57 (15.62)*