# Jamie L. Whitten Plant Materials Center

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## Results of a WRP Planting in the Lower Mississippi Valley Alluvium

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### ABSTRACT

Most moist soil units on Wetland Reserve Program (WRP) sites in the Lower Mississippi Valley are remarkable for their lack of plant species diversity. WRP sites in Quitman County, Mississippi were planted with perennial herbaceous wetland plants to determine the capability of using these plants to increase diversity. Species used were common rush (*Juncus effusus* L.) (JUEF), woolgrass [*Scirpus cyperinus* (L.) Kunth] (SCCY), softstem bulrush [*Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla] (SCTA2), and powdery thalia or powdery alligator-flag (*Thalia dealbata* Fraser ex Roscoe) (THDE). SCTA2 is probably more commonly known by the synonym *Scirpus validus* Vahl. Two water regimes were tested, 1) seasonal flooding with the boards removed from the water control structure in the spring, and 2) permanent flooding with the boards not removed from the water control structure. Plants were planted –1 ft to +1 ft relative to the winter water pool level and hydrologic changes were tracked throughout the course of the evaluation period. Plots were planted in the spring of 1998 and 1999 and the fall of 1998. Allowing the water to remain permanently on the planting site increased plant survival for all species except SCTA2, which had very poor survival and would not be recommended for WRP sites. All these plants require sufficient water during the establishment phase, which due to limited rainfall was not available for plots in either water regime in the 1998 spring planting. Fall planting allows plants to take full advantage of winter rainfall to improve establishment. Plant survival decreased for all species at later evaluation dates, especially when plants were planted at some distance from ponded water on the site. Additional studies showed that glyphosate treatments did not appear to improve establishment of mowed plots and containerized plants had greater vigor than bare-root plants and would provide more uniform planting stock.

### INTRODUCTION

WRP sites in Mississippi are primarily planted with bottomland hardwood tree species, which are the native vegetation for most wetland sites in this region of the country. However, within many WRP tracts are smaller areas called moist soil units that are managed to provide food for waterfowl and other wildlife. Most units are planted with annual food crops (e.g. sunflowers (*Helianthus* L. sp.), corn (*Zea mays* L.), soybeans [*Glycine max* (L.) Merr.], or Japanese millet (*Echinochloa frumentacea* Link) or some might be left to regenerate a natural population of annual plant species that can also provide sources of food and cover. Most moist

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soil units have water control structures that are manipulated to flood the area in the fall, after annuals have produced seed, and drain the field in early spring

These planting schemes have led to little species diversity on these areas. Plantings consisting of monocultures of one species or with a small number of species are often subject to increased pressure from insects, diseases, or environmental stresses. Also, they may not be the most desirable situation for many species of wildlife due to limited diet variability and lack of suitable or sufficient cover. The Jamie L. Whitten Plant Materials Center (PMC) was asked to establish a planting on a WRP site in Quitman County, Mississippi that could address this problem of limited diversity. Personnel at the PMC had previously worked with several perennial herbaceous emergent wetland plants and were familiar with establishment requirements for several of these species. Planting these species would increase their population in the wild and it was assumed that these plants would be capable of providing more cover for wildlife during the winter than annual species and some could also act as an additional food source.

However, when the planting was being planned, it quickly became apparent that there were too many unknown variables that might affect the success of the planting. For example, although preferred water depths may be known for a particular species, where will these water depths be located on the WRP site? And how long will water levels be maintained during the long, hot summer months? These and numerous other questions led to the conclusion that it was necessary to collect hydrologic data that could be used to help explain the patterns of plant survival on the planting site.

Therefore, the planting was planned to measure survival of four emergent wetland species, JUEF, SCCY, SCTA2, and THDE as a function of water levels on the planting site. These plants were chosen because JUEF, SCTA2, and to a somewhat lesser extent, SCCY, are species commonly used in constructed wetlands and wetland restoration projects in the U.S. (U.S. Army Engineer Waterways Experiment Station, 1978; Thunhorst, 1993). SCCY and JUEF were also chosen for their drought tolerance. THDE was a species that performed well in plantings at the PMC. All four species are native to Mississippi, although SCTA2 is not commonly found in the Delta where Quitman County is located. THDE is native to the Delta, but native populations are rarely found, probably a result of limited seed dispersal potential and habitat disruption.

Two water management schemes were to be examined; 1) normal seasonal flooding (TEMP), where the boards were to be pulled from the water control structures in the spring, and 2) permanent flooding (PERM), where the boards were not removed from the water control structure. Spring and fall plantings were also planned to assess the effect of planting season on plant survival. Instrumentation was installed to determine rainfall, water ponding depths, and evapotranspiration (ET) on the planting site. Additional smaller studies examined the effect of pre-planting herbicide treatment and bare-root versus containerized planting materials on establishment success.

## MATERIALS AND METHODS

The planting sites were located at two separate WRP tracts (Deere and Baxley) owned by a single landowner near Lambert, Mississippi. Both WRP tracts had extensive improvements (i.e. roads, water control structures) put in place by the landowner prior to the testing period. Much of the acreage had been or was scheduled to be planted to bottomland hardwoods. Two moist soil units at each WRP tract were chosen for testing. Site 1 at the Deere tract and site 3 at the Baxley tract were assigned to the permanent flooding regime, where the boards were not to be pulled from the water control structure in the spring. The hydrology of these sites will be referred to as PERM A and PERM B. The other sites (site 2 at Deere and site 4 at Baxley) were to be managed using a seasonal flooding regime, where the boards were pulled from the water control structure in the spring and will be referred to as TEMP A and TEMP B, respectively. This design gave two replications of each water regime. The landowner requested that the water regimes at the Baxley tracts be switched after the initial planting (site 3 TEMP B and site 4 PERM B) due to concerns that some tree plantings would be inundated. The natural plant community at an adjacent, unplanted site on the Baxley tract was also to be monitored.

Each planting area was surveyed in the spring of 1998 prior to drawdown. Planting elevations were determined relative to the winter water pool level. Plots were located in the area ranging from –1 ft winter water level (WL) to +1 ft WL, with each 0.5 ft elevation change marked with a flag. The distance between the 0.5 ft elevation marks were divided into three equidistant sections and a planting row was located parallel to the water line at each elevation mark and interior measurement, resulting in 13 planting rows. Because the distance between elevation markers varied, the distance between the planting rows also varied within each planting site and between planting sites. Elevation difference between adjacent rows was approximately 2 in. Each species was planted on 10 ft rows in a band running the length of the planting site, which resulted in a split plot design.

Planting materials used for the main test were dug from plant growing ponds at the PMC. SCCY, accession 9062741, was grown from plants collected in Jones County in southern Mississippi, although the species itself is common in the Delta. THDE, accession 9059002, was grown from seeds collected in Bolivar County, Mississippi, however, the plants were reported to have originally come from Washington County, Mississippi. These two accessions were released by the PMC in 1996 as Leaf River and Indian Bayou source-identified germplasm, respectively. SCTA2, accession 9062732, was also collected in southern Mississippi, in Jackson County. The JUEF used, accession 9062735, originated from a commercial nursery in Parrish, Florida, however, this species is common in the Delta and was found already growing on the planting site. Plants were dug, soil washed from the root system and planting propagules were divided from the parent plants. Plant tops were trimmed to facilitate planting and the bare-root propagules were stored in a cool place with either water or moistened sphagnum moss covering the roots and rhizomes until planting.

Plots were planted on May 12-13, 1998, November 18, 1998, and May 10, 1999. The planned second fall planting was not completed. The planting area was mowed prior to planting when necessary (some fields had been disked by the landowner). Plots with weed growth were sprayed with a 3% solution of glyphosate (Roundup) several weeks before planting in 1998, but not in the following year. Three propagules were planted on each planting row.

The herbicide test was located on sites 1 and 3, with site 3 beginning at –1 ft WL and site 1 starting at 0 ft WL. This test was only planted in spring 1998 (dates indicated above). One half of the plot area was sprayed with glyphosate at the same rate used for the main planting and the other half was left unsprayed. Planting rows were located perpendicular to the water level and were 10 ft in length. Five bare-root propagules of each accession were planted on the row. There were 5 replications of each treatment in a split plot design.

The container versus bare-root test was located on site 1 beginning at –1 ft WL and was planted in both spring and fall of 1998 (dates indicated above). Containerized plants of the four accessions were grown from seed in the PMC greenhouse in early 1998. For the spring planting, plants were in 4 inch pots and in the fall they had been moved up into 1 gallon nursery containers. Bare-root plants were the same as those used in the main study. Row length, orientation, and propagule number were the same as used for the herbicide test. Because species were not to be compared, each was considered a separate study. Treatments were arranged in a randomized complete block with five replications.

Instrumentation was installed at site 1 (PERM A). An 8" tipping bucket raingage was installed with a single event data recorder (OmniData DP-101) to record the rainfall on-site. Daily rainfall was determined from the recorded data. An atmometer (manually read) was installed to determine evapotranspiration on a bi-weekly basis. An RDS WL-20 water monitoring device was installed to record the ponded water level on the site, set to record the water level every 12 hours. At all other sites water level was recorded manually, referenced to the winter flooding level.

## RESULTS AND DISCUSSION

All sites were ponded prior to drawdown in March of 1998. Due to below average rainfall in the spring and summer of 1998, the permanent sites were not able to reestablish ponding any earlier than the temporary sites (Fig. 1). At the time of the fall planting (November 18, 1998), no ponding had been reestablished. Both sets of sites had ponding by January 1999. The TEMP A site was inaccessible for two months, so data is missing and shows no ponding.

Sites maintained their ponded condition until March 10, 1999, when the boards were removed from the temporary sites and one of the permanent sites (PERM B) at the landowner's discretion. What appears as a re-flooding of TEMP A was actually a backwater flooding event. The PERM B site had the boards reinstalled in the water control structure immediately after the landowner drained it, however precipitation was not sufficient to reestablish any degree of ponding until late June 1999.

The 1999 spring planting had only one site with remaining ponding (PERM A) so that plants at the WL, WL-0.5 ft and WL-1 ft level were planted in standing water on that site. The PERM A site has fluctuated throughout its entire ponding range (dry to full). It has dried out by fall of both 1999 and 2000.

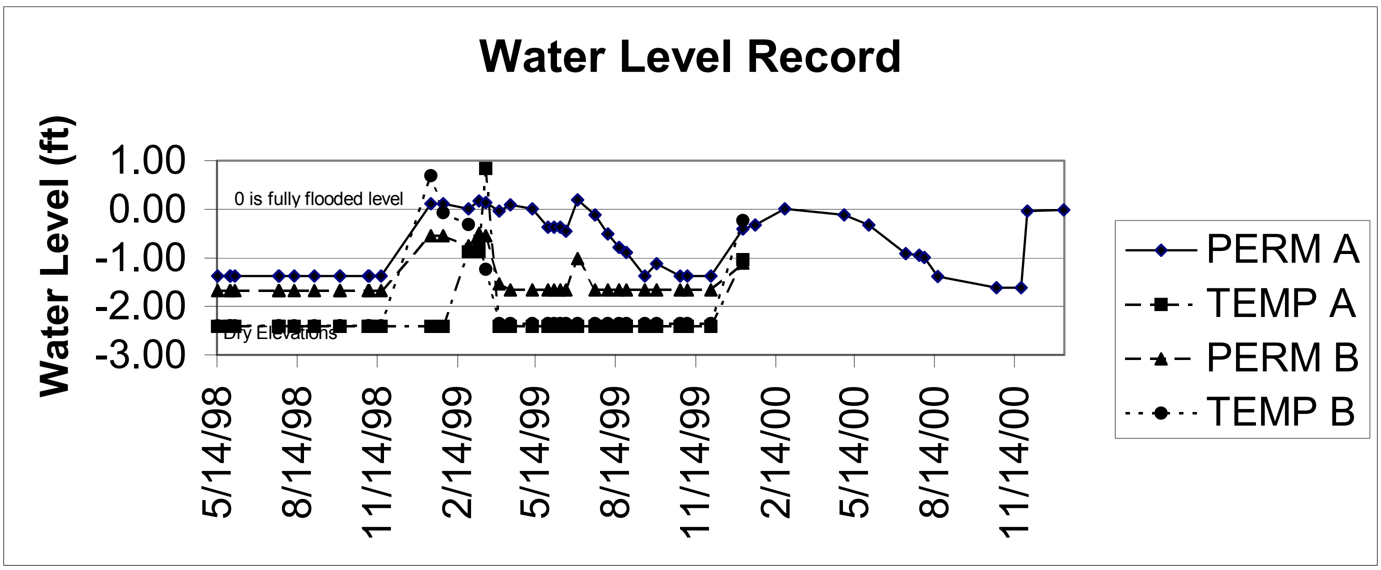


Fig 1. Water levels on the four planting sites during the initial measurement period.

The period following the spring 1998 planting had below average monthly rainfall (Fig. 2) resulting in a lack of reestablishment of ponding on the permanently flooded sites. In the period May through October the site received 10.72" of rainfall when the average for the same period is 24.05". July was the only month with above average precipitation (5.32" measured, 4.21" average). ET rates measured by the atmometer on-site recorded rates of 0.30"/day maximum and 0.20"/day average for the months recorded (June and July).

After the fall planting the weather remained dry, with 2.00" of rain for November and December when the average is 10.68". The sites finally began to receive significant rainfall in January 1999. For the period January through April 1999, the accumulated rainfall was 23.72" when the average is 19.97". This allowed all sites to pond. The spring 1999 planting was followed by a dry May (1.96" measured, 5.48" average) with a wet June (9.88" measured, 4.66" average).

For the initial period of measurement (May 1998 through September 1999), the rainfall would be considered "normal" based upon the climatic record for Lambert, Mississippi, from

1961 to 1990. The measured rainfall of 54.3" is between the dry side of normal (46.6") and the wet side of normal (92.2") while being 21.5" below the “average” of 75.8". For the 17 months of rainfall measurement, eight were “DRY”, three were “WET”, and six were “NORMAL” (Table 1).

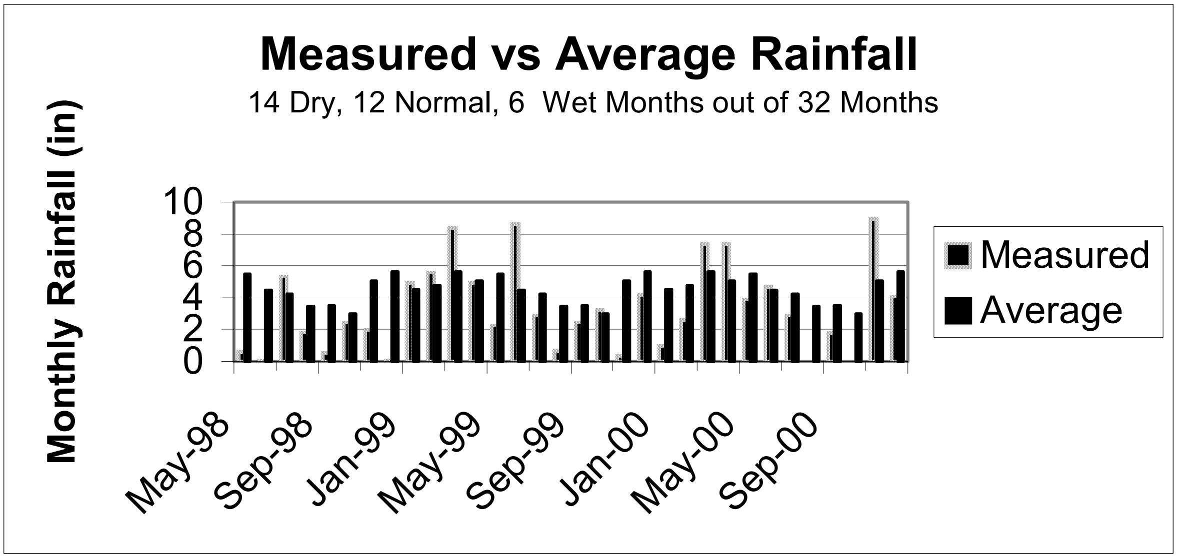


Fig 2. Monthly rainfall

Table 1. Wetness condition by month for initial measurement period

| Month | Rain | Average | DRY 30%< | WET 30%> | Condition |
|---|---|---|---|---|---|
| | ----- | ----- | (in) | ----- | |
| May-98 | 0.56 | 5.48 | 3.60 | 6.58 | D |
| Jun-98 | 0.04 | 4.46 | 2.66 | 5.61 | D |
| Jul-98 | 5.32 | 4.21 | 2.68 | 5.08 | W |
| Aug-98 | 1.84 | 3.44 | 1.85 | 4.20 | D |
| Sep-98 | 0.52 | 3.49 | 2.09 | 4.23 | D |
| Oct-98 | 2.44 | 2.97 | 1.74 | 3.74 | N |
| Nov-98 | 1.96 | 5.05 | 3.18 | 6.09 | D |
| Dec-98 | 0.04 | 5.63 | 3.41 | 6.82 | D |
| Jan-99 | 4.88 | 4.53 | 2.67 | 5.50 | N |
| Feb-99 | 5.60 | 4.75 | 2.91 | 5.76 | N |
| Mar-99 | 8.36 | 5.63 | 3.64 | 6.78 | W |
| Apr-99 | 4.88 | 5.06 | 3.28 | 6.09 | N |
| May-99 | 1.96 | 5.48 | 3.60 | 6.58 | D |
| Jun-99 | 9.88 | 4.46 | 2.66 | 5.61 | W |
| Jul-99 | 2.88 | 4.21 | 2.68 | 5.08 | N |
| Aug-99 | 0.68 | 3.44 | 1.85 | 4.20 | D |
| Sep-99 | 2.44 | 3.49 | 2.09 | 4.23 | N |
| **Period** | **54.3** | **75.8** | **46.6** | **92.2** | **N** |

The spring 1998 planting was adversely affected by a lack of rainfall after planting (Fig. 2), therefore, plant survival data for this planting is not presented. THDE survived in small numbers, mainly due to the elevated amounts of food that can be stored in its large rhizome system. The rhizomes of the other species are much smaller and not capable of providing as many food reserves to support the propagule until it becomes established. Established plants of

JUEF and SCCY are highly drought tolerant, but the propagules desiccated before late season rainfall could allow establishment. An additional problem experienced with this planting was small-sized propagules. When the plants were dug, many were divided into propagules with a very small number of growing points. Propagules ideally should have several growing points to regenerate from. Later plantings used mainly larger-sized propagules.

The landowner removed the boards from the water control structure on the PERM B site in both evaluation years. This prevented statistical analysis of the data because there was only one replication of this treatment. The plant evaluation data for the fall 1998 (Table 2) and spring 1999 plantings (Table 3) are presented as the number of plants, from the original three propagules planted, surviving on each row, with row number 1 located at -1 ft WL and row 13 at +1 ft as described previously. Overall survival was better for the fall planting than for the spring planting; however, it will be necessary to conduct a second year of testing to confirm this. This result is not unexpected because fall planting allows the plants to take advantage of increased water levels in the winter months (Fig. 1) for their root systems to become established. Survival was also better under the PERM water regime than the TEMP regime for most species, however, the fact that only one site was exposed to this regime does not entirely substantiate this. In a normal precipitation year, the PERM water regime allows the plants access to increased water during the summer months.

Both JUEF and SCCY appear to be better adapted to slightly higher elevations than THDE where the plants are not flooded as deeply. This is also not unexpected because these species are both adapted to shallow-water sites (Thunhorst, 1993) along the margin of bodies of water or on mud flats. THDE is a taller growing plant and is adapted to somewhat deeper water (J. Grabowski, personal observation). Survival of most species decreased at the higher planting elevations, however, maximum elevations differed between species and water management regimes. It appears that the +1 ft WL level was above the maximum that even drought tolerant species such as SCCY and JUEF could tolerate for long-term survival. THDE is the only species that consistently performed well when planted in both spring and fall. SCTA2 is not well suited to planting on sites such as these, and if used, should be planted at the lower elevations with no drawdown. Survival began to decrease by the final evaluation date; however, survival of SCCY in the fall planting was still very good on the PERM site. JUEF, SCCY, and THDE all appear to be persistent on locations on the planting site with suitable water relations and where still present when the sites were visited in 2002 (Fig. 3 and 4). THDE is the only species that has demonstrated the capability to regenerate on areas of the site where hydrologic conditions were appropriate (Fig. 4).

Fig 3. Site 1 in 2002.

Fig. 4. THDE regeneration on site 1.

Table 2. Number of plants surviving from three propagules planted in the fall of 1998 on planting rows at thirteen different elevations on sites exposed to two water management schemes on WRP sites in Quitman County, Mississippi (evaluation dates in 1999)

| Site | Row # | JUEF | | | SCCY | | | SCTA2 | | | THDE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eval. Date | | 4/29 | 6/22 | 9/14 | 4/29 | 6/22 | 9/14 | 4/29 | 6/22 | 9/14 | 4/29 | 6/22 | 9/14 |
| | | ---------------------------------------------# of plants surviving on row--------------------------------------------- | | | | | | | | | | | |
| PERM* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | 2 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| | 3 | 0 | 1 | 0 | 3 | 3 | 3 | 1 | 0 | 0 | 1 | 1 | 1 |
| | 4 | 1 | 2 | 1 | 3 | 3 | 3 | 1 | 0 | 0 | 1 | 1 | 1 |
| | 5 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 0 | 0 | 1 | 1 | 0 |
| | 6 | 1 | 1 | 2 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 |
| | 7 | 1 | 1 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| | 8 | 3 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 9 | 3 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 10 | 3 | 3 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 12 | 3 | 1 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13 | 3 | 1 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| TEMP** | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| | 2 | 2 | 1 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 2 | 0 |
| | 3 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 0 |
| | 4 | 3 | 1 | 0 | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 2 | 0 |
| | 5 | 3 | 2 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| | 6 | 3 | 2 | 0 | 3 | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 0 |
| | 7 | 3 | 1 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | 8 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | 9 | 2 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 10 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 11 | 3 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 12 | 2 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | 13 | 2 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

*   Observations from one site only.

** Average of observations from three sites.

Table 3. Number of plants surviving from three propagules planted for in the spring of 1999 on planting rows at thirteen different elevations on sites exposed to two water management schemes on WRP sites in Quitman County, Mississippi (evaluation dates in 1999)

| Site | Row # | JUEF | | SCCY | | SCTA2 | | THDE | |
|---|---|---|---|---|---|---|---|---|---|
| Eval. Date | | 6/22 | 9/14 | 6/22 | 9/14 | 6/22 | 9/14 | 6/22 | 9/14 |
| PERM* | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 3 |
| | 2 | 1 | 1 | 2 | 0 | 2 | 1 | 3 | 2 |
| | 3 | 3 | 3 | 2 | 1 | 3 | 1 | 3 | 3 |
| | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 1 | 2 |
| | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 1 |
| | 6 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 13 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| TEMP** | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 |
| | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 1 |
| | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| | 7 | 1 | 0 | 0 | 1 | 1 | 0 | 2 | 0 |
| | 8 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 |
| | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 |
| | 11 | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 0 |
| | 12 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 0 |
| | 13 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 0 |

* Observations from one site only.

** Average of observations from three sites.

Plant species observed during the summer of 1998 at the non-planted site were goldenrods (*Solidago* L. sp.), rough sumpweed or annual marshelder (*Iva annua* L.), trumpet creeper (*Campsis radicans* (L.) Seem. ex Bureau), sedges (*Cyperus* L. sp.), foxtails (*Setaria* Beauv. sp.), rushes (*Juncus* L. sp.), and Illinois bundleflower [*Desmanthus illinoensis* (Michx.) MacM. ex B.L. Robins. & Fern.]. There were also scattered individuals of rattlebox [*Sesbania drummondii* (Rydb.) Cory] and swamp rose mallow or wild cotton (*Hibiscus moscheutos* L.). Johnsongrass [*Sorghum halepense* (L.) Pers.] was found at higher elevations, which would have been above the +1 ft WL maximum planting area used at the other sites. These species appeared to be fairly representative of the native vegetation, however, density and species composition varied between the planting sites. Also, the fact that the landowner disked some of the planting sites had a profound effect on vegetative cover on those sites.

Data for the herbicide study are not presented because survival was poor for this planting for the same reasons cited for the main study plots planted at the same time (spring 1998). The glyphosate treatment did not appear to visibly reduce weed growth. This is probably because the plants were well established at the time of treatment and a majority of the weeds present were perennial species. Glyphosate has limited activity on well-established perennial weeds. The treatment area was mowed before spraying and this treatment appeared to have a greater effect on weed cover than the herbicide treatment. Weeds such as trumpet creeper had little canopy remaining after the mowing treatment. Also, mowing probably affected uptake and translocation of the herbicide. It did not appear that the extra effort and expense of a herbicide treatment was warranted on these planting areas. However, there might be cases with severe weed infestations that are susceptible to the herbicide where spraying would have greater effect.

Survival for the spring 1998 propagule type study was also poor, so data are again not presented for this planting. Survival was much better for the fall 1998 planting (Table 4). There were no significant differences in survival between containerized and bare-root plants; however, there was a slight trend for improved survival of containerized plants of SCCY and THDE. In addition to survival, a subjective vigor rating was also taken at each evaluation date. There were significant differences in plant vigor between propagule types, with containerized plants of JUEF and SCCY showing increased vigor (lower vigor rating) compared to bare-root plants. Vigor of containerized THDE probably did not show increased vigor likely because of the available food reserves in the rhizomes of bare-root plants discussed previously. Vigor ratings for most species decreased over the evaluation period, indicating that vigor increased as the plants became more fully established. Unlike bare-root stock, containerized material has a uniform-sized root ball that can simplify the planting operation and this may justify the additional expense of using containerized material.

Table 4. Evaluation of containerized versus bare-root propagules planted in the fall of 1998

| Species | Propagule type | 4/29/99 | | 6/22/99 | | 9/14/99 | |
|---|---|---|---|---|---|---|---|
| | | # Plants | Vigor | # Plants | Vigor | # Plants | Vigor |
| JUEF | Bare-root | 4 | 5a | 4 | 6a | 3 | 6a |
| | Container | 4 | 3b | 4 | 4b | 3 | 3b |
| SCCY | Bare-root | 3 | 7a | 3 | 3 | 3 | 4 |
| | Container | 5 | 3b | 5 | 3 | 5 | 3 |
| THDE | Bare-root | 3 | 4 | 3 | 3 | 4* | 2 |
| | Container | 5 | 1 | 5 | 3 | 5 | 2 |

Vigor ratings 1 = excellent; 3 = good; 5 = fair; 7 = poor; and 9 = dead. Means with different letters are significantly different at $P<0.05$.
*Difficult to accurately count number of plants because of spreading.

## CONCLUSIONS

Plant survival was slightly better when the boards were left in the water control structure, but the spring 1998 planting demonstrated that this would only be true when sufficient rainfall was available to retain ponding during the critical plant establishment phase. Observation wells showed that water did not move laterally to any great extent in these soils, so for plants to benefit from the accumulated rainfall they would have to be located close to the ponded water. Not allowing the water to drawdown in the spring would be a major alternation in the normal management scheme that most landowners follow. However, this change would promote establishment and growth of herbaceous wetland plants, which can increase plant diversity and could also improve wildlife benefits of WRP sites. Another approach would be to design moist soil units to have a portion of the area allowed to retain water year-round, while the rest of the area is drained in the spring according to normal practice. Of the plant species tested, THDE and SCCY appeared to be the best choices for these sites. JUEF had fairly good survival, but it is fairly ubiquitous and would probably invade suitable areas on WRP sites without planting. Herbicide treatments are probably not warranted on WRP sites similar to those used in this test. Use of containerized planting stock may improve establishment success. Additional plantings are planned to determine if native grasses and legumes can also be used as another tool to increase diversity on these planting sites and improve management options for some problem areas.

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