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Los Lunas Plant Materials Center Annual Technical Report

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Bottlebrush Squirreltail – Idaho Plant Materials Center Intercenter Strain Trial

Study Number: NMPMC-T-0902-RA

This intercenter strain trial (ICST) was initiated by the Idaho Plant Materials Center (PMC) to evaluate the adaptability of commercially available releases and a potential accession of bottlebrush squirreltail (*Elymus elymoides spp. elymoides ssp. brevifolius and spp. californicus).*

The following Plant Materials Centers were participants in the ICST:

- Colorado PMC (Upper Colorado Plant Center)
- Idaho PMC
- Los Lunas PMC
- Montana PMC
- Nevada PMC

The ICST included the following selected germplasm or potential accession releases:

Selected germplasm/Potential Accession	**Released or in advanced evaluation by:**
'Sand Hollow' 'Toe Jam' 'Fish Creek'	Idaho Plant Materials Center and the USDA Agricultural Research Service.
'Tusas'	Los Lunas Plant Materials Center and New Mexico State University.
'Pueblo' 'Wapiti' Accession 9092275	Upper Colorado Plant Center and the USDA Agricultural Research Service.

The Idaho PMC assembled and distributed the selected germplasm/potential accession to each participant. The participants placed the selections into random, replicated plantings. The plantings were installed and evaluated by each participant, and each participant was required to submit all evaluations and an annual report to the West National Technical Support Plant Materials Specialist.

Establishing the Trial at the Los Lunas Plant Materials Center

The Los Lunas Plant Materials Center planted four of the six selected germplasm: 'Toe Jam', 'Fish Creek', 'Tusas', 'Wapiti', and the potential Accession 9092275.

On July 20, 2009, the selected germplasm/potential accession seed was planted (using a Kincaid plot drill) into 15 plots using randomized, replicated blocks at the rate of 7-pounds-per-acre. The seed was planted on 12-inch row centers, 38 inches between rows, four rows per plot, and with three replications of each of the selections. See Attachment 1–Bottlebrush ICST Plot Plan.

The planting was irrigated to germinate the seed and to provide optimum growing conditions throughout the growing season:

Amount of Irrigation per Application	**Year**	**Date of Irrigation**
3 inches	2009	July 29, August 7, September 9, October 5
3 inches	2010	March 31, April 30, May 25

Evaluating the Trial at the Los Lunas Plant Materials Center

The following evaluations were performed on the trial plots:

Evaluation Date	Evaluation Findings
September 25, 2009	No seedlings were found in any of the trial plots.
October 23, 2009	No seedlings were found in any of the trial plots.
June 21, 2010	Plot 104 – 'Tusas' germplasm germination was found to be at 8% in the plot. Plants in the plot averaged 8 inches in foliage height and all of the germinated plants had produced seedheads.
	Plot 304 – Accession 9092275 was found to be at 1% germination rate. The plants had averaged 7-inches in foliage height, and all of the germinated plants had produced seedheads.
October 21, 2010	Plot 104 – 'Tusas' was at an 8% germination rate. The plants in the plot had averaged 10-inches in height.
	Plot 304 – Accession 9092275 had a1% germination rate and the plants averaged 8-inches in height.

The remaining plots did not germinate and additional evaluations were not performed in 2010.

Conclusions by the Los Lunas Plant Materials Center

The outcome of the study was not successful, and no additional evaluations will be performed at the Los Lunas Plant Materials Center. If needed, a new trial planting could be installed at the Los Lunas Plant Materials Center in 2011.

Normally, because we flood irrigate our fields at the LLPMC, seedlings of native grasses are usually done on raised beds to prevent the seed from washing away as it floats to the surface as the entire field becomes submerged. With raised beds, the irrigation water is not allowed to flow over the beds, and the surface is watered through capillarity of the soil, in this case, clay loam. But because the seed of bottlebrush squirreltail is large and is similar in size to grain (which we often plant successfully on a flat surface), we thought the bottlebrush squirreltail seed could be planted similarly. Consequently, seedling emergence and establishment was poor, and future studies of bottlebrush squirreltail will be done on raised beds.

Field 18 - Bottlebrush squirreltail ICST June 2010

Field 18 - Bottlebrush squirreltail ICST June 2010

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Field 18 - Bottlebrush squirreltail ICST June 2010

Little Bluestem Polycross Increase Block and Advance Evaluation

Study Number: NMPMC-P-0604-RA

Little bluestem is a native, warm-season, bunch grass and is recognized as an important species for revegetation seeding in its area of adaptation. The LLPMC has released the variety 'Pastura' little bluestem, and it has been used extensively in revegetation efforts throughout the LLPMC service area. There are several little bluestem varieties that have been developed by the Natural Resources Conservation Service Plant Materials Program in the past and currently are available through commercial seed sources.

1990-1991 – In 1990, a re-collection of little bluestem accessions from the LLPMC service area was done to attempt finding an improved selection of little bluestem; one that might out-perform 'Pastura.' In 1991, these accessions were grown in a greenhouse at the LLPMC and then transplanted to an initial evaluation planting. After extensive evaluation of this collection, five accessions were identified that appeared to have improved attributes.

2006 – On March 8, 2006, culms of these five accessions were dug from the parent plants and placed into containers to produce new transplant material. On August 2, 2006, some of these transplants were then planted into Field 28S into a replicated polycross block. Several of the transplants did not survive the initial container planting, and therefore new plants had to be grown in 2007 to complete the polycross block.

2007 –On May 1, 2007, additional culms were taken of the five accessions, placed into transplant containers, and on August 22, 2007, the new transplants were planted into the polycross block in Field 28S. Unfortunately all of the transplants did not survive until the August planting date, and as a result, we had to produce additional transplants in 2008 to complete the polycross planting.

2008 – On April 25, 2008 more culms of the five accessions of little bluestem were dug from the initial evaluation planting in Field 6 and placed in transplant containers. On August 7, 2008 these transplants were then planted into the crossing block in Field 28S. All of the transplants of 2008 survived and completed the planting of the little bluestem polycross block. Seed harvest from the little bluestem will allow for new evaluations to be started on this polycross material. These evaluations along with those of the initial evaluation planting should provide the data necessary to complete the plant material release process.

See previous LLPMC *Annual Technical Reports* to examine data on the evaluation process of the little bluestem.

Field 28S – Treatment and Harvest Information

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 28S	**2010 Date**
Fertilizer Applications	
40 pounds Nitrogen	10/19
40 pounds Phosphorous	2/18
Herbicide Application	3/9
Harvest seed	
Flail-vac	8/20
Irrigation 3" applications	3/17, 5/13, 6/9, 6/24, 7/14, 8/12, 11/3

Action – Field 28S	2010 Date
Pesticide Applications	6/11, 7/13, 7/29, 8/24

Field 28S will be irrigated and fertilized in 2011 for optimum growth.

Tobosagrass Polycross Increase Block

Study Number: NMPMC-P-0602-RA

Tobosagrass (*Pleuraphis mutica* Buckley) is an important, warm-season bunch grass that grows in the Los Lunas Plant Materials Center's (LLPMC) service area. There has been a high-priority need to develop an improved selection of tobosagrass, and to provide this selection to commercial seed source. Since the initial evaluation collections were done in the late 1970s, the LLPMC has been in the process of selecting a plant material release of this species. This species of bunch grass is in high-demand for seeding efforts in the low rainfall, southern desert areas of the LLPMC service area.

2006 – In 2006, culms were taken from six accessions in the initial evaluation planting in Field 6 at the LLPMC, which were identified as having the potential for a plant material release. The vegetative material was used to start transplants for inclusion in a polycross block to be established in Field 28S at the LLPMC.

The transplants of the six accessions were planted into Field 28S on August 2, 2006. Several of the transplants from the six accessions had died prior to the August planting, and this required new plants to be harvested in 2007 to complete the polycross block.

2007 – On May 1, 2007, culms were taken again from the initial evaluation planting in Field 6 and potted in containers to grow transplants for the polycross block in Field 28S. On August 22, 2007, the transplants were planted in the polycross block in Field 28S. Several transplants had died prior to this planting, and as a result, new culms had to be dug and transplanted in 2008 to complete the polycross block.

2008 – On April 25, 2008 culms were taken from the initial evaluation planting in Field 6 were harvested once again in order to complete the polycross block in Field 28S, and were planted on August 7, 2008. All of the transplants had survived and the tobosagrass polycross block was complete.

In 2008 plant samples of the six accessions were taken from the tobosa crossing block. These plant samples were individually packaged into plastic bags and on November 3, 2008, they were sent to Dr. Kelly Allred at New Mexico State University in Las Cruces, New Mexico. Dr. Allred is a plant identification specialist for the university and the LLPMC has requested the samples be examined to determine if they all are indeed tobosagrass.

See previous *LLPMC Annual Technical Reports* for information on the accessions in the initial evaluation planting of tobosagrass at the LLPMC.

Field 28S Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting:

Action – Field 28S	**2010 Date**
Irrigation 3" application	3/17, 5/13, 6/9, 6/24, 7/14, 8/12, 11/3
Fertilizer	
40 pounds Nitrogen	10/19
40 pounds Phosphorous	2/18
Herbicide	3/9
Pesticide Application	6/11, 7/13, 7/29, 8/24
Harvest Seed	
Flail-Vac	7/16, 8/20

Field 28S will be irrigated and fertilized in 2011 for optimum growth.

Blue Grama Variety Trial

Study Number: NMPMC-T-0401-RA

High-elevation grazing between elk and livestock was a concern for landowner Carl Smith. Elk were grazing on his forage pasture during the spring which would decrease the available forage for livestock during the summer-grazing season. The elk herd in the area would eat the cool-season grass forage prior to the introduction of livestock in the summer months. Without the cool-season species forage, and because of the low production rates of warm-season indigenous forage grass species, the livestock would have an insufficient amount of feed during the summer grazing period.

Blue grama is a component of the warm-season range species indigenous to the area. The native blue grama at this location exhibits low forage production and does not adequately contribute to the total amount of forage production of this rangeland. It was possible that improved varieties of blue grama could possibly provide a greater forage potential at this high-elevation site (8,200 feet).

Installation July 27, 2004 – In an attempt to solve this problem, the NRCS Field Office in Espanola, New Mexico and the LLPMC installed a trial planting of four improved varieties of blue grama: 'Hachita,' 'Lovington,' 'Alma' and Bad River Ecotype. The seed was installed using a plot drill on .10 acres and in 16 replicated plots. 'Hachita,' 'Alma' and 'Lovington' were developed by the LLPMC. Bad River Ecotype is an ecotype release from the Bismarck Plant Materials Center in North Dakota. Including the Bad River Ecotype in the trial planting gives us the opportunity to evaluate an accession from a northern climate.

Evaluation October 1, 2004 –. None of the blue grama seed had germinated. This planting may have been installed too late in the season for germination to occur at this elevation. This planting was disked out by Mr. Smith in the spring of 2005 to prepare the area for a new trial planting.

Installation June 6, 2006 –The same four varieties of blue grama were installed on June 6, 2005 by personnel from the Espanola Field Office and the LLPMC. The seeding was installed using the same procedures as in 2004 except for the earlier planting date in hopes to provide a longer growing season for any seed that may germinate. This earlier planting date compensates for the shorter growing period at this elevation.

2010 Evaluation – No evaluations of the Carl Smith blue grama study were completed in 2010.

See the *2004-2009 Los Lunas Plant Materials Center Annual Technical Reports* for previous information on this study.

This study is now inactive.

Giant Sacaton (*Sporobolus wrightii*)

Study Numbers: NMPMC-P-8401-CP and NMPMC-S-0901-CP

Giant sacaton is a native, robust, perennial warm-season bunchgrass. It is found throughout the southwestern United States, usually occurring on low alluvial flats and flood plains. It is useful forage for livestock and wildlife. Under irrigation, Giant sacaton may reach heights exceeding 3 m. The mature plants range in height from 1–4 m. Based upon its density and height, it has the potential as a windbreak plant for irrigated cropland.

NMPMC-S-8401-CP – Initial Seed Collection and Propagation

Seed collections of Giant sacaton were taken from 37 locations throughout New Mexico. These collections were used to establish non-replicated, accession rows that consisted of 520 plants in a field at the Los Lunas Plant Materials Center. Based on a visual evaluation of vigor and height, ten superior plants were selected. Each selected superior plant came from a separate accession to maintain a diverse population. From these ten plants, one super selection was made. A hybrid, cross-planting was established as an attempt to improve the height of the progeny.

In 1992, colonal shoots of each selected plant were planted into a hybrid, seed-production block with the super plant as the male pollinator. In 1995, seed was hand-harvested from each female parent. In 1996, this seed was used to establish an evaluation planting that contained both parents and progeny. The progeny were derived from seed, and the parents were vegetatively propagated. Both sets of plants were grown in 6-inch square pots for eight months in an attempt to equalize carbohydrate reserves in the seed derived plants and the clones. The planting design was an 8-replicated, split-plot, randomized block design. Each replication consists of 20 plants spaced on 10-ft. centers. A plot consists of a parent and the progeny plant.

The planting is mowed in the winter to remove plant liter from the previous year. By the end of the third growing season, the leaf blades of most plants had approached 3 m in height. When the plants are flowering they may approach 4 m.

In August 2002, the planting was evaluated for leaf height, basal width, and appearance. A separate, paired, T-test statistical analysis was performed on each replication comparing the height of each parent to its progeny. The progeny and parent plants were not significantly different in height (alpha .05). However, there appears to be a difference in leaf blade width, color, and uprightness between the parents and progeny plants. The cloned parent plants remain identical to their source where the progeny plants seem to have random variation.

The August 2002 colonal giant sacaton planting was removed in 2009. See previous *LLPMC Annual Technical Reports* for information on study NMPMC-P-8401-CP.

NMPMC-S-0901-CP – Seed Increase of Giant Sacaton Accession No. 9066790

In 2009, giant sacaton seed from the original parental selections was used to start transplants in the LLPMC greenhouse. The transplants were used to plant seed increase plantings of the giant sacaton into fields at the LLPMC. These increase plantings will continue the process towards producing a conservation plant release of giant sacaton by the LLPMC. The increase field plantings are on 38 row centers and use three different in row planting intervals; one foot, two feet and three feet. The three in row intervals will be harvested and cleaned separately to look for any significant affects they may have on seed production. These plantings will increase seed of this accession of giant sacaton for continued testing as a potential plant materials release.

2010 Treatment and Harvest for the Parent Plantings

The 2010 field maintenance for the parent plantings consisted of the following activities:

Field Number	**Action**	**2010 Date**
Field 13 Parent Lines	Weed control was performed throughout the growing season. Field will be fertilized and irrigated in 2011.	
	Swath	November
Field 26N Parent Lines	Weed control was performed throughout the growing season. Field will be fertilized and irrigated for optimum growth of planting in 2010.	
	Irrigation 3” Application	6/17
Field 8 and 14 Accession 9066790 Giant sacaton seed increase	Weed control was performed throughout the growing season. Tields will be fertilized and irrigated for optimum growth of planting in 2011.	
	Fertilizer Field 8 40lbs. Nitrogen 40 lbs. Phosphorous Field 14 40 lbs. Nitrogen 40 lbs. Phosphorous	 7/2 3/2 7/2 3/3
	Irrigation 3” Application Field 8 Field 14	 3/5, 5/11, 6/17, 7/15, 8/13, 9/13, 10/28 3/10, 5/10, 6/2, 6/17, 7/15, 8/13, 9/13, 10/12
	Herbicide Application Field 8 Field 14	 3/4 3/4
	Harvest Field 8 Field 14	 9/20 9/20

Evaluation of Giant Sacaton for Use in Field Windstrip Plantings

Study Number: NMPMC-P-9801-CP

Background information on the Los Lunas Plant Materials Center's (LLPMC's) evaluation of the native grass species giant sacaton (*Sporobolus wrightii*) can be found in *LLPMC Annual Technical Reports* from 1981 to present and in study number NMPMC-9601-CP. This study details the LLPMC's efforts to develop a selected accession of giant sacaton for a possible plant materials release. The study also details the efforts of producing giant sacaton seed and transplants from advanced plantings grown at the LLPMC.

NRCS Field Offices in our service area continue to be very interested in using the giant sacaton species for windstrip plantings to control or prevent existing soil erosion on various types of land uses. Distribution and planting of this native species continues to promote the utility of this species for use as a windstrip and further defines its range of adaptability.

Active and Inactive Windstrip Plantings

In 2010, the LLPMC evaluated giant sacaton windstrip trial plantings in the state of New Mexico. Several windstrip plantings are no longer being evaluated on an annual basis.

Active Windstrip Plantings

The following windstrip plantings are currently being evaluated by the Los Lunas Plant Materials Center:

- Espanola, New Mexico – Rio Arriba County Rural Event Center
- Estancia, New Mexico – Pete Golden Farm
- Lordsburg, New Mexico – Joshua Sanchez Farm
- Taos, New Mexico – Tony Benson Ranch and the Taos County Extension Office

Inactive Windstrip Plantings

For background and evaluation information about the following inactive windstrip plantings, please see previous *LLPMC Annual Technical Reports*:

- Clayton, New Mexico – Ken Dellinger
- Columbus, New Mexico – Rancho La Frontera
- Deming, New Mexico – Keeler Farm, Diaz Ranch
- Hobbs, New Mexico – Landfill Site
- Isleta, New Mexico – Bernard Lujan
- Jal, New Mexico – City of Jal
- Lovington, New Mexico – Lovington USDA Service Center
- McIntosh, New Mexico – Schwebach Farm
- Tatum, New Mexico – Tatum Memorial Cemetery and the Tatum Town Park
- Tucumcari, New Mexico – Tucumcari Outdoor Classroom

Espanola, New Mexico – Rio Arriba County Rural Event Center

Installation August 8, 2006– A giant sacaton trial windstrip planting was installed at the Rio Arriba County Rural Event Center just northwest of Espanola on Highway 554. The planting site is located in USDA Plant Hardiness Zone 6 (see Table 1) at an elevation of 5,900 feet.

Personnel from the New Mexico State University's Rio Arriba County Extension Office, the Rio Arriba County Office, the NRCS Espanola Field Office, and the LLPMC planted 100 giant sacaton transplants

into two rows using six-foot spacing. The planting is located along the west side of the Event Center's access road, and it acts as a visual screen for a property owner next to the Event Center. The purpose of this planting is to provide wind erosion protection along the Event Center. The windstrip will help the LLPMC to evaluate the adaptability of giant sacaton as a windstrip or windbreak species in this area of New Mexico. The planting has a drip irrigation system for supplemental watering.

Rio Arriba Fairgrounds giant windstrip sacation planting October 2010

Evaluation October 8, 2010 – The plants appeared to be healthy, and plant growth was vigorous with good forage and abundant seedheads on each plant. The plants had an average height of 70 inches, and the forage width averaged 38 inches. This planting has received supplemental irrigation through the drip system. No giant sacaton seedlings were seen near the parent plants.

No evaluations are scheduled for 2011.

Estancia, New Mexico – Pete Golden Farm

This giant sacaton windstrip planting is located on the Pete Golden Farm near Estancia, New Mexico. The planting site is located in USDA Plant Hardiness Zone 6 (see Table 1) at an elevation of 6,100 feet. The windstrip was installed to help protect Mr. Golden's irrigated cropland during the high-wind, soil-erosive period. The East Torrance Soil and Water Conservation District and the NRCS Estancia Field Office are sponsors of this project.

Installation July 16, 2010 – The LLPMC delivered 650 giant sacaton transplants to Mr. Golden. The windstrip was planted in two staggered rows along the east and west boundaries of Mr. Golden's pivot-irrigated cropland. The giant sacaton transplants were hand watered during the 2010 growing season.

Evaluation September 21, 2010 – The planting had very limited growth; 40 to 50 percent of the planting appeared to have died. There was significant damage from rabbits and gophers on the surviving plants. The plants had very poor growth and were in poor condition. Most plants appeared to be stressed from a lack of moisture, although Mr. Golden stated he had watered the planting.

No evaluations are scheduled for 2011.

Pete Golden Farm, Estancia, NM giant sacaton windstrip planting September 2010

Lordsburg, New Mexico – Joshua Sanchez Farm

This giant sacaton windstrip planting is located on the Joshua Sanchez Farm near Lordsburg, New Mexico. The planting site is located in USDA Plant Hardiness Zone 7 (see Table 1) at an elevation of 4,275 feet. The windstrip was installed to help protect Mr. Sanchez's irrigated farmland during the high-wind, soil-erosive period. NRCS's Hidalgo Soil and Water Conservation District and Lordsburg Field Office are sponsors of this project.

Installation May 27-28, 2009 – The LLPMC delivered 1,900 giant sacaton transplants to the Sanchez farm. The windstrip was planted in two staggered rows along the west and south boundaries of Mr. Sanchez's cropland to help protect his land and farm roads from blowing soil coming from rangeland adjacent to his farm. The windstrip was planted using two different row-spacing measurements between plants of five-feet and six-feet. An evaluation will determine if using these different measurements will have an effect on the height or width of the foliage.

This planting received supplemental water from an existing irrigation system. To promote optimum growth of the giant sacaton plants, a drip irrigation system was installed to water the windstrip.

Evaluation October 2010 – Penny Driscoll, District Conservationist from the NRCS Lordsburg Field Office visited the site and provided the LLPMC with pictures of the planting. The plantings looked healthy and vigorous. Judging by the pictures Penny provided, the west windstrip planting had improved substantially since the 2009 evaluation. The plants appeared to be robust with good seedhead and forage production. The southern windstrip looked just as robust with abundant forage and seedhead produced in the planting.

No evaluations are scheduled for 2011.

Joshua Sanchez Farm, Lordsburg, NM west windstrip planting October 2010

Joshua Sanchez Farm southern windstrip planting Ocotober 2010

Taos, New Mexico

Tony Benson Ranch

This giant sacaton windstrip planting is located west of Taos, New Mexico on the Tony Benson Ranch in Section 4 Township 26N and Range 11E. The planting site is located in USDA Plant Hardiness Zone 5 (see Table 1) at an elevation of 7,200 feet.

Installation July 10, 2008 –Personnel from the LLPMC, Taos Field Office, and the foreman of the Benson Ranch installed 300 giant sacaton transplants in a fenced-in plot at the Benson Ranch. Mr. Benson would like to use the giant sacaton windstrip for protection around his buildings and other areas on the ranch. The fenced-in area was intended to the plants safe from animal predation. The transplants were irrigated using a hand-watering system. This trial planting is a continuation of evaluating the adaptability of giant sacaton in different locations in the LLPMC service area.

Evaluation October 9, 2010 – The plants had not produced much forage in 2010. They had averaged 22 inches in height and 10-inches in width. The survival rate was good with only a few plants being lost to predation by gophers. The planting had produced a few seed stalks, and it is possible a few seeds made it to maturity. The plants, though lacking much in forage production, survived the very harsh winter conditions of the 2009-2010. The planting received supplemental watering during the 2010 growing season.

No evaluations are scheduled for 2011.

Tony Benson giant sacaton planting, Taos, NM October 2010

Taos County Extension Office

This giant sacaton planting was installed next to the Taos County Extension Office which is located in the Juan I. Gonzales building at the Taos County Fairgrounds. The planting site is located in USDA Plant Hardiness Zone 5 (see Table 1) at an elevation of 6,900 feet.

Installation July 9, 2008 – Thirty-six giant sacaton transplants grown at the LLPMC were planted into an existing, fenced-in, demonstration planting area just east of the office building. This area previously was used by the Taos County Extension Office for planting and drip irrigation trials. The giant sacaton was irrigated using an existing drip irrigation system. The purpose of this planting was to evaluate the adaptability of giant sacaton at this location.

Evaluation October 8, 2010 – There were only five surviving giant sacaton plants, and the plants were in poor condition. No supplemental irrigation has been provided for the past two years. The site also has a gopher infestation which has contributed to the loss of plants. On the positive side, the surviving plants had a limited amount of moisture and two harsh winters in Taos, New Mexico.

No evaluations are scheduled for 2011.

Table 1: USDA Plant Hardiness Zones	
Zone 5	To –20°F
Zone 6	To –10°F
Zone 7	To 0°F
Zone 8	To 10°F

For an entire list of plant hardiness zones, see USDA Miscellaneous Publication No. 1475, January 1990.

Active Field Production Studies for 2010

Propagation of Autumn Amber

Study Number: NMPMC-P-9803-UR

Field 26S Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action Field 26S *	2010 Date
Irrigation 3" application	4/27, 7/19, 10/12

- Field 26S was irrigated for optimum growth in 2010.

Hope Desert Willow Stock Plant Production

Study Number: NMPMC-P-0102-UR

Field 26S Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. Seed was not harvested in 2010.

Action Field 26S *	2010 Date
Irrigation 3" application	10/14, 4/1, 4/29, 5/27, 6/17, 7/9, 9/8, 10/12, 11/19
Fertilizer	
5 lbs. Nitrogen	1/12
40 lbs. Phosphorous	1/12

* **Field 26S will be irrigated and fertilized in 2011 for optimum growth.**

Regal Desert Willow Stock Plant Production

Study Number: NMPMC-P-0101-UR

Field 26S Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Seed was not harvested in 2010 from this planting.

Action Field 26S *	2010 Date
Irrigation 3" application	1/14, 4/1, 4/29, 5/27, 6/17, 7/9, 9/8, 10/12, 11/19
Fertilizer	
5 lbs. Nitrogen	1/12
40 lbs. Phosphorous	1/12

* **Field 26S will be irrigated and fertilized in 2011 for optimum growth.**

Four Corners Region Species

Study Number: NMPMC-P-9505-CR

Field 35N Treatment and Harvest

The plantings of different shrub species collected from the Four Corners region of New Mexico continue are to be grown for possible plant material release in the future. The desert needlegrass and bluebunch

wheatgrass collections that were part of these original collections have been placed into seed increase for a possible plant release in cooperation with the Bureau of Land Management. Evaluations will be completed as needed on the remaining collections of this study.

Weed control was performed throughout the growing season to keep the fields clean and promote vigorous growth of the plantings.

Action Field 35N *	**2010 Date**
Shrub collections	
Irrigations 3" water application	4/6, 4/30, 6/1, 6/24, 10/12

* **Field 35N will be irrigated and fertilized in 2011 for optimum growth.**

Mexican Whitesage

Study Number: NMPMC-9801-WL

Field 26N Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

No seed was harvested in 2010. Seed harvest will be attempted in 2011.

Action Field 26N *	**2010 Date**
Irrigation (3" application)	6/18

* **Field 26N will be irrigated and fertilized in 2011 for optimum growth.**

Single Leaf Ash and Fragrant Ash

Study Number: NMPMC-P-9804-UR

Field 26S Treatment and Harvest

Evaluation of these accessions of ash will continue in 2011 for a possible conservation plant materials release.

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action Field 26S *	**2010 Date**
Irrigation 3" application	1/14, 4/1, 4/29, 5/27, 6/17, 7/9, 9/8, 10/12, 10/19
Fertilizer	
5 lbs. Nitrogen	1/12
40 lbs. Phosphorous	1/12

* **Field 26S will be irrigated and fertilized in 2011 for optimum growth.**

Advanced Planting of Needle and Thread grass

Study Number: NMPMC-S-9503-RA

These accessions of needle and thread grass are being evaluated for a possible variety release by the LLPMC. No evaluations were completed in 2010.

Field 12 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 12 *	**2010 Date**
Irrigation 3" application	3/10, 4/27
Fertilizer 40 lbs. Nitrogen	 2/24
Herbicide	3/4

* Field 12 will be irrigated and fertilized in 2011 for optimum growth.

Initial Evaluation Planting of Blowout Grass

Study Number: NMPMC-P-8501-RA

Field 20N Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting. No seed was harvested from this planting in 2010.

Action – Field 20N *	**2010 Date**
Irrigation 3" application	5/13, 6/7, 6/25, 7/14
Fertilizer 40 pounds Nitrogen	 10/19
Herbicide	3/4
Pesticide	6/11, 7/13

* This planting is scheduled for removal in 2011.

Observational Planting with Kingsville, Texas

Study Number: NMPMC-P-0601-RA

Four accessions of windmill grass were being evaluated for adaptability at the LLPMC. The LLPMC was also evaluating seed and forage production in Los Lunas. The planting was established in 2006 using transplants grown from seed sent to the LLPMC from the STPMC. The planting is a replicated plot design, established in field 10 at the LLPMC.

In 2007 two accessions were received by the LLPMC for inclusion in the STPMC observational planting. Kinney two-flower trichloris and Dilley slender grama seed sent from STPMC was used to start transplants in the LLPMC greenhouse. These transplants were used to establish a spaced rod row planting of each accession into field 10 of the LLPMC on 9-06-07. The The LLPMC was evaluating the adaptability for these two releases at Los Lunas.

These plantings are scheduled for removal in 2011.

Field 10 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 10	**2010 Date**
Irrigation 3" application	5/12, 6/1, 6/18, 7/19
Fertilizer 40 pounds Phosphorous	 3/3
Herbicide	3/4

Observational Planting with Kansas PMC

Study Number: NMPMC-P-0701-RA

Three accessions of blue grama, 421282, 421283, 9050485 are being evaluated for adaptability at the LLPMC. The planting is also evaluating seed and forage production in Los Lunas. The planting was established in 2007 using transplants grown from seed sent to the LLPMC by the KSPMC. The planting is a replicated plot design and was planted into field 10 of the LLPMC on 9/06/2007. Evaluations were completed in 2010.

Field 10 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 10 *	**2010 Date**
Irrigation 3" application	5/12, 6/1, 6/18, 7/19
Fertilizer 40 lbs. Phosphorous	 3/3
Herbicide	3/4

* Field 10 is scheduled for removal in 2011.

Observational Planting with James E. 'Bud' Smith PMC, Knox City, TX

Study Number: NMPMC-P-0802-RA

In 2008, seed from three accessions of native species, Arizona cottontop, Prairie acacia, and little bluestem were sent from the James E. Bud Smith Plant Materials Center to the Los Lunas Plant Materials Center, to establish an observational planting. The accessions are being evaluated for possible plant materials cultivar releases. The planting will be used to evaluate adaptability and performance of the three species in the climate found at the LLPMC. The seed sent received by the LLPMC was used to start transplants of the three accessions. These transplants were then used to establish rod rows of each accession in field 10 at the LLPMC on 8/06/2008.

The planting will be evaluated by the LLPMC for adaptability and plant performance for three years.

Field 10 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth.

Action – Field 10 *	**2010 Date**
Irrigation 3" application	5/12, 6/1, 6/18, 7/19
Fertilizer 40 lbs. Phosphorous	 3/3
Herbicide	3/4

* Field 10 is scheduled for removal in 2011.

Alkali Sacaton - Tucson PMC - ICST

Study Number: NMPMC-P-0801-RA

In 2008, seed of alkali sacaton from three plant material releases, Salado, Saltalk and Vegas, along with one collection from California, were sent by the Tucson Plant Materials Center to the Los Lunas Plant Materials Center to establish an intercenter strain trial. The seed was planted into replicated plots on 8/13/08 in Field 18 at the LLPMC. Each accession will be evaluated for its performance.

Field 18 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 18	2010 Date
Irrigation 3" application	3/31, 4/30, 5/27, 7/21
Herbicide	4/14, 7/14

* Field 18 will be irrigated and fertilized in 2011 for optimum growth.

Mesa Dropseed Initial Evaluation Planting

Study Number: NMPMC-P-0702-RA

In 2006, 18 collections of the warm season native bunchgrass, mesa dropseed, (Sporobolus flexuosus), were made in the LLPMC service area for inclusion into an initial evaluation study. These collections will start the evaluation process to produce a conservation plant release of mesa dropseed.

In 2007, seed from each of these collections was used to start transplants in the LLPMC greenhouse. The transplants were planted into replicated plots in field 31S at the LLPMC on 8/21/2008. The replicated initial evaluation planting will be evaluated annually to provide data for a possible conservation plant material release from the LLPMC of mesa dropseed.

The mesa dropseed IEP was evaluated in 2010.

Field 31S Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth.

Action – Field 31S *	2010 Date
Irrigation 3" application	3/19, 5/12, 6/8, 7/9, 9/3, 11/3
Herbicide	3/18
Harvest	9/20

* Field will be irrigated and fertilized in 2011 for optimum growth of planting.

CSU-10–Paloma Indian Ricegrass Comparison Trial

Study Number: NMPMC-P-0903-RA

On 10/27/2009 transplants of two accessions of Indian ricegrass, 9065428 (CSU-10) and Paloma were transplanted into Field 23N of the LLPMC. The planting consists of two 38" spaced rows with groups of 10 plants of the Paloma and CSU-10, randomly located in the rows. The 10 plants in each group are spaced at one foot intervals with a 2 feet spacing between the groups. This study will be evaluating the forage and seed production of the CSU-10 accession against that of Paloma, in order to determine the possibility of a future plant material release of CSU-10.

The planting was evaluated in 2010.

Field 23N Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth.

Action – Field 23N *	2010 Date
Irrigation 3" application	1/14, 3/17, 4/1, 4/14, 5/7, 5/21, 6/10, 7/13, 9/7, 10/7
Fertilization	
40 lbs. Nitrogen	10/19

* Field will be irrigated and fertilized in 2011 for optimum growth.

Gila National Forest Foxtail Prairie Clover Seed Production

Study Number: NMPMC-P-0602-WO

In 2006, the LLPMC received seed from the Gila National Forest of the native legume species Foxtail Prairie Clover, (*Dalea leporina).* This species is highly suitable for seeding efforts following fire events, especially in forested areas of the Gila National Forest. The LLPMC agreed to plant the prairie clover to provide a suitable quantity of seed back to the Gila National Forest for reseeding affected sites of the forest.

Field 23S, 24S, and 27NTreatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth of the planting.

Action – Field 23N	**2010 Date**
Irrigation 3” application	4/2, 4/27, 5/13, 6/17, 7/6, 7/21, 8/12, 9/2, 9/16
Herbicide	5/4, 5/20
Harvest	11/2

Note: This annual species is not scheduled for planting in 2011.

Plant Species for Pollinators Evaluation Study

In 2010, the LLPMC began a study to evaluate the potential of selected plant species to attract and be used by various plant pollinators. The study will determine which pollinators are attracted to the plant, the plant’s vigor, the plant’s survival, and the plant’s duration of beneficial flowering at the LLPMC.

A planting was installed at the LLPMC using 42 herbaceous perennial species, 23 annual and biennial species, and 30 woody species. The project is being conducted in collaboration with Dr. Tess Grasswitz, Urban/Small Farms IPM Specialist with New Mexico State Universities Agricultural Science Center in Los Lunas. Additional pollinator species are scheduled to be added to this planting in 2011.

Field 7 Treatment and Harvest

Weed control was performed throughout the growing season to keep the field clean and promote vigorous growth.

Action – Field 7 Pollinator Species*s	**2010 Date**
Transplant	6/2010
Irrigation 3” application	6/23, 7/1, 7/6, 7/9, 7/12, 7/15, 8/12, 8/20, 9/2, 9/17, 10/7, 10/29, 11/19

* The planting will be fertilized and irrigated in 2011for optimum growth.

Bernalillo Priority Site Longstem Transplant Study

Study Number: NMPMC-T-0901-RI

During an eight day period from December 2006 through January 2007, the USDA Natural Resources Conservation Service Los Lunas Plant Materials Center (LLPMC) installed 2,481 plants on the east side of the Rio Grande. The site is located approximately ½-mile south of the Bernalillo Bridge on Highway 550, near Bernalillo, NM (Sandoval County) Only the frontage area was planted, which incorporated about 3,000 linear feet. The planting area located near the river has a groundwater depth of less than eight feet. Some plants were also installed on a one-acre sandbar island located directly across from the river bank planting, about midway to the west bank.

The Albuquerque Area Office, Bureau of Reclamation (Reclamation) stabilized a section of the east bank of the Rio Grande by changing the contour of the river bank and constructing weirs made of boulders, mature cottonwood trunks, and stumps. The weir structures help to deflect the flows off the bankline, slowing the flow and allowing sediment to deposit all while reducing bank erosion.

Overview of the Bernalillo Priority Site planting (looking northwest on June 10, 2009.

Much of the original vegetation was impacted during construction by bulldozers and excavators. The LLPMC's goal was to replace the vegetation, increase species diversity and density (also which helps stabilize the river bank), and improve wildlife habitat. The Bureau of Reclamation provided the funding under their river maintenance program for this restoration project.

Commonly in the Southwest, many riparian areas have shallow water tables which support established native riparian phreatophytic vegetation. Because of flood control structures and flow regulation, the surface water hydrology has been altered. Therefore, these former floodplain sites often to not experience overbank flooding. Supplemental water from flooding is critical in the arid Southwest for the recruitment of new seedling stands of common obligate riparian species. Without supplemental water, seedlings of these riparian species do not occur naturally.

The establishment of obligate riparian plants in the arid Southwest requires either lengthy irrigation until the transplants' root systems can extend into the permanent soil moisture above the water table (capillary fringe), or planting techniques that allow immediate or rapid root extension into the water source by utilizing deep planting methods (such as the Longstem Planting Method and the Whip and Pole Cutting Planting Method). The longstem planting method allows for planting riparian woody species that requires minimal or no follow-up irrigation, and improves survival rates and reduces long-term maintenance costs.

Method

The LLPMC staff deep planted 178 New Mexico olive, 209 false willow, and 146 false indigo longstem transplants. Also deep planted were 25 cottonwood pole cuttings, 26 Goodding's willow pole cuttings, and 1,897 willow whip cuttings.

Longstem transplants are grown in 30″x 4″x4″ tapered containers. This nursery stock type takes about three to four years to produce transplants from liner stock or four to five years from seed to achieve a height of 6-ft. to10-ft. The plants are kept well fertilized and irrigated during the growing process.

Unloading longstem transplants

Dormant cottonwood and Goodding's willow sapling tree plantations at the LLPMC were started from seed. To produce pole cuttings, the saplings were cut at the ground level and their lateral branches were removed while leaving their branch collars intact. These cuttings were harvested by the third or fourth growing season. Coyote willow whip cuttings were wild-land harvested along local irrigation canals in Los Lunas, NM. These cuttings also had their lateral limbs removed. Both pole and whip cuttings were kept hydrated until they could be planted at the site, which occurred within two weeks of harvesting.

The longstem transplants were planted on the floodplain terrace above bankfull (the incipient elevation on the bank where flooding begins) during December 2006 and January 2007. The lower portion of the root ball was placed in contact with the capillary fringe of the water table. Sixty-five longstem transplants and 300 coyote willow whip cuttings were also planted across the island. All of the planting was done with a 9″- by- 8′ auger mounted to the front loader of a 65-hp farm tractor.

During the winter period, the evapotransporation demands of plants are reduced, and the water table is usually near or at its lowest level. The deep water table is important because newly augured holes in loamy to coarsely textured soils (common for Southwest alluvium soils) will collapse at the water table depth which could possibly be too shallow if planted during high spring runoff. The root crown of the transplant often needs to be buried at a minimum of 4- to 6-feet, the depth of capillary water during the mid-to late-summer period. At the time of planting, a 40″ long by 1″ diameter watering tube was embedded with each transplant. If the capillary water happens to drop beneath the root ball, supplemental water can be provided until the root system once again comes into contact with capillary water.

Drilling down to capillary water to plant tallpot longstem transplant

Typically, these plants do not require any supplemental water. If a transplant is placed too deep in the soil and the water table submerges the entire root ball, the leaves of the plant will begin to display a yellowing or chlorosis. If the soaking persists longer than four to five weeks, the transplant may die. If the transplant survives, by springtime new adventitious root growth will be initiated on the main stem of the plant just below the soil surface providing needed oxygen to the root system.

The cottonwood and Goodding's willow pole cuttings were planted on the floodplain terrace above bankfull at water table depth. These pole cuttings were protected from beaver by using a5-ft. long by 10-inch diameter poultry wire tree-guard that enclosed the base of the main stem. Coyote willow whip cuttings were planted just above the bank-full stage to the depth of the water table. By spring, new adventitious root growth will occur on cuttings near the soil surface and at the depth of the capillary zone of the water table where there is both moisture and air.

Dropping a longstem transplant into a 9-inch diameter, 6-ft hole as the auger bit is being removed

Planting coyote willow to groundwater depth at bankfull elevation

The longstem transplants were irrigated at the time of installation to achieve good soil-to-root contact by collapsing air pockets in the soil. Since then, there has been no supplemental water provided to any of the transplants at this location.

Results and Discussion

The 65 longstem transplants and 300 coyote willows planted on the island were washed out the first year by the high spring flow. The island has been submerged for the past three spring run-off periods. The remaining 1,597 coyote willow whips that were installed on the east bank were not counted for survival determination. Many were cut by beaver and were resprouting while others had been washed out by very high spring runoff. Some are suckering with new shoots. Nevertheless, a healthy, vigorous stand has established providing some protection of the outside bank of this meander in the river. Of the 468 remaining plants (which include long stem transplants, cottonwood pole cuttings, and black willow pole cuttings), the survival rate was at 93% on June 10, 2009 (shown in the following table).

Third Year Survival Rate Results

Species	Type	Total Planted on Island	Percent Survival	Total Planted on East Bank	Surviving Plants	Percent Survival
New Mexico olive	longstem	22	0	156	151	97
Emory's baccharis	longstem	58	0	151	134	89
desert false indigo	longstem	29	0	117	108	92
Rio Grande cottonwood	pole cutting	7	0	18	18	100
Goodding's willow	pole cutting		0	26	25	96
coyote willow	whip Cutting	300	0	1,597		
Total		**416**	**0**	**2,065**		**Weighted Mean 93%**

Survival of all species was excellent with the lowest survival at 89% for Emory's baccharis. Plants did not die of desiccation which is usually common in Southwest plantings, but by submergence from high spring flows which ran longer than a four-week period. The watering tubes that remained allowed easy identification of missing (washed out) plants.

Established resprouting coyote willow whip cuttings after beaver predation

Established coyote willow whip cuttings with suckering at root crown depth and adding new shoots to the stand.

Beaver damage occurred on shrubs planted near the river's edge. However, the plants readily resprouted from the new root crown. There was no beaver damage on cottonwoods and black willow trees because they were protected with tree guards. When the tree species become damaged, they develop into a multi-stem shrub/tree which slows their ability to provide substantial shade (cooling) which may enhance the natural seedling recruitment of desirable plant species in the arid southwest.

Because riparian trees and shrubs are phreatophytes, they grow very quickly when planted into either capillary water or groundwater. After about 40 days into the third growing season, the New Mexico olive shrubs had put on nearly 12-inches of new growth. Generally the shrub species had doubled or tripled in size from their original planting height of 2-feet. Many of the cottonwoods and Goodding's willows trees are producing about 3-feet of annual growth.

Natural flooding of Rio Grande inudating established black willow pole cuttings and New Mexico olive longstem transplants.

Established cottonwood pole cuttings approaching 20 feet

Resprouting established longstem desert fals indigo after beaver predation the prior summer.

Dark stems show new growth on a New Mexico olive longstem transplant after 40 days into its 3rd growing season

Established longstem transplant group of Emory's baccharis that are more than 6 feet tall.

Established longstem transplant group of New Mexico olive that are more than 4 feet tall.

Apache-Sitgreaves National Forests
Seed Production of Upland Grass Species

The purpose of this project was to develop new, native plant materials for use in Southwestern site restoration and rehabilitation, especially following wildfire, prescribed fire, and watershed restoration. Grass seed sources were evaluated from wildland collections ranging in elevation from 6,100 to 10,500 feet and representing piñon/juniper woodland, ponderosa pine forest, and mixed conifer forest types. The intent was for the Los Lunas Plant Materials Center (LLPMC) to develop source-identified, germplasm releases that could be made available to commercial seed growers in the Southwest.

Seed Collection, Seed Cleaning, and Plug Seedling Propagation

The Apache-Sitgreaves National Forest (ASNF) developed a list of preferred grass species for development that span forest types from piñon/juniper to mixed conifer. With input from United States Department of Agriculture Forest Service (USDA-FS) personnel regarding potential collection sites, Mel Wilhelm of *3C Consulting*, Vernon, Arizona collected the seed in both 2006 and 2007. The collected seed was sent to the LLPMC for cleaning, producing plug seedlings, and installing the seedlings into production fields for eventual seed harvest.

The collected seed was used to produce plug seedlings for planting in the seed production fields. Plugs trays with 341 cells (each cell measuring ¾”x ¾” x 2½”) were filled with a sphagnum peat moss/perlite media. The media incorporated micro-pellet, controlled-release fertilizer that provides major and minor nutrients. The seed was sown by diluting it with 1 cup of media and then dispersing it through a large mesh, soil sieve to achieve uniform seed distribution. The seeded plug trays were placed in the greenhouse on a bench under micro-sprinklers that automatically watered them daily for five minutes. After germination and initial seedling growth, the plug trays were set on mesh flats to allow air pruning of the roots. The trays were watered once per day and were fertilized with a balanced, soluble, nutrient solution several times a week. Several weeks before planting the seedlings into the seed production fields, they were placed in the nursery to harden off.

The following tables present information on:

- Seed collection locations for 2006 and 2007
- LLPMC accession number assignment
- Cleaned seed weight

2006 and 2007 seed collection information provided by Mel Wilhelm of *3C Consulting*, Vernon, AZ. Collection number, LLPMC accession number, collection date, ranger district, and elevation.

Genus	Species	Wilhelm Collection Number	LLPMC Accession Number	Collection Date	Ranger District	Elevation
2006 Collections						
Festuca	*thurberi*	W-1	9066725	9/29/06	Alpine	10,480
Pleuraphis	*jamesii*	W-2	9066724	10/11/06	Black Mesa	6,100
Bouteloua	*gracilis*	W-3	9066721	10/11/06	Black Mesa	6,100
Bouteloua	*gracilis*	W-4	9066722	10/19/06	Lakeside	6,700
Muhlenbergia	*wrightii*	W-5	9066726	10/19/06	Lakeside	7,100
Bouteloua	*gracilis*	W-6	9066723	10/20/06	Clifton	6,400
Lycurus	*setosus*	W-7	9066720	10/20/06	Clifton	6,400
Muhlenbergia	*montana*	W-8	9066727	10/20/06	Alpine	8,100
Festuca	*arizonica*	W-9	9066728	10/21/06	Springerville	9,500
Bromus	*frondosus*	W-10	9066729	10/21/06	Springerville	9,500
2007 Collections						
Festuca	*thurberi*	W-1	9066725	9/29/07	Alpine	10,480
Festuca	*arizonica*	W-9	9066728	10/27/07	Springerville	9,500
Bromus	*frondosus*	W-10	9066729	10/27/07	Springerville	9,500

2006 and 2007 seed collection information provided by Mel Wilhelm of *3C Consulting*, Vernon, AZ. Township, range, section and quarter section, location description, associated species, soil type, and weight of cleaned seed.

Genus	Species	TP	RG	Section and Quarter	Location	Assoc. Species	Soil	Cleaned Seed Wt. (g)
2006 Collections								
Festuca	*thurberi*	7N	31E	Sec. 31 SW	Bead Spring Meadow, Escudilla Mtn.	MUMO, FEAR, BRMA,IRMI, Achillea	Red silty loam, eastern aspect	14.6
Pleuraphis	*jamesii*	14N	20E	Sec. 21 NW	Town Draw Area	BOGR, ATCA, SPAI, SPCR	Derived from rim gravels	3.3 caryopsis
Bouteloua	*gracilis*	14N	20E	Sec.20 NE	Town Draw Area	ATCA, GUSA, JUMO	Gravelly silt	38.4
Bouteloua	*gracilis*	9N	23E	Sec. 23 NE	Ranger District Horse Pasture	BLTR, ELEL, PIPO, JUDE	Clay with surface rock	21.0

2006 and 2007 seed collection information provided by Mel Wilhelm of *3C Consulting*, Vernon, AZ. Township, range, section and quarter section, location description, associated species, soil type, and weight of cleaned seed.

Genus	Species	TP	RG	Section and Quarter	Location	Assoc. Species	Soil	Cleaned Seed Wt. (g)
Muhlenbergia	*wrightii*	9N	23E	Sec. 34 NW	Sky Hi Road Trailhead	IRMI, FEAR, PIPO	Silty clay, upland meadow	15.6
Bouteloua	*gracilis*	1S	29E	Sec. 34 SW	Four Bar Mesa	BOCU, LEDU, PAOB, PIED, JUDE	Granitic soil	11.1
Lycurus	*setosus*	1S	29E	Sec. 34 SW	Four Bar Mesa	BOCU, LEDU, PAOB, PIED, JUDE	Granitic soil	19.7
Muhlenbergia	*montana*	5N	30E	Sec. 6 NW	FR 249 to Big Lake	BLTR, MUWR, ELEL, POTR, PIPO	Volcanic origin, upland meadow	26.9
Festuca	*arizonica*	8N	26E	Sec. 2 SW	East Side of Greens Peak FR 117	BRMA, MUMO, POTR	Volcanic origin, upland meadow	39.7
Bromus	*frondosus*	8N	26E	Sec 25 NE	Beehive Spring FR 117	FEAR, MUMO, POTR	Upland meadow	22.1
2007 Collections								
Festuca	*thurberi*	7N	31E	Sec. 31 SW	Bead Spring Meadow, Escudilla Mtn.	MUMO, FEAR, BRMA,IRMI, Achillea	Red silty loam, eastern aspect	600
Festuca	*arizonica*	8N	26E	Sec. 2 SW	East Side of Greens Peak FR 117	BRMA, MUMO, POTR	Volcanic origin, upland meadow	29.9
Bromus	*frondosus*	8N	26E	Sec 25 NE	Beehive Spring FR 117	FEAR, MUMO, POTR	Upland meadow	14.2

Seed Field Planting

When the plug seedlings had developed cohesive root balls, they were installed using a mechanical, vegetable transplanter with two people manually feeding the plugs into the planter. The rows were spaced 38 inches apart, and the plugs were placed approximately 12 inches apart in each row. As the plugs were being installed, each row was sprayed with water from a water trailer. Once the entire field was planted, it was flood irrigated.

The following tables delineate the field installation information for each species planted in 2007, 2008, and 2009. The 2009 planting involved the installation of 11 rows of galleta.

Using a mechanical transplater to install grass plugs seedlings

The seedheads produced in the brome field in the early summer of 2008 did not appear to be mountain brome. Mitchel White of the Apache-Sitgreaves National Forests identified the brome to be weeping brome; so all information pertaining to this accession has been changed accordingly. During the winter of 2008, Mitchel White identified the spike muhly contaminant to be deergrass (*Muhlenbergia rigens*). After receiving the go-ahead from ASNF, we proceeded to transplant deergrass clumps from the spike muhly field into an adjacent plot which became the deergrass seed production field.

Seed Harvest

The only grasses that produced a significant amount of seed in 2007 were the blue grama (5 lbs bulk, 3.6 lbs PLS) and wolfstail (28 lbs bulk). A small amount of spike muhly seed with deergrass seed contamination was also harvested and cleaned (36 g bulk) as well as galleta (0.46 lb); these seed lots were too small to submit for seed testing.

2008 Seed Harvest

Species	Amount of Bulk Seed	Test Results
Blue grama	0.9 lbs	no seed test performed
Spike muhly	5.2 lbs	95% purity and 92% germination (1% dormant seed).
Wolfstail	28.1 lbs	72% purity and 53% germination (7% dormant seed)

The galleta field was completed in 2009 with plug seedlings grown from seed collected in 2007 and 2008.

2009 Seed Harvest

Species	Amount of Bulk Seed	Test Results
Arizona Fescue	1.54 lbs	89% purity and 89% viable
Blue grama		
Black Mesa	1.06 lbs	81% purity and 84% viable
Clifton	0.88 lbs	97% purity and 70% viable
Lakeside	1.64 lbs	78% purity and 69% viable
Deergrass	0.85 lbs	no test results

Species	Amount of Bulk Seed	Test Results
Spike Muhly	5.6 lbs	89% purity and 89% viable
Weeping brome	7.4 lbs	93% purity and 91% viable
Wolfstail	4.64 lbs	79% purity and 86% viable

2010 Seed Harvest

Species	Amount of Bulk Seed	Test Results
Blue grama	16.5 lbs (composite harvest)	72% purity and 89% viable
Deergrass	2.3 lbs	No test results
Spike muhly	1.7 lbs	No test results
Wolfstail	3.62 lbs	92% purity and 35% viable

Apache-Sitgreaves National Forest grass species planted into seed fields at the Los Lunas Plant Materials Center in 2007 and 2008.

Common Name	Species	Number of Rows	Field Size (acre)	Accession Number	Collection Location	Date Plug Trays Seeded	Date Plug Seedlings Planted	LLPMC Field
2007 Plantings								
Wolfstail	*Lycurus setosus*	12	0.28	9066270	Four Bar Mesa	4/26/07	6/14/07	33N (west end)
Blue Grama	*Bouteloua gracilis*	4	0.09	9066722	Horse Pasture	4/26/07	6/14/07	33N (west group)
Blue Grama	*Bouteloua gracilis*	4	0.09	9066723	Four Bar Mesa	4/26/07	6/14/07	33N (middle group
Blue Grama	*Bouteloua gracilis*	4	0.09	9066721	Town Draw	4/26/07	6/14/07	33N (east group)
Galleta	*Pleuraphis jamesii*	1.2	0.03	9066724	Town Draw	3/20/07	6/14/07	33N
Spike Muhly	*Muhlenbergia wrightii*	15	0.24	9066726	Sky Hi Road Trailhead	5/25/07	7/10/07	14
Mountain Muhly	*Muhlenbergia montana*	9	0.19	9066727	FR 249 to Big Lake	5/25/07	7/17/07	6
Weeping Brome	*Bromus frondosus*	8	0.18	9066729	Beehive Spring	7/19/07	9/10/07	13
Arizona Fescue	*Festuca arizonica*	7	0.16	9066728	Greens Peak	7/19/07	9/10/07	33N (east end)
Thurber Fescue	*Festuca thurberi*	3	0.06	9066725	Bead Spring Meadow	7/19/07	9/25/07	23N
2008 and 2009 Plantings		**(Total)**	**(Total)**					
Weeping Brome	*Bromus frondosus*	10	0.22	9066729	Beehive Spring	7/1/08	9/3/08	13
Arizona Fescue	*Festuca arizonica*	10.5	0.23	9066728	Greens Peak	7/1/08	9/3/08	33N (east end)
Thurber Fescue	*Festuca thurberi*	14	0.30	9066725	Bead Spring Meadow	7/1/08	8/12/08	23N
Deergrass	*Muhlenbergia rigens*	2	0.03	9066740	Sky Hi Road Trailhead		5/12/08 (Clumps)	14
Galleta	*Pleuraphis jamesii*	12.5	0.28	9066724	Town Draw	4/1/09	6/14/09	33N

The following figures show the field plantings installed in 2007 and 2008. The photos were taken in the middle of July 2008 or early September 2008.

Wolfstail (Four Bar Mesa) seed production field 33N. Seedlings planted June 14, 2007; photo Sept 3, 2008.

Galleta (Town Draw) seed production field 33N comprising 1.2 rows (middle of photo). Seedlings planted June 14, 2007; photo taken July 15, 2008.

Blue grama seed production field 33N. Seedlings planted June 14, 2007; photo taken Sept 3, 2008. Left 4 rows Horse Pasture, middle 4 rows Four Bar Mesa, right 4 rows Town Draw.

Spike muhly (Sky Hi Road Trailhead) seed production field 14. Seedlings planted July 10, 2007; photo Sept 3, 2008.

Mountain muhly (FR 249) seed production field 6. Seedlings planted July 17, 2007; photo Sept 3, 2008.

Weeping brome (Beehive Spring) seed production field 13. Seedlings planted Sept 10, 2007; photo taken July 15, 2008. Additional plugs planted Sept 3, 2008.

Arizona fescue (Green Peak) seed production field 33N. Seedlings planted Sept 10, 2007; photo July 15, 2008. Additional plugs plnated Sept 3, 2008.

Deergrass (Sky Hi Road Trailhead) seed production field 14. One-year-old plants transplanted May 12, 2008; photo Sept 3, 2008.

Thurber fescue (Escudilla Mtn.) seed production field 23N. Three rows planted Sept 25, 2007; remaining 11 rows planted Aug 12, 2008; photo July 11, 2008.

Conclusions

Cool-Season Grasses

All of the cool-season grasses have performed poorly. Although Arizona fescue and weeping brome produced some seed, the stands were in such poor condition that the plants were plowed under in the spring of 2010. The Thurber fescue did not produce any seed, and therefore the seed production field was removed in the fall of 2009.

The high temperatures and alkaline soils at the LLPMC were not conducive for vigorous growth of these cool-season grasses. Some cool-season grasses from the Southwest that have done well at the LLPMC include bottlebrush squirreltail, Indian ricegrass, needleandthread, desert needlegrass, western wheatgrass, and muttongrass. These better performing grasses were collected from lower elevations and more arid sites. If the Apache-Sitgreaves National Forests (ASNF) cool-season accessions could be grown in a cooler location and in the appropriate soils, it is possible that they could produce a reasonable amount of seed. However, a single accession collection would not be a likely source for a release that exhibits high yields of seed and good agronomic qualities. Therefore, such source-identified releases generally would be expected to result in more expensive seed than hypothetical selected releases that have undergone intensive selection and testing.

To develop a cool-season release with the desirable agronomic characteristics that would appeal to commercial seed growers, likely would require selection among numerous collections and the use of the superior selections to develop a new release.

Warm-Season Grasses

Except for mountain muhly, all of the warm-season grasses had good, vegetative vigor (for example, good production of leaves and culms).

Mountain Muhly

The mountain muhly showed poor signs of vigor from the beginning. The LLPMC has attempted to grow mountain muhly in the past from other sources and had similar performance problems. This species may have requirements similar to the ASNF cool-season grasses.

Blue Grama

The blue grama collections, as a whole and individually, had poor seed production. The LLPMC has had similar experiences with other high-elevation collections of blue grama (for example, Grand Canyon South Rim germplasm). However, selected releases of blue grama such as ‘Hachita,’ ‘Alma,’ and ‘Lovington’ produce high seed yields, and these cultivars are grown commercially because they perform well on a region-wide basis and are relatively inexpensive to grow.

Galleta

The galleta grass had poor seed production. This was not unexpected because the LLPMC has had similar seed production problems from other source-identified galleta accessions. The only acceptable galleta seed production has been achieved with the LLPMC release ‘Viva’ whose development required an intensive selection process to find an accession with a high yield of seed.

Spike Muhly and Deergrass

The seed production from the spike muhly and deergrass was marginal, which would translate to expensive seed.

Wolfstail

The best-performing species was wolfstail which yielded high amounts of seed in the first two years of production. The reason for its poor performance in the third year is open to question. The initial yields of wolfstail would make it a viable collection for seed increase if a demand for this species existed.

Summary

To produce seed that will be attractive to commercial seed growers, it must have high, viable seed yields and should be shown to perform well over a broad area.

To achieve high seed yields, a development program assessing seed production of numerous accessions will be required to select superior seed producers for further breeding efforts. After a superior strain is developed, it should be tested throughout the Southwest to prove its general adaptability.

Selection and production of cool-season grasses should be accomplished at a high-elevation site in the Southwest.

Warm-season grass seed can be produced at a low-elevation site, but selection of superior strains and testing will be necessary to interest commercial growers. The growers will also insist on proof of sufficient demand for a particular species before proceeding with production.

National Park Service Production of Plant Materials

Study Number: NMPMC-S-9101-OT

The US Department of Interior (DOI), the National Park Service (NPS) and the USDA-NRCS Los Lunas Plant Materials Center (LLPMC) made agreements with the following national parks and monuments:

- Grand Canyon National Park (GCNP)
- Pipe Spring National Monument (PSNM)
- Zion National Park (ZNP)
- Carlsbad Caverns National Park (CCNP)
- Wupatki National Monument (WNM)

Grand Canyon National Park

In July 1990, an agreement was made with the LLPMC for the collection, propagation, and increase of native grasses, forbs, shrubs, and trees. The agreement states that the LLPMC will produce the plant materials for the purpose of revegetating disturbed areas and native landscaping projects in the GCNP which includes both the north and south rim areas of the park. Amendment No. 1 of 1999 and Amendment No. 2 of 2001 states that the LLPMC will produce seed of two native species (blue grama and muttongrass), and the LLPMC will grow transplants started from native tree and shrub seed collected from the park.

* In 2006 the LLPMC agreed to add bottlebrush squirreltail to the list of grass species to be grown for seed production
* In 2007 the LLPMC agreed to add sideoats grama to the list of grass species to be grown for seed production
* In 2009 the LLPMC agreed to add a new accession of blue grama. In addition, spike muhly was added to the list of grass species to be grown for seed production
* In 2010 an addendum to the GCNP agreement was finalized, and the LLPMC agreed to grow additional transplants of both woody and herbaceous species for GCNP

The following table shows the complete list of the GCNP plant species accessions:

Common Name	Scientific Name	Plant Symbol	Accession Number
Grasses:			
Blue grama	*Bouteloua gracilis*	BOGR	9062875
Blue grama	*Bouteloua gracilis*	BOGR	9066803
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066659
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9062858
Indian ricegrass	*Achnatherum hymenoides*	ORHY	9062857
Muttongrass	*Poa fendleriana*	POFE	9062861
Needleandthread	*Hesperostipa comata*	HECO	9062859
Sideoats grama	*Bouteloua curtipendula*	BOCU	9066732
Spike muhly	*Muhlenbergia wrightii*	MUWR	9066802
Western wheatgrass	*Pascopyrum smithii*	PASM	9062860

Common Name	Scientific Name	Plant Symbol	Accession Number
Trees and Shrubs:			
Apache plume	*Fallugia paradoxa*	FAPA	9062865
Big sagebrush	*Artemisia tridentata*	ARTR	9066056
Century plant	*Agave utahensis*	AGUT	9062874
Cliffrose	*Purshia mexicana*	COME	9062876
Curl-leaf mountain mahogany	*Cercocarpus ledifolius*	CELE	9062867
Currant	*Ribes spp.*	RI SPP.	9066057
Datil yucca	*Yucca baccata*	YUBA	9066058
Desert barberry	*Berberis fremontii*	BEFE	9066059
Elderberry	*Sambucus spp.*	SA SPP.	9066047
Fernbush	*Chamaebatiaria millefollium*	CHMI	9062866
Fourwing saltbush	*Atriplex canescens*	ATCA	9062873
Gambel oak	*Quercus gambelii*	QUGA	9062872
Lupine	*Lupinus spp.*	LU SPP.	9062863
Penstemon (blue)	*Penstemon spp.*	PE SPP.	9062862
Penstemon (red)	*Penstemon spp.*	PE SPP.	9066054
Pinyon (twoneedle) pine	*Pinus edulis*	PIED	9066467
Ponderosa pine	*Pinus ponderosa*	PIPO	9066466
Rabbitbrush	*Chrysothamnus nauseosus*	CHNA	9062877
Utah juniper	*Juniperus osteosperma*	JUOS	9066055
Utah serviceberry	*Amelanchier utahensis*	AMUT	9062869
Wolfberry	*Lycium spp.*	LY SPP.	9062870

2010 ACCOMPLISHMENTS

In 2010, the GCNP sent seed of several woody and grass species to the LLPMC from collections made at the park. The seed received by the LLPMC from the GCNP in 2010 will be stored and used to produce containerized transplants.

In 2010, plug transplants of the GCNP muttongrass and blue grama were grown using seed harvested from the production seed fields at the LLPMC. These plugs were used to establish a 1.00 acre of field of muttongrass and a 0.75 acre field of blue grama at the LLPMC.

The following tables describe the seed production fields established at the LLPMC, the type and amount of seed delivered to GCNP, the amount of seed production, the amount of pure live seed on inventory, and the species of grass and shrub transplants grown at the LLPMC and delivered to GCNP:

2010 Established GCNP Production Fields at the LLPMC

Common Name	Scientific Name	Agreement Acreage	2010 LLPMC Acreage
Blue grama	*Bouteloua gracilis*	2.00	2.59
Bottlebrush squirreltail	***Elymus elymoides***	0.50	0.00*
Muttongrass	***Poa fendleriana***	1.00	1.78
Sideoats grama	***Bouteloua curtipendula***	0.50	0.00*
Spike muhly	***Muhlengbergia wrightii***	0.50	0.70

* The bottlebrush squirreltail and sideoats grama fields were removed prior to 2010 as per agreement with GCNP.

2010 Amount of Seed Delivered to the GCNP

Common Name	Scientific Name	Pounds Delivered
Blue grama	*Bouteloua gracilis*	6.6
Muttongrass	*Poa fendleriana*	17.00

2010 Amount of Seed Production for the GCNP

Common Name	Scientific Name	Pounds Cleaned
Blue grama	*Bouteloua gracilis*	36.84
Muttongrass	*Poa fendleriana*	21.10
Spike Muhly	*Muhlenbergia wrightii*	12.56

2010 Amount of Pure Live Seed on Inventory for the GCNP

Common Name	Scientific Name	Accession	Pure Live Seed On Inventory (lbs)	Test Date
Blue grama	*Bouteloua gracilis*	9062875	2.17 14.96	11/17/09 12/10/10
Blue Grama	*Bouteloua gracilis*	9066803	8.43	1/28/11
Muttongrass	*Poa fendleriana*	9062861	2.00	9/23/10
Sideoats grama	*Bouteloua curtipendula*	9066732	0.50	12/04/09
Spike muhly	*Muhlenbergia wrightii*	9066802	9.31	N/A*

* Spike muhly seed is still being tested at the New Mexico State Seed Laboratory

2010 Amount of Transplants Delivered to the GCNP

Common Name	Scientific Name	Transplants Delivered
Apache plume	*Fallugia paradoxa*	212
Artemisia tridentate	*Big sagebrush*	680
Blue grama	*Bouteloua gracilis*	329
Fernbush	*Chamaebatiaria millefolium*	178
Fremonts mahonia	*Mahonia fremontii*	365
Mexican cliffrose	*Purshia Mexicana*	150
Pinyon pine	*Pinus edulis*	600
Rubber rabbitbrush	*Ericameria nauseosa*	150

Field 21S GCNP blue grama seed production field

Field 20S GCNP spike muhly seed production field

Pipe Spring National Monument

On September 12, 2002, an agreement was made with the LLPMC for propagating and harvesting native seed collected from the PSNM for the purpose of revegetation projects.

The following table shows a complete list of the accessions involved in the PSNM agreement:

Pipe Spring National Monument Accessions

Common Name	Scientific Name	Plant Symbol	Accession Number
Blue grama	*Bouteloua gracilis*	BOGR	9066558
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066590
Galleta	*Pleuraphis jamesii*	PLJA	9066559
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066587

2010 Accomplishments

The following tables describe the seed production fields established at the LLPMC, the amount of seed production, and the amount of pure live seed on inventory for the PSNM:

2010 Established PSNM Production Fields at the LLPMC

Common Name	Scientific Name	Agreement Acreage	2010 LLPMC Acreage
Blue grama*	*Bouteloua gracilis*	0.00	0.00
Bottlebrush squirreltail	*Elymus elymoides*	0.00	0.00
Galleta	*Pleuraphis jamesii*	0.00	0.00
Indian ricegrass* *	*Achnatherum hymenoides*	0.50	0.30*

* The LLPMC has never received any blue grama see from the PSNM, therefore no production field has been established.

* *Only 0.30 acres of Indian ricegrass was established due to the amount of seed originally received from PSNM.

2010 Amount of Seed Production for the PSNM

Common Name	Scientific Name	Pounds Cleaned
Indian ricegrass	*Achnatherum hymenoides*	69.00

2010 Amount of Pure Live Seed on Inventory for the PSNM

Common Name	Scientific name	Accession	Pure Live Seed on Inventory (lbs)	Test Date
Bottlebrush squirreltail	*Elymus elymoides*	9066590	46.26	11/26/07
Galleta	*Pleuraphis jamesii*	9066559	0.41 4.22 2.70	3/05/07 1/14/08 10/28/09
Indian ricegrass	*Achnatherum hymenoides*	9066587	39.76 57.66 37.70 6.02	4/30/08 8/04/09 3/05/10 11/29/10

Field 8 PSNM Indian ricegrass seed production field

Zion National Park

On September 12, 2002, an agreement with the Los Lunas Plant Materials Center (LLPMC) was made for the collection of native seed from the ZNP, the propagation of those seeds at the LLPMC, and the increase of native grass species.

The agreement states that ZNP will use the plant materials produced by the LLPMC to revegetate disturbed areas at the park. The seed will be collected by the park staff and sent to the LLPMC for conditioning; it then will be used to establish seed production fields to satisfy the agreement.

The following table shows a complete list of the accessions involved in the ZNP agreement:

Zion National Park Accessions

Common Name	Scientific Name	Plant Symbol	Accession Number
Blue grama	*Bouteloua gracilis*	BOGR	9066530
Bottlebrush squirreltail	*Elymus elymoides*	ELEL5	9066532
Cane bluestem	Bothriochloa barbinodis	BOBA	9066543
Galleta	*Pleuraphis jamesii*	PLJA	9066586
Indian ricegrass	*Achnatherum hymenoides*	ACHY	9066528
Muttongrass	*Poa fendleriana*	POFE	9066531
Sand bluestem	*Andropogon hallii*	ANHA	9066529

2010 Accomplishments

The LLPMC established a 1.00 acre bottlebrush squirreltail seed production field in 2010. The seed field was established using transplants grown by the LLPMC and planted into Field 19. This new field increases the total bottlebrush squirreltail production acreage to 1.84.

See the following tables for the seed production fields established at the LLPMC, the amount of seed delivered to the ZNP, the amount of seed production, the amount of pure live seed on inventory for the ZNP:

2010 Established Production Fields at the LLPMC

Common Name	Scientific Name	Agreement Acreage	2010 LLPMC Acreage
Bottlebrush squirreltail	*Elymus elymoides*	1.50	1.84
Indian ricegrass	*Achnatherum hymenoides*	0.50	0.42*
Sand bluestem	*Andropogon hallii*	0.50	0.00*

* Only 0.42 acres of Indian ricegrass was established due to the amount of seed originally received from ZNP.

* The sand bluestem field was removed prior to 2010 as per agreement with ZNP.

2010 Amount of Seed Delivered to the ZNP

Common Name	Scientific Name	Pounds Delivered
Bottlebrush squirreltail	*Elymus elymoides*	21.80

2010 Amount of Seed Production for the ZNP

Common name	Scientific name	Pounds cleaned
Bottlebrush squirreltail	*Elymus elymoides*	63.42
Indian ricegrass	*Achnatherum hymenoides*	100.68

Amount of Pure Live Seed on Inventory for ZNP

Common Name	Scientific name	Accession	Pure Live Seed on Inventory (lbs)	Test date
Bottlebrush squirreltail	*Elymus elymoides*	9066532	4.32	8/29/09
			38.11	9/23/10
			0.47	8/27/07
			14.35	8/12/05

Amount of Pure Live Seed on Inventory for ZNP

Common Name	Scientific name	Accession	Pure Live Seed on Inventory (lbs)	Test date
Cane bluestem	*Bothriochloa barbinodis*	9066543	1.40 Bulk 1.36 2.19 1.58 0.20 Bulk	No test* 1/21/05 1/17/06 3/09/07 No test*
Galleta	*Pleuraphis jamesii*	9066586	1.51 0.58 Bulk 0.46 Bulk	1/08/07 No test* No test*
Indian ricegrass	*Achnatherum hymenoides*	9066528	25.48 44.13 76.59 33.06 22.74	10/16/06 4/28/08 10/31/08 11/11/09 12/14/10
Muttongrass	*Poa fendleriana*	9066531	4.55 0.70 1.84 Bulk	5/30/08 11/20/08 No test*
Sand bluestem	*Andropogon halii*	9066529	2.73 Bulk 2.80 8.89 3.26 9.84 24.80	No test* 3/20/06 3/21/07 6/14/10 7/07/10 4/19/10

* Seed was not sent for testing due to an insufficient amount of seed or seed was from the collections made at the ZNP.

Field 19 ZNP bottlebrush squirreltail seed production field

Field 35N ZNP Indian ricegrass seed production field

Carlsbad Caverns National Park

On August 23, 2004, an agreement with the LLPMC was made for the collection, propagation, and the increase of native grass species. A new agreement was started in 2010 that provides for the propagation of transplants and seed increase by the LLPMC for CCNP native grass species.

The following table shows a complete list of the accessions involved in the CCNP agreement:

Carlsbad Caverns National Park Accessions

Common Name	Scientific Name	Plant Symbol	Accession Number
Blue grama	*Bouteloua gracilis*	BOGR	9066604
Curlyleaf muhly	*Muhlenbergia setifolia*	MUSE	9066608
Green sprangletop	*Leptochloa dubia*	LEDU	9066658
Plains bristlegrass	*Setaria vulpiseta*	SEVU2	9066606
Purple threeawn	*Aristida purpurea*	ARPU9	9066607
Sideoats grama	*Bouteloua curtipendula*	BOCU	9066605

2010 Accomplishments

In 2010, the grass species blue grama, green sprangletop, plains bristlegrass, sideoats grama, and threeawn plug transplants were grown from seed harvested from seed production fields at the LLPMC.

The following tables describe the seed production fields established at the LLPMC, the amount of seed delivered to CCNP, the amount of seed production, the amount of CCNP pure live seed on inventory, and the amount of the transplants grown and delivered to CCNP:

2010 Established CCNP Production Fields at the LLPMC

Common Name	Scientific Name	Agreement Acreage	2010 LLPMC Acreage
Blue grama	*Bouteloua gracilis*	0.50 acre	0.50 acre
Green sprangletop	*Leptochloa dubia*	0.50 acre	0.50 acre
Plains bristlegrass	*Setaria vulpiseta*	0.50 acre	0.90 acre
Purple three-awn	*Aristida purpurea*	0.50 acre	0.50 acre
Sideoats grama	*Bouteloua curtipendula*	0.50 acre	0.50 acre

2010 Amount of Seed Delivered to the CCNP

Common name	Scientific Name	Pounds Delivered
Blue grama	*Bouteloua gracilis*	32.40
Green sprangletop	*Leptochloa dubia*	17.00
Plains bristlegrass	*Setaria vulpiseta*	25.70
Sideoats grama	*Bouteloua curtipendula*	26.00
Threeawn	*Aristida purpurea*	18.30

2010 Amount of CCNP Seed Production

Common Name	Scientific Name	Pounds Cleaned
Blue grama	*Bouteloua gracilis*	21.80
Green sprangletop	*Leptochloa dubia*	63.02
Plains bristlegrass	*Setaria vulpiseta*	51.90
Sideoats grama	*Bouteloua curtipendula*	16.82
Threeawn	*Aristida purpurea*	7.52

2010 Amount of CCNP Pure Live Seed on Inventory at the LLPMC

Common Name	Scientific Name	Accession	Pure Live Seed on Inventory (lbs)	Test Date
Blue grama	*Bouteloua gracilis*	9066604	17.40	1/24/07
			8.12	1/09/08
			20.50	6/17/10
			2.59	12/01/09
			16.82	1/19/11
Green sprangletop	*Leptochloa dubia*	9066658	41.44	1/19/07
			82.23	1/03/08
			60.91	7/13/10
			28.09	12/10/09
			29.92	12/01/10
Plains bristlegrass	*Setaria vulpiseta*	9066606	1.56	3/20/07
			17.57	5/15/08
			166.06	7/13/10
			24.06	2/12/10
			14.53	12/08/10
Purple threeawn	*Aristida purpurea*	9066607	2.96	3/21/06
			9.10	3/09/07
			7.90	4/23/08
			15.39	6/11/10
			6.34	1/19/10
			5.11	12/13/10
Sideoats grama	*Bouteloua curtipendula*	9066605	63.84	1/19/06
			36.34	1/23/07
			117.07	3/10/08
			59.07	6/29/10
			13.53	12/23/09
			9.72	12/15/10
			3.00 Bulk	No test*
			1.02 Bulk	No test*

* Seed not sent for testing due to an insufficient amount of seed or seed was from the collections made at the CCNP.

2010 Amount of Transplants Delivered to the CCNP

Common Name	Scientific Name	Transplants Delivered
Blue grama	*Bouteloua gracilis*	1070
Green sprangletop	*Leptochloa dubia*	1070
Plains bristlegrass	*Setaria vulpiseta*	1070
Sideoats grama	*Bouteloua curtipendula*	875
Threeawn	*Aristida purpurea*	1070

Field 13 CCNP blue grama seed production field

Field 24S CCNP purple threeawn seed production field

Field 24N CCNP green sprangletop seed production field

Wupatki National Monument

On May 16, 2006, an agreement with the LLPMC was made to produce seed for the WNM. This agreement was terminated in 2009.

2010 Accomplishments

The following table describes the seed delivered to the WNM from the LLPMC in 2010.

2010 Seed Delivered to the WNM

Common Name	Scientific Name	Pounds Delivered	Accession
Sideoats grama	*Bouteloua curtipendula*	28.30	9062880
Galleta	*Pleuraphis jamesii*	8.80	9066657
Needleandthread	*Hesperostipa comata*	93.40	9066655
Black grama	*Bouteloua eriopoda*	1.50	9066053
Galleta	*Pleuraphis jamesii*	1.00	9062882
Spike dropseed	*Sporobolus contractus*	61.00	9062881
Alkali sacaton	*Sporobolus airoides*	1.50	9062883

2010 Seed Production Report

Project Number/Name	Field No.	Acres	Planting Dates	Fertilizer Applications	2010 Irrigation Dates (3" Application)	Harvest Dates	Harvest (Cleaned Wt. lbs.)
NMPMC-P-0602-WO Gila NF Foxtail prairie clover seed production	7	0.30	2010		4/2, 4/27, 5/13, 6/17, 7/6, 7/21, 8/12, 9/2, 9/16	11/2	187.46
NMPMC-S-0901-CP 9066790 SPWR Seed Increase	8	0.85	8/2009	40 lbs Nitrogen 40 lbs Phosphorous	3/5, 5/11, 6/17, 7/15, 8/13, 9/13, 10/28	9/20	256.90
	14	0.40					
NMPMC-S-0402-WO Pipe Spring National Monument Indian ricegrass seed production	8	0.25	2004	120 lbs. Nitrogen 40 lbs. Phosphorous	3/5, 4/2, 4/29, 6/14, 7/20, 10/6	5/27, 6/4, 6/9	69.00
NMPMC-S-0302-RA Salado Alkali Sacaton foundation seed field	11	1.0	2003	80 lbs. Nitrogen	4/6, 5/26, 6/23, 7/15, 9/20	No harvest	
NMPMC-S-0402-RI Westwater germplasm Alkali muhly foundation seed field	11	1.0	2004		3/17, 58/27, 6/24, 7/20, 8/16, 10/8	9/28	
NMPMC-S-0403-RA Carlsbad Caverns NP blue grama seed production	13	0.50	7/6/2005	40 lbs. Nitrogen 40 lbs. Phosphorous	3/17, 5/27, 6/24, 7/20, 8/16, 10/8	11/2	21.80
NMPMC-S-0703-PA Grenville Switchgrass seed production	14	0.14	2007	40 lbs. Nitrogen 40 lbs. Phosphorous	3/10, 5/10, 6/2, 6/17, 7/15, 9/13		
NMPMC-S-0503-RI Composite Vine mesquite seed increase field	14	1.0	2005	40 lbs. Nitrogen	4/1, 6/4, 7/9, 9/16	10/13	
NMPMC-S-7801-RA Hachita blue grama Foundation seed field	16	2.0	1963	40 lbs. Nitrogen	6/3, 7/1, 7/23	10/25	21.82
NMPMC-S-0701-OT Boulder County CO big bluestem seed production	16	0.33	2007	80 lbs. Nitrogen 40 lbs. Phosphorous	3/19, 5/4, 6/2, 7/1, 7/21, 9/7	9/30	10.64
NMPMC-S-0801-PA **Jose** Rush wheatgrass foundation seed production	18	1.0	2008	40 lbs. Nitrogen	4/8, 4/29, 6/1, 7/6, 9/10	8/23	

2010 Seed Production Report

Project Number/Name	Field No.	Acres	Planting Dates	Fertilizer Applications	2010 Irrigation Dates (3" Application)	Harvest Dates	Harvest (Cleaned Wt. lbs.)
NMPMC-S-0402-RA Vaughn sideoats grama foundation seed field	19	1.20	7/22-28/2004	80 lbs. Nitrogen 40 lbs. Phosphorous	5/26, 7/1, 7/22, 9/6	9/10	324.52
NMPMC-S-0401-RA Pastura little bluestem foundation seed field	19	0.86	2004	40 lbs. Nitrogen	3/10, 5/12, 6/2, 6/24, 7/21	9/17	38.54
NMPMC-S-0301-RA **Viva** galleta foundation Seed field	19	2.4	2003	40 lbs. Nitrogen	6/16, 7/6, 9/3	7/29, 11/9	54.52
NMPMC-S-0004-WO Grand Canyon NP muttongrass seed production	20N	0.50	4/20/2006	80 lbs. Nitrogen 40 lbs. Phosphorous	3/17, 4/1, 4/14	5/10	21.10
	28S	1.00	2006	80 lbs. Nitrogen 40 lbs. Phosphorous	3/10, 4/2, 4/26		
	21S	0.28	2008	160 lbs. Nitrogen 40 lbs. Phosphorous	3/17, 4/1, 4/14, 5/10, 6/8, 6/25, 7/6, 7/20, 8/13, 9/7, 10/5, 10/28, 12/8		
NMPMC-S-1001-WO Grand Canyon NP muttongrass seed production	28S	1.00	2010		11/2,3,4, 11/8, 11/22, 12/14	No harvest	
NMPMC-S-0003-RA Grand Canyon NP blue grama seed production	20N	0.50	2000	40 lbs. Nitrogen 40 lbs. Phosphorous	5/13, 6/8, 6/25, 7/14, 8/13	9/24	23.74
	28S	0.50	2006	40 lbs. Nitrogen 40 lbs. Phosphorous	3/17, 5/13, 6/8, 6/24, 7/14, 8/12		
	18	0.75	2010		9/16, 9/20, 10/6, 10/14, 11/1, 11/15	No harvest	
NMPMC-S-0901-WO Grand Canyon NP Spike muhly seed production	20S	0.70	2009	80 lbs. Nitrogen 40 lbs. Phosphorous	3/5, 4/14, 5/13, 6/3, 6/25, 7/13, 9/8	11/12	12.56
NMPMC-S-0403-RA Carlsbad Caverns NP bristlegrass seed production	20S	.50	2006	40 lbs. Nitrogen 40 lbs. Phosphorous	5/19, 6/4, 6/25, 8/12, 9/16	8/5, 11/10	51.90
	28S	0.17	2007	40 lbs. Nitrogen	3/17, 5/13, 6/3, 7/13, 8/13, 10/12		

2010 Seed Production Report

Project Number/Name	Field No.	Acres	Planting Dates	Fertilizer Applications	2010 Irrigation Dates (3" Application)	Harvest Dates	Harvest (Cleaned Wt. lbs.)
				40 lbs. Phosphorous			
NMPMC-S-9701-RA Nogal black grama foundation seed field	21N	1.3	1997	40 lbs. Nitrogen 40 lbs. Phosphorous	5/26, 6/30, 7/20, 9/16	11/16	11.88
NMPMC-S-0904-RA Grand Canyon NP blue grama seed production	21S	0.60	2009	40 lbs. Nitrogen 40 lbs. Phosphorous	3/17, 4/14, 5/19, 6/10, 7/13, 9/7, 11/3, 12/14	10/20	13.10
NMPMC-S-0802-RA Desert needlegrass seed production	23N	0.45	2008 2010	160 lbs. Nitrogen	10/14, 3/17, 4/1, 4/14, 5/7, 5/21, 6/10, 7/18, 9/7, 10/7, 12/3	6/1, 6/4, 6/9, 6/14, 6/16	11.06
	23S	0.50	2010	40 lbs. Nitrogen	8/19, 8/23, 9/2, 9/16, 10/5, 10/29, 11/15, 12/15	No harvest	
NMPMC-S-0403-RA Carlsbad Caverns National Park Sideoats grama seed production	23N	0.50	6/8/2005 6/29/2006	160 lbs. Nitrogen	5/13, 6/3, 6/23, 7/15, 9/3	10/12	16.82
BLM Seeds of Success Species Seed Increase	23S	0.30	2010		8/5, 8/13, 8/20, 8/23, 9/3, 9/16, 10/5, 10/29, 11/15, 12/3	1/5/2011	0.44
	24S	0.50	2010		10/5, 10/14, 10/28, 11/8, 12/3	No harvest	
	27N	0.50	2010		10/5, 10/8, 10/15, 10/29, 12/3	No harvest	
NMPMC-S-0403-RA Carlsbad Caverns NP Sprangletop seed production	24N	0.50	2006	160 lbs. Nitrogen	3/19, 5/11, 6/2, 6/17, 7/7, 7/21, 8/12, 9/7	9/30	63.02
NMPMC-S-0501-RA Llano Indiangrass foundation seed field	24N	0.25	9/8/2005	80 lbs. Nitrogen	3/18, 5/12, 6/2, 6/18, 7/7, 7/21, 8/12, 9/7	9/29	85.56
NMPMC-S-0403-RA Carlsbad Caverns National Park Three-awn seed production	24S	0.50	6/2/2005 6/22/2006	125 lbs. Nitrogen 40 lbs. Phosphorous	3/19, 5/11, 6/2, 6/17, 7/20, 9/7	7/12, 9/15, 10/15	7.52
NMPMC-S-9401-RA Paloma Indian ricegrass foundation seed field	25N	0.89	2000	45 lbs. Nitrogen	3/31, 5/10, 7/16, 10/18	6/2, 6/10	67.12
	20N	0.37	2009	40 lbs. Phosphorous 160 lbs. Nitrogen	1/13, 3/5, 3/31, 4/14, 5/7, 5/21, 6/2, 6/25, 7/13, 7/8, 10/5, 11/3	No harvest	

2010 Seed Production Report

Project Number/Name	Field No.	Acres	Planting Dates	Fertilizer Applications	2010 Irrigation Dates (3" Application)	Harvest Dates	Harvest (Cleaned Wt. lbs.)
NMPMC-S-0801-CR US Army Fort Bliss Mesa dropseed seed production	25S	0.90	2008	85 lbs. Nitrogen 40 lbs. Phosphorous	5/12, 6/1, 6/23, 7/16, 10/12		82.36
	34S	0.13		125 lbs. Nitrogen 40 lbs. Phosphorous	3/18, 5/12, 6/1, 6/213, 7/7, 8/13, 9/8, 10/12		
NMPMC-S-0301-WO Zion NP bottlebrush squirreltail seed production	26N	0.25	2007	85 lbs. Nitrogen 40 lbs. Phosphorous	1/413, 3/17, 3/31, 4/14		63.42
	19	0.20	2008	80 lbs. Nitrogen	3/5, 3/31, 4/14, 5/10, 6/14, 7/7, 7/21, 8/16, 9/7	6/4, 6/7, 6/10, 6/11, 6/14, 6/21	
	20S	0.40	2009	120 lbs. Nitrogen	1/13, 3/5, 3/29, 4/14, 5/7, 5/21, 6/2, 7/7, 8/12, 9/7, 10/5, 10/29, 12/8	6/4, 6/7, 6/10, 6/11, 6/14, 6/21	
	34S	0.44	2009	160 lbs. Nitrogen	1/15, 3/17, 4/1, 4/26, 5/10, 5/26, 6/23, 7/6, 8/13, 9/8, 10/6, 10/29, 11/8	6/4, 6/7, 6/10, 6/11, 6/14, 6/21	
	19	1.00	2010		10/29, 11/1, 11/12, 11/19, 12/3	No harvest	
NMPMC-S-0801-RA 9066431 bluebunch wheatgrass seed production	35N	0.30	2008	125 lbs. Nitrogen 40 lbs. Phosphorous	1/13, 3/18, 4/2, 4/26, 5/10, 5/26, 6/23, 7/9, 8/12, 9/13, 12/3	No harvest	
	18	0.65	2010	40 lbs. Nitrogen	8/31, 9/2, 9/6, 9/16, 10/6, 11/1, 11/15, 12/8	No harvest	
NMPMC-S-0802-CR US Army Fort Bliss spike dropseed seed production	35N	0.30	2008	120 lbs. Nitrogen	3/19, 5/11, 5/27, 6/24, 7/19, 8/12, 9/8	9/22	26.80
NMPMC-S-0301-WO Zion NP Indian ricegrass seed production	35N	0.50	2004 2005	85 lbs. Nitrogen 40 lbs. Phosphorous	3/31, 4/29, 6/18, 8/3, 10/12	5/27, 6/3, 6/4, 6/8	100.68
NMPMC-S-1001-Grand Canyon NP muttongrass seed production	35S	0.50	11/2010		11/1, 11/5, 11/8, 11/22, 12/14	No harvest	
NMPMC-T-0603-WO Apache-Sitgreaves seed production							
bristly wolftail	33N	0.25	2007	125 lbs. Nitrogen 40 lbs. Phosphorous	4/26, 6/10, 7/7, 8/16, 9/16	10/6	3.62

2010 Seed Production Report

Project Number/Name	Field No.	Acres	Planting Dates	Fertilizer Applications	2010 Irrigation Dates (3" Application)	Harvest Dates	Harvest (Cleaned Wt. lbs.)
blue grama	33N	0.25	2007	125 lbs. Nitrogen 40 lbs. Phosphorous	4/26, 6/10, 7/7, 8/16, 9/16	10/20	16.46
galleta	33N	0.25	2007 2009	125 lbs. Nitrogen 40 lbs. Phosphorous	3/19, 4/27, 5/27, 6/18, 7/7, 8/16	No harvest	
spike muhly	14	0.25	2007	120 lbs. Nitrogen 40 lbs. Phosphorous	3/10, 5/26, 6/18, 7/20, 8/16, 9/13	11/17	1.66
deergrass	14	0.08	2008	120 lbs. Nitrogen 40 lbs. Phosphorous	3/10, 5/26, 6/18, 7/20, 8/16, 9/13	12/15	2.28

Partnership With the Bureau of Land Management "Seeds of Success Program"

The Los Lunas Plant Materials Center (LLPMC) is participating in the Bureau of Land Management (BLM) "*Seeds of Success*" program which is an ongoing effort to improve the health and productivity of public lands, including those recently affected by wildfire. This collaborative effort is to collect native seed for the establishment of seed production fields at the LLPMC. Seed collectors from this program gather between 400 and 600 native collections annually. Germplasm will be used for long-term conservation and immediate restoration needs on public lands. Eventually the seed harvested from the established production fields will be released to commercial growers.

Assisting BLM Staff

The LLPMC's assistance to the "*Seeds of Success*" program included supervising two of their interns who were collecting seed in the southern portion of the Colorado Plateau during the spring and summer of 2010. We provided a home base for their field collections and the necessary training when they experienced difficulties. Their training also included two separate weeks of a LLPMC person assisting them off-center in their field collection work. They made more than 40 seed collections during 2010.

Transferring Technology

Other assistance from the LLPMC included developing the presentation "*Planting Methods for the Colorado Plateau and Other Arid Areas"* which was presented at two separate conferences: "*Seeds of Success Annual Meeting*" in Salt Lake City, Utah (February 2010) and "*The 10th Biennial Conference Integrating Science & Management*" on the Colorado Plateau in Flagstaff, Arizona (October 2009). In addition, we published an article with the same title which was included in the *Biennial Conference of Research on the Colorado Plateau Proceeding Series.*

Collecting Seed

The following seed was collected by the BLM seed collectors and delivered to the LLPMC to establish seed production fields at the LLPMC:

- 1.9 g of *Ratibida columnifera* (prairie coneflower) (~2000 seed)
- 0.3 g of *Oenothera pallida* (primrose) (~2000 seed)
- 6.1 g of *Ipomopsis aggregata* (scarlet gilia) (~2000 seed)
- 0.6 g of *Sphaeralcea parvifolia* (scarlet globemallow) (~1000 seed).
- *Pseudoroegneria spicata* (bluebunch wheatgrass) seed and *Achnatherum speciosum* (desert needlegrass) seed was collected from San Juan County, in Farmington, New Mexico by the LLPMC.

In addition, *Rumex hymenosepalus* (wild rhubarb) was collected in May 2010 by the LLPMC and BLM in San Juan County, New Mexico.

Germinating Seed

The germination of the collected seed was conducted as follows:

- Bluebunch wheatgrass and desert needlegrass – Sown into plug trays covered with 4mm peat/perlite mix and germinated in a warm greenhouse.
- Prairie coneflower – Seed was covered with 2 mm of peat/perlite mix and germinated in a warm greenhouse at the LLPMC.
- Primrose – Sown on surface of peat/perlite mix, moistened, and then cold stratified for six weeks at 3° C. This primrose had very poor germination results even though we used the same conditions we have used for successful germination of other seed lots of primrose. A handful of the seedlings survived, and they were planted into a raised bed. However, only minimal seed was produced which will prevent a field planting in 2011.
- Scarlet gilia – Sown was on the surface of peat/perlite mix, moistened, and then cold stratified for six weeks at 3° C.
- Scarlet globemallow – Seed was scarified with MAT-OSU pneumatic seed scarifier for 10 sec at 20 psi, sown on surface of peat/perlite mix, moistened, and then cold stratified for six weeks at 3° C. A minimal amount of seed produced about 80 seedlings which were kept in containers for seed collection during the summer and fall of 2010. Sufficient amounts of seed were produced to allow a field planting to be installed in 2011 (see the following table).
- Wild rhubarb – Seed was covered with 4 mm of peat/perlite mix and germinated in a warm greenhouse.

BLM Seed Production Fields Established at the LLPMC

Species	Field Size	Date Planted	Harvest Date	Cleaning Screen Size	Seed Harvested (Clean Seed)	BLM Available Seed
bluebunch wheatgrass	1 acre	8/31/10 9/02/10	N/A	No harvest	0	0
desert needlegrass	1 acre	8/19/10	6/01/10 6/09/10 6/14/10 6/16/10	297-D screens Hammermill screens ¾″ x ¼″	11.06 lbs	0
prairie coneflower	½ acre	Aug 2010	01/2011	297-Dsuper x cleaner Hammermill with ¼″ screen 297-DSuper x cleaner	0.44 lbs	
primrose	20 plants	Mar 2010	Nov 2010	>34x34 mesh < 26 x 26 mesh	0.28g (300 seeds)	0
scarlet gilia	¼ acre	Aug 2010	N/A		0	0
scarlet globemallow	80 plants	N/A	Jul-Sep 2010	>1/25 < 1/15 sieves	14.8 g	
wild rhubarb	¾ acre	Oct 2010	N/A	No harvest	0	0

Wild rhubarb seed ready to be collected on BLM land near Farmington, NM (June 2010)

Establishing Seed Production Fields

The prairie coneflower, wild rhubarb, and scarlet gilia germinated well enough to produce a sufficient amount of seedlings for field plantings. Using seedling transplants, the following table lists the field plantings that have been established at the LLPMC.

The fields were fertilized, irrigated, and then weed control was applied. Only the desert needlegras, prairie coneflower, primrose, and scarlet globemallow plantings produced seed this year, and their seed was harvested. This seed will be tested for germination and used for field increase in 2011 at the LLPMC.

The scarlet gilia field was drenched on September 24, 2010 with the fungicide Subdue Maxx to control root-rot which was killing the plants. The drenching seemed to control the disease since few plants were lost after the treatment. The plants did not flower this year, and so there was no seed production. The seed that is produced from this field next year will be used for further field expansion.

Transplanting wild rhubarb seedlings into 1/2-acre seed production field (Sept 2010)

Established BLM wild rhubarb field receiving irrigation (October 2010)

Combine harvesting prairie coneflower seed (January 2010)

Drenching scarlet gilia transplants Subdue Maxx (Sept 24, 2010)

Using Hydrogel Filled, Embedded Tubes to Sustain Grass Transplants for Arid Land Restoration

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Authors: David R. Dreesen, M.E. Lucero, D.M. VanLeeuwen

Reseeding grasses on remote arid sites is expensive and failure prone (Ethridge et al., 1997). Irrigation during germination and establishment phases could improve survival rates, but substantially increases remediation costs. Bainbridge (2007) described watering into buried perforated pipes or clay pots to minimize irrigation water for desert plant establishment. Use of containerized transplants with long root balls and application of hydrogel dips also increases establishment success (Bainbridge, 1995; Miller and Holden, 1993; Rodgers, 1995; Thomas, 2008). The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) has combined the use of 30" long root systems, embedded watering tubes and a starch-based hydrogel (Soil Moist™ Natural, JRM Chemical, Inc., Cleveland, Ohio) to provide a long-lasting store of soil moisture available for plant uptake with minimal evaporation and percolation losses (Los Lunas Plant Materials Center, 2004). This technique provided for greater than 80% long-term survival of various shrub species and appreciable vegetative growth after eight growing seasons in a semiarid environment experiencing prolonged drought (Dreesen, 2009, personal communication).

Interest in restoring surface disturbances on arid grasslands, combined with high reseeding failure rates prompted interest in evaluating grass transplants for restoration. Transplants of stoloniferous species may establish and reproduce more successfully than plants initiated from seed, but establishment using starch hydrogels could be difficult to manage at the shorter root depths required for grasses. Acrylic gels, which are less fluid and slower to degrade, may offer a more satisfactory solution.

In the greenhouse study, we compared the survival, growth, and development of *Bouteloua eriopoda* (Torr.) Torr. (black grama) irrigated with either starch-or acrylic-based hydrogels encased in various styles of watering tubes embedded to the maximum depth (46 cm) expected for mature black grama root systems (Gibbens and Lenz, 2001).

Irrigation tubes were constructed by cutting 5.08 cm schedule 40 PVC pipe into 50.8 cm (20") segments. A single line of 13 holes 1.27 cm in diameter placed 3 cm apart, was drilled beginning at the bottom of each tube. Type A tubes were capped on both ends. Type B tubes left the bottom opening uncapped, providing increased contact area between soil and hydrogel. Type C tubes included a wire mesh liner to facilitate retention of dessicated acrylic gels, which could be rehydrated if additional irrigation were needed.

Tubes were filled with JRM Chemical's Soil Moist Natural™ starch polymer, or either 1–2 mm or 2–4 mm crosslinked polyacrylamide (Soil Moist™, JRM Chemical, Inc., Cleveland, Ohio). The fully hydrated starch polymer is fluid, so to prevent seepage loss, a rate of 1 mg starch polymer to 10 mL water was necessary. For consistency across treatments, this rate was also utilized for the acrylic-based products. Because the tube volume was 1.1 L, this rate allowed containment of approximately 1 L of water in each tube.

Ten-week old black grama (cultivar Nogal) transplants dipped in a mixture of 4.7 g/L Soil Moist Natural™ in water to reduce transplant shock, were placed in 36 cm deep plastic Treepots™ (Stuewe & Sons, Inc, Tangent, Oregon) containing a single, hydrogel-filled irrigation tube. The tube was rotated so that the openings faced the plant roots (see the following figure). The pots were filled with potting mix and irrigated to saturation at time zero. Pots were placed in a climate controlled greenhouse in Las Cruces, New Mexico which was maintained at 25 ± 5°C with natural daylight filtered through

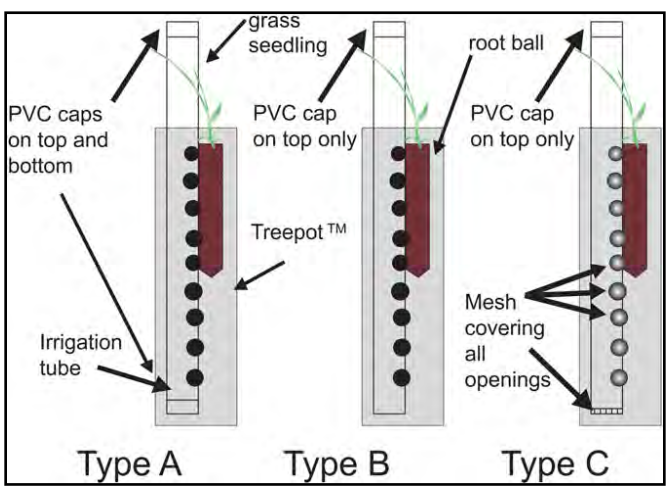
whitewashed glass panels. Maximum light intensity measured during the study was 820 µmol m^{-2} s^{-1}. After one week, wilted transplants were given an additional 350 mL of tap water to ensure survival. No additional irrigation was provided.

The experiment was set up in a randomized block design using 9 replicated blocks consisting of randomly arranged transplants representing one of each irrigation tube style by hydrogel polymer treatment combination. Gel height within each tube (representing an approximate measure of remaining water content) and plant growth variables were recorded at regular intervals throughout the study. The volume of water lost from the hydrogel over time was estimated using the formula V ¼pr^2h (V ¼volume, r ¼radius of the tube, and h ¼ gel height). The radius of the gel column within the tube was assumed constant. This estimate provided a rough approximation of minimal water loss. After harvest, leaf area and tissue biomass were measured.

A field study examining establishment success was conducted in a 5.5 x 7 m plot within an existing exclosure on the Jornada Experimental Range. This site lies within the Jornada Basin, in the northern Chihuahuan Desert at 32° 36.906° North latitude and 106° 44.731 West longitude. The location is characteristic of a Sandy Ecological Site (ID # R042XBO12NM) as delineated by the Natural Resource Conservation Service's Ecological Site Information System (ESIS). Average precipitation is 245 mm/year. Mean maximum summer temperature is 36°C.

Ten-week old, greenhouse cultivated black grama plants with 14 cm root balls were transplanted into eight randomized blocks. The Soil Moist Natural™ aqueous dip described above was applied to reduce transplant shock. Each experimental block contained two groups of 4 transplants, 1 of which was irrigated by tubes filled with 1 –2 mm crosslinked polyacrylamide, hydrated as above. The second group utilized empty irrigation tubes as controls. Transplant survival and basal cover were determined after 15 weeks, using actual counts and a grid-point intercept method, respectively.

Statistical analyses were executed using SAS version 9.1.3 software (SAS Institute Inc., 2004). Greenhouse data were analyzed as a randomized complete block with a 3 x 3 treatment structure defined by the variables tube type (A, B, or C) and hydrogel (large acrylic, small acrylic, and starch) and, for some variables, with repeated measures.

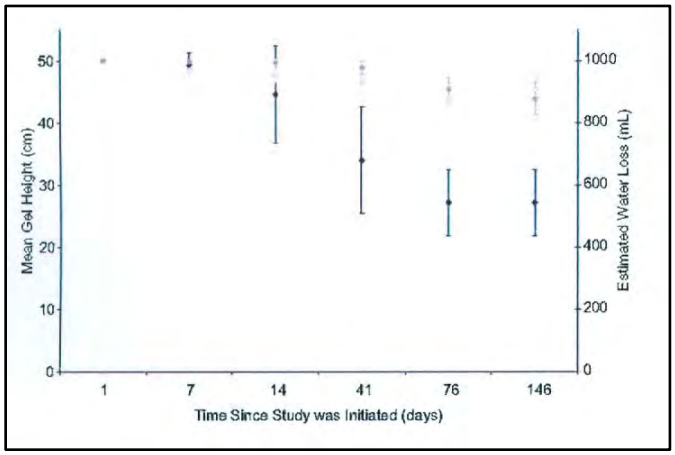


Irrigation of grass transplants with hydrogel filled irrigation tubes. Type A tubes, left, were capped on the top and bottom to reduce moisture loss. Type B tubes, center, were open on the bottom, allowing for more contact between the hydrated gels and the soil. Type C tubes, right, were identical to type B except that the inside of the tube was lined with stainless steel mesh to ensure retention of desiccated gel particles. All irrigation tubes contained a single row of openings to direct water toward the transplant root. PVC tubes were placed in Treepot™ containers next to transplants, such that holes exposing hydrogel were aligned with the original, cone shaped rootball of the transplant.

Continuous response variables were analyzed with SAS PROC MIXED software using models that included fixed effects for tube type, hydrogel, date, and all interactions of these factors. Blocking was accounted for with random effects for both block and block x date. Correlations among repeated observations from the same unit were accounted for with a REPEATED statement specifying date as the repeated factor, the individual experimental unit as the subject and an unstructured covariance. The Kenward-Roger denominator degree of freedom option was specified.

Results

Gel heights within starch filled irrigation tubes were consistently lower (representing greater water loss) than for either acrylic-based hydrogel. At the end of the study, the remaining volume of gels suggested water losses of approximately 455 mL from starch gels and 115 mL from the acrylic gels (see the following figure). Tube styles also influenced the rate of water loss from acrylic gels, such that the end of the study, large and small hydrogels in tube type C (mean heights of 35.2 and 35.6 cm, SEM ¼ 1.422) had lost more water, as measured by gel height, than either large or small hydrogels in tube types A (mean heights of 42.2 and 42.9 cm) or B (mean heights of 40.5 and 40.1 cm).

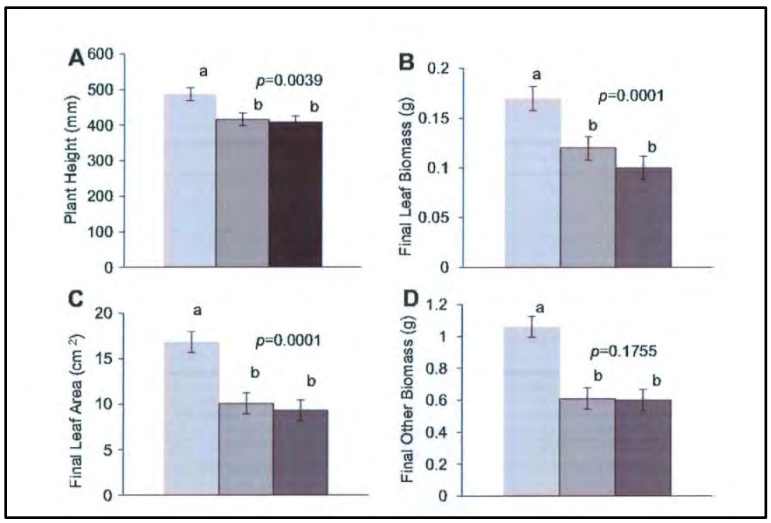


Gel height in cm decreased over time for all treatments. Heights for each treatment are shown with symbols for starch (diamonds), small acrylic (squares), and large acrylic (circles) hydrogels. Regression lines modeling loss over time are shown with 95% confidence intervals.

Plant height differed with hydrogel type. There was no evidence of hydrogel or tube type effects upon root biomass. However, there was a significant hydrogel effect upon the leaf biomass , and total leaf area.

Above ground, non-leaf biomass, including seedheads, stems, and stolons, comprised 92% of the total biomass and are identified in as ‘‘other’’ biomass. For other biomass, tube and hydrogel main effects were significant ($p = 0.0232$, <0.0001). Tube types A and B produced higher mean other biomass than tube type C (estimated other biomass = 0.85, 0.79, 0.63, respectively, SEM = 0.067) and starch produced more other biomass than either acrylic hydrogel. See the following four-part figure (A,B,C,and D).

Field transplant survival was high (94%) for both gel-treated and control groups. Basal cover by black grama transplants ranged from 1.1 to 2.4%, with neither date nor gel treatment significantly affecting basal cover.



Selected variables illustrate differences among *Bouteloua eriopoda* greenhouse transplants irrigated with starch (light grey), large acrylic (dark grey), or small acrylic (black) hydrogels. Error bars represent SEM. Treatments with different letters are statistically different according to an F-protected LSD ($p < 0.05$).

Discussion

Greenhouse results indicated more rapid water loss and faster plant growth from the starch than from the acrylic hydrogels. These values should be interpreted with caution, since all of the plants irrigated with starch hydrogels (and none of the plants associated with acrylic hydrogels) received 350 mL water additions in the first week after planting. This suggests transplants may have initially accessed more water from the acrylic gels (in which wilting was not observed), and improved growth of the starch hydrogel treatments may simply reflect the benefit of this added free water.

The water holding efficay of hydrogels is influenced by various factors. The base polymer, water pH, salinity and ionic composition can all have significant effects on maximum water absorption capability (Johnson, 1984). When polyacrylamide gels are mixed with sandy soils the maximum water absorption is substantially reduced compared with the gel alone; the swelling of the gel is limited by confinement by the soil mixture (Bhardaj et al., 2007). Larger granules are also able to absorb more water (Bhardwaj et al., 2007). The use of irrigation tubes to hold the gel might allow increased sorption of water if the gel is rehydrated because gel granules would not be confined by the soil matrix. Reported water holding capacities of Soil Moist™ products in particular vary among vendors, but JRM chemical reports both acrylic and starch-based products can hold 200 times their weight in water. Hence, the gels used in this study were far below maximum water holding capacity.

Plants irrigated with starch-based hydrogels produced more leaf area and total biomass than plants irrigated with the acrylic gels. This is likely due to the higher fluidity of the gel, the receipt of additional water (applied to the soil) at the end of week one, the more rapid loss of water from the starch-based gel, and the greater bioavailability of the starch, which may have provided additional organic carbon to beneficial microbes.

Low overall counts of seedheads and plantlets (not shown), reduced biomass, and lower heights and leaf areas among plants irrigated with acrylic gels suggests that water was limiting reproductive capacity. Rowe et al. (2005) indicated crosslinked polyacrylamide gels hydrated to a 1:10 polymer to water ratio have a water potential of about –0.4 MPa; at ratios of 1:100 or less, water potentials of approximately –0.1 MPa were reported. A polymer to water ratio of 1:200 would have increased both the bioavailability and the rate of consumption of the polymer-bound water, more adequately ensuring sufficient moisture for growth and reproduction. Increasing the water bound to the starch gel would have had a less positive

impact, since this would have resulted in excess seepage, making added water unavailable to the relatively shallow grass roots.

Of the three tube styles used, type B provided the most surface contact between hydrogels and soils. However, tube style did not significantly influence plant height, root biomass, leaf biomass, or leaf area, suggesting tube styles were not appreciably influencing plant water availability.

Differences in field transplant growth that could be attributed to the presence of hydrogel filled embedded irrigation tubes were not seen. This is probably due to above-average precipitation (216 mm in 15 weeks) observed during the study. Transplant survival was identical for both treatments (94%). This value is high compared to a recent field study in which only 38% of black grama transplants survived through the end of the season (Lucero et al., 2008). The high survival rate could be attributed to the use of deeper rooted transplants, the starch gel dip utilized at planting, and the timely arrival of precipitation. Tubes examined at the end of the study were still completely filled with hydrogel, suggesting that high moisture levels in the surrounding soil either reduced water loss from the tubes or that the tubes captured runoff from precipitation, permitting the gels to rehydrate.

Implications

Deep-rooted grass transplants receiving adequate moisture exhibited high survival rates on arid rangelands. Starch-based hydrogels in embedded irrigation tubes described here provided moisture sufficient to ensure plant growth and reproduction beyond a single growing season. However, the amount of polymer required to retain the gel within tubes is high, making the starch gels expensive to utilize. Acrylic gels also supported plant growth, but the hydration ratio of 1 part hydrogel to 10 parts water applied in this study limited growth and reproduction. Ratios of 1:200 (hydrogel:water) should provide initial water potentials near -0.05 mPa (Rowe et al., 2005), which would significantly improve plant performance. For this reason, transplants irrigated with fully hydrated acrylic gels are expected to produce the best restoration outcomes at the lowest cost. Additional field studies should be implemented to assess these expectations. Plant growth differences between large and small acrylic particle sizes were insignificant. Minor differences in plant growth and water consumption suggested small tradeoffs for various tube styles. Larger openings may increase water availability for the transplant, but may also increase water available to surrounding weeds. Although reproduction via stolons and seeds was only observed for large particle hydrogels in tubes with maximum exposed hydrogel surface area (tube style B), a lower ratio of hydrogel to water within the other tube styles would increase the moisture available to transplants without augmenting risk of increased weed competition. Placement of tube openings in direct contact with the transplant roots is recommended.

Acknowledgements

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