United States Department of Agriculture
Natural Resources Conservation Service

Tucson Plant Materials Center Annual Technical Report

2010

Eragrostis intermedia

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Plant Materials Center Staff

Manuel Rosales	Manager
Heather Dial	Assistant Manager
David Forestieri	Farm Manager
Mary E. Hershdorfer	Natural Resource Specialist (Special Assignment-Bishop, California)
Cash Veo	Student Intern
Steven Lunt	Student Intern
Nick Robbs	Student Intern
Erin Boyd	Student Intern

Plant Materials Specialist

Bruce Munda

Introduction

In 1935, the United States Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS) recognized the need for adapted plant material for use in conservation programs. This need was addressed by the establishment of plant materials nurseries in critical areas throughout the United States. The Tucson Plant Materials Center (AZPMC) was one of the initial centers established in the southwest. Since 1935, the Plant Materials program has grown into a network of 27 centers located throughout the United States, each with their own area of responsibility.

The AZPMC service area encompasses the Sonoran, Mohave, and Chihuahuan desert regions. The center works in partnership with NRCS field offices, resource conservation and development (RC&D) groups, conservation districts, federal and state agencies, non-profit groups, and private landowners to develop resource technology to meet the service area's conservation needs. Rangelands, mined lands, urban and urban interface areas, riparian areas, croplands, water and air quality, invasive species, and wildlife habitat all present resource challenges within the AZPMC service area.

In order to develop resource technologies, the center evaluates the conservation potential of native grasses, shrubs, forbs, and trees at the federally owned 45-acre farm. Selected plant materials become part of advanced trials designed to develop cultural and management practices that enhance seed production and ease of establishment. These practices, along with efficiency and adaptability, are assessed using field plantings at selected test sites throughout the PMC service area.

This publication provides a summary of studies and activities carried out by the AZPMC during fiscal year 2010. For further information please contact us at:

USDA-NRCS
Tucson Plant Materials Center
3241 N. Romero Rd.
Tucson, AZ 85705
520-292-2999

Summary of 2010 Weather Conditions at the Tucson Plant Materials Center Tucson, Arizona

Month	Temperature (°F)		Precipitation (inches)
	Maximum	Minimum	
January	74	33	2.10
February	76	35	1.89
March	88	36	0.52
April	89	41	0.23
May	101	43	0.02
June	109	60	0.00
July	108	69	2.71
August	106	69	4.75
September	105	62	0.70
October	102	51	0.46
November	88	23	0.00
December	84	25	0.46

Frost Free Days	=	359
Days Above 100 ^{o}F	=	74
Coldest Temperature	=	23° (November 30)
Hottest Temperature	=	109° (June 23)
1st day 100 ^{o}F	=	May 28
1st day 32 (or Below) ^{o}F	=	November 30

Tucson Plant Materials Center Service Area

Tucson Plant Materials Center Studies

Tobosa Grass Study Plan

Study ID Code	AZPMC-P-0503-CR
Title	Development of a tobosa grass (*Pleuraphis mutica*) population for southeastern Arizona
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Population Development and Technology Development, Initial Evaluation Planting
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial, Mary Hershdorfer, AZPMC
Duration	2006 through 2012
Description	Tobosa is a common grass in southeastern Arizona; however no tobosa germplasm is currently available to growers or the market.
Status of Knowledge	Tobosa is a highly drought tolerant grass species in southern Arizona on both lowland and upland sites with heavy clay soils. Sod forming, it may be a good competitor with invasive species such as buffelgrass (*Cenchrus ciliaris*), particularly along roadsides. This species is generally characterized as having poor germination; however preliminary germination of its seed appears good. For field plantings, the AZPMC recommends using seed with genetic origins from the area of intended use. The greater the genetic diversity of the composite population, the potentially greater likelihood of adaptation and persistence across the region.
Experimental Design	Randomized complete block design with six replications of 14 accessions. This design is used to arrange accessions to maximize intercrossing by placing the accessions adjacent to each other as frequently as possible (see plot plan). Fewer plants of accessions 15-18 were grown (due to insufficient seed), but were planted in an adjacent plot in order to increase genetic diversity of the planting. Data may or may not be collected from these accessions.
Materials & Methods	Samples of seed were assembled by AZPMC and AZ field office and technical staff from southeastern Arizona. Seed of each accession will be planted into individual flats in the greenhouse, and seedlings will be transplanted into plugs. Each experimental unit consists of 6 transplants. The plants will be planted into an irrigated field at the Tucson PMC. Rows will be approximately 38 inches apart and spacing between plants will be approximately 18 inches. Cultural practices may include mechanical and chemical weed control, fertilization and chemical control of pests. Prior to conducting evaluations of the accessions, 4 replications of the 14 accessions will need to be marked in the field. Due to loss of individual plants throughout the field, more intact replications will be selected for evaluation. When seed ripens during the growing season, seed will be hand harvested from the center 3 plants of each unit of the marked accessions. Germination tests of the seed of each accession will be conducted in the greenhouse. If certain accessions have poor germination, this planting may be re-examined and accessions with higher germination may be selected to create a new planting block. Reducing the diversity of the population may be necessary in order to produce a commercially viable product. To describe the population, the following data (growth characteristics) will be collected from individual plants once at the end of the growing season:

- plant height
- basal width
- total dry biomass

Additional data will be collected throughout the growing season to determine the extent to which the accessions are hybridizing, and the diversity of the seed harvest:

- flowering times
- seed maturity
- seed yield

For the growth characteristics data, selected plants will be clipped at the base 4" from the ground level (with electric clippers) and used for evaluation. Height will be estimated in mm using a yard stick prior to clipping the plant. Basal width will be measured after the plant material is cut. Flowering times, seed maturity, and seed yield will be documented several times during the season, as flowering and seed maturity episodes become apparent. Data will be entered into Statistix (Version 8.1) and analyzed to determine statistical differences between accessions.

The planting will be harvested throughout the season for seed and hay bales.

Final Evaluations

Field Plantings will be installed in various locations in southeastern Arizona to test adaptation of the material. Seed from original collections and from the new population will be analyzed for genetic diversity within and between populations.

Technology Transfer Products

Plant fact sheet, planting guide, internal reports, research article

Literature Cited

Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development; Experimental Design, ANOVA and Regression.

Tobosa Grass (AZPMC-T-0503-CR) Plot Plan:

Irrigation Ditch

ACCESSIONS START ON THE EAST SIDE OF THE BORDER

PRIMARY PLOTS
6 plants/unit
16 REPLICATIONS

(#) represents plants/unit other than 6

	8		5		2		8		9		11		9		1
	14 (5)		9		12		14		4		7 (5)		3		2
	2		13		4		5		6		9		7		3
	5		2		8		1		14 (5)		3 (4)		14		4
	7 (2)		10		7		6		10		2		4		5
	3		8		11		10		11		1 (5)		10		6
	12		6		1		2 (5)		8		13		8		7
	10		12		14		13		5		6		12		8
	6		11		3 (4)		9		12		10 (5)		5		9
	1		14		6		11		2		12		2		10
	13 (5)		7		10		3		1		4		11		11
	4		1		13		12		7 (4)		14		6		12
	11		4		5		7 (3)		3 (5)		8 (5)		13		13
	9		3		9		4		13 (5)		5 (5)		1		14
	6		1		8		11		12		13		3		12 (5)
	12		5		1		3		6		12		5		3
	4		10		13		10		5		2		7		7 (4)
	8		11		14		2		8		1		6		4
	13		9		6		8		13		7 (2)		5		13 (5)
	10		12		10		6		2		6		14		11
	1		4		4		5		9		4 (4)		13		2
	5		6		5		1		14 (5)		8		10		9
	3		2		12		13		3		11		3		6 (5)
	9		14		3		9		7		14 (5)		12		5 (5)
	2		13		9		4		11		10		9		1 (4)
	7 (5)		8		7 (2)		12		10		5		4 (4)		14
	14 (4)		3		11		7		4		3 (5)		8		10
	11		7 (5)		2		14		1		9		11		8
SECONDARY PLOT 5 plants/unit	15		18		16		15		18		16		15		15
	16		15		18		18		15		18		18		17
	17		18		15		18		17		15		15		16
	18		15		18		15		16		15		17		18

Accession	ID Within the Plot Plan
9092489	1
9092490	2
9092491	3
9092522	4
9092562	5
9092575	6
9092576	7
9092627	8
9092657	9
9092658	10
9092668	11
9092688	12
9092701	13
9092707	14
9092492	15
9092577	16
9092720	17
Unknown	18

Accomplishments/Results:

Background:

This field (field 6, border 7) was established in July of 2006. Fourteen accessions were used within the primary plot. Accessions 15-18 did not produce enough plugs to fill the sixteen replications of the primary plot. However, they were used to establish a secondary plot in order to increase the genetic diversity of the entire population. Due to the mortality of some of the plugs after the planting, fewer than the usual 6 plants per unit exist in the plot in some cases. These differences are presented in the plot plan.

During 2007, the planting survived the lack of irrigation (due to well repair) and a late seed crop was harvested. The amount of seed harvested during the growing season of 2007 was 14.3 bulk pounds.

Growing season 2008:

During the 2008 growing season the field was harvested once with a total of 7.5 bulk pounds collected. It appears that the planting is not producing as much seed as expected to consider the species for a plant materials release as of yet. Further agronomic techniques will have to be evaluated to improve seed production.

Growing season 2009:

Technology:
In early March, the field was treated with 5 quarts/acre of a pre-emergent (pendimethalin). The field was irrigated three times (March, June, July) for a total of 0.69 acre feet application. The field was harvested in July with the Woodward FlailVac for a total of 4 bulk pounds collected.

Genetic Diversity:
The field exhibited uniform greening in early March and was in full bloom by the first week of June 2009. Four complete replications out of the 16 were selected to collect data from due to time constraints and plant mortality in some of the replications. These are identified in blue in the above plot plan and were staked out for collection of data. In the growing season of 2010, the planting will be evaluated for plant height, biomass, flowering times and seed production.

Growing season 2010:

During growing season 2010, it was determined that both the technology and genetic diversity studies would be discontinued. The genetic diversity study has become impossible to evaluate due to the age of the planting and the growth habits of tobosa. The accessions in the field have exhibited significant die off and movement proving identification of individual accessions difficult. The technology study has been discontinued as no appreciable data has been collected since establishment of the field.

Because tobosa is still a species in high demand in the southwest, the field will not be removed. The field will instead be split and have different irrigation treatments applied to each half to determine if irrigation frequencies and amounts have any appreciable effects on seed production in tobosa.

Sideoats Grama Study Plan

Study ID Code	AZPMC-T-0601-CR
Title	Development of Technology for Production of Sideoats grama (*Bouteloua curtipendula*) for Southeast Arizona
National Project No.	Natural Areas 1.1 Rangeland Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Population Development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial AZPMC
Duration	2006 through 2010
Description	Sideoats grama is common throughout Arizona and well recognized by the general public. A regional ecotype for the Southeastern Arizona Basin and Range MLRA would be a welcome addition to seed mixes for conservation plantings.
Status of Knowledge	Sideoats grama is a native grass common throughout Arizona, particularly in the Southeastern Arizona Basin and Range MLRA. 'Niner' and 'Vaughn' sideoats from NM have been shown to be short-lived in field trials in Arizona, particularly following drought, and likely not adapted to Arizona's environmental conditions.
Experimental Design	Randomized Complete block Design with 8-replications of 28 accessions. Fewer numbers of plugs from accessions 29-36 did not allow for their inclusion in the primary plots. However, they were used to establish a secondary plot to increase the genetic diversity of the planting. This design is used to arrange accessions to maximize intercrossing by placing the accessions adjacent to each other as frequently as possible. (See plot plan)
Materials & Methods	Samples of seed were assembled by AZPMC and AZ field office and technical staff from southeastern Arizona. Seed will be planted at the Tucson Plant Materials Center. Plants will be grown in plugs in the greenhouse and transplanted to the field. Each experimental unit will consist of an equal number of transplants. The plants will be planted into an irrigated field. Rows will be approximately 38 inches apart and spacing between plants will be approximately 12 inches. Cultural practices may include mechanical and chemical weed control, fertilization and chemical control of pests. Growth characteristics such as height, mass, flowering times and seed production will be evaluated for the different accessions throughout the growing season.
Final Evaluations	Field Plantings will be installed in various locations in southeastern Arizona to test adaptation of the material. Seed from original collections and from the new population will be analyzed for genetic diversity within and between populations.
Technology Transfer Products	Plant fact sheet, planting guide, internal reports, research article, presentations
Literature Cited	Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development; Experimental Design, ANOVA and Regression.

Sideoats grama (AZPMC-T-0504-CR) Plot Plan:

IRRIGATION DITCH

ACCESSIONS START ON THE EAST SIDE OF THE BORDER

PRIMARY PLOT
10 plants/unit
8 REPLICATIONS

I	II	III	IV	V	VI	VII	VII
23	13	22	14	28	16	22	25
13	18	4	26	16	11	26	13
9	24	10	5	25	19	9	22
20	27	9	23	1	22	24	8
7	5	14	16	12	10	8	11
22	16	26	13	26	20	14	3
4	14	28	25	11	9	2	16
1	8	16	12	13	28	1	21
17	22	21	27	14	12	21	7
14	23	17	15	9	7	5	2
8	2	18	4	2	26	18	6
5	6	3	10	19	24	28	18
12	17	19	7	3	1	12	24
6	1	27	2	24	13	19	9
11	9	20	3	10	5	15	17
28	19	13	24	8	2	20	26
24	11	1	21	17	3	23	14
25	3	15	18	7	4	17	26
27	7	2	1	4	8	6	1
15	12	11	6	27	23	3	19
19	4	25	19	23	15	11	5
10	26	12	22	15	18	13	12
2	20	24	11	6	14	7	23
16	10	8	9	20	17	10	4
21	28	6	28	5	21	16	15
18	25	23	8	22	27	25	28
26	15	5	20	21	6	4	27
3	21	7	17	18	25	27	10
29	31		29	31	33	34	32/33
30	35	33	30	32	29	31	
31	34	29	35/36	29/31	34	33	30
32	29	31	34	35	33	32	29
33	30	32	33	30	31	29	31

SECONDARY PLOT
8 plants/unit

missing a plant

missing two plants

20 plugs

Accession	ID Within the Plot Plan	Accession	ID Within the Plot Plan
9092528	1	9092704	19
9092550	2	9092705	20
9092551	3	9092718	21
9092580	4	9092737	22
9092581	5	9092519	23
9092582	6	9092538	24
9092599	7	9092588	25
9092623	8	9092613	26
9092651	9	9092616	27
9092654	10	9092641	28
9092660	11	9092517	29
9092667	12	9092518	30
9092672	13	9092521	31
9092674	14	9092629	32
9092579	15	9092555	33
9092604	16	9092520	34
9092682	17	9092553	35
9092694	18	9092578	36

Accomplishments/Results:

Background:

This field (field 6, border 10) was planted in late July of 2006. In 2007, seed samples were collected from four of the planted rows to evaluate how seed quality and germination varied between the accessions. Approximately 500 seed per accession were harvested from the middle 6 plants of each 10 plant unit. Out of the 500 seeds, four packets of 100 seed were counted exactly using a Count-A-Pak seed counter. These packeted seeds will be used for a greenhouse germination experiment planned for next year.

Growing season 2008:

In 2008, the majority of seed set in the field was lost to a summer thunderstorm.

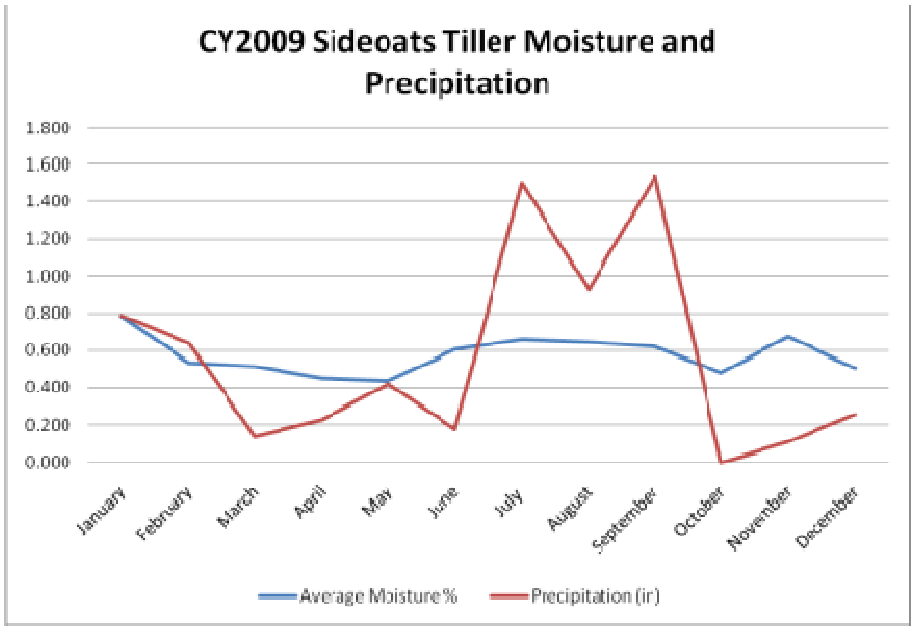
Growing season 2009:

Technology:

Germination trials were conducted in December of 2008 on seed collected from the field in 2007. The trials consisted of four replications of 100 seed from 28 accessions collected from four rows. Each 100 seed replication was cleaned on a rubbing board and placed in germination trays in the greenhouse at alternating temperatures of approximately 60°F/85 °F for four weeks. None of the replications exhibited a germination response. University of Arizona professor, Dr. Steve Smith, was consulted in mid January 2009 about the germination trial results.

Dr. Smith indicated that in order to encourage viable seed production from plants adapted to this region, it might be necessary to decrease the irrigation frequency of the planting. A monitoring schedule for the tiller moisture of individual plants within the planting was initiated to estimate the field's drought stress. To determine the tiller moisture of the plants, a four inch section of green tiller was cut, weighed, dried, and weighed again. The following equation was then used to determine the moisture fraction of the tillers: % dry weight = (fresh weight – dry weight) / (fresh weight). The planting was to be irrigated when average tiller moisture reached ~30% due to precipitation inputs (see graph below). Tiller moisture measurements never fell below 40%, although significant drought stress was apparent in some accessions. A single irrigation of 0.17 acre feet was conducted in early August to prevent mortality of these accessions. The field was treated with 3 quarts/acre of a pre-emergent herbicide (oryzalin) in March 2009 to control broadleaf weeds.

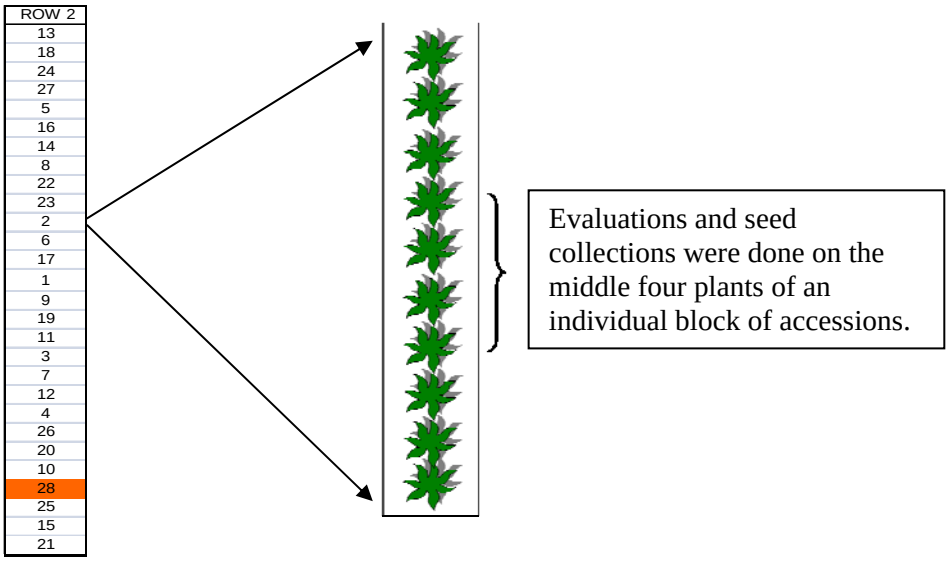
Graph of Average Tiller Moisture Percentages and Precipitation Totals for 2009



Genetic Diversity:

It is believed that the majority of the accessions in this field are of the variety *caespitosa*, a predominately apomictic reproducer. However, MLRA 41 may harbor populations of varieties *curtipendula* or *tenuis*, which in general produce sexually or vegetatively. To determine which varieties are present in the planting, evaluations of individual accessions were conducted on 5 and 13 August 2009. The following characteristics were evaluated on the middle four plants of an accession: # of branches/panicle, # of spikelets/branch, anther color, vegetative color, and the presence or absence of stolons.

In mid-September 2009, hand harvests were conducted from three rows (2, 4, and 6) within the field. Seed was collected from the middle four plants of an individual block of accessions. Seed produced per accession was estimated by counting intact seed found in 0.5 grams of harvested seed. The seed will be used in germination tests in fiscal year 2010.



Growing season 2010:

On 21 May 2010, the sideoats plot was damaged by archaeologists working for the Arizona Department of Transportation (ADOT). The western accessions in replication one were completely removed from the ground. The western accessions in replications 2-8 were buried by soil dug up from replication one. The majority of the damage done to the plants was done to those of the secondary plot. The archaeological crew completed the backfill of the trenches dug in the plot on the 27th of May.

Trenches dug in sideoats field

Sideoats field after backfilling

For the remainder of 2010, the field was allowed to recover from the damage and no data was collected. A significant amount of re-leveling/furrowing between the planted replications was necessary to allow for irrigation waters to reach the end of the field. The buried plants recovered slowly from the damage.

Bush Muhly Genetic Variation for Sonoran Desert Study Plan

Study ID Code	AZPMC-P-0801-CR
Title	Develop a Bush muhly (*Muhlenbergia porteri*) population for the Sonoran Desert MLRA 40
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Population Development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial, Mary E. Hershdorfer AZPMC
Duration	2008 through 2011
Vegetative Practices	342 Critical Area Planting 550 Range Planting 543 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management 512 Pasture and Hay Planting
Description	A population of Bush muhly with regional adaptation to the Sonoran Desert would provide a valuable commodity. This is one of the few grasses that persists in this region of remarkably low rainfall. 24 accessions were collected throughout the Sonoran Desert Major Land Resource Area (MLRA 40) to develop this composite, and planted at the PMC in a replicated plot. Data will be collected on the growth characteristics of the majority of accessions.
Status of Knowledge	Bush muhly is a highly palatable bunch grass, even after dormancy, likely the reason it has retreated to the interiors of shrubs, where it is protected from grazing. Following winter dormancy, new growth begins at nodes at the tips of the stems, rather than from the base of the plant, which forms the plant into a bush like shape. Bush muhly is a highly desirable warm season bunchgrass throughout the desert southwest. No germplasm is currently available from commercial growers. This planting is a second composite population of this species (the first is from MLRA 41, Southeast Arizona) assembled recently at the AZPMC in order to provide germplasm adapted to the Sonoran Desert. Adaptation of a population across a known geographic region is desirable, because it has a greater likelihood of establishment and persistence at varying sites across that region. Genetic diversity also gives a population the ability to more easily adapt to changes in the climate. If the different accessions flower simultaneously throughout the season, they have potential to hybridize and increase genetic diversity of the population. Seed of the different accessions that reach maturity at approximately the same time will be represented in those harvests.
Experimental Design	Randomized complete block with six replications of 20 accessions (Attachment 1).
Materials & Methods	Samples of seed were assembled by AZPMC and AZ field office and technical staff from within the Sonoran Desert. Seed was planted at the Tucson Plant Materials Center. Plants were grown in plugs in the greenhouse and transplanted to the field. Each experimental unit consisted of multiple transplants. The plants were planted into an irrigated field with rows approximately 38 inches apart and spacing between

plants approximately 18 inches. Borders 4, 5, 6 and 7 in Field 1 were planted with this composite, however a replicated plot was placed in only 1 of these borders – Border 5 – to collect data. Growth characteristics such as height, mass, flowering times and seed production will be collected from accessions 1-19 throughout the growing season. Additional accessions 20-24 were included in order to increase genetic diversity of the planting, but not intended for data collection.

Each experimental unit of each accession in the plot plan consists of 3 plants in a row. To describe the population, the following data (growth characteristics) will be collected from individual plants once at the end of the growing season:

- height
- basal width
- color

Additional data will be collected throughout the growing season to determine the extent to which the accessions are hybridizing, and the diversity of the seed harvest:

- flowering times
- seed maturity
- seed yield

For the growth characteristics data, four replicates (individual plants) will be randomly selected from randomly selected experimental units of each accession, clipped at the base (with hand clippers) and used for evaluation. Height will be estimated in cm using a yard stick prior to clipping the plant. Basal width will be measured after the plant material is cut. Plant color will be determined using the Munsell color chart. Flowering times and seed maturity will be documented several times during the season, once each week as flowering and seed maturity episodes become apparent. Data will be entered into Statistix (Version 8.1) and analyzed to determine statistical differences between accessions.

Aside from the replicated plot, the rest of the borders will be harvested throughout the season for seed and hay bales. Cultural practices may include mechanical and chemical weed control, fertilization and chemical control of pests.

Final Evaluations

Field Plantings will be installed in various locations in the Sonoran Desert (and compared with the Bush muhly population from southeast Arizona MLRA) to test adaptation of the material. Seed from original collections and from the new population (the second generation) will be analyzed for genetic diversity within and between populations.

Technology Transfer Products

Plant fact sheet, planting guide, internal reports, research article

Literature Cited

Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development; Experimental Design, ANOVA and Regression.

Plot Plan for Sonoran Desert-MLRA-40:

IRRIGATION DITCH

ACCESSIONS START ON THE EAST SIDE OF THE PLOT

Randomized								Randomized
		1		7		16		
		2		2		6		
		3		11		15		
		4		3		14		
		5		15		2		
		6		4		17		
		20		1		18		
		7		13		3		
		8		6		19		
		9		20		11		
		10		5		10		
		11		19		12		
		12		18		7		
		13		17		20		
		14		10		4		
		15		12		5		
		16		14		9		
		17		8		8		
		18		16		1		
		19		9		13		
		16		19		2		
		6		20		9		
		3		6		5		
		5		13		8		
		8		17		7		
		14		10		20		
		2		11		14		
		12		5		3		
		13		18		11		
		1		15		13		
		18		1		15		
		10		7		1		
		11		3		12		
		15		4		10		
		4		2		19		
		20		12		6		
		7		8		16		
		9		14		17		
		19		16		4		
		17		9		18		

	Rep 1	
	Rep 2	
	Rep 3	3 plants/unit
	Rep 4	
	Rep 5	
	Rep 6	4 plants/unit (accessions 1-16)

ID Within the Plot Plan	Accession	ID Within the Plot Plan	Accession
1	9092749	11	9093945
2	9092750	12	9093946
3	9092748	13	9093949
4	9093909	14	9093953
5	9093910	15	9093954
6	9093912	16	9093957
7	9093915	17	9093963
8	9093929	18	9093965
9	9093933	19	9093969
10	9093936	20	9093975

Accomplishments/Results:

Background:

The Sonoran Desert-MLRA-40 field (field one, borders 4-7) was established in November 2007. Of the four borders planted, only border six had a replicated plot. No seed crop was harvested in 2007.

Growing season 2008:

The Sonoran desert MLRA-40 planting of bush muhly produced 13.6 bulk pounds of seed.

Growing season 2009:

Technology:
The Sonoran Desert MRLA 40 field was treated with a pre-emergent herbicide (oryzalin) at 3 quarts/acre on 4 March 2009. 2-4, D was applied at 2 pints/acre on July 21. The planting was irrigated in March and June with a total application of 0.28 acre feet. On 18 August, a combine harvest was attempted of one border of bush muhly. It was not an effective method of harvesting. On 20 August, the remaining three borders were harvested with the Woodward FlailVac resulting in approximately 45 bulk pounds.

Genetic Diversity:
The MLRA 40 planting had specific replications staked out for evaluations during the 2009 growing season. Growth characteristics such as height, mass, flowering times and seed production will be evaluated for the different accessions throughout the 2010 growing season.

Growing season 2010:

During growing season 2010, it was determined that both the technology and genetic diversity studies would be discontinued. The genetic diversity study has become impossible to evaluate due to the age of the planting and the growth habits of bush muhly. The accessions in the field have exhibited significant die off and movement proving identification of individual accessions difficult. The technology study has been discontinued as no appreciable data has been collected since establishment of the field.

Bush Muhly Genetic Variation for Southeast Arizona Study Plan

Study ID Code	AZPMC-P-0602-CR
Title	Investigate genetic differences between accessions of Bush muhly (*Muhlenbergia porteri*) from southeastern Arizona
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Population development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial, Mary E. Hershdorfer AZPMC
Duration	2006 through 2013
Vegetative Practices	343 Critical Area Planting 551 Range Seeding 544 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management 512 Pasture and Hay Planting
Description	A composite population of Bush muhly created with 8 accessions collected throughout Southeast Arizona Major Land Resource Area (MLRA 41) was planted at the AZPMC in a replicated planting design. Evaluation of growth characteristics of the different accessions would provide valuable information about this population, and document some of the measurable differences in genetic diversity in this species from within a relatively small geographic region.
Status of Knowledge	Bush muhly is a highly desirable warm season bunchgrass in southern Arizona. No germplasm is currently available to commercial growers, however growers have made it known that germplasm from this region would be a welcome commodity. Adaptation of a population across a known geographic region is desirable, because it has a greater likelihood of establishment and persistence at varying sites across that region. Genetic diversity also allows for the population to more easily adapt to changes in the climate. If the different accessions flower simultaneously throughout the season, they have potential to hybridize and increase genetic diversity of the population. Seed of the different accessions that reach maturity at approximately the same time will be represented in those harvests.
Experimental Design	Randomized complete block with 18 replications of 8 accessions (Attachment 1)
Materials & Methods	Samples of seed were assembled by Tucson AZPMC, AZ field office and volunteers from southeastern Arizona. Seed was planted at the Tucson Plant Materials Center, grown in plugs in the greenhouse and transplanted to the field in 2006. 7 rows of plugs are planted approximately 38 inches apart and spacing between plants is approximately 18 inches. 18 replications of the 8 accessions are planted into 6 of the rows (to be evaluated), and the final row consists of additional accessions randomly placed (which further increase the genetic diversity of the population, but are not placed in a design for evaluation). Each experimental unit of each accession in the plot plan consists of 8 plants in a row. To describe the population, the following data (growth characteristics) will be collected from individual plants once at the end of the growing season: • height • basal width • color

Additional data will be collected throughout the growing season to determine the extent to which the accessions are hybridizing, and the diversity of the seed harvest:

- flowering times
- seed maturity

For the growth characteristics data, four or more replicates (individual plants) will be randomly selected from randomly selected experimental units of each accession, clipped at the base (with electric clippers) and used for evaluation. Height will be estimated in mm using a yard stick prior to clipping the plant. Basal width will be measured after the plant material is cut. Plant color will be determined using the Mundsell color chart. Flowering times and seed maturity will be documented several times during the season, once each week as flowering and seed maturity episodes become apparent. Data will be entered into Statistix (Version 8.1) and analyzed to determine statistical differences between accessions. In addition to the replicated study, the planting will be harvested throughout the season for seed and hay bales.

Final Evaluations

Field Plantings will be installed at various locations in southeastern Arizona to test adaptation of the material. Seed from original collections and from the new population (second generation) will be analyzed for genetic diversity within and between populations.

Technology Transfer Products

Plant fact sheet, planting guide, internal reports, research article

Literature Cited

Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development; Experimental Design, ANOVA and Regression.

Plot Plan for Southeast Arizona MLRA-41:

IRRIGATION DITCH

ACCESSIONS START ON THE EAST SIDE OF THE PLOT

8 Plants/unit
18 replications

I	II	III	IV	V	VI	VII
5	4	2	5	8	6	
2	1	7	2	1	2	
7	2	1	4	7	3	E
3	8	3	6	3	7	X
4	3	5	3	5	5	T
6	7	6	8	2	8	R
8	5	4	4	7	1	A
1	6	8	1	6	4	
8	6	4	8	8	6	A
7	1	6	7	3	2	C
3	8	5	1	4	7	C
2	5	7	2	1	5	E
5	3	8	5	2	4	S
4	4	3	4	7	1	S
1	7	2	6	5	3	I
6	2	1	3	6	8	O
5	6	5	2	3	3	N
8	5	4	5	8	4	S
4	8	3	6	4	6	
2	7	1	1	5	1	9
3	3	8	4	2	7	thru
6	4	6	7	1	8	16
7	1	7	3	6	5	
1	2	2	8	7	2	

PRIMARY PLOT

ID Within the Plot Plan	Accession
1	9092495
2	9092574
3	9092621
4	9092626
5	9092631
6	9092636
7	9092666
8	9092680
9	9092493
10	9092494
11	9092549
12	9092594
13	9092708
14	9092721
15	9092727
16	9092734

PRIMARY PLOT

Row 7

Accomplishments/Results:

Background:

The Southeast Arizona MLRA-41 field (field six, border 6) was established in July of 2006. As such, no crop was harvested in 2006. During the 2007 growing season, the planting suffered due to lack of irrigation while the AZPMC well was down. Again, there was no seed crop harvested.

Growing season 2008:

The bush muhly for Southeastern Arizona MLRA-41 produced 5.25 pounds of seed.

Growing season 2009:

Technology:
The Southeast Arizona MLRA-41 field was treated with a pre-emergent (oryzalin) at 3 quarts/acre on 4 March 2009. 2-4, D was applied at 2 pints/acre on July 21. The planting was irrigated in March, June, and July with a total application of 0.41 acre feet. On September 9, the border was harvested with the Woodward FlailVac with a total of 16 bulk pounds.

Genetic Diversity:
The MLRA 41 planting had specific replications staked out for evaluations during the 2009 growing season. Growth characteristics such as height, mass, flowering times and seed production will be evaluated for the different accessions throughout the 2010 growing season.

Growing season 2010:

During growing season 2010, it was determined that both the technology and genetic diversity studies would be discontinued. The genetic diversity study has become impossible to evaluate due to the age of the planting and the growth habits of bush muhly. The accessions within the field have exhibited significant die off and movement proving identification of individual accessions difficult. The technology study has been discontinued as no appreciable data has been collected since establishment of the field.

Desert Saltgrass Study Plan

Study ID Code	AZPMC-P-0802-CR
Title	Development of Technology for Production of Desert Saltgrass for Southern Nevada
National Project Number	Natural Areas 1.1
Study Type	Initial Evaluation Planting
Study Status	Active
Location	Tucson Plant Materials Center
Study Leader	Manuel Rosales, Heather Dial, Mary Hershdorfer AZPMC
Duration	2005-2012
Cooperators	BLM-Las Vegas Office and High Desert RC&D
Land Use	Restoration of riparian areas in Southern Nevada
Vegetative Practices	**Primary** Critical area planting **Secondary** Conservation cover

Resource Concern(s)

Resource	**Consideration/Problem**
Native species	Lack of viable commercial sources of DISP
Restoration of Disturbed Areas	No commercial sources of DISP with genetic origins from southern Nevada

Long Range Plan

Strategic Goal 1, Objective 1.1: Conserve and enhance soil resources with plant science technology

Strategic Goal 2, Objective 2.1: Provide for and promote the commercial production of NRCS plant releases to ensure adequate seed and plant availability for use in cooperative conservation programs.

Description

The purpose of this project is to develop a genetically diverse population of *Distichlis spicata* (Desert saltgrass) that can be grown by commercial growers in the desert southwest, USA. A comparison of 3 plots with differing sex ratios of male and female Desert saltgrass plants were planted in 2007 to investigate the potential for increasing seed production, information that would be of interest to seed growers.

Status of Knowledge

Salt grass is available to the seed market, but not one with genetic origin in southern Nevada. The original plant materials for this composite population were collected at three locations in southern Nevada to increase the genetic diversity of the population. Saltgrass is dioecious and a poor seed producer, so three field plantings were designed with increasing numbers of female plants to male plants to attempt to increase seed production.

Experimental Design	Three plots with differing sex ratios of male to female plants	
Treatment 1	**Title:**	Ratio 1:3 male to female plants
	Description:	Every 3 female plugs a male plug was planted
Treatment 2	**Title:**	Ratio 1:5 male to female plants
	Description:	Every 5 female plugs a male plug was planted
Treatment 3	**Title:**	Ratio 1:10 male to female plants
	Description:	Every 10 female plugs a male plug was planted

Materials and Methods

Tillers of both male and female plants were collected at three locations in southern Nevada, composing 6 total accessions. These tillers were cloned (increased) in multiple containers and transferred into individual plugs until sufficient plugs were grown to complete the three plots, over a period of approx. 4 months. Field plots were planted at the AZPMC in December, 2007 and are composed of approximately 280 plants, 8 rows each. Three ratios of female to male plants - 3:1, 5:1 and 10:1- are used to compare seed yields. A 5 ft border was placed between the first two plots (Field 2, Border 5), and the third was placed in its own border (Field 2, Border 6). A plot design for the plantings was developed to maximize crossing of the 6 accessions, thereby maintaining the genetics of the original collections (Attachment 1).

Seed yield from the three plots will be evaluated once at the end of the growing season. In each planting, 1 ft x 2 ft frames will be placed randomly over female plants at five locations lengthwise along rows within the middle 6 rows of the plantings (outside rows are used as buffers). If certain female accessions do not develop seed, those accessions will not be used for the evaluation of seed yield. The contents of the frames will carefully be collected and seed counted. A mean seed yield will be determined for each planting. The field with highest seed production is expected to become the foundation field. Field design recommendations (male-female plant ratio) for commercial growers will be provided. Seed harvested will be provided to the BLM-Las Vegas Office.

Additional data may also be collected throughout the growing season:

- Flowering dates for the three female accessions
- Stand density

Data will be analyzed statistically.

Final Evaluations

The seed from these plantings will be used in plots in southern Nevada throughout the region of intended use.

Technology Transfer Products

In addition to the annual project reports for the BLM and internal documents on the results of the above study, general production information (for commercial growers) will include field requirements, seed yield, harvest techniques and years until production.

Literature Cited

Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol. 72. New York and Oxford.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Keywords Saltgrass, *Distichlis spicata*, seed production

Reviewed by: Plant Materials Specialist _____

Approvals: State Conservationist _____

Accomplishments/Results:

This study was completed in 2010. The final report delivered to our BLM cooperators follows.

Development of Technology for Production of Desert Saltgrass for Southern Nevada
Study Number: AZPMC-P-0802-CR
Tucson Plant Materials Center

Introduction:

Desert saltgrass (*Distichlis spicata*) is a warm-season, dioecious, perennial grass with deep horizontal rhizomes. It is an important species in many arid riparian areas, especially in saline estuaries and stream banks for soil stabilization. Four federal agencies cooperating in southern Nevada land restoration: Bureau of Land Management (BLM), United States Forest Service (USFS), National Park Service (NPS), and the Fish and Wildlife Service (FWS) would like to use salt grass for riparian restoration along the Muddy and Virgin Rivers and within other springs and waterways. However, low natural seed production impedes the use of this species in restoration (Paylicek et al. 1977) (Cluff et al. 1983).

Distichlis is often found in populations that are either male or female dominated, a pattern known as spatial segregation of the sexes (Eppley 2006). By manipulating the sex ratios in cultivated populations, we may be able to increase seed production. Seed and plants derived from these trials may be used for common garden studies, to evaluate methods for delivering vegetative and sexual propagules, and for various small restoration projects.

Materials and Methods:

Vegetative samples from locations in Southern Nevada (Figure 1) were obtained by BLM personnel in September 2007. Tillers of both male and female plants were collected from three locations resulting in 6 total accessions (Table 1).

Figure 1: Sample collection sites

	Longitude	Latitude	Accession
Ashmeadows NWR	-116.3298	36.4206	
Male			9094097
Female			9094098
Corn Creek Desert Refuge Complex	-115.3597	36.4381	
Male			9094099
Female			9094100
Pahranagat NWR	-115.0961	37.2311	
Male			9094101
Female			9094102

Table 1. Saltgrass collection sites

Collected tillers were cloned by layering each accession in separate 1020 trays (Figure 2). When sufficient root growth was obtained, tillers were clipped at the nodes and transferred into HV93 HIKO™ trays (http://www.stuewe.com/products/hiko.html).

Figure 2: Saltgrass tillers layered in 1020 trays for cloning in the AZPMC greenhouse

Three experimental populations with known proportions of females to males were established in July 2008. Population 1 was planted to achieve a 1:3 male to female plant ratio, population 2 a 1:5 male to female ratio, and population 3 a 1:10 male to female ratio (Figures 3-5). Populations were established with the Holland transplanter in adjacent fields and were each approximately 0.08 acres. Rows are 42” apart with 14” between each plug within the rows. Each plot was evaluated individually to determine quantity of seed produced and to observe the effects of sex ratios on seed production. Additionally, data on flowering dates and noted physiological differences was collected.

Figure 3: Population 1 planting plan with 1:3 male to female plant ratio

IRRIGATION DITCH

1	2	3	4	5	6	7	8
Border Rows	1	4	5	4	3	4	Border Rows
	2	4	2	4	2	4	
	2	3	2	1	2	5	
	2	6	2	6	2	6	
	1	6	5	6	3	6	
	4	6	4	6	4	6	
	4	3	4	1	4	5	
	4	2	4	2	4	2	
	1	2	5	2	3	2	
	6	2	6	2	6	2	
	6	3	6	1	6	5	
	6	4	6	4	6	4	
	1	4	5	4	3	4	
	2	4	2	4	2	4	
	2	3	2	1	2	5	
	2	6	2	6	2	6	
	1	6	5	6	3	6	
	4	6	4	6	4	6	
	4	3	4	1	4	5	
	4	2	4	2	4	2	
	1	2	5	2	3	2	
	6	2	6	2	6	2	
	6	3	6	1	6	5	
	6	4	6	4	6	4	
	1	4	5	4	3	4	
	2	4	2	4	2	4	
	2	3	2	1	2	5	
	2	6	2	6	2	6	
	1	6	5	6	3	6	
	4	6	4	6	4	6	
	4	3	4	1	4	5	
	4	2	4	2	4	2	
	1	2	5	2	3	2	
	6	2	6	2	6	2	
	6	3	6	1	6	5	
	6	4	6	4	6	4	
	1	4	5	4	3	4	
	2	4	2	4	2	4	
	2	3	2	1	2	5	
	2	6	2	6	2	6	
	1	6	5	6	3	6	
	4	6	4	6	4	6	
	4	3	4	1	4	5	
	4	2	4	2	4	2	
	1	2	5	2	3	2	

ID in plot plan	Accession	Collection Location
1	9094097	Ashmeadows NWR (Male)
2	9094098	Ashmeadows NWR (Female)
3	9094099	Corn Creek Desert Refuge Complex (Male)
4	9094100	Corn Creek Desert Refuge Complex (Female)
5	9094101	Pahranagat NWR (Male)
6	9094102	Pahranagat NWR (Female)

Figure 4: Population 2 planting plan with 1:5 male to female plant ratio

IRRIGATION DITCH

1	2	3	4	5	6	7	8
Border Rows	2	4	5	4	3	4	Border Rows
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	4	3	2	1	2	5	
	4	6	4	6	4	6	
	1	6	4	6	4	6	
	4	6	5	6	3	6	
	6	2	4	2	4	2	
	6	2	6	2	6	2	
	6	3	6	1	6	5	
	2	2	6	2	6	2	
	1	4	2	4	2	4	
	2	4	5	4	3	4	
	2	4	2	4	2	4	
	4	6	2	6	2	6	
	4	3	4	1	4	5	
	4	6	4	6	4	6	
	1	6	4	6	4	6	
	6	2	5	2	3	2	
	6	2	6	2	6	2	
	6	2	6	2	6	2	
	2	3	6	1	6	5	
	2	4	2	4	2	4	
	1	4	2	4	2	4	
	2	4	5	4	3	4	
	4	6	2	6	2	6	
	4	6	4	6	4	6	
	4	3	4	1	4	5	
	6	6	4	6	4	6	
	1	2	6	2	6	2	
	6	2	5	2	3	2	
	6	2	6	2	6	2	
	2	4	6	4	6	4	
	2	3	2	1	2	5	
	2	4	2	4	2	4	
	1	4	2	4	2	4	
	4	6	5	6	3	6	
	4	6	4	6	4	6	
	4	6	4	6	4	6	
	6	3	4	1	4	5	
	6	2	6	2	6	2	
	1	2	6	2	6	2	
		2	5	2	3	2	
		4	6	4	6		
		4	2	4	2		

ID in plot plan	Accession	Collection Location
1	9094097	Ashmeadows NWR (Male)
2	9094098	Ashmeadows NWR (Female)
3	9094099	Corn Creek Desert Refuge Complex (Male)
4	9094100	Corn Creek Desert Refuge Complex (Female)
5	9094101	Pahranagat NWR (Male)
6	9094102	Pahranagat NWR (Female)

Figure 5: Population 3 planting plan with 1:10 male to female plant ratio

IRRIGATION DITCH

1	2	3	4	5	6	7	8
Border Rows	1	4	5	4	3	4	Border Rows
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	2	6	2	6	2	2	
	4	6	4	6	4	2	
	4	3	4	1	4	5	
	4	6	4	6	4	2	
	6	2	6	2	6	6	
	6	2	6	2	6	6	
	6	2	6	2	6	6	
	2	4	2	4	2	4	
	1	4	5	4	3	4	
	2	4	2	4	2	4	
	2	6	2	6	2	2	
	4	6	4	6	4	2	
	4	6	4	6	4	2	
	4	3	4	1	4	5	
	6	2	6	2	6	6	
	6	2	6	2	6	6	
	6	2	6	2	6	6	
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	1	4	5	4	3	4	
	2	6	2	6	2	2	
	4	6	4	6	4	2	
	4	6	4	6	4	2	
	4	2	4	2	4	6	
	6	3	6	1	6	5	
	6	2	6	2	6	6	
	6	2	6	2	6	6	
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	1	6	5	6	3	2	
	4	6	4	6	4	2	
	4	6	4	6	4	2	
	4	2	4	2	4	6	
	6	2	6	2	6	6	
	6	3	6	1	6	5	
	6	2	6	2	6	6	
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	2	4	2	4	2	4	
	4	6	4	6	4	2	
	1	6	5	6	3	2	

ID in plot plan	Accession	Collection Location
1	9094097	Ashmeadows NWR (Male)
2	9094098	Ashmeadows NWR (Female)
3	9094099	Corn Creek Desert Refuge Complex (Male)
4	9094100	Corn Creek Desert Refuge Complex (Female)
5	9094101	Pahranagat NWR (Male)
6	9094102	Pahranagat NWR (Female)

Accomplishments/Results:

Growing season-2008

Plots established well over the year with minimum mortality of the transplanted plugs. Flood irrigation frequency was once per month from July-Oct 2008 for a total of 0.55 acre feet of water applied. Weed control consisted of hand rouging. There was no application of herbicide and/or fertilizer. Plants were not well enough established to warrant seed harvest in the fall of 2008. However, plots were evaluated in October of 2008 to determine percent flowering by accession (Table 2).

Table 2: Percent flowering of saltgrass accessions in three populations during the 2008 growing season

Accession	Collection Location	Population 1 1:3	Population 2 1:5	Population 3 1:10
9094097	Ashmeadows NWR (Male)	0.00	14.29	0.00
9094098	Ashmeadows NWR (Female)	1.45	2.74	4.82
9094099	Corn Creek Desert Refuge Complex (Male)	86.96	100.00	88.89
9094100	Corn Creek Desert Refuge Complex (Female)	76.81	78.95	86.90
9094101	Paranaghat NWR (Male)	82.61	86.67	88.89
9094102	Paranaghat NWR (Female)	52.17	47.89	56.58

As the data indicates, the accessions from the Ashmeadows NWR had very little to no flowering while the other accessions exhibited more than 50% flowering in the three different sex ratios.

Growing Season-2009

In March, all three plots were treated with 3 quarts/acre of a pre-emergent herbicide (oryzalin). The plantings were irrigated twice in March and July with a total application of 0.41 acre feet. The plants showed immediate response to the March irrigation by flowering. On the 8th of April the plantings were evaluated for percent flowering by accession (Table 3).

Table 3: Percent flowering of saltgrass accessions in three populations during the 2009 growing season

Accession	Collection Location	Population 1 1:3	Population 2 1:5	Population 3 1:10
9094097	Ashmeadows NWR (Male)	4.35	0.00	0.00
9094098	Ashmeadows NWR (Female)	5.80	1.37	4.82
9094099	Corn Creek Desert Refuge Complex (Male)	65.22	6.67	22.22
9094100	Corn Creek Desert Refuge Complex (Female)	59.42	46.05	67.86
9094101	Pahranagat NWR (Male)	17.39	13.33	22.22
9094102	Pahranagat NWR (Female)	14.49	14.08	38.16

Flowering was significantly reduced in all six accessions when compared to the 2008 flowering data, particularly Corn Creek and Pahranagat. This may be due to the season of

evaluation, October in 2008 versus April in 2009. However, the Ashmeadows accessions still exhibited minimal to no flowering.

Each set of collections has a distinguishing growth form that could be used to differentiate the accessions within the plantings. Attempts to illustrate the differences seen between the accessions in April 2009 are shown in the photos below (Figures 6-8).

The Ashmeadows NWR accessions are of an average height of 7 inches. They have largest interspaces on the rhizomes resulting in a more "open" look than the other collections.

Figure 6: Ashmeadows NWR female accession in the 1:3 plot (April 2009)

The Corn Creek accessions are very low growing, with an average height of 5 inches. They have formed dense, compact mats and aggressively filled in open areas in the planting blocks.

Figure 7: Corn Creek female accession in the 1:3 plot (April 2009)

The Pahranagat NWR accessions have an average height of 11 inches. The foliage is thinner and grows more closely together than the Ashmeadows accessions.

Figure 8: Pahranagat NWR female accession in the 1:3 plot (April 2009)

Although the accessions have different appearances, as the planting fills in the interspaces of the planting blocks, it will soon become too difficult to distinguish individual plants from one another for reliable flowering data collection. This is primarily due to stolons and rhizomes filling in the field. While not impossible, it was difficult to determine whether flowers occurring at an individual flag belong to the accession planted there or if they belong to a neighboring accession.

Growing Season-2010:

In November 2009, spikelets from plants within the 1:3 plot were collected to gauge seed production. Spikelets from rows 3, 4, 5, and 6 were snipped from the middle plant of one female replication. In all instances, florets were empty; no seed production occurred within the 1:3 plot. Spikelets from the 1:5 and 1:10 plots were not collected as flowering data from April 2009 indicated minimal to no flowering as compared to the 1:3 plots. As expected, reliable collection of flowering data in the sex ratio plots was not possible during the 2010 growing season due to the prolific vegetative reproduction of the plants (Figure 9).

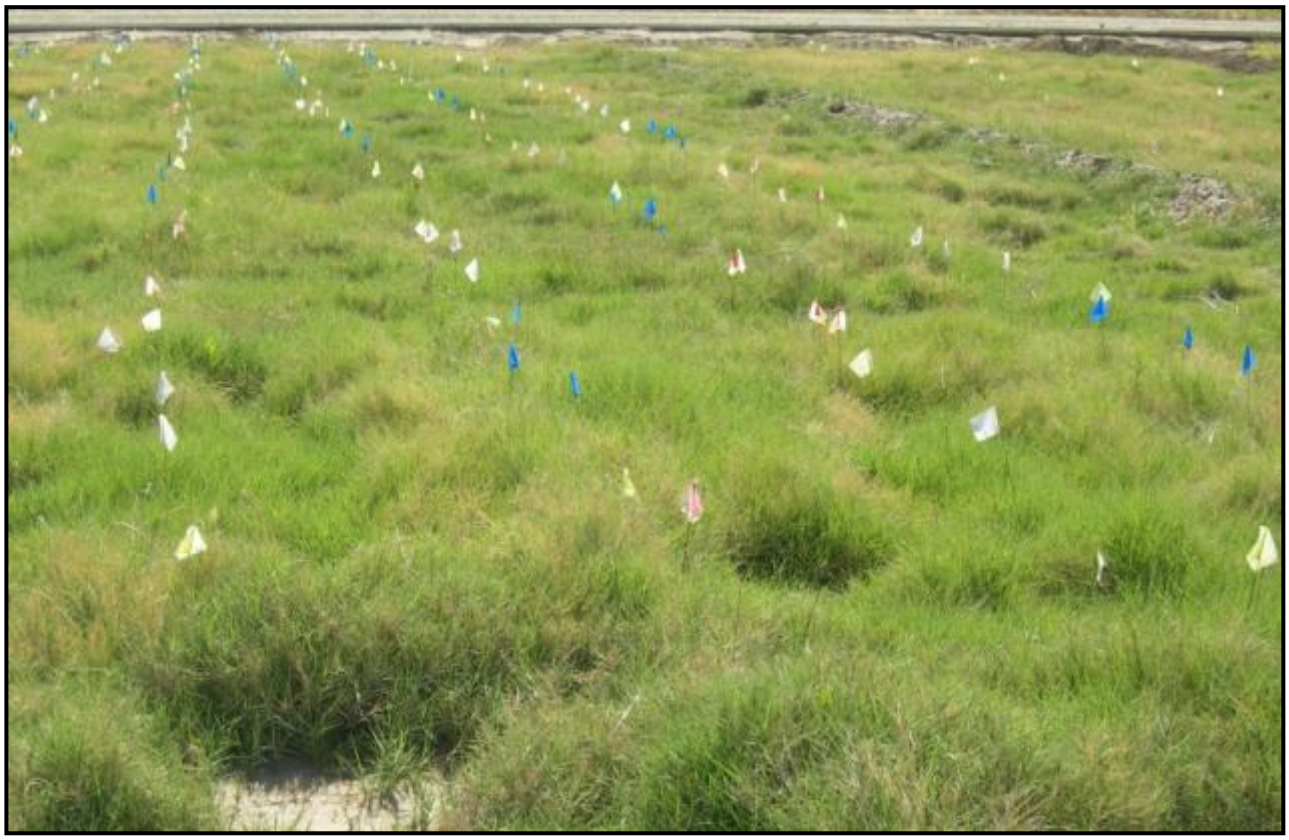


Figure 9: Saltgrass plants filling in interspaces in the 3:1 planting block (April 2010)

Conclusions and Discussion:

Seed production using the sex ratio manipulation plots from years 2007-2010 has been non-existent. However, seed production of a regionally adapted Nevada desert saltgrass is still believed possible. Literature suggests that a saltgrass breeding program is more likely to be successful if parent plant materials are selected from plants with similar phenotypic characteristics (Ram et al. 2004). Other evidence for phenotypic selection of parent materials has been reported by researchers at Colorado State University and the University of Arizona. These researchers report successful saltgrass seed production when male and female lines are selected that flower abundantly and at the same time (Hughes et al. 2002). Based on this information and data taken during the life of this project, it is believed that the flowering windows and phenotypic characteristics of the saltgrass accessions currently in the AZPMC plots are too variable for successful and/or consistent seed production.

Discussions with personnel at the Karsten Turfgrass Research Facility at the University of Arizona have revealed that saltgrass has a wide ploidy level with anueploids and haploids and that saltgrass can have a chromosome range of 56 to72 chromosomes (David Kopec, University of Arizona, written communication 2009). Additionally, plants collected from the southern Great Basin range (Nevada ecotypes) by Colorado researchers have shown that Nevada selections can bear this wide range of chromosome types within the same eco-cline (Kopec, personal communication). Because of the variable chromosome numbers found in *Distichlis spicata* by the Colorado State Research group, successful seed set will only most likely occur from ecotypes with the same chromosome numbers.

For future seed production efforts, it should be worthwhile to invest in root tip chromosome counts of at least 50 phenotypically similar accessions to avoid the sterility issues common to saltgrass found in southern Nevada before attempting seed production trials. If accessions originating in southern Nevada can be found with matching chromosome numbers, those accessions would be likely candidates for seed production trials. Other options include using seed from male and female accessions from a specific location (such as the prolific accessions of Corn Creek) or collection of additional clones from areas which are more likely to have genotypes with the same chromosome number. A new planting similar to the current plantings, with increasing ratios of male to female plants, would provide the option to investigate the potential to increase seed production of this species.

Disclaimer:
The mention of trade and company names does not imply any guarantee, warranty or endorsement by the USDA Natural Resources Conservation Service nor does it imply approval to the exclusion of other products that may also be suitable.

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Black Grama Study Plan

Study ID Code	AZPMC-S-0503-CR
Title	Development of technology for seed production of 'Sonora' Black grama (*Bouteloua eriopoda*)
National Project No.	Natural Areas 1.1 Rangeland 1.1 Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Technology development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial
Duration	2006 through 2011
Description	Develop agronomic protocols for seed production of the 1965 release 'Sonora' Black grama
Status of Knowledge	In demo garden, 'Sonora' has been shown to be better adapted to southern Arizona than 'Nogal' and appears to be much more rhizomatous. 'Sonora' black grama [*Bouteloua eriopoda* (Torr.) Torr.] was released by the AZPMC in 1965. It was the first improved black grama cultivar to be released for commercial seed production. The cultivar was developed from 11 vegetative and 47 seed accessions collected from Arizona and New Mexico in 1957. At the time of release 'Sonora' was characterized as outstanding for leafiness, vigor, forage production, vegetative spread, seed set and seed production. However, seed production in subsequent years declined and 'Sonora'was abandoned due to poor seed yield. Subsequent research has provided information indicating that the reduction in seed yield was due to a buildup of parasitic insects.
Experimental Design	Randomized complete block or split plot with 3-4 replications will be utilized depending on need.
Materials & Methods	Seed will be planted at the Tucson Plant Materials Center. Plants will be grown in plugs in the greenhouse and transplanted to the field. The plugs will be planted into an irrigated field. Rows will be approximately 38 inches apart and spacing between plants will be approximately 12 inches. Cultural practices may include mechanical and chemical weed control, fertilization, and chemical control of pests.
Final Evaluations	Field Plantings will be installed in various locations in southeastern Arizona to test adaptation of the material. Seed from original collections and from the new population will be analyzed for genetic diversity within and between populations.
Technology Transfer Products	Plant fact sheet, planting guide, internal reports, research article
Literature Cited	Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development; Experimental Design, ANOVA and Regression.

Accomplishments/Results:

Background:

In 2005, a 0.25 acre production field was established at the AZPMC to determine if agronomic and pesticide protocols could be developed that would make 'Sonora' a viable cultivar for southern Arizona and New Mexico. No seed crop was harvested from this plot until 2008 due to minimal seed set.

Growing season 2008:

During the 2008 harvest, personnel were caught in a typical summer/late fall monsoon. The small amount of seed collected was soaked. As such, no data was collected. Thrips have been observed in the florets of the plants and could be a contributing factor for the low amount of seed that is being set every year. Our next step is to set up an insecticide spraying program to control the thrips.

Growing season 2009:

In early March, the field was treated with 5 quarts/acre of a pre-emergent herbicide (pendimethalin). The field received 4 irrigations (March, June, June, and July) totaling 0.93 acre feet of application. On June 4th, a 20 lb/acre application of nitrogen was completed and during the month of July 1.5 pints/acre of 2,4-D was applied for weed control. In August, 6.25 bulk pounds of seed was collected using the Woodward FlailVac. Field investigations conducted throughout the season indicate that thrips are active in the field. A trial using two to three insecticides for thrips control is being planned for growing season 2010.

Growing season 2010:

In June, BASF Sensor® 3x5 in. yellow pest monitoring cards were placed in the field to aid in identification of insect populations. As expected, an unusually high population of thrips (Order *Thysanoptera*) was found. A randomized complete block design with 3 replications was established in the field to conduct an insecticide trial. The field dimensions are 388 feet long by 32 feet wide with a total area of approximately 0.3 acres.

FIELD LAYOUT

IRRIGATION DITCH

REP-III		REP-II		REP-I	
R-6	**R-5**	**R-4**	**R-3**	**R-2**	**Row-1**
Control	**Spray**	**Spray**	**Control**	**Control**	**Spray**

Three insecticides were evaluated for use in the trial. The insecticide chosen for use in the trial was Pyreth-it® based on its low risk for humans and the environment.

The field was sprayed twice (July and August) at a rate of 16oz. / acre. On November 1st, three square meter samples were clipped from each row to determine what effect, if any, the insecticide applications had on seed production. The samples have not been processed and statistically analyzed at the time of this report. The frequency of spray treatments will be adjusted during growing season 2011 based on the sample results.

Thrips monitoring

Collecting samples

Establishment of Arizona Native Seed Growers Study Plan

Study ID Code	AZPMC-S-0602-CR
Title	Development of Technology for Seed Production of Various AZPMCReleases for First-Time Native Seed Farmers in Southern Arizona
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Development of Establishment Technology
Study Status	Active
Location	AZPMC
Study Leaders	Mary E. Hershdorfer, Heather Dial AZPMC
Duration	2006 through 2012
Vegetative Practices	344 Critical Area Planting 552 Range Seeding 645 Wildlife Upland Habitat Management
Description	Develop a protocol for establishment of commercial seed production fields for first-time native seed growers in southern Arizona.
Status of Knowledge	The native seed business for the Desert Southwest is currently in peril. Few native seed growers exist in southern Arizona, or for that matter, within the AZPMCService Area. Potential seed purchasers in this region are often discouraged from native seed plantings because of the high cost of seed and frequently low germination rate or persistence. Many plantings have been conducted using "common" seed without consideration of genetic origin, possibly the cause of the previous plantings' failures. Most seed available to the market with adaptation to this region is hand-harvested by contracted seed collectors at a steep price. The AZPMCwould like to encourage the use of regionally adapted ecotypes in rangeland plantings to increase their success. Having seed grown under agronomic conditions would decrease the per pound price of the seed. A recent study conducted by the AZPMCcomparing multiple Alkali sacaton accessions from southern Nevada suggests that harsh dry climates likely require the use of adapted germplasm in order for the plants to germinate and persist. AZPMCreleases are now developed from multiple collections across their intended region of use. Few AZPMCreleases are commercially available, although the AZPMC has made an effort in recent years to work on species currently in demand. The AZPMCwould like to encourage interested farmers in southern Arizona to enter into native seed production agreements, however, locating farmers willing to take the initial risk of transitioning to a new crop with different requirements is a challenge. Several ideas to decrease risk to the farmer and increase chances of their success have been suggested to encourage this transition. Experiences and lessons learned will be included in this study.
Experimental Design	None. The study is designed to increase seed production of AZPMC releases in Southern Arizona.
Materials & Methods	Multiple AZPMCReleases are currently in demand and simple to grow, including 'Loetta' Arizona cottontop, Pima Germplasm Pima pappusgrass, Vegas Germplasm Alkali sacaton and Moapa Germplasm Alkali muhly. Several species not yet released but in development at the AZPMChave origins in southeast Arizona, and the establishment of growers in this region would be

ideal due to the adaptive nature of the species.

Experienced farmers willing to try new crops will be considered for this project. Only simple to grow species with a guaranteed market will be recommended for these first-time growers. Assistance with specialized equipment will be provided or possibly available through the local RC&D for loan.

Final Evaluations

Farmers will need to keep their fields weed free, sufficiently irrigated/maintained, and harvested at appropriate times for commercial success. Evaluations of field success will be conducted using adapted versions of the On Farm Assessment & Evaluation sheets (Attachment 1). With producer's approval, other information to be documented will include:

- How long it takes producer to come up with a saleable product
- Yield data for the 1st several years to determine when the crop reaches optimal yield
- Length of time for stand establishment
- Difficulties such as weed control, irrigation, harvest

Technology Transfer Products

Tech Note on establishment protocol, Planting guides, internal reports.

Literature Cited

- Native Grass Seed Production for Southern Nevada, Tucson PMC, USDA- NRCS, March 2006
- Native Seed Production, AZPMCin cooperation with Coronado RC&D, USDA-NRCS, September 2004
- Steve Smith and Debra Hendenheim, Seed of wildland plants in Arizona: Evaluating current supplies and projecting demands, University of Arizona, 2004.
- BLM annual project reports (also in AZPMC Annual Technical Report)– yr 2005, 2006, 2007

Accomplishments/Results:

Growing season 2008:

AZPMC personnel met with Tohono O'odham Farming Authority representatives during the growing season of 2008. Afterward, the AZPMC provided seed of Pima germplasm Pima pappusgrass and 'Loetta' Arizona cottontop to the authority for the establishment of a pilot project. Authority representatives have since been in contact with AZPMC personnel to discuss planting times and requirements. Additionally, AZPMC personnel met with Bob Roth, the director of the University of Arizona Maricopa Agricultural Center, about production of native grasses. Seed of Vegas alkali sacaton and Moapa alkali muhly was provided to Mr. Roth for a growing trial. AZPMC personnel have maintained contact with Mr. Roth and are working to provide technical assistance in the planting of the seed.

Growing season 2009:

In April of 2009, Bruce Munda, Arizona Plant Materials Specialist, visited the Tohono O'odham Schuk Toak Farm to provide technical assistance to the farm supervisor, Max Banda. In September of 2009, 'Loetta' Arizona cottontop and Pima germplasm Pima pappusgrass were direct seeded into a five acre planting on the farm. AZPMC staff was on hand during the planting to provide technical assistance and have since visited the farm twice to check the status of the plantings. Plantings of Vegas alkali sacaton and Moapa alkali muhly were not initiated at the University of Arizona Maricopa Agricultural Center but are still being discussed.

Growing season 2010:

The plantings of Pima germplasm Pima pappusgrass (*Pappophorum vaginatum*) and 'Loetta' Arizona Cottontop (*Digitaria californica*) conducted during September of 2009 at the Tohono O'odham Schuk Toak Farm were a success. Both species germinated well. Pima germplasm had an approximately 90 percent germination rate and Arizona Cottontop exhibited approximately 70 percent germination. In May of 2010, AZPMC staff provided an on-site demonstration of the Woodward flail-vac seed stripper to harvest the Pima pappusgrass. Approximately 350-400 bulk pounds of seed were harvested from the 5 acre field. The harvested seed was sold by Tohono O'odham Schuk Toak Farm to a local seed vendor. The AZPMC provided information on harvesting equipment and seed cleaning equipment to the Schuk Toak Farm and continues to provide technical assistance. It is our hope that the Schuk Toak farm will continue growing native grasses to supply the local market.

Pima Pappusgrass- Tohono O'odham Schuk Toak Farm

Establishment of California Native Seed Growers Study Plan

Study ID Code	AZPMC-S-0803-CR
Title	Development of Technology for Seed Production of Various AZPMCReleases for First-Time Native Seed Farmers in California
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Development of Establishment Technology
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial, Mary E. Hershdorfer AZPMC
Duration	2006 through 2012
Vegetative Practices	345 Critical Area Planting 553 Range Seeding 645 Wildlife Upland Habitat Management
Description	Develop a protocol for establishment of commercial seed production fields for first-time native seed growers in the Mojave region of California.
Status of Knowledge	The native seed business for the Desert Southwest is currently in peril. Few native seed growers exist in southern Arizona, or for that matter, within the AZPMCService Area. Potential seed purchasers in this region are often discouraged from native seed plantings because of the high cost of seed and frequently low germination rate or persistence. Many plantings have been conducted using "common" seed without consideration of genetic origin, possibly the cause of the previous plantings' failures. Most seed available to the market with adaptation to this region is hand-harvested by contracted seed collectors at a steep price. The AZPMCwould like to encourage the use of regionally adapted ecotypes in rangeland plantings to increase their success. Having seed grown under agronomic conditions would decrease the per pound price of the seed. A recent study conducted by the AZPMCcomparing multiple Alkali sacaton accessions from southern Nevada suggests that harsh dry climates likely require the use of adapted germplasm in order for the plants to germinate and persist. AZPMCreleases are now developed from multiple collections across their intended region of use. Few AZPMCreleases are commercially available, although the PMC has made an effort in recent years to work on species currently in demand. The AZPMCwould like to encourage interested farmers in California to enter into native seed production agreements, however, locating farmers willing to take the initial risk of transitioning to a new crop with different requirements is a challenge. Several ideas to decrease risk to the farmer and increase chances of their success have been suggested to encourage this transition. Experiences and lessons learned will be included in this study.
Experimental Design	Only individuals with extensive experience in farming, interest in a new challenge need apply. Only simple to grow species with a guaranteed market will be recommended for these first-time growers. The PMC will provide technical assistance as needed.
Materials & Methods	Multiple AZPMC Releases are currently in demand and simple to grow, including 'Loetta' Arizona cottontop, Pima Germplasm Pima pappusgrass, Vegas Germplasm Alkali sacaton and Moapa Germplasm Alkali muhly. Several

	additional species are currently in development at the Tucson PMC.
Final Evaluations	Farmers will need to keep their fields weed free, sufficiently irrigated/maintained, and harvested at appropriate times for commercial success. Evaluations of field success will be conducted using adapted versions of the On Farm Assessment & Evaluation sheets (Attachment 1). With producer's approval, other information to be documented will include: • How long it takes producer to come up with a saleable product • Yield data for the 1st several years to determine when the crop reaches optimal yield • Length of time for stand establishment • Difficulties such as weed control, irrigation, harvest
Technology Transfer Products	Tech Note on establishment protocol, Planting guides, internal reports.
Literature Cited	• Native Grass Seed Production for Southern Nevada, Tucson PMC, USDA- NRCS, March 2006 • Native Seed Production, AZPMCin cooperation with Coronado RC&D, USDA-NRCS, September 2004 • Steve Smith and Debra Hendenheim, Seed of wildland plants in Arizona: Evaluating current supplies and projecting demands, University of Arizona, 2004. • BLM annual project reports (also in PMC Annual Technical Report)– yr 2005, 2006, 2007

Accomplishments/Results:

Growing season 2009:

PMC personnel attended the Desert Mountain RC&D meeting in Needles, CA on April 30th to discuss the project with the RC&D. Few agriculturalists showed up for the meeting but it was an opportunity to meet key individuals from participating agencies, including NRCS local field offices and the councils for Desert Mountain and the Antelope Valley RC&Ds. On June 3, 2009, a second meeting was scheduled in Lancaster, CA, with the help of the Lancaster NRCS field office and the Desert Mountain RC&D, to present the project to a larger group of agriculturalists. The primary members of the collaborative project gave a presentation to a group of about 20 individuals. A site visit was made to an interested farmer's farm the following day and a decision was made to pursue planting at the farm. PMC personnel began planting alkali sacaton plugs to fill 5 acres on the farmer's farm in June. Unfortunately, the prospective farmer decided to leave his business in July. PMC personnel maintained the alkali sacaton plugs overwinter while the search began anew for an interested farmer.

Growing season 2010:

A new interested farmer located near Needles, California was located in late 2009 with the assistance of the NRCS field office in Kingman, Arizona. A contract was secured with the farmer via the High Desert RC&D based out of Las Vegas, Nevada. On April 12th, PMC personnel traveled to Needles, CA to plant the alkali sacaton plugs started the previous growing season. Approximately 5 acres of alkali sacaton plugs were planted using the Holland Mechanical Transplanter. An estimated 30,000 plugs were used for the 5 acres.

The planting had an 80% survival rate and the first harvest was conducted with a Woodward flail-vac seed stripper in November.

Alkali Sacaton in Jiffy Plugs-TPMC

Alkali sacaton ready for harvest-Near Needles, CA

Development of Technology for Seed Production of 'Stevan' Plains Bristlegrass Study Plan

Study ID Code	AZPMC-T-0405-CR
Title	Development of technology (cultural practices) for seed production in plains bristlegrass
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Technology Development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial AZPMC
Duration	2004 through 2011
Vegetative Practices	346 Critical Area Planting 554 Range Seeding 545 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management 512 Pasture and Hay Planting
Description	The objective of this study is to develop cultural practices for good seed production in plains bristlegrass.
Status of Knowledge	Plains bristlegrass [*Setaria leucopila* (Scribn. & Merr.) K. Schum.] is a very desirable grass for restoration, providing good grazing for livestock and wildlife. 'Stevan' plains bristlegrass was released by the Tucson Plant Materials Center in 1994. 'Stevan' was selected for vigor and forage production. New plantings of 'Stevan' produced quality seed; however as the plantings aged seed fill reduced significantly. 'Stevan' was removed from production in 2001 at the PMC because seed fill was extremely poor.
Experimental Design	Randomized complete block design .
Materials & Methods	To re-establish 'Stevan' Plains bristlegrass transplants were grown in 5.7 cu. in. containers in the lathhouse at the PMC.
Final Evaluations	This planting will be evaluated for cultural practices with the potential to increase the seed viability and yield..
Technology Transfer Products	Technical note, Planting guide, internal reports, research article
Literature Cited	1. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol 25. New York and Oxford. 2. Gould, Frank W. 1977. Grasses of Southwestern United States. University of Arizona Press, Tucson, Arizona. pp.270-271. 3. Pater, Mark. 1994. Notice of Naming and Release of 'Stevan' Plains Bristlegrass (*Setaria leucopila*). USDA, Soil Conservation Service, Tucson, Arizona. June 1994. 14p. 4. Tapia, C.R. and E.M. Schmutz. 1971. Germination responses of three desert grasses to moisture stress and light. Jour. of Range Mgmt. 24:292-295. 5. Toole, V.K. 1941. Germination of seed of vine-mesquite, *Panicum obtusum*, and plains bristle-grass, *Setaria macrostachya*. Jour. Amer. Soc. Agron. 32:503-512.

Accomplishments/Results:

Background:

In September of 2004 a small border (field 2, border 4) of plains bristlegrass was established. Harvests began in 2005 and continued through 2007. In the spring of 2007, three separate harvest years (2003, 2005, and 2006) were tested for germination in containers in the greenhouse. Three replications of 100 seed per lot were planted in 5”x 3” pots with 2” of potting soil. Very few seeds germinated in any of the lots. No seed was collected during growing season of 2007 due to well repairs. Significant damage may have occurred to this planting due to the lack of water during this time.

Growing season 2008:

Even though plants seem to have recuperated well from the stress suffered in 2007, only 3.7 pounds of seed was harvested during the 2008 growing season. This planting will continue to be monitored for latent damage resulting from the lack of water during 2007. This field may need to be re-established in a future growing season.

Growing season 2009:

In early March the planting was treated with a pre-emergent herbicide (orazylin) at a rate of 3 quarts per acre. In June, 20 pounds/acre of nitrogen was applied. In August, 2,4-D was applied at a rate of 2.5 pints/acre. The planting was irrigated a total of four times (March, June, July, and August) for a total application of 0.48 acre feet. The planting was harvested with the Woodward FlailVac three times. In June, the bulk harvest total was 4.28 pounds, in July 4.94 pounds, and in October 2.48 pounds for a combined total of 11.7 pounds for the growing season. The planting is beginning to exhibit signs of age with extensive die-off.

Growing season 2010:

Seed viability of harvests from the current planting of bristlegrass has continued to be poor. This study will be discontinued and this planting will re-established from breeder stock in either 2011 or 2012.

Desert Zinnia Technology Study Plan

Study ID Code	AZPMC-T-0501-CR
Title	Development of Technology for Production of Desert Zinnia for Southeast Arizona
National Project No.	Natural Areas 1.1
Study Type	Technology study
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial AZPMC
Duration	2005 to 2010
Vegetative Practices	347 Critical Area Planting 555 Range Seeding 546 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management
Description	Desert zinnia is an attractive wildflower that establishes on rocky eroded sites, and would be a welcome addition for seed mixes for conservation plantings. Harvesting difficulties with the composite population planting (developed from collections from MLRA 41), where rows were spaced 40" apart and harvested with a Flail Vac, inspired this planting design study. Expected results of this study: recommendations for field design for harvest using a 6 ft wide Woodward Flail vac.
Status of Knowledge	Desert zinnia is a common small shrub-like perennial forb that grows on rocky open slopes, often in calcareous soils, throughout southern Arizona. It typically grows 4-10" tall with numerous branches and scores of narrow leaves 0.75-1.5" long. The flowers have 5-7 white to off-white ray flowers and 8-13 yellow disc flowers. The ray flowers are lightly dentate at the tips. Desert zinnia is completely self-incompatible with a chromosome number of n=10. Nine accessions were collected throughout MLRA 41 (southeast Arizona) to develop the original population. At this time no Desert zinnia germplasm is available to commercial growers, however its use as a conservation species, such as for erosion control, as well as being an attractive wildflower for landscaping, makes this species desirable. Challenges for commercial production include fragility of the plant and its low-growing nature. The flail vac used for harvesting had to be lowered to such a degree that it destroyed plants in adjacent rows in the original planting. In order to make desert zinnia a commercially viable crop, methods for commercial seed harvest, such as spacing and use of a flail vac, are essential.
Experimental Design	Compare two field designs, one to address the height issue and one to address the spacing issue. The first design places individual rows of plants on raised beds 1 ft high. The second places plants at ground level, and similar to "skip row cotton" where 2 rows of plants are planted close to each other and spaced apart from the next 2 rows. The first treatment contains 3 raised beds 7 ft apart from the center of each bed. A single row of desert zinnia was planted on top of each bed by hand, approximately every 1.5 ft along its length (Attachment1). The second field design does not have beds but has several double rows of zinnia with large spaces between each double row. Due to limitations of the planter, two versions of this treatment were planted in two separate borders. One version has three "double rows" (1.5 ft apart) with larger spaces between each double row (4 ft and 7 ft respectively). The second border also has a total of 6 rows, but with two double rows in the center with a single row of zinnia on the outside of each, with approx. 4 ft between the double rows and two single rows (Attachment2). These plantings are second generation and represent foundation fields.

Materials & Methods	About 1500 Desert zinnia plugs were grown in the greenhouse using seed from the composite population development study for southeast Arizona. Approximately 6 months is needed for plugs to be of sufficient size for transplanting into the field. In November 2007 three borders were planted at the Tucson PMC. For the design with spaced double rows, the planter seats were set about 70 in apart. Two double rows were planted with two passes of the tractor, once in each direction. The tractor was driven in one direction for the first 2 consecutive rows, then driven the opposite direction approximately 18.5" alongside the first row for the second consecutive rows. Plugs for the design with raised beds were planted by hand.
Final Evaluations	Yield of the different designs will not be compared because each border has differing numbers of plants per ac. However, preferable planting design for desert zinnia using flail vac for harvest, including maximum plants per ac (narrowest spacing between double rows) and minimum effort (if raised beds are necessary) will be determined from this study.
Technology Transfer Products	Planting guide, internal reports, commercial grower information (planting requirements, yield and number of years of production).
Literature Cited	1. Fehr, Walter R. 1987. Principles of Cultivar Development, Vol. 1 Theory and Technique. Macmillan Publishing Company, New York. 2. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol 72. New York and Oxford. 3. Hickman, James C., ed. 1993. The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p. 4. Jones, T.A. and D.A. Johnson. 1998. Integrating genetic concepts into planned rangeland seedings. Journal of Range Management 51: 594-606. 5. Kearney, T.H. and R.H. Peebles. 1969. Arizona flora. University of California Press, Berkely, CA. 6. Phillips, S.L. and M.S. Wolfe. 2005. Evolutionary plant breeding for low input systems. Journal of Agricultural Science. 143:245-254. 7. Torres, Andrew M. 1962. Cytotaxonomy of cespitose zinnias. American Journal of Botany. 49(10):1033-1037 8. Torres, Andrew M. 1963. Taxonomy of zinnia. Brittonia. 15(1):1-25. 9. Torres, Andrew M. 1964. Hybridization studies in perennial zinnias. American Journal of Botany. 51(5):567-573 10. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Accomplishments/Results:

Growing season 2008:

In 2008, the AZPMC released Desert Zinnia (*Zinnia acerosa*) as Batamote Germplasm. An evaluation of the planting designs for the technology study was conducted during the 2009 growing season. A summary follows. This study was finalized in 2010 based on the results of the evaluation.

Growing season 2009:

On the 30th of January Plant Materials personnel conducted a harvesting evaluation to determine which row spacing would facilitate the greatest harvest with the least amount of damage to the plantings.

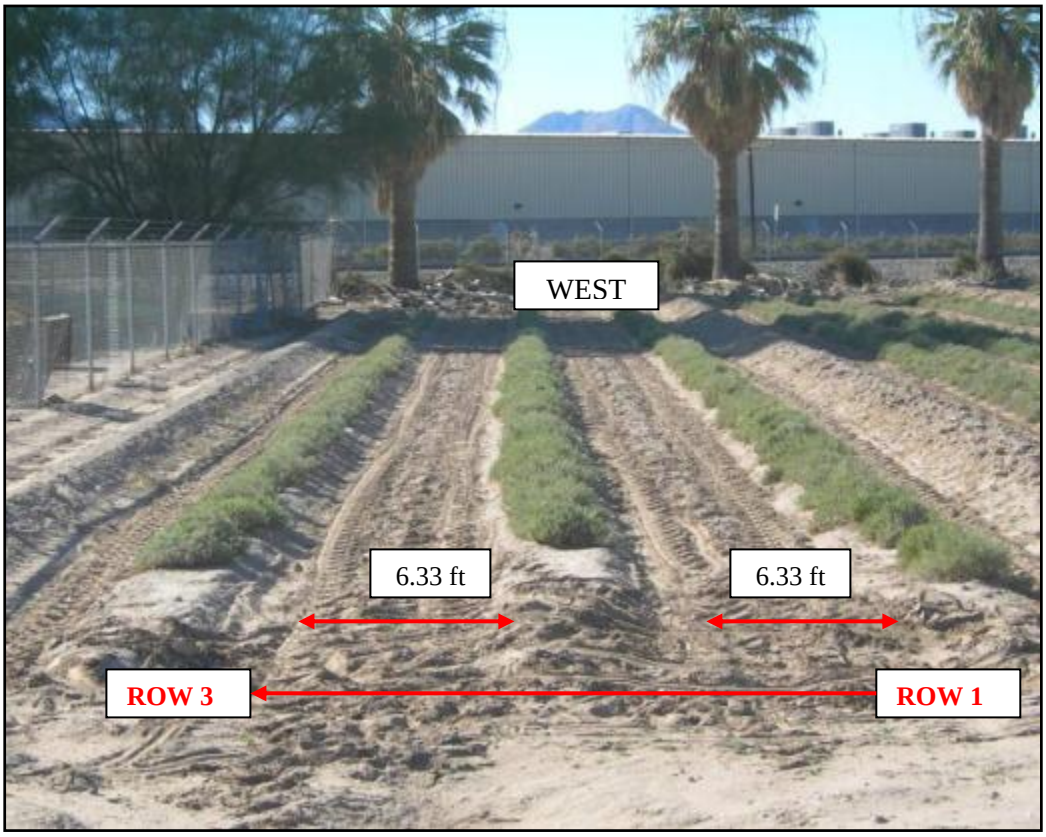
Growing season 2010:

During growing season 2010, the results from 2009's harvesting evaluation were verified. This study was finalized and discontinued in late 2010.

Materials/Methods: Rows were harvested using the Woodward Flail-Vac. Each row was harvested twice, once with the tractor moving east to west, and again with the tractor moving from the west to east. The hopper of the flail-vac was emptied after the harvest of each row when applicable. During the harvest, the following variables were evaluated and adjusted: tractor gear, Power Take Off (PTO) speed, flail-vac Revolutions Per Minute (RPM), and height/angle of the flail vac. RPM of the flail-vac was measured with the Stewart-Warner Portable Hand Tachometer, model 757-W.

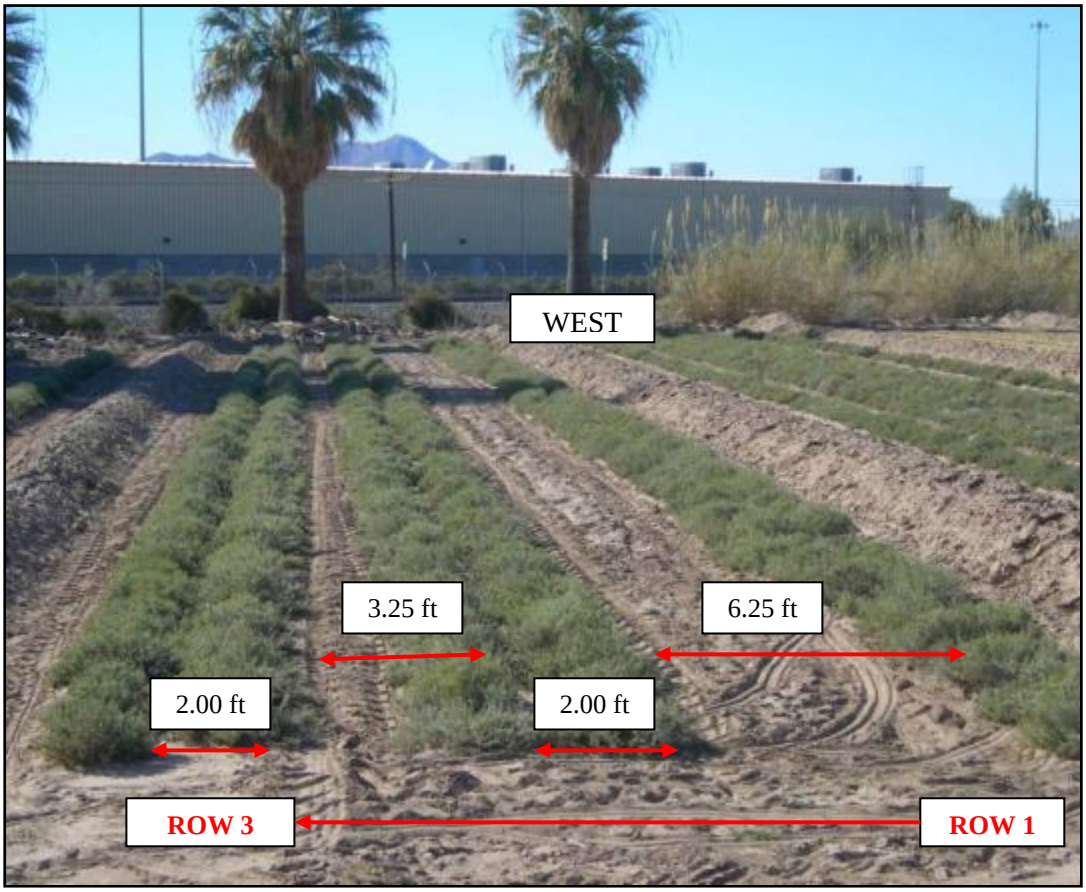
Field 2: Border 1

Three rows: individual plants on raised (0.5 ft) beds.



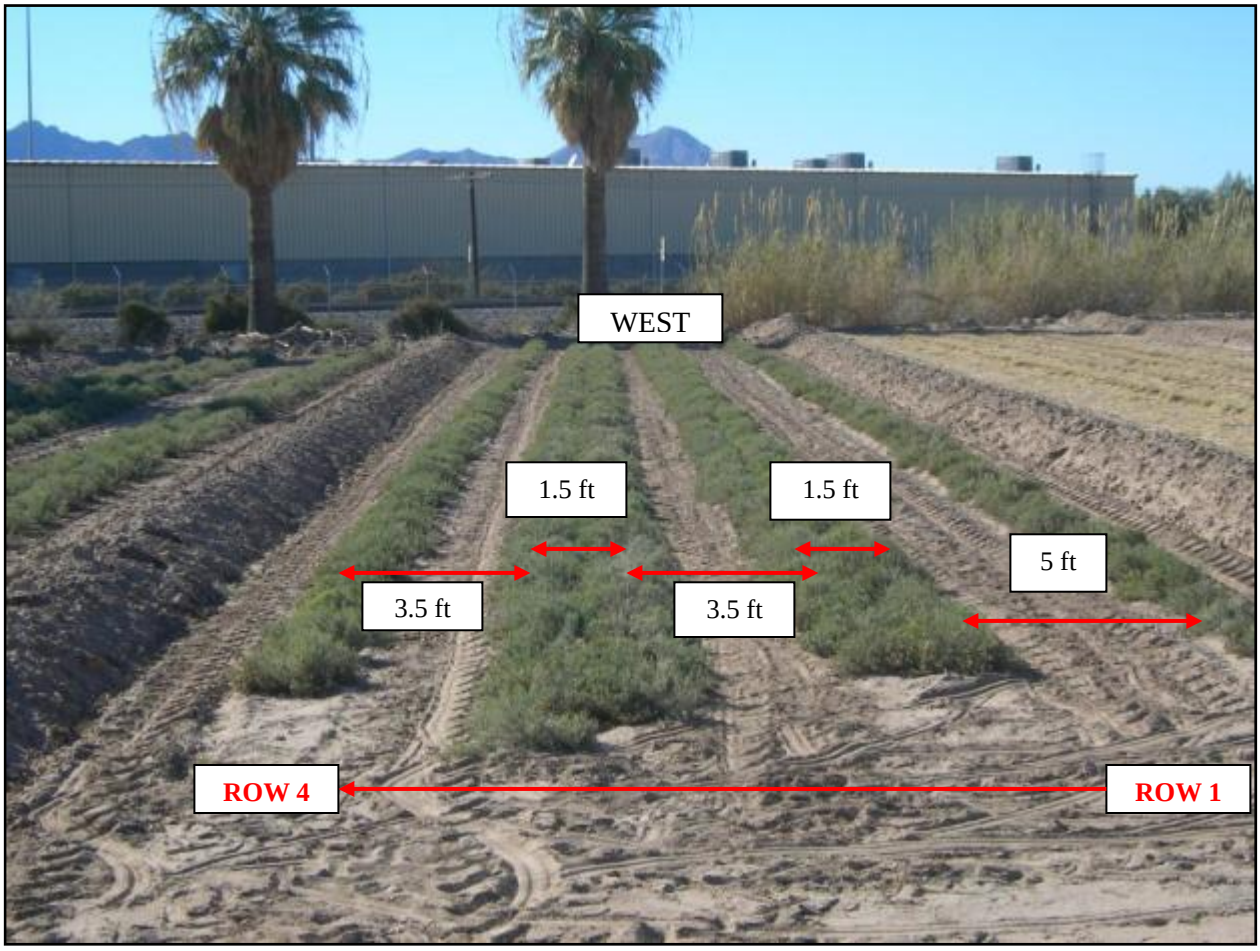
Field 2: Border 2

Three rows: two plants wide, plants approximately 2 ft apart (from middle of plants) with varying row spacing between rows due to limitations of planter



Field 2: Border 3

Four rows: rows one and four comprised of single plants, rows 2 and 3 are two plants wide, approximately 1.5 ft apart



Results: Based upon our initial harvesting evaluation, the row spacing of 3.25 ft resulted in the highest harvest weights. However, it should be noted that the angle at which the flail-vac is used and the RPM speed of the flail-vac, greatly affect the amount of seed gathered during harvest. Based upon visual observations of plant status before and after harvest and the data below, a flail-vac RPM of 500 seemed most efficient. Future evaluations will use this RPM. It was not necessary to vary the tractor speed from low/1st gear or to vary the PTO speed from 1150. Height of the flail-vac from the ground has very little effect on harvesting amounts and will not be evaluated in the future. This is primarily because the flail-vac moves up and down with the irregularities of the soil surface in the fields. Some damage to plants was observed from flail-vac "bounce" over uneven soil surfaces. Nevertheless, ensuring the brush of the flail-vac makes contact with plants should be sufficient for accurate flail-vac height.

Border and Row	Space between plants	Tractor Speed	PTO Speed	RPM of Flail Vac	Appx. height of Flail Vac (in)	Angle of Flail Vac (degrees)	Amount harvested (lbs)	Harvest totals (lbs)
3, 1	1.5 ft	Low/1st gear	1150	300	8.75	none	N/A	
3, 1				500	7.5	none	N/A	
3, 1&2				500	8.75	11	0.313	
3,3				500	8.5	11	0.25	
3,4				500	8.5	11	0.125	0.688
2,1	2.0 ft	Low/1st gear	1150	500	8.5	14	1.375	
2,2				400	8.5	14	0.5	
2,3				450	8.5	14	0.375	2.25
1,1	6.3 ft	Low/1st gear	1150	450	7.5	14		
1,2				450	6.5	14		
1,3				450	6	14	1.75	1.75

Photos:

Measuring flail-vac RPM

Adjusting the angle of the flail-vac

Harvest

Flail-vac must be kept low to ground
for effective harvest.

Damage from flail-vac “bounce”
due to uneven soil surface.

Plains lovegrass for Major Land Resource Area 41 Study Plan

Study ID Code	AZPMC-T-0603-CR
Title	Development of Technology for Production of Plains lovegrass (*Eragrostis intermedia*) for Major Land Resource Area 41
National Project No.	Natural Areas 1.1 Rangeland 1.1 Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Technology development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial AZPMC
Duration	2006 through 2010
Description	Plains lovegrass (*Eragostris intermedia*) is a native, warm season perennial bunchgrass Seed stalks are wiry and erect with heights of 1.2 to 3.5 inches (30-90 mm) The leaf blades are usually narrow and up to 12 to 35 inches (10-25 cm) long. The inflorescence is an erect, diffuse, panicle 6 to 14 inches (15-35 cm) long. The spikelets have 3 to 9 flowers The seed is very small rectangular-prismatic and reddish brown. Plains lovegrass has had various chromosome numbers reported; 2n = ca. 54, 60, 72, ca., 74, 80, 100, 120. Plains lovegrass occurs from Florida west to Arizona and extends north into Missouri and Kansas and south into scattered localities in Central America
Status of Knowledge	In southern Arizona it is most productive on sandy and sandy loam soils with poorly developed profiles and least productive on shallow, rocky soils. Plains lovegrass often grows in areas where annual precipitation is bimodal, with a wet season in winter and another in summer, when the bulk of the forage is produced. Mean annual precipitation in areas where plains lovegrass grows productively usually exceeds 15 inches (400 mm). Plains love grass produces quality forage on the grazing lands of Arizona and New Mexico. Because of its high seed stalk to forage ratio it does not produce a lot of forage. Plains lovegrass is considered to provide forage that is intermediate in preference to cattle. It is often heavily grazed since it is often the first species to green up in spring. In areas rested from grazing, Plains lovegrass increases, but decreases on areas where grazing occurs.
Experimental Design	Randomized complete block with 9 replications
Materials & Methods	Twenty nine accessions from MLRA 41 were grown in 35mm Jiffy forestry pellets in the greenhouse for 6 weeks. They were planted in July 2006 into a randomized complete block design (RCB) with 9 replications. Each experimental unit consists of 8 individual plants. Plugs were planted into the field 18 inches apart with 40 inch centers. Extra accessions were planted at the end of the plot to fill out the field.
Final Evaluations	The accessions will be evaluated for characters such as size, flowering date, germination and vigor. Agronomic techniques will be evaluated to determine yield potential of seed and forage.
Technology Transfer	Plant fact sheet, planting guide, internal reports, research article

Products

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Accomplishments/Results:

Background:

Twenty nine accessions from MLRA 41 were planted in July 2006 into a randomized complete block design with 9 replications. In 2006, a harvest of 20.6 bulk pounds was harvested. In the spring of 2007, the harvest resulted in 18.7 bulk pounds of seed. The lack of irrigation in 2007 (during the period of well repair) caused severe damage and ultimately the loss of this planting.

Growing season 2008:

The seed harvested in 2006 was used to reestablish the planting in the spring of 2008. In 2008, 10.7 bulk pounds of seeds was harvested.

Growing season 2009:

In early March a pre-emergent (oryzalin) was applied to the field at a rate of 3 quarts per acre. On June 3rd, a nitrogen application of 20 lbs/acre was conducted. The planting was irrigated four times during the year (March, June, July and September) for a total application of 0.93 acre feet. In early July, an additional two rows were added to the

planting block from plugs grown earlier in the year. The planting was harvested twice with the Woodward FlailVac. In August, the total bulk harvest was 20.48 pounds. In October, the harvest was 12.84 bulk pounds resulting in a combined total of 33.3 pounds harvested during the growing season. This species is scheduled for release during the growing season of 2010.

Growing season 2010:

Bonita Plains lovegrass was released in 2010. The release notice follows. The technology study for production of this species was finalized in 2010 to coincide with the release. All data gained was added to the plant guide.

THE UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
TUCSON PLANT MATERIALS CENTER
TUCSON, ARIZONA

NOTICE OF RELEASE OF BONITA GERMPLASM PLAINS LOVEGRASS

The Natural Resources Conservation Service, U.S. Department of Agriculture announces the naming and release of Bonita Germplasm Plains Lovegrass (*Eragrostis intermedia* A.S. Hitchc.). Bonita Germplasm Plains Lovegrass has been assigned the NRCS Accession number 9094065.

Bonita Germplasm is released as a selected class of certified seed. This alternative release procedure is justified by the lack of existing commercial sources of Plains Lovegrass. Propagation material of this species is needed for ecosystem restoration and enhancement in southern Arizona. The potential for immediate use is high. There is currently no released Germplasm of Plains Lovegrass.

Species:	*Eragrostis intermedia* A.S. Hitchc.
Common Name:	Plains Lovegrass
Plant Symbol:	ERIN
Accession Number:	9094065

Collection Site Information

Bonita Germplasm is a composite of 30 accessions collected from mixed grasslands of southeastern Arizona, Major Land Resource Area 41 (MLRA 41), the Southeast Arizona Basin and Range, located in Arizona and southwest New Mexico (Table 1). MLRA 41 corresponds with Level 3 Ecoregion 79. This area is a transition between the Chihuahuan Desert and Sonoran Desert Regions. Plant materials were collected from distinct locations in southeast Arizona to develop a population of Plains Lovegrass with a broad genetic base and greater likelihood of adaptation to the range of conditions found in the region of collection (Fig. 1).

Figure 1. Collection Locations of Bonita Germplasm Plains Lovegrass.

Table 1. Accession number and collection location of 30 accessions for Bonita Germplasm Plains Lovegrass

Number	Accession Number	Collection Location	Number	Accession Number	Collection Location
1	9092484	Lon-109.3711 Lat-32.1175	16	9092686	-109.3992 31.3508
2	9092485	-109.8257 32.7662	17	9092692	-109.0908 31.4747

3	9092486	-109.8892 31.3439	18	9092703	-110.2814 33.5106
4	9092487	-110.7667 32.6167	19	9092709	-110.1011 32.6214
5	9092496	-110.4697 32.7712	20	9092716	-110.0214 32.6161
6	9092535	-109.9667 31.9500	21	9092743	-110.9000 32.3333
7	9092543	-110.8612 32.3607	22	9063991	-109.8320 32.2529
8	9092563	-109.9865 32.2312	23	9058812	-110.1160 32.7951
9	9092573	-111.6147 31.9585	24	9058768	-110.0306 32.8240
10	9092586	-111.3047 31.5089	25	9058769	-111.5469 31.8636
11	9092587	-111.3131 31.5000	26	9058770	-109.1610 33.0124
12	9092600	-110.5019 31.5901	27	9058806	-111.6067 31.9736
13	9092647	-110.0664 31.5033	28	9058771	-110.3846 33.4737
14	9092671	-109.0517 31.4978	29	9047438	-111.2167 31.4667
15	9092673	-109.0356 31.5111	30	9047439	-111.2000 31.4667

Description

Plains Lovegrass is a native, warm season perennial bunchgrass (Kearney et al 1960). Plains Lovegrass typically grows 2 to 3 ½ ft. Seed stalks are wiry and erect with heights of 1.2 to 3.5 inches (3-9 cm) (Kearney et al 1969). The leaf blades are usually narrow and grow to 12 to 35 in (10-25 cm) in length. The inflorescence is an erect, open, broadly pyramid-shaped panicle 8 to 16 in (15-35 cm) long and 6-12 in (15-30 cm) wide, with numerous branches that branch again. The fresh inflorescence is pinkish in color. The spikelets have 3 to 9 flowers (Hitchcock 1951). The seed is reddish-brown, very small (3,386,000 per lb) and rectangular-prismatic in shape. Plains Lovegrass has had various chromosome numbers reported; 2n = ca. 54, 60, 72, ca. 74, 80, 100, 120 (Flora of North America 2002).

Plains Lovegrass occurs from Florida to Arizona and extends north into Missouri and south into scattered locations of Central America (Gould 1977). Plains Lovegrass occurs on clay, sandy and rocky soils and often on disturbed sites, at 0 to 6069 ft (0 to 1850 m) elevation. In Arizona Plains Lovegrass occurs at elevations from 3,800 to 6,000 ft (1066 to 1800 m). Plains Lovegrass will grow in most soil textures (Canfield 1948, Frost and Smith 1991). In southern Arizona it is most productive on sandy and sandy loam soils with poorly developed profiles, and least productive on shallow, rocky soils. Plains Lovegrass often grows in areas where annual precipitation is bimodal, with a wet season in winter and a second one in summer, when the bulk of the forage is produced. In areas where Plains Lovegrass grows productively, mean annual precipitation usually exceeds 15 in (400 mm) (Wallmo 1955).

Plains Lovegrass produces quality forage on the grazing lands of Arizona and New Mexico (Gould 1977 and Hitchcock 1951). However, because of its high seed stalk to forage ratio it does not produce a lot of forage. Plains Lovegrass provides forage that is intermediate in preference to cattle. It is often

heavily grazed because it is one of the first species to green up in spring. Where cattle are present, this species often declines. Because of its importance as an early spring forage plant, ranges where this grass remains should be managed to maintain or increase it (Ruyle and Young 1997).

Bonita Germplasm Plains Lovegrass is not distinguishable from in situ populations of Plains Lovegrass occurring in southeast Arizona.

Method of Selection

Bonita Germplasm was developed from collections made at 30 distinct sites within southeast Arizona (Table 1). Accessions were planted into a 0.2 acre field at the Tucson Plant Materials Center in September 2005. Plugs of each accession were planted into a randomized complete block design with 9 replications. Visual evaluations conducted during 2005-2010 revealed little to no discernible differences among accessions for flowering dates, number of flowers, size or vigor. The assemblage contained no observable detrimental characteristics, therefore no selection was made. Efforts were made to avoid direct and indirect selection to maintain the genetic diversity of the assemblage. Seed harvested using the Woodward Flail-Vac was used to produce the composite population of Bonita Germplasm. Due to hybridization that may occur within the assemblage it should not be assumed that this Germplasm may be reproduced by repeating collections from the original collection sites. Composite populations such as this are not simply mixtures of the genotypes present in the field, but are expected to have a continuously changing genetic makeup (Fehr 1987). When a composite cross population is to be used for restoration, the earliest filial generation available should be used. This allows successive generations of the segregating population to be produced in a specific environment, allowing natural selection to become the principal component acting to produce genetic change.

By producing composite cross populations from a defined land resource area, we hope to match the abiotic and biotic factors of the area of intended use, such as elevation, soil characteristics, climate regime, pathogens and predators. Composite cross populations respond dynamically to complex natural selection from abiotic and biotic stresses (Phillips and Wolfe 2005). By avoiding making selections for traits such as vegetative vigor or high productivity, we seek to produce a product that does not disrupt the ecological interaction between species or the gene pools of local plant communities. We also hope to produce a product with greater sustainability in the landscape.

Ecological Considerations

Bonita Germplasm is a composite of naturally occurring Germplasm and has undergone no purposeful selection. Bonita Germplasm does not differ significantly in rate of spread, seed production, or vigor from naturally occurring Plains Lovegrass. Bonita Germplasm Plains Lovegrass was determined “OK to release” when evaluated through the “Worksheet for Conducting and Environmental Evaluation of NRCS Plant Releases”.

Anticipated Conservation Use

The potential uses of Bonita Germplasm Plains Lovegrass include restoration of disturbed areas, wildlife habitat improvement and increasing plant diversity on lands in southeast Arizona and southwest New Mexico (MLRA 41). Bonita Germplasm Plains Lovegrass reproduces through seed. Because of its importance as an early spring forage grass, and its quick response following fire (Bock et al 2009), the potential for use of this species for restoration is high.

Anticipated Area of Adaptation

Bonita Germplasm Plains Lovegrass was developed for use in southeastern Arizona Basin and Range (MLRA 41).

Availability of Plant Materials

Seed production will be maintained by the USDA-NRCS Tucson Plant Materials Center. Limited quantities of G2 seed are available to seed producers for increase and to other interested parties, as available.

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Prepared by:

Mary E. Hershdorfer, USDA-NRCS Tucson Plant Materials Center, 3241 N. Romero Road, Tucson, Arizona 85705

Heather Dial, USDA-NRCS Tucson Plant Materials Center, 3241 N. Romero Road, Tucson, Arizona 85705

Manuel Rosales, USDA-NRCS Tucson Plant Materials Center, 3241 N. Romero Road, Tucson, Arizona 85705

Signatures for release of:

Bonita Germplasm Plains Lovegrass (*Eragrostis intermedia*)

_____ _____

David McKay Date
Arizona State Conservationist
United States Department of Agriculture
Natural Resources Conservation Service
Phoenix, Arizona

_____ _____

Mike Hubbs Date
Director, Ecological Sciences Division
United States Department of Agriculture
Natural Resources Conservation Service
Washington, D.C.

Transition to Organic: A comparable study between conventional and organically grown alfalfa

Study ID Code	AZPMC-T-1002-PA
Title	Transition to Organic: A comparable study between conventional and organically grown alfalfa
National Project No.	Natural Areas 1.1
Study Type	Technology study
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, David Forestieri & Heather Dial-AZPMC
Duration	2010 to 2015
Vegetative Practices	327-Conservation Cover 340-Cover Crop 590-Nutrient Management 512-Pasture and hayland Planting
Objective:	To collect information and data to facilitate and support the National Organic Program initiative and to provide technical information regarding the transition to organic production to Arizona NRCS-Field Offices.
Status of Knowledge	Alfalfa (*Medicago sativus*) is a crop that lends itself to transition to organic production due to its soil benefits and biological nitrogen fixing capability. Organic production integrates cultural, biological and mechanical practices that improve cycling of resources, promote ecological balance and conserve and enhance biodiversity. Production of organically grown alfalfa involves following guidelines of the National Organic Program standards as defined by the U. S Department of Agriculture. Growing alfalfa organically as compared to conventionally can be quite challenging. This study was set up to investigate some of the challenges that a producer may encounter while transitioning from a conventional to an organic system, as well as to compare forage production under both systems.
Experimental Design	Non-replicated trial
Materials & Methods	Two fields (0.7 acre each) were seeded to the alfalfa variety CUF -101 at 15 lb per acre. Soil amendments were incorporated into both fields before seeding. One field was prepared conventionally by adding soil amendments (phosphorous (0-45-0) and sulfur (85-3.5-1.5) each at 800lbs. / acre) according to soil test results. The field reserved for the organic treatment received only sulfur to help counteract high soil pH. Both fields were laser leveled prior to planting to improve irrigation efficiency.
Evaluations	Incidence of weeds, insects, and diseases will be observed and recorded. Annual production of forage as well as the number of cuttings/clippings will be recorded. Costs of production inputs to establish the plots and maintenance of the plots after the first year of establishment will be recorded. Any other noticeable differences between the plots will be noted.
Technology Transfer Products	Technical note, fact sheet and internal reports.

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12. Tickes, B. and M. Ottman. 2008. Alfalfa Weeds Control in the Low Desert Deserts of Arizona. The University of Arizona Cooperative Extension.
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Accomplishments/Results:

Growing season 2010:

On April 28, the comparative trial for alfalfa, conventional versus organic, was seeded. The plots germinated well with approximately 70-80% germination in the organic plot and 80-90% in the conventional plot. The plots were irrigated immediately after planting and thereafter as needed until the end of September. Ten irrigations were applied from April-September for a total of a 2.0 acre feet of water applied. Throughout the growing season the organic plot was treated with a solution of TeraGanix, Inc. EM-1®, a microbial inoculant soil conditioner, through the irrigation water. EM-1® complies with USDA organic standards. Applications were done every other irrigation at the recommended label rate.

During the growing season, both plots had a diversity of grass and broadleaved weeds. Weeds were controlled by mowing in both plots and the conventional plot was also treated with herbicide ('Poast'(sethoxidim) at a rate of 2 pints/acre) in an attempt to control grass weed species. No herbicide was applied in the organic plot. No forage production samples were collected during the establishment year. Forage production data will be collected during the growing season of 2011.

Germinating Alfalfa-May 2010

Alfalfa & Weeds-2010

Bonita Planting Study Plan

Study ID Code	AZPMC-T-0610-CR
Title	Bonita Seeding Trial
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Development of Establishment Technology
Study Status	Active
Location	AZPMC
Study Leaders	Heather Dial, Mary E. Hershdorfer AZPMC, Wilma Renkin NRCS- Wilcox FO
Duration	2006 through 2009
Vegetative Practices	348 Critical Area Planting 556 Range Planting 645 Wildlife Upland Habitat Management
Description	Five AZPMC releases ('Loetta' Arizona cottontop, 'Stevan' Plains bristlegrass, Saltillo germplasm Cane beardgrass, Cochise germplasm Spike dropseed, and Pima Germplasm Pima pappusgrass) developed for Arizona were planted on a ranch near Bonita, Arizona in 2006 for a seeding rate study.
Status of Knowledge	Recommended seeding rates have not been determined for these species. The standard seeding rate for rangeland plantings is 20 seed/ft^2. This planting was one of several conducted for experimentation in southern Arizona in 2006. Ranchers in Arizona are often discouraged from native seed plantings because of the high cost of seed and frequent low germination rate. The AZPMCwould like to encourage the use of regionally adapted ecotypes to increase the success of plantings, as well as decrease price per pound, if possible. Many failed plantings have been conducted using "common" seed without consideration of genetic origin, possibly the cause of the previous plantings' failures. Arizona's harsh climate likely requires the use of adapted germplasm in order to germinate and persist. Few AZPMCreleases are commercially available, but successful plantings will hopefully encourage the creation of a market for these products.
Experimental Design	Non-replicated field planting: 12 equal sized plots (550 ft x 24 ft) were placed in an open unvegetated site approx. 100m from the road. The drill passed through the plot in adjacent lines once for the single seeding rate and twice for the doubled rate.
Materials & Methods	This planting was conducted in July 2006 on a ranch near Bonita, in Cochise County, Arizona. The site was ideal for demonstration, as it was open, unvegetated, located within view of a well-traveled road, and not to be grazed for an extended period of time. Sufficient space allowed for large plots. Five AZPMCreleases were planted with a Truax II rangeland drill at two seeding rates- 'Loetta' Arizona cottontop, 'Stevan' Plains bristlegrass, Saltillo germplasm Cane beardgrass, Cochise germplasm Spike dropseed, and Pima Germplasm Pima pappusgrass. Each species (except cane beardgrass) was planted at the standard rangeland seeding rate of approximately 20 seed/ft (what the drill was set at) as well as a doubled rate, where the drill was passed through the plot twice. Because the seed of Cane beardgrass was too fluffy to pass through the drill at the standard rangeland rate, a total of approx. 5 lb was planted at single and double rates. Colored flags were placed at the ends of each of the 12 plots to delineate the different treatments.

Final Evaluations	Evaluations may consist of local ecotype evaluation and appropriate seeding rates for the 5 species. Photo plots, visual observations and frame measurements may be employed.
Technology Transfer Products	Planting guides, internal reports
Literature Cited	Flora of North America, Vol. 25; A Field Guide to the Grasses of New Mexico; Principles of Crop Improvement; Principles of Cultivar Development.

Accomplishments/Results:

Background:

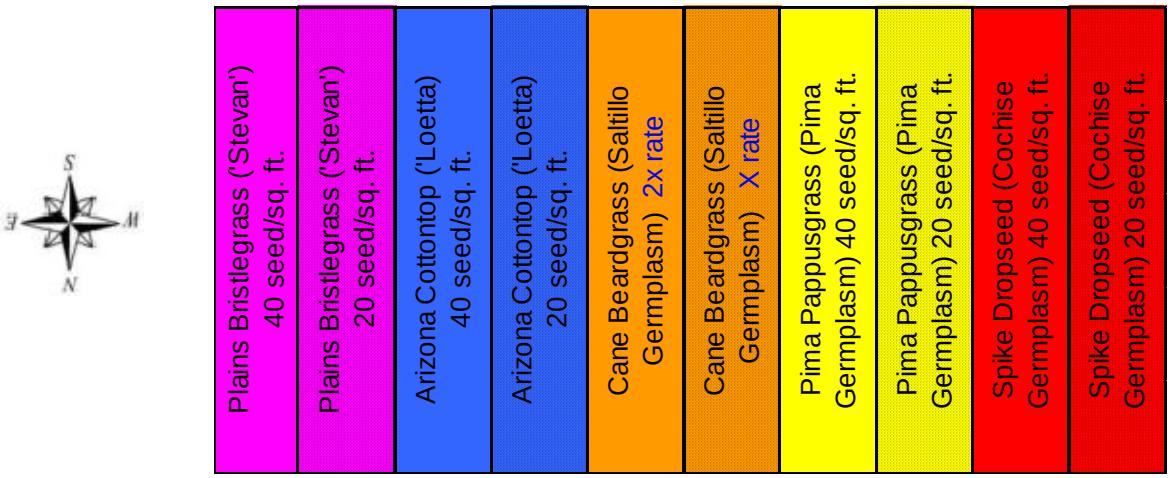
In July 2006, the Truax II Seed Drill was used to plant five PMC releases: 'Loetta' Arizona Cottontop (*Digitaria californica*), Pima germplasm Pima pappusgrass (*Pappophorum vaginatum*), 'Stevan' Plains bristlegrass (*Setaria leucopila*), Saltillo germplasm Cane beardgrass, and Cochise germplasm Spike dropseed (*Sporobolus contractus*). The Willcox Field Office assisted with this planting. Approximately 3 acres were planted in total, equaling about 0.3 ac/treatment for the ten treatments.

Growing season 2008-2009:

Willcox field office personnel have reported that the planting germinated well and provided photos of the planting. The planting will be evaluated for species composition, stand establishment, and persistence during the growing season of 2010.

Growing season 2010:

The Bonita planting was evaluated in October of 2010. Of the species planted in 2006, only the Arizona cottontop persisted. Because there was only one species remaining of the five planted, it was not possible to evaluate the success or failure of the single versus double seeding rate. Additionally, the cooperator had begun brush removal in the area and had driven through the planting plot. This study was discontinued in 2010.



Bonita planting site. Arizona cottontop is visible in the background.

Arizona cottontop planting block.

Control of Buffelgrass at Santa Rita Experimental Range Study Plan

Study ID Code	AZPMC-T-0612-IN
Title	Control of Buffelgrass at the Santa Rita Experimental Range
National Project No.	Natural Areas 1.1 Rangeland 1.1
Study Type	Development of Establishment Technology
Study Status	Active
Location	AZPMC
Study Leaders	Mary E. Hershdorfer, Heather Dial, Ramona Garner AZPMC
Duration	2006 through 2010
Vegetative Practices	349 Critical Area Planting 645 Wildlife Upland Habitat Management 547 Land Reclamation, Abandoned Mine Land
Description	Control of Buffelgrass will take place within 13 ac PMC exclosure at the Santa Rita Experimental Range, as well as on associated satellite infestations around its borders. Chemical spraying using tractor (for central infestation), and ATV sprayer and backpacks (for isolated smaller infestations) will be conducted, with attention to avoid native vegetation as much as possible. Experimental use of grass-specific herbicide in small plots will also take place. The majority of the infestation will hopefully be controlled in the first 3 years, followed by spot spraying in subsequent years, until only occasional treatments are necessary at the site.
Status of Knowledge	Little information is known about Buffelgrass (*Cenchrus ciliaris*) increase or control in southern Arizona. In recent years, significant increases along roadsides, other disturbed areas as well as undisturbed sites with certain conditions have been observed from Mexico to low desert areas of southern Arizona. This species is drawing increasing concern from land managers, researchers and widely by the general public. Based the records of numerous plantings conducted inside the PMC planting exclosure at the SRER since the 1930s, the current infestation of buffelgrass that has taken over much of the exclosure appears to stem from a planting conducted in 1985. The PMC has taken this opportunity to examine the effectiveness of chemical spraying of this species, as well as the responsibility of this particular infestation. Based on seed germination trials, the seed appears to survive 3 years in the soil. Hopefully after 3 consecutive years of careful treatments, this infestation will be significantly decreased and control efforts will be minimized. Following the success of the initial treatment year in 2006, the UA began a process to exterminate buffelgrass across the entire SRER.
Experimental Approach	Careful spraying of buffelgrass within the 13 ac fenced PMC exclosure at the SRER and associated satellite infestations beyond the fence line. Infestation within the plot as well as its spread to nearby washes and roads were plotted using a GPS before any treatment began. Three small (1000 sq ft) plots inside the exclosure (marked with colored rebar) along the western fenceline were reserved for experimentation with a grass-specific herbicide, Fluazifop which has been effective on seedlings and young grasses. A Tractor with an 18-ft boom is used for the central part of the infestation (a monoculture of approx. 7 ac), and the ATV sprayer and backpack sprayers are used for smaller isolated infestations, in order to avoid spraying of native vegetation- which will hopefully re-colonize the sprayed areas as buffelgrass populations are reduced.

Materials & Methods	Tractor, ATV and backpacks used for chemical applications. Spraying period begins once plants have sufficient green growth (as early as July), and ends well before they re-enter dormancy (before September). Ideally spraying begins in conjunction with summer rains, when the plants are most vigorously growing. Younger, less decadent plants are easier to treat. 5% Roundup applications (combined with dish soap and blue dye) were used to spray the buffelgrass. Approximately 130 gal of water was transported to the site to spray the densest section of the infestation (approx. 7 ac) with the tractor. To cover the entire infestation, approx. 240 gal of water may be required. A truck and trailer hauling the tractor, and a separate truck hauling four 60-gal water drums, chemical, ATV and other necessities, arrive at the site in the early morning. One person is needed for tractor work, and a 2 person crew operates the ATV (one driving, one spraying). Several days may be required to cover the entire infestation. The experimental plots were treated (complete coverage) with backpack sprayers according to label.
Final Evaluations	Document the decrease in infestation using GPS after 3 years, and every year following until spot treatments are reduced to very few. Reconnaissance efforts will continue as needed into the future.
Technology Transfer Products	Tech Note on Buffelgrass control, internal reports.
Literature Cited	• PMC Annual Technical Report – yr 2006, 2007 • Financial evaluation of spray equipment

Accomplishments/Results:

The following report is a synopsis of PMC activities concerning AZPMC-T-0612-IN from 2006-2010.

Santa Rita Experimental Range: Buffelgrass Control in PMC Exclosure

STUDY NUMBER: AZPMC-T-0612-IN

Introduction.

In recent years, significant increases in Buffelgrass (*Cenchrus ciliaris)* populations have been observed from Mexico to low desert areas of southern Arizona along roadsides, other disturbed areas, and undisturbed sites. These increases have drawn the attention of land managers, researchers and the general public. In 2006, Tucson Plant Materials Center (PMC) personnel noted that a 1985 Initial Evaluation Planting of Buffelgrass within the PMC exclosure at the Santa Rita Experimental Range (SRER) had taken over much of the exclosure and spread outside the exclosure. Little information was known about effective Buffelgrass control. The PMC took this opportunity to examine the effectiveness of chemical spraying of this species, as well as the responsibility of this particular infestation. Based on seed germination trials, the Buffelgrass seed appears to survive three years in the soil. We hypothesize that after three consecutive years of careful treatments, the infestation will be significantly decreased and continued control efforts will be minimized.

Materials & Methods

Control of Buffelgrass will take place within the 13 acre PMC exclosure at the SRER, as well as associated satellite infestations around its borders. Chemical spraying with a 5% Round-Up solution using a 150 gallon 18-foot boom sprayer pulled by a tractor (for the central infestation) and 30 gallon ATV sprayers and backpack sprayers (for isolated smaller infestations) will be conducted. Experimental use of a grass-specific herbicide (Fluazifop) in small plots within the exclosure will also take place. We expect the majority of the infestation will be controlled within the first three years of control. Thereafter, spot spraying will be conducted on remaining Buffelgrass plants until only occasional treatments are necessary at the site.

Results

2006-Buffelgrass Control

In August 2006, the University of Arizona and the AZPMCagreed it was time to contain the buffelgrass infestation in the test plot. In three days of spraying over a period of a month, using a variety of equipment and multiple individuals, the infestation was sprayed. On the first day, the tractor with an 18 ft boom was used for spraying, requiring a driver and two additional people for directing the tractor movement to assure good coverage. 130 gallons of 5% Roundup solution was used to cover approximately 7 ac, the area of densest infestation. The infestation was located with GPS, which was centered in the exclosure, but also spread to nearby washes and roads. For the following two days of work only ATV and backpacks were used to spray the

Jace Householder sprays the infestation of Buffelgrass at SRER plot in 2006

smaller patches.

The first two visits occurred during the monsoon period, when the plants were growing vigorously. By the third visit a month later, the Buffelgrass was yellowing, entering dormancy. The first two days of spraying killed the Buffelgrass but the third visit was inconclusive.

Ramona Garner rejoices at her success two weeks after spraying Buffelgrass (June 2006)

2007 Buffelgrass Control

Early in April 2007, a visit to the SRER revealed two striking observations. The first was color throughout the plot: many native winter forbs were establishing in the plot. It was also clear that the third spray day in September had not likely been as successful as the previous two. Spraying during the height of buffelgrass growth had left the vegetation grey (dead), but spraying following the beginning stages of dormancy only turned many plants a suspicious straw color. It was not until the following visit in June, still early in the growing season and too dry to begin spraying, did the yellowed plants reveal life in the form of green leaves.

A patch of straw-colored buffelgrass with a sprig of green life, surrounded by dead buffelgrass (June 2007)

Needle grama grows densely in the open areas.

Jace Householder sprays the primary infestation with the tractor

In August, after the summer rains, the first of two spray days took place. This year the plot was a verdant green with needle grama (*Bouteloua aristidoides*) covering the ground in the open areas, feather fingergrass (*Chloris virgata*) came up under the drip line of trees, and young buffelgrass plants as seedlings covered the same area as it had the previous year. The seedbank of previous years had plenty of seed left to germinate. The treatment plan in this second year was to use the tractor in the same central infestation as last year, as well as the smaller patches surrounding it. The success with the previous tractor work made it clear that spraying with the tractor was preferable. Only the individual plants and small satellite patches outside the fenced plot were sprayed with the ATV. Many flourishing patches of native plants, particularly Arizona cottontop, were avoided. Three (1000 ft^2) experimental plots for testing a grass-specific herbicide (Fluazifop) were marked with rebar up against the western-fence line.

The truck and trailer carrying the tractor were brought to the plot, followed by a truck with four 30 gal drums of water and several containers of Round up, dish soap and blue dye. The tractor's spray tank was refilled once. The ATV's 30-gal tank was refilled multiple times. A two-person crew used the ATV, while the tractor required only one person.

In one day the entire area was covered. The experimental plots were sprayed with the grass-specific herbicide; however expectations were low because the grasses at this point were larger than anticipated. Grass-specific herbicide is more effective on seedlings, less so on mature plants.
In September a reconnaissance day was scheduled to visit the results of the previous spraying, and to follow up by spraying any missed individual patches or plants. The ATV and several back packs were transported, along with water and chemicals. Few patches needed spraying, however the experimental plots with grass-specific herbicide appeared unaffected. Fears were confirmed that the treatment did not work on plants at that stage of maturity.

An experimental plot for grass-specific herbicide did not kill the buffelgrass (September 2007).

Leslie Wood sprays buffelgrass.

The second year of spraying required treatment of similar acreage, but this is to be expected with an invasive plant such as buffelgrass. The seedbed has been establishing for the past 20 years, and the dead plants from 2006 left space and resources for establishment of seedlings the following year. The second year required less effort however, as the spraying of young plants as opposed to decadent 4 ft tall plants, cut the work by over half. These young plants were not quite young enough to make the grass-specific herbicide effective, however if attempted earlier, at a younger stage of growth, this treatment may be effective. The fact that in the second year feather fingergrass was found under the tree that previously had only buffelgrass was encouragement enough to feel success had been achieved. If greenhouse experiments on buffelgrass seed longevity of 3 years prove correct, then after a following year of spraying, we expect to see a marked decrease in the infestation by 2009.

Ramona Garner displays the feather finger grass in 2007 growing under the mesquite tree sprayed in 2006.

2008 Buffelgrass Control

In April of 2008, a reconnaissance trip was made to the exclosure to determine the success of 2007's control efforts. While it was apparent that the infestation had been significantly reduced in both size and scope, patches of buffelgrass remained. The patches were concentrated in areas more difficult to reach with spraying equipment and/or those plants located in swales. It was determined that spraying would not be effective until later in the year as the majority of the buffelgrass plants were not exhibiting active growth.

Buffelgrass, growing within prickly pear plants, greening up in early 2008.

Rains prompted a second scouting trip in early July to determine if the buffelgrass plants were in the appropriate stage for effective spraying. Plants found growing within or underneath well-established existing vegetation were just beginning to show vigorous growth. Additionally, areas with large patches of dead buffelgrass showed the re-establishment of new buffelgrass from seed. However, it was interesting to note the increase in native species within the exclosure as compared to previous years. A spraying trip was scheduled for the following month.

Buffelgrass seedlings emerging from a large patch of dead, adult buffelgrass plants

Buffelgrass control occurred on August 7. Ten gallons of Round-Up concentrate, 150 gallons of water, blue dye, and dish soap were transported to the site. As in previous years, a tractor to pull a 130 gallon 8 ft boom sprayer was taken to spray the larger patches of infestation. An ATV with a 30 gallon spray tank was also taken to concentrate on smaller patches of buffelgrass found outside the exclosure and within/underneath existing vegetation.

After a brief walk through the exclosure to determine tractor pathing, spraying with both the ATV and boom sprayer

began. After approximately 3.5 acres of the primary infestation had been sprayed with the boom sprayer, disaster struck. The boom spray tank pump lines were irreparably damaged when they were caught by low growing woody vegetation within the exclosure. For the rest of the day, personnel worked with the ATV to spray patches found along the fenceline, over the fenceline and under/around existing vegetation. Approximately 2 gallons of grass specific herbicide were sprayed on the plots established in 2007 using a small hand pump sprayer. Due to the loss of the large boom sprayer, at the end of the day only three-quarters of the infestation had been sprayed.

Image shows the density of buffelgrass plants sheltering underneath woody vegetation

On August 12, the area was evaluated to determine what equipment would be necessary to finish the control. Buffelgrass sprayed the week before was already yellowing and allowed for an excellent contrast to the green plants missed during the previous spraying. It was determined that the larger boom sprayer and tractor would not be necessary for the second trip as most of the remaining green patches were found in difficult to reach places. Spraying was conducted again the following day. Two ATV's with 30 gallon spray tanks and 5 foot booms were transported to the site. Personnel sprayed areas missed the week before with the ATV booms and used the spray tank wands to reach plants growing within/underneath woody vegetation.

During the 2009 spraying season, the grass specific herbicide trial will be discontinued as its success has been limited. There are also plans in place for the establishment of monitoring protocols to quantitatively track the success of the herbicide control throughout the life of the project.

The line of demarcation: the right side of the picture had been sprayed prior to the equipment breaking, the left side of the picture had not.

2009 Buffelgrass control

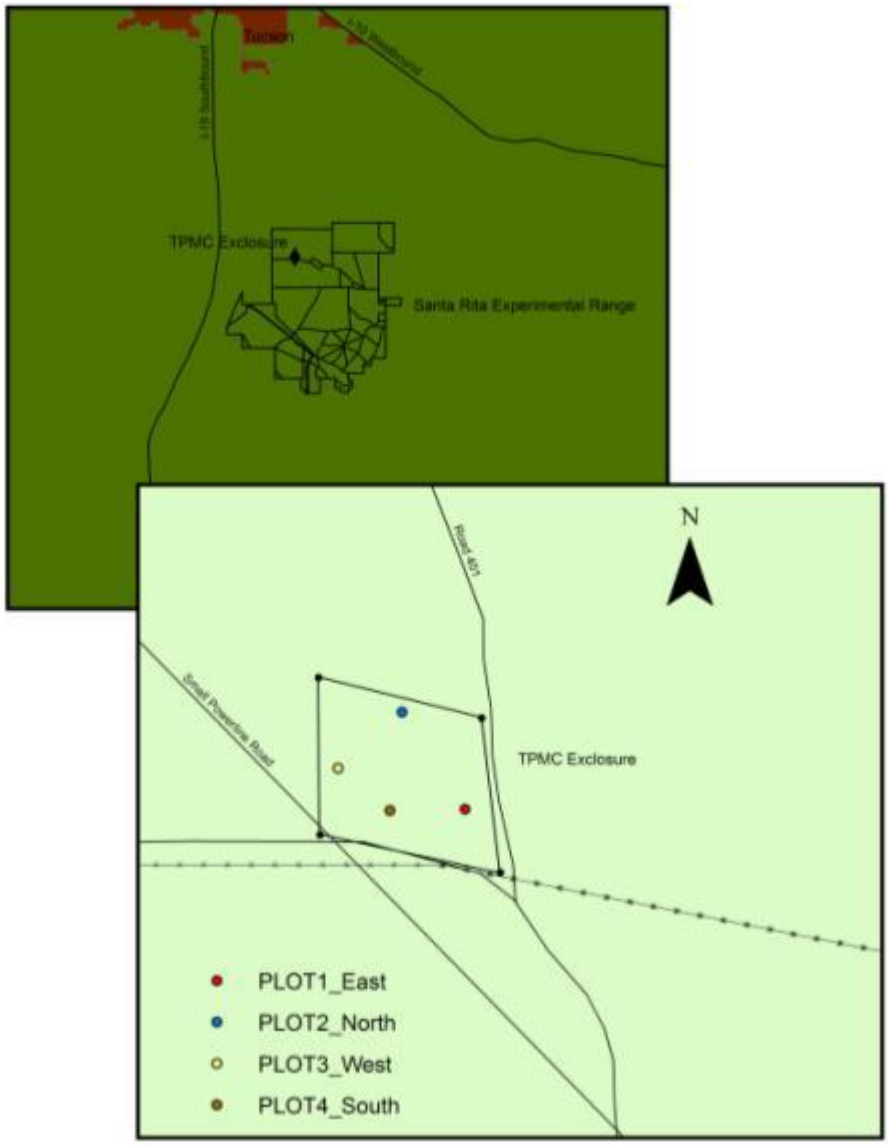
A scouting trip was conducted in April 2009 to plan for the year's control efforts. No significant "greening-up" was observed during this trip. A second trip to the site took place on June 29th. Plants were beginning to show their first growth and control efforts were scheduled for early July. A trip on the 13th of July showed vigorously growing plants and prompted full control efforts on the 15th. As in trips before, ten gallons of Round-Up concentrate, 150 gallons of water, blue dye, and dish soap were transported to the site. A tractor to pull a 130 gallon 8 ft boom sprayer was again taken to spray the larger patches of infestation. Two ATVs with 30 gallon spray tanks were also transported to the site to spray buffelgrass found outside the exclosure and within/underneath existing vegetation. Five personnel participated in the control spraying on the 15th.

A second trip with the same equipment and six personnel was made on the 22nd of July. During this trip, four monitoring plots (20' x 20') to evaluate herbicide effectiveness were established at the north, south, east, and west corners of the exclosure (please see the table and maps below). Each plot was sprayed with 5% glyphosate, the same treatment applied to the rest of the exclosure. The percent cover of buffelgrass within each plot was estimated on the 20th of August and will be compared to cover estimates taken during growing season 2010. Additional trips were made to the exclosure on August 11th and September 25th to monitor herbicide effectiveness.

SRER Monitoring Plots established 7/22/2009

PLOTS*	DATE OF EVAL	PERCENT COVER**	APPEARANCE OF PLANTS
1-EAST	8/20/09	50	BROWN/DEAD, NONE GREEN
2-NORTH	8/20/09	25	BROWN/DEAD, NONE GREEN
3-WEST	8/20/09	55	BROWN/DEAD, NONE GREEN
4-SOUTH	8/20/09	15	BROWN/DEAD, NONE GREEN

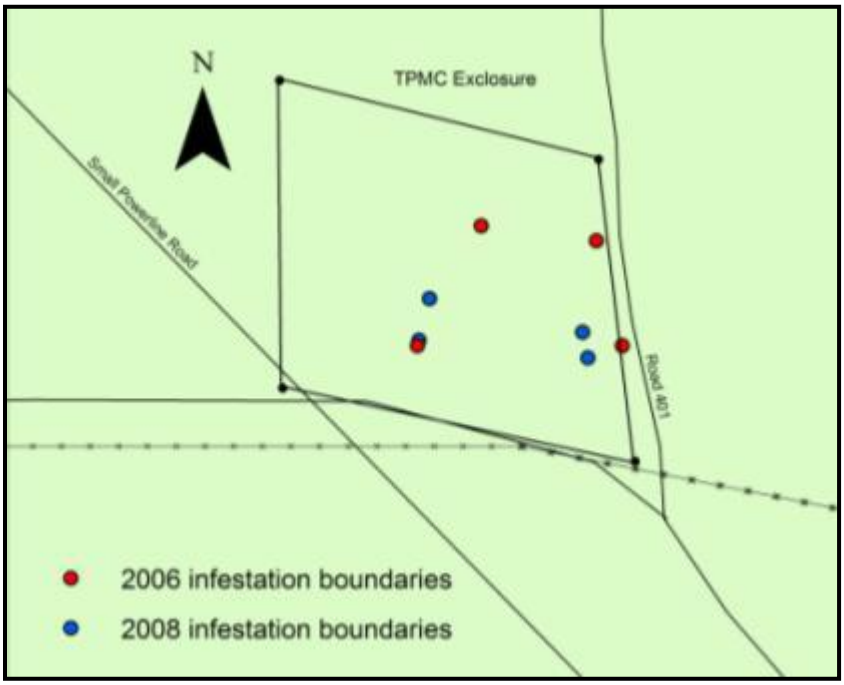
*Plot size = 20 feet X 20 feet ** Visual estimate of buffelgrass cover



PMC exclosure, looking NW the first day of spraying

One month after spraying (11 August) PMC exclosure, looking NW

PMC personnel believe the original infestation area to have markedly decreased since the initial spraying efforts took place in 2006. GPS points were taken at the boundaries of the central infestation in 2006 and again in 2008. They are shown below. This preliminary data confirms the original hypothesis that after three consecutive years of herbicide treatment, the infestation would be significantly decreased and continued control efforts would be minimized.



Buffelgrass infestation boundaries: 2006 and 2008

Nevertheless, a continual effort must be maintained in order to ensure control of buffelgrass. Each year plants are missed during spraying efforts due to simple oversight by personnel, equipment failure, and/or timing. Even one missed plant can result in thousands of new seedlings the next year and beyond. During the growing season of 2010, PMC personnel will continue spraying and monitoring efforts.

2010 Buffelgrass control

A scouting trip was conducted in February 2010 to plan for the year's control efforts. Some sporadic greening up of buffelgrass was apparent and attributed to winter rains. PMC personnel spot sprayed green plants with 5% glyphosate near the fence on the east side of the exclosure. Three more site visits were made in March, May and July. During the July visit, it was determined that a full spraying trip should be made as soon as possible as the buffelgrass was exhibiting vigorous growth.

On August 10th, four personnel traveled to spray the entire exclosure. As in trips before, ten gallons of Round-Up concentrate, 150 gallons of water, blue dye, and LI-700, a spray adjuvant, were transported to the site. Two ATVs with 30 gallon spray tanks and an extra

ATV were also transported to the site. Backpack sprayers were used to spray buffelgrass found outside the exclosure and within/underneath existing vegetation. A total of 5 quarts of glyphosate were used during this application. PMC personnel made a follow-up trip on the 23rd of August. Re-treatment was necessary in a shallow depression running from the west fence to the middle of the exclosure. During the re-treatment, six gallons of glyphosate were used in backpack and hand pump sprayers.

A final trip was made on September 13th. Treated areas with dead plants were noticeable however, the herbicide application did not appear to be as effective during the 2010 season as in previous years. PMC personnel believe this to be the result of a heavy rain following the August 10th treatments. Percent cover within the four plots established in 2009 varied from trip to trip suggesting emergence of remaining seed in response to monsoon rains. Scouting, mapping and spray treatments will continue in 2011. In addition, permanent photo points will be selected to provide more consistent treatment data.

Inter-center Trials

Alkali Sacaton Study Plan

Study ID Code	AZPMC-T-0701-ICST
Title	Alkali Sacaton (*Sporobolus airoides*) Intercenter Strain Trial
National Project No.	Natural Areas 1.1
Study Type	Advanced Evaluation
Study Status	Active
Location	AZPMC, NVPMC, WTXPMC, STXPMC, NMPMC, CAPMC
Study Leader	Heather Dial, AZPMC
Duration	2007 through 2012
Description	Alkali sacaton has multiple releases and accessions, either in commercial production, recently released or under current development. Intercenter strain trials are designed to refine and strengthen our understanding of these plants performance over broad geographic areas and further improve our recommendations to conservation practitioners

Status of Knowledge

Sporobolus airoides typically grows on dry, sandy to gravelly flats or slopes, at elevations from 50 to 2350 m. It is usually associated with alkaline soils. Alkali sacaton grows in saline and nonsaline soils, sometimes in dense, pure stands. Alkali sacaton has been reported from sites with soil salinity ranging from 0.003% to 3%. It grows in soil textures from sand to clay, usually with low organic matter. It is tolerant of both drought and inundation by water. Alkali sacaton has a wide range of distribution throughout most states west of the Mississippi river.

Experimental Design

Randomized Complete Block Design (RCBD). 4 replications; 4 treatments (accessions) (See plot plan)

Materials & Methods

Samples of seed will be assembled by the AZPMCand distributed to participants. Seed will be planted by each participant at their location. The plots will consist of four, 50 ft long rows. Rows will be approximately 38 inches apart. Seeding rate will be approximately 20 seed/sq. foot. Seed/lb of each accession will be measured and used to determine accurate seeding. Each participant will receive packets with the correct amount of seed for a 50 ft. row. Cultural practices may include mechanical and chemical weed control, fertilization and chemical control of pests (to be determined by participants). The planting will receive irrigation as needed for establishment. After establishment irrigation will occur every 5 weeks.

Data collection from center 2 rows and will include:

1st year - **s**tand evaluation at end of season, survival, photos of each plot, visual observations (protocols to be determined)

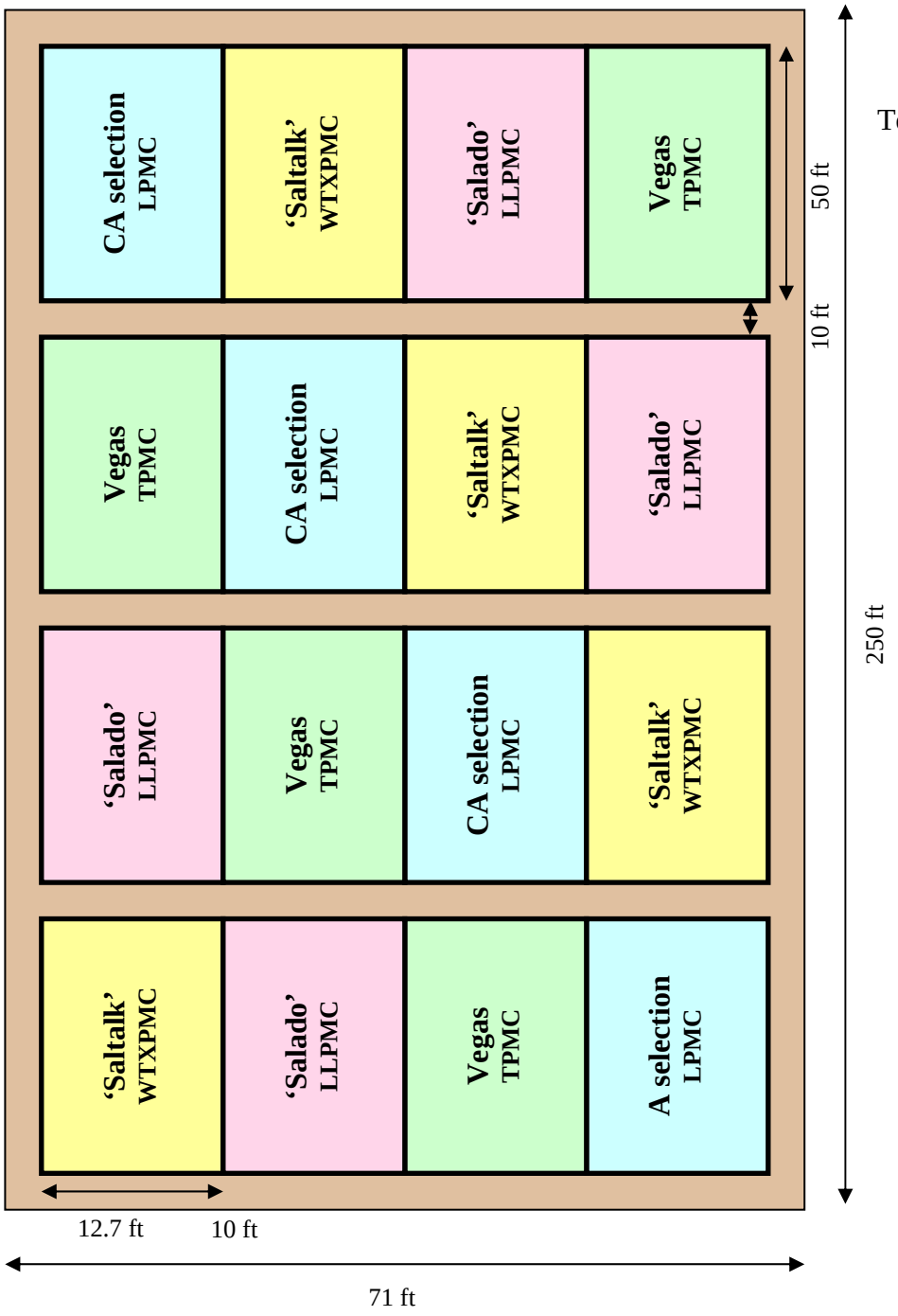
2nd year – date dormancy ends (if goes dormant), date of flowering , date of harvest, percent stand (30 days after dormancy breaks), forage (fresh and dry weight) 1 linear meter clipped from each row, seed production from each plot, photos, visual observations.

Length of data collection to be determined. Each participant will receive data collection sheets for selected variables.

Final Evaluations

Data will go to Jim Briggs (WRPMS) for analysis and reporting.

Technology Transfer Products Planting guide, internal reports, research article



Total = 0.41 acres

Accomplishments/Results:

Growing season 2008:

Seed for this study was received from West Texas PMC (‘Saltalk’), Los Lunas PMC (‘Salado’), and Lockeford PMC (California selection) at the Tucson PMC. These seeds, along with the AZPMCrelease, Vegas, were then counted, packaged, and distributed by AZPMCpersonnel to cooperating Plant Materials Centers for planting. The trial will be planted at the AZPMCduring the 2009 growing season.

Growing season 2009:

The trial was established May 18 in field 3, borders 8-9 using a Kincaid Cone Planter. The planter was set with ¼” depth bands. Prior to planting, the field was leveled. The planting was irrigated in the months of May, June, July, and August for a total of 0.90 acre feet of application. The planting was evaluated on the 4th of June for germination. Germination of all accessions was spotty in blocks 1 and 2. These blocks are closest to irrigation outlets. Pressure from irrigation water may have caused the seeds to be pushed to blocks three and four which had excellent germination. Additionally, these blocks are shaded for a short duration in the morning hours.

V= Visible Germination NV= Not Visible

Date	**4-Jun**																Rep 4
	V	V	V	V	V	V	V	V	NV	NV	NV	NV	NV	NV	NV	NV	
Accession	1	1	1	1	4	4	4	4	3	3	3	3	2	2	2	2	
Date	**4-Jun**																Rep 3
	V	V	V	V	V	V	V	V	NV	NV	NV	NV	V	V	NV	NV	
Accession	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	
Date	**4-Jun**																Rep 2
	V	V	V	V	V	V	V	V	V	V	V	V	V	V	NV	NV	
Accession	3	3	3	3	2	2	2	2	1	1	1	1	4	4	4	4	
Date	**4-Jun**																Rep 1
	V	V	V	V	V	V	V	V	V	V	V	V	NV	NV	NV	NV	
Accession	2	2	2	2	1	1	1	1	4	4	4	4	3	3	3	3	
		Block 4				Block 3				Block 2				Block 1			

1=TX (Saltalk), 2=CA, 3=AZ (Vegas), 4=NM (Salado)

Growing season 2010:

An interim report for the data collected during 2010 at each participating PMC follows.

2010 Interim report of the evaluation of four alkali sacaton selections in four common gardens

November 2010

James Briggs1/, H. Dial2/, A. Young-Mathews3/, G. Fenchel4/, B. Carr5/

Abstract

Alkali sacaton, *Sporobolus airoides*, is a native warm season grass which grows throughout most states west of the Mississippi river. Alkali sacaton is considered valuable forage for domestic livestock and wildlife in arid-semi-arid environments and can be moderately grazed without ill effect. It is reported to be somewhat tolerant of fire, with recovery in 2-5 years after a burn. Alkali sacaton is frequently used for reseeding and has special applicability in revegetation of sites disturbed by oil exploration due to its ability to remove selenium from contaminated soils. The purpose of this study was to document performance differences among cultivars 'Saltalk' and 'Salado, Vegas Germplasm, and a California experimental line 9083020 in common gardens located at sites representing diverse western habitats.

Results from the Arizona trials shows no significant (P=<.05) difference in yield among accessions. Similarly all accessions exhibit similar flowering and dormancy responses among accessions at the Texas and Arizona sites.

1/ James Briggs, Plant Materials Specialist. USDA-NRCS West Region Technology Support Center, Portland, Oregon.

2/ H. Dial, Assistant Manager. USDA-NRCS, Tucson Plant Materials Center, Tucson, Arizona.

3/ A. Young-Mathews, agronomist. USDA-NRCS, California Plant materials Center, Lockeford, California

4/ G. Fenchel, Manage. USDA-NRCS Los Lunas Plant Materials Center, Los Lunas, New Mexico

5/ B. Carr, Agronomist. USDA-NRCS James "Bud"Smith Plant Materials Center, Knox City, Texas

Introduction

Alkali sacaton, *Sporobolus airoides*, is a native warm season grass which grows throughout most states west of the Mississippi river. It typically grows on dry, sandy to gravelly flats or slopes, at elevations from 50 to 2350 m. It is usually associated with alkaline soils. Alkali sacaton grows in saline and nonsaline soils, sometimes in dense, pure stands and is frequently the dominant grass in the landscape. Alkali sacaton is rated as saline tolerant which indicates it can tolerate approximately ECe 6-10 dS/m without reduction in yield and ECe 15-21 dS/m with only a 50% reduction in yield (Maas 1990). It grows in soil textures from sand to clay, usually with low organic matter. It is tolerant of both drought and inundation by water.

Alkali sacaton is considered valuable forage for domestic livestock and wildlife in arid-semi-arid environments and can be moderately grazed without ill effect. It is reported to be somewhat tolerant of fire, with recovery in 2-5 years after a burn. Alkali sacaton is frequently used for reseeding disturbed sites and has special applicability in revegetation of sites disturbed by oil exploration due to its ability to remove selenium from contaminated soils. The seed remains viable for up to 7 years. (Hatch 2004)

The purpose of this study was to document performance differences of the selections in common gardens located at sites representing diverse western habitats.

Materials and Methods

Seed of two cultivars, one selected class germplasm, and one experimental line of alkali sacaton were planted at the Tucson, AZ, Knox City, TX; Lockeford, California, and Los Lunas, NM PMCs. The two cultivars are ‘Salado’, originally collected south of Claunch, NM at an elevation of 1170 m and annual precipitation of 300 mm; and ‘Saltalk’, which originated near Erick, Oklahoma (Alderson 1995). The selected class germplasm is ‘Vegas’ which is a composite of materials collected in Clark, Lincoln, and Nye Counties in southern Nevada (USDA1 undated). The California experimental line, 9083020, was collected near the Kern Nat'l Wildlife Refuge in Wasco, Kern County (southern San Joaquin Valley, MLRA 17). Each PMC is able to evaluate performance in different habitats described by Major Land Resource Areas (MLRA) (USDA 3 2006) and EPA eco-regions. The AZPMCis located in MLRA 40 (EPA Eco-region 81), the Knox City PMC is in MLRA 78 (EPA Eco-region 26), Los Lunas PMC is in MLRA 35 (EPA Eco-region 22), and the California PMC is in MLRA 17 (EPA-Ecoregion 7).

Alkali sacaton entries were planted into plots replicated 4 times using a Randomized Complete Block design. Each plot consists of four 50 foot long rows spaced 38 inches apart. Planting dates were variable and were appropriate to the site. Seeding rate was 20 Pure Live Seed (PLS) per foot. Plots were irrigated, as needed, to insure establishment. Irrigations after establishment occurred every 5 weeks as required. Weed and other pest control measures as well as fertilization were applied as needed.

Accessions were evaluated for stand and survival in the first year. In year 2-4 green-up, anthesis, and seed maturity dates were documented, stand evaluated, ocular evaluation of seed production, and air-dry biomass production determined by harvesting a 1 meter sample from interior plot rows that was representative plot growth.

Results and Discussion

Texas PMC plots were planted fall 2008. Stand estimates in 2009 and 2010 were highly variable (trial CVs of 94 and 107) and generally poor. Plant stand was estimated at 13-14% in 2009 and 2010 respectively, with no apparent relationship to accession. In efforts to control weeds in 2009 several plots were damaged. No differences in flowering dates (June 9-8 and June 15-18 in 2009 and 2010 respectively) or spring green-up (April 10 and April 12 in 2009-2010 respectively) was observed among accessions.

Arizona plots were established in 2008. Some plots had variable initial plant establishment, but this appeared related to irrigation rather than a difference in accessions. None of the accessions entered full dormancy during the 2009 winter period and all accessions were vigorously growing by mid March of 2009. 2010 yields were not significantly different (P=<.05) among accessions and averaged 1.3 tons/ac for Salado to 2.2 tons/ac for Vegas Germplasm. Results are similar to an earlier study (Alba-Avila 1988) which showed that soil texture and depth of seeding had significant (P=<.01 and .001) effects on above and below ground biomass production, while differences in biomass yield associated with the cultivars Salado and Saltalk were non-significant (P=<.05).

Interestingly the cultivars and other entries in this trial originated from approximately the same latitude 34.2 – 36.2 degrees north, although represent distinctly different eco-regions from east to west.

New Mexico and California PMCs were unable to provide data for 2010, but it is anticipated that data will be available in 2011.

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Arizona Cottontop Study Plan

Study ID Code AZPMC-T-0702-ICST

Title Arizona cottontop (*Digitaria californica*) Intercenter Strain Trial

National Project No. Natural Areas 1.1

Study Type Advanced Evaluation

Study Status Active

Location AZPMC, KCPMC

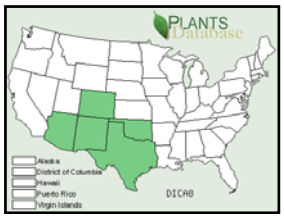
Study Leader Bruce Munda, Heather Dial, AZPMC

Duration 2009 through 2012

Cooperators AZPMC, KCPMC

Description AZ cottontop has multiple releases and accessions, either in commercial production, recently released or under current development. Intercenter strain trials are designed to refine and strengthen our understanding of these plants performance over broad geographic areas and further improve our recommendations to conservation practitioners

Status of Knowledge 'Arizona cottontop is a native, perennial bunchgrass that contributes considerable range forage in the Southwest, from southern Colorado to Texas, Arizona, and northern Mexico. This species can be found in the oak woodland, chaparral, and semidesert grassland types, between 300 and 1,800 m.



Experimental Design Randomized Complete Block Design (RCBD). 4 replications; 3 treatments (accessions) (Attachment 1)

Materials & Methods Samples of seed from STX PMC (La Salle), KCPMC (PMT-389), and AZPMC (Loetta), will be planted by each participant at their location. The plots will consist of four, 50 ft long rows. Rows will be approximately 40 inches apart. Seeding rate will be approximately 20 seed/sq. foot. Seed/lb of each accession will be measured and used to determine accurate seeding.

Cultural practices may include mechanical and chemical weed control, fertilization (50 au of N/season) and chemical control of pests. All cultural practices will be recorded. The planting will receive irrigation as needed for establishment. After establishment, irrigation will occur every 5 weeks.

Data collection will be from center 2 rows and will include:

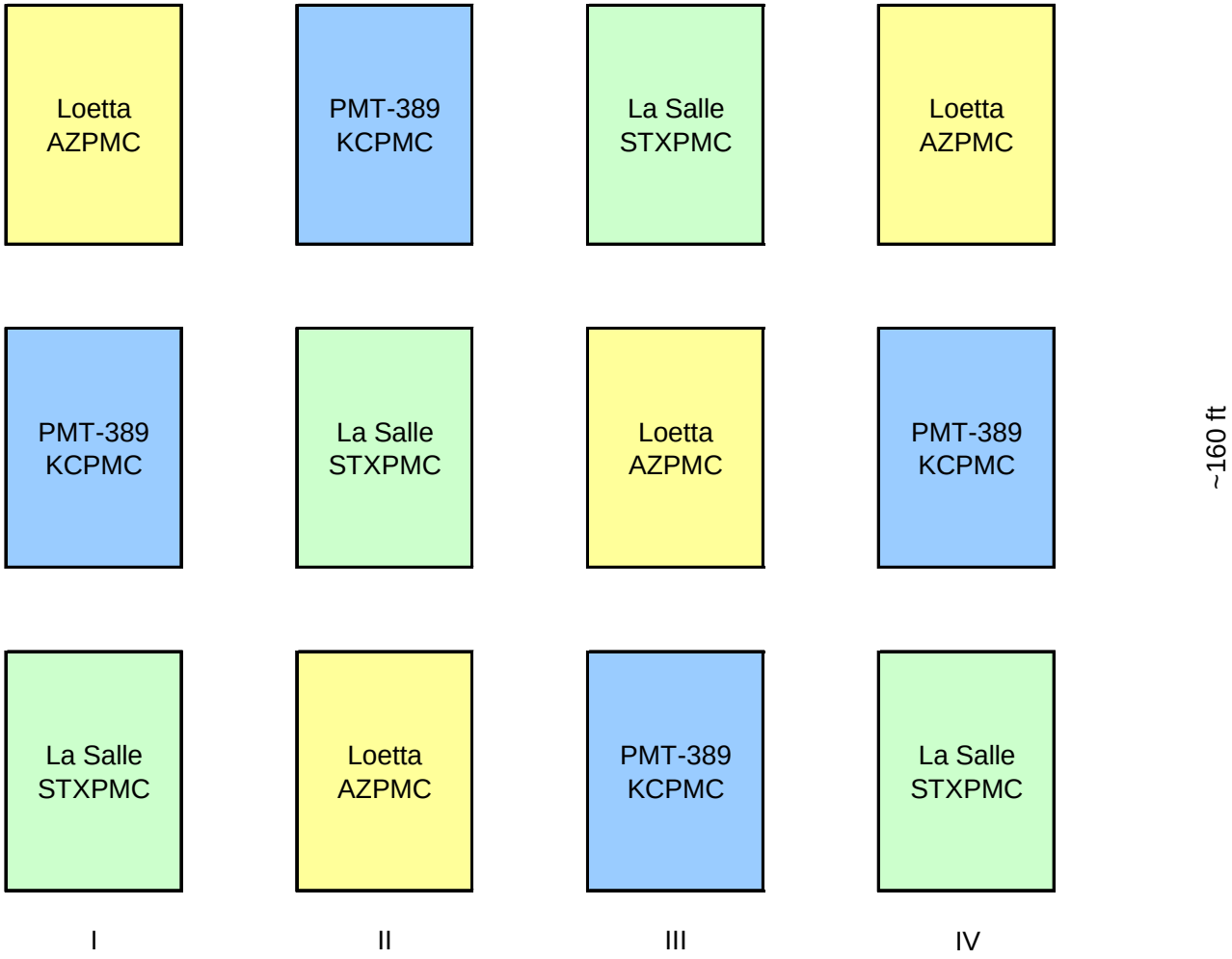
1st year – visual observations will include % stand establishment at the beginning of the season and % survival at end of season. Photos of each plot should be taken to document stand observations.

2nd year –date dormancy ends (if it goes dormant); date of flowering; date of harvest; percent stand (30 days after dormancy breaks); forage (fresh and dry weight) to be determined from 1 linear meter clipped (to ~4" height) from designated rows; seed production (lbs) from each plot (seed to be harvested with FlailVac); photos/ visual observations

Data collection will continue until the end of the growing season 2012. Each participant will receive data collection sheets for selected variables.

Final Evaluations Data will go to Jim Briggs (WRPMS) for analysis and reporting.

Technology Transfer Products Planting guide, internal reports, research article



Growing season 2009:

The planting was established the 18th of May in field 4, border 5 with a Kincaid cone planter. The planter was set with ¼" depth bands. Prior to planting, the field was leveled. The planting was irrigated in the months of May, June, July, and August for a total of 0.62 acre feet of application. The planting was evaluated on the 5th of June for germination. All three accessions had visible germination in all blocks. However, the middle rows of all blocks were very hard to distinguish. Later in the growing season, it became apparent that the middle rows of all blocks would not germinate. It is possible that the repeated trips over the middle rows during the planting process created too much compaction for the seedlings to survive.

Growing season 2010:

The following data was collected during 2010: date dormancy ended, date of flowering, percent stand (30 days after dormancy breaks), and fresh and dry weight of forage. The data is reported in the table below.

					Forage	
Plot #	**Date Dormancy Ended**	**% Stand (30 days after dormancy breaks)**	**Harvest Date**	**Flowering Date**	**Fresh wt.**	**Dry wt.**
1	15-Mar-10	100	6-Aug	12-Apr-10	1.92	0.93
2	15-Mar-10	100	6-Aug	12-Apr-10	1.26	0.53
3	15-Mar-10	100	6-Aug	12-Apr-10	1.84	1.05
4	15-Mar-10	100	6-Aug	12-Apr-10	1.84	1.11
5	15-Mar-10	100	6-Aug	12-Apr-10	2.42	1.39
6	15-Mar-10	100	6-Aug	12-Apr-10	2.16	1.00
7	15-Mar-10	100	6-Aug	12-Apr-10	2.82	1.45
8	15-Mar-10	100	6-Aug	12-Apr-10	1.86	0.90
9	15-Mar-10	100	6-Aug	12-Apr-10	1.78	0.96
10	15-Mar-10	100	6-Aug	12-Apr-10	1.56	0.78
11	15-Mar-10	100	6-Aug	12-Apr-10	1.68	0.81
12	15-Mar-10	100	6-Aug	12-Apr-10	1.46	0.79

Adaptibility of 'Tropic Sun' Sunn Hemp Study Plan

Study ID Code	AZPMC-T-0902-CP
Title	Adaptability of 'Tropic Sun' Sunn Hemp
Study Type	ICST
Study Status	Active
Location	Tucson, AZ; Boonville, AK; Lockeford, CA; Meeker, CO; Brooksville, FL; Americus, GA; Hoolehua, HI; Aberdeen, ID; Manhattan, KS; Galliano, LA; Beltsville, MD; East Lansing, MI; Coffeeville, MS; Elsberry, MO; Bridger, MT; Fallon, NV; Cape May, NJ; Los Lunas, NM; Corning, NY; Bismarck, ND; Corvallis, OR; Kingsville, TX; Nacogdoches, TX; Knox City, TX; Pullman, WA; Alderson, WV.
Duration	2009
Cooperators	AZPMC, ARPMC, CAPMC, UCEPC, FLPMC, GAPMC, HIPMC, IDPMC, KSPMC, LAPMC, MDPMC, MIPMC, MSPMC, MOPMC, MTPMC, NVPMC, NJPMC, NMPMC, NYPMC, NDPMC, ORPMC, STXPMC, NTXPMC, ETXPMC, WAPMC, WVPMC
Vegetative Practices	Primary
	Secondary
Resource Concern(s)	Resource Consideration/Problem
Description	Sunn Hemp (*Crotalaria juncea)* has been touted as a great green manure and cover crop since the 1930s, when it was reported to be an excellent soil-improving crop. Sunn hemp produces high organic matter yields while fixing large amounts of nitrogen. However, the difficulty in acquiring seed and cheap fertilizer prices caused many farmers to abandon the use of this crop. Energy costs have brought leguminous cover crops back to the forefront for sustainable agriculture production and have led to efforts to increase production of sunn hemp seed. This study attempts to determine the areas of the country with the potential to use sunn hemp for green manure and cover crops. The anticipated use of sunn hemp is as a 30-45 day green manure crop. Sunn hemp does not produce seed above 28 degrees N latitude (southern tip of Florida or Texas). Since it does not produce seed through most of the US and is sensitive to frost it has little potential to be weedy.
Status of Knowledge	Sunn hemp is a tropical or sub-tropical plant that acts like a summer annual when grown in the continental United States. Sunn hemp's adaptation to a wide range of soils and superior performance on poor

sandy soils has attracted attention as cover crop Sunn hemp can produce 5,000-6,000 pounds of biomass per acre in southern climates in 60-90 days. It also can produce 120-140 pounds of nitrogen in the same amount of time.

Experimental Plan

Each plant materials center will receive seed to plant an approximately 36’ X 46’ block.

1. The planting should be done after any chance of frost has past. The planting date for tomatoes would be a good guide.
2. The block will be drilled at a seeding rate of 50 lbs/acre. Row spacing of approximately 8”. The seed bed will be well prepared and weed free.
3. The seed will be inoculated with a cow pea type *Bradyrhizobium* sp. which will be sent along with the seed. Heat and direct sunlight kill bacteria in stored innoculum, even while packaged. Since a short period of heat can reduce the number of live bacteria the package should be kept in a cool place and out of direct sunlight - even when taking it to the field (keep it off the dashboard). The preferred storage place for innoculum is the refrigerator (do not freeze).
4. The seed should be thoroughly coated with innoculum to achieve the best distribution; the innoculum should be mixed with seed in a large tub or bucket not the planter seedbox. Seed should be coated with an adhesive (sticker) before innoculant is added. Sticker can be made from a 1:10 mixture of syrup or from a dilute soda. Mix seed with enough sticker to moisten all seed. To the moistened seed add innoculant and mix to thoroughly coat the seed. Air dry by spreading the coated seed in a cool shaded place. The seed will need to be dry to flow through the seeder. Give yourself time for the seed to dry but the seed must be used within 24 hours of inoculation.
5. Irrigation after planting is up to you, some will have to others may not have that option. Just record as much information about when and amounts of irrigation and natural precipitation as possible. Watering should follow the schedule for a forage crop in your area.
6. It may beneficial to put up a fence to protect the plot from deer.
7. Record planting date, date of emergence and date of complete stand.
8. Record height of plant at time of clipping.
9. Clipping dates will be 30 days, 60 days and 90 days after planting date. Four 1 meter squares will be clipped just above

the soil surface.

Fresh clipped material will be weighed for each harvest. Air dry the sample for 30 days and weigh again.

Dry and fresh weights will be recorded.

10. Record the date first flowers appear.
11. Record the date of last frost.
12. Record the height of the material when it is killed by frost.

Technology Transfer Products

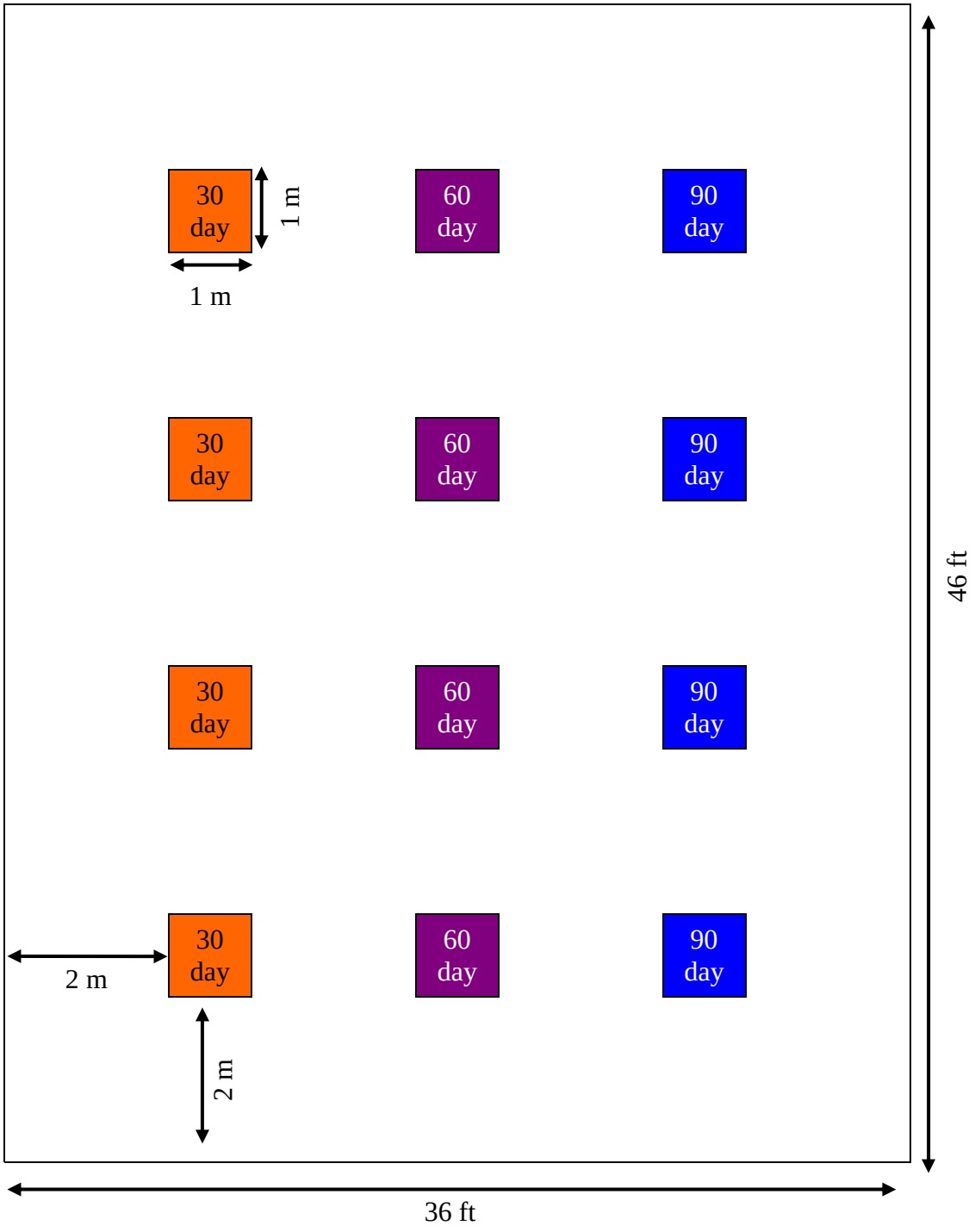
national tech note, state tech notes, referred journal article

Literature Cited

Rotar, P.P. and R.J. Joy. 1983. 'Tropic Sun' sunn hemp (*Crotalaria juncea* L.)Res. Ext. Ser. 36. Hawaii Inst. Trop. Agric. and Human Resour., Univ. of Hawaii, Honolulu.

USDA-NRCS. 1999 Sunn Hemp: A Cover Crop for Southern and Tropical Farming Systems. Technical Note No.10 Soil Quality Institute, Auburn, AL

Plot Plan
National Plant Materials Sunn Hemp Evaluation



Growing season 2009:

The sunn hemp seed was inoculated with *Bradyrhizobium* sp. on the 18th of May using a sugar water solution as an adhesive. On the 19th of May, the sunnhemp was planted into field four, border three using a John Deere grain drill with approximately 7" row spacing. The planting was irrigated six times (May, June, July, and August) during the growing season for a total application of 0.31 acre feet. The date of complete stand was the 28th of May. Between the 28th of May and the 1st of June, approximately 2/3 of the planting block was eaten by ground squirrels. PMC personnel fenced in the planting on the 1st of June to prevent further damage. Harvest amounts taken from the remaining 1/3 of the planting block during the growing season is shown below.

2009 Sunn hemp Trial Harvest Amounts:

Plot#	Rep	Harvest Date	Plt. Ht inches*	Total** Wet wt/Plot Grams	Total Dry wt /plot Grams	Pct Dry wt/plot	Yield (lb/acre)	Tons/ acre
1	I	June26		148.3	27.05	18	1153	0.58
2	II			183.19	31.24	17	1132	0.57
3	III			138.85	24.15	17	1030	0.52
Avg/ Harvest.			**14.8***	**156.78**	**27.48**	**17.3**	**1171.8**	**0.58**
1	I	July-23		833.75	154.99	18.6	6609	3.30
2	II			984.94	208.95	21.2	8910	4.45
3	III			1160.44	228.26	19.7	9734	4.86
Avg/ Harvest			**59.4**	**993.04**	**197.4**	**19.8**	**8417.8**	**4.21**
1	**I**	Aug-24		893.00	259.22	29.0	11054	5.52
2	II			931.11	248.12	26.7	10581	5.29
3	III			1123.05	323.33	28.8	13788	6.89
Avg/ Harvest			**80.4**	**982.39**	**276.89**	**28.2**	**11807.5**	**5.90**

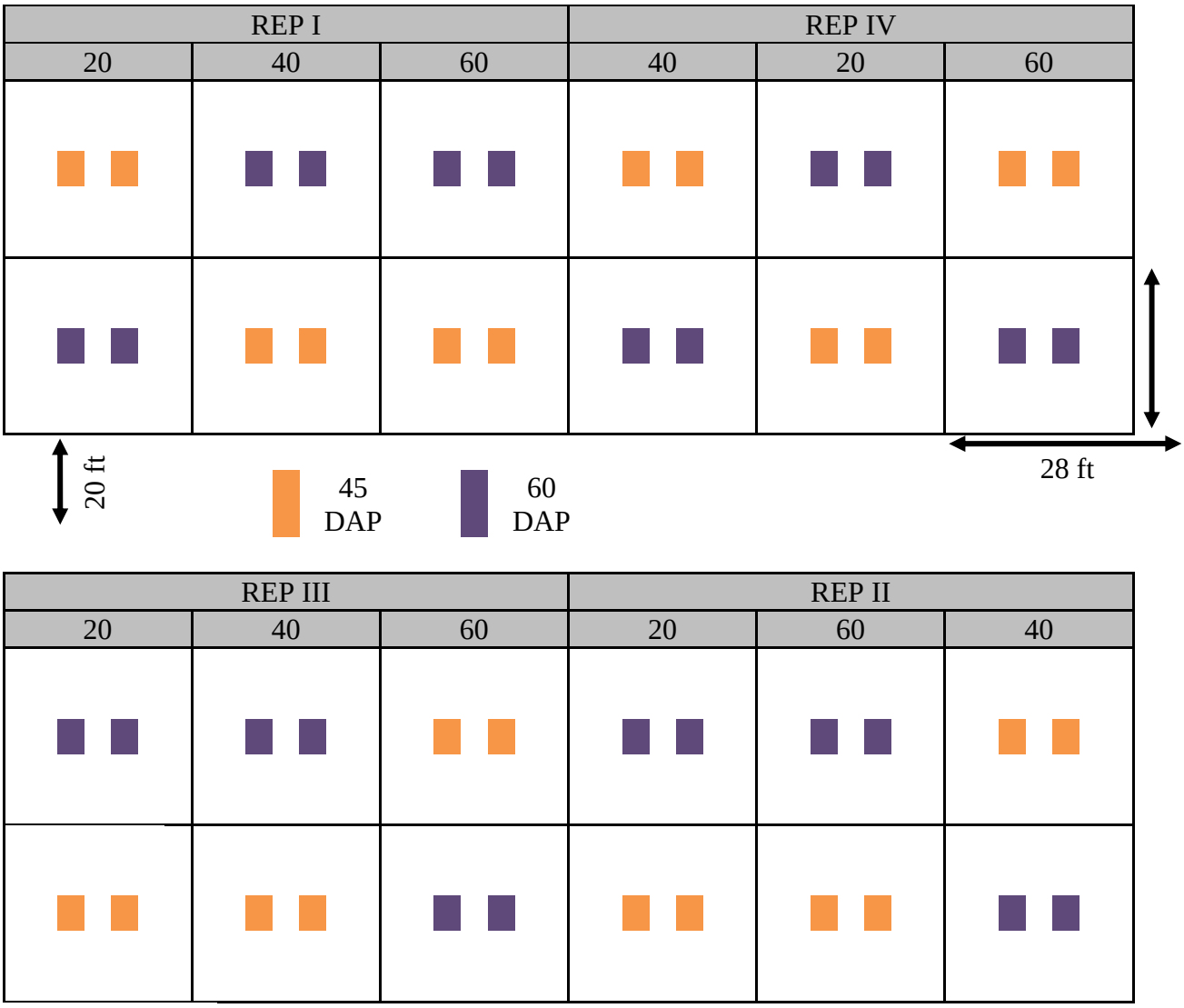
* Average of 5 plants/harvest ** Total weight of plot: Plot size harvested = 0.20 m^2 (0r 2.25 $ft^{2)}$

Additional notes:

- The first bloom was recorded on 27 August with 50% bloom recorded on the 17th of September.
- Sunn Hemp did not have any re-growth after clipping at approximately 4 inches from the ground.
- Inflorescence is apical
- A micro-nutrient deficiency was noted in some plants(most likely Iron or Zinc deficiency)
- Sunn Hemp produced viable seed at our latitude
- As Nov 12, 2009 Sunn Hemp is approximately 9 feet tall

Growing season 2010:

During 2010 a new sunn hemp study was initiated nationally. The primary purpose of the study was to evaluate three different planting rates to determine the most effective/efficient planting rate for green manure (nitrogen) production. The plots were drill seeded on September 2 and were evaluated at 45 and 60 day intervals for wet and dry biomass production. The plot plan and data collected follow.



45 day biomass evaluations of sunnhemp

	18-Oct-2010		29-Oct-2010	
	WET		**DRY**	
	Weights in grams		*Weights in grams*	
Rep 1	eastern	western	eastern	western
20 seeds/sq. ft	365.94	350.63	80.40	92.12
40 seeds/sq. ft	485.67	626.37	106.10	134.01
60 seeds/sq. ft	859.40	879.38	169.82	176.89
Rep 2				
20 seeds/sq. ft	688.10	578.96	168.50	130.57
40 seeds/sq. ft	978.88	706.87	242.01	174.40
60 seeds/sq. ft	727.54	889.55	177.74	207.03
Rep 3				
20 seeds/sq. ft	670.32	288.07	136.73	59.00
40 seeds/sq. ft	731.24	756.25	147.95	162.07
60 seeds/sq. ft	880.45	1015.19	185.07	221.30
Rep 4				
20 seeds/sq. ft	528.07	448.55	114.21	94.40
40 seeds/sq. ft	809.63	649.09	153.00	136.40
60 seeds/sq. ft	874.88	596.06	214.53	147.31

Average height of plants at clipping = 2 .83 feet

60 day biomass evaluations of sunn hemp

	2-Nov-2010		10-Nov-2010	
	WET		**DRY**	
	Weights in grams		*Weights in grams*	
Rep 1	eastern	western	eastern	western
20 seeds/sq. ft	1025.83	1022.06	273.31	249.39
40 seeds/sq. ft	1548.93	1565.83	335.63	307.60
60 seeds/sq. ft	2320.93	2272.77	615.36	498.42
Rep 2				
20 seeds/sq. ft	1156.15	996.52	273.34	241.93
40 seeds/sq. ft	997.52	883.75	261.24	240.43
60 seeds/sq. ft	1776.54	1773.73	435.94	420.25
Rep 3				
20 seeds/sq. ft	1180.78	1219.97	286.35	301.47
40 seeds/sq. ft	1338.76	1693.88	293.88	377.48
60 seeds/sq. ft	1782.04	1585.12	368.33	301.10
Rep 4				
20 seeds/sq. ft	1308.94	1418.67	322.7	346.15
40 seeds/sq. ft	1651.97	1496.67	352.29	347.73
60 seeds/sq. ft	1633.00	1429.89	376.31	324.11

Average height of plants at clipping = 4.20 feet

Conservation Trials

Audubon Mixed Species Field (AZPMC-F-0702-CR)

Seed was harvested in October of 2005 from a site at the Appleton-Whittell Research Ranch. Seed was then used to establish production fields at the PMC. Seed from the harvest was run through the hammer mill to make the material uniform in size. Further seed conditioning was conducted with the Office Clipper to ensure even seed distribution throughout the planting. One week prior to the planting, fields (field 9, borders 21-22) were treated with Glyphosate to minimize potential problems with weeds. The seed was planted with the Truax II seed drill. The planting was irrigated as needed for establishment and weeded either chemically or mechanically when necessary.

Seed and hay bales have been harvested throughout the growing seasons and available to Audubon Research Ranch personnel since 2006. The products have been used for the establishment of native species and invasive species research projects in southeast Arizona. Please see AZPMCstudy AZPMC-T-0606-IN. During the growing season of 2008, approximately 40 haybales were cut from these fields. During growing season 2009, 44 bales were cut from the Audubon borders. This study will be discontinued during growing season 2011 due to the age of the planting.

National Parks Agreements Progress Reports

CANYON DE CHELLY NATIONAL MONUMENT

FY2010 Annual Summary Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project involves the production of 120 PLS lbs of *Sporobolus airoides* and 140 PLS lbs of *Aristida purpurea*. Seed produced will be used for revegetation of disturbed areas in Canyon de Chelly National Park. The original agreement (IA No.: 1211-08-002) was signed the 14th of November, 2007 with the project ending the 30th of September, 2010. In September of 2010, an amendment was signed that extended this agreement until December 31, 2012 to allow for additional seed collection and production time.

ACCOMPLISHMENTS – In June 2008, 0.36 acres were planted to *Sporobolus airoides* using seed collected by park personnel in 2006. Harvest totals for years 2008-2010 are shown in the table below. At the time of this report, seed lab results have not been received for some harvests. As a result, it is not possible to calculate PLS pounds in storage at the center.

***Sporobolus airoides* bulk harvest totals 2008-2010**

	Harvest Year				
	2008	**2009**		**2010**	
Bulk lbs.	15.00	29.30	19.25	10.84	5.96

Seed collections made within the park by a contracted seed collector were received at the center throughout 2009-2010. Species and amounts received include: *Aristida purpurea* = 8.26 lbs, *Bouteloua gracilis* = 6.12 lbs, *Plueraphis jamesii* = 1.18 lbs and *Sporobolus cryptandrus* = 1.5 lbs.

In March of 2010, approximately 3,700 *Aristida purpurea* plants were started from seed received in 2009. In June 2010, these plants were used to establish a 0.54 acre seed production field. In late 2010, 23 bulk pounds of seed were harvested from the field. Seed samples will be sent for germination and purity testing in 2011.

TECHNOLOGY DEVELOPMENT – Seed cleaning techniques for *Aristida purpurea* are under development at the time of this report. Seed cleaning techniques being tested include use of the Westrup Brush Machine, Eclipse Model 324 Seed and Grain Cleaner and/or various hammermills.
It is believed that removing the awns from the harvested seed during the cleaning process may reduce seed viability. However, park personnel have requested cleaned seed. Attempts are being made to find a seed cleaning method that removes the long awns of *Aristida purpurea* without significantly reducing seed viability.

PMC personnel planting *Aristida purpurea*, June 2010

Aristida purpurea field, November 2010

ZION NATIONAL PARK

FY2010 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project involves the production of 900 PLS lbs of *Sporobolus cryptandrus* to be used for revegetation of disturbed areas in Zion National Park. The last signature on the agreement was the 8th of January 2007, with the project originally extending until the 30th of September 2009. In August of 2009, a modification was completed which extended the agreement until December 31, 2011. A sub agreement was signed in August 2010 to produce an additional 130 PLS of *Sporobolus cryptandrus*, increasing the total amount of seed to be produced for this project to 1030 PLS lbs. The sub agreement ends December 2011 to coincide with the project extension.

ACCOMPLISHMENTS – In October of 2007, 1.68 acres of land was planted to *Sporobolus cryptandrus* at the center. The acreage was increased to a total of 5.25 in March of 2009. For the increase, approximately 16,000 *Sporobolus cryptandrus* plants were grown in our greenhouse from the seed originally sent to the center in November 2006. Harvest totals for 2008-2010, along with their germination and purity results, are presented in the table below. In August of 2009, 170 pounds of bulk seed (154 PLS pounds) was sent via Fed Ex ground to Great Basin Seed, Ephraim, Utah, as requested by park personnel.

***Sporobolus cryptandrus* harvest totals for years 2008-2010:**

	Harvest Year				
	2008	**2009**		**2010**	
Bulk lbs.	34.69	265.62	208.48	296.36	342.10
Cleaned lbs.	16	154.00	153.78	249.02	257.20
Germination %	94	91	80	66	64
Purity %	99.21	99.77	99.32	99.88	99.96
Test date	5/17/2010	8/14/2009	3/18/2011	3/18/2011	3/18/2011
PLS %	93.26	90.79	79.46	85.9	77.97
PLS lbs.	*14.92	*139.82	122.19	213.91	200.54

* These totals have been shipped to Zion and are no longer maintained at the Tucson Plant Materials Center

TECHNOLOGY DEVELOPMENT – Center personnel continue to use a Massy Ferguson 8XP plot combine for harvesting *Sporobolus cryptandrus*. PMC Personnel have experimented with various fan and concave speed settings on the combine to maximize seed collected and minimize the collection of extraneous materials. Settings used during the 2010 harvesting will be verified during 2011 harvests.

Center personnel cleaning out the Massy Ferguson combine after harvest.

A view of the back of the combine showing harvested material.

A close up of harvested seed prior to cleaning.

CORONADO NATIONAL MEMORIAL

FY2010 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This agreement (IA 1211-09-005) was initiated July 17, 2009 and is expected to be completed September 30, 2013. The Tucson Plant Materials Center (AZPMC) will propagate a total of 5000 containerized plants of agave (*Agave palmeri*) during the course of the contract. Approximately 1500-2000 plants will be delivered to the Memorial each year in order to meet the amount stipulated in the agreement. The agave plants will be out-planted in an area disturbed during the construction of the border fence along the Arizona - Mexico border. At present, there is limited information available on growth protocols for this species. Therefore, the AZPMC has initiated studies to collect data on optimal propagation techniques.

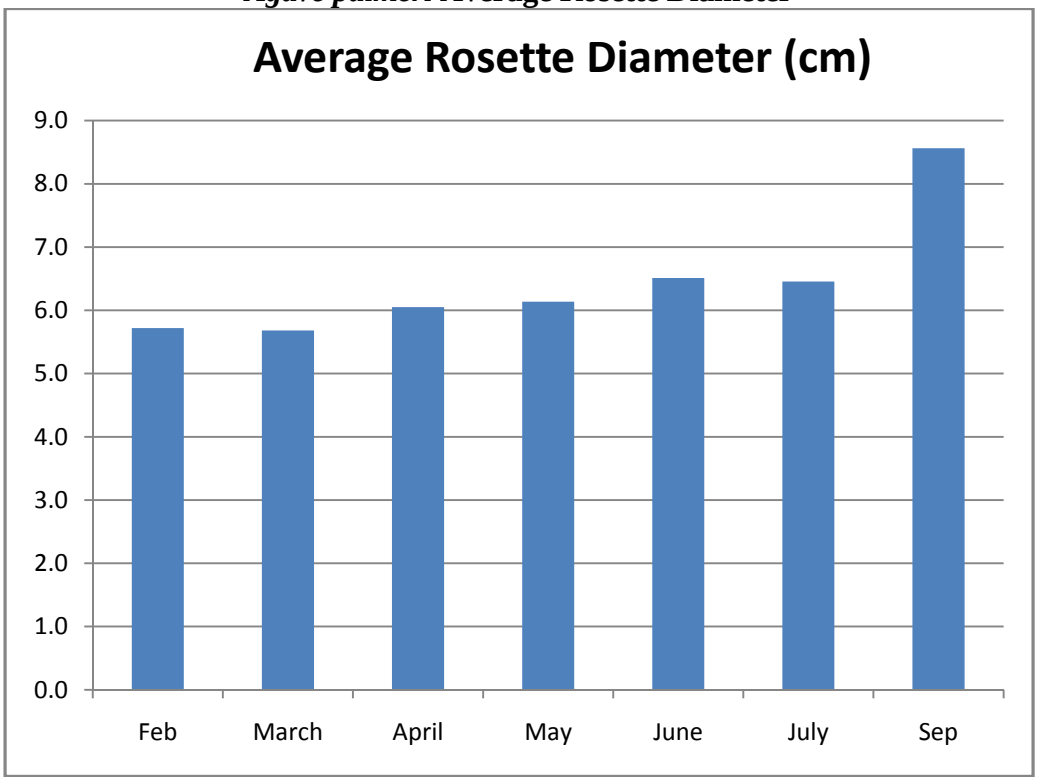
ACCOMPLISHMENTS – Seed collected at the Memorial was cleaned and production of plants was initiated in July 2009. The first batch of seeds was pre-soaked in water for 12 hours, drained and then placed in the greenhouse to germinate. Germination was excellent resulting in about 1600 seedlings which were transplanted to 3 x 5 inch zipset plant band containers (45 cubic inches in volume). The 1600 containerized plants were delivered to the Coronado National Memorial on July 16, 2010 (see photos below). The size of each individual plant rosette averaged about 2-3 inches at the time of delivery. Another 1600-2000 plants are scheduled to be delivered in late summer of 2011.

TECHNOLOGY DEVELOPMENT– Limited information is available in the literature regarding *Agave palmeri* culture under nursery conditions. The AZPMC initiated observational trials and a growth rate study to find out more about the cultural requirements for this plant. The following are some of the observations recorded during the first year of the grow-out:

Growing Media: A mixture of peat moss and perlite at a 1:2 ratio provided the best results for drainage and growth. A mixture of 3:1:1 of shredded bark, sand and peat moss did not work as well as the 1:2 ratio of peat moss and perlite. A mixture of medium texture field soil, peat moss and perlite (1:1:1) did not provide adequate drainage.
Irrigation Frequency: Ten minute irrigation frequencies of 3 days, 2 days and 1 day per week were compared to observe differences in growth rates. Additional watering days per week did not improve growth rates but did result in a fungus gnat infestation in the greenhouse. An irrigation frequency of one watering day per week provided sufficient water for the agave plants and control of the fungus gnat infestation.
Fertilization: Plants were fertilized approximately once per month with 200 parts per million of 20-20-20 Peter's Professional soluble fertilizer.

Growth Rate Study: A greenhouse/shade house growth rate study was initiated soon after the agave plants were transplanted into individual containers. Three replications of 16 plants were used for the study. Initially, leaf growth was recorded to measure growth. However, once the plants began forming rosettes, this task became time consuming and rosette diameters were recorded instead. Below is a figure illustrating average rosette diameter growth in centimeters for 16 plants from February through September 2010 (data was not collected for the month of August). Rosette diameter increased significantly during the late summer months.

***Agave palmeri* Average Rosette Diameter**



Agave, approximately one year old.

Trailer of agave plants delivered July 17, 2010.

MONTEZUMA CASTLE NATIONAL MONUMENT

FY2010 Annual Summary Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project involves the production of approximately 1600 containerized trees and shrubs and the seeding of six acres of pasture at Montezuma Well National Monument. The ultimate goal of the project (IA No.:1211-09-005) is to restore and re-connect two riparian habitats within the park. The project began May 2009 and was completed in February of 2011.

ACCOMPLISHMENTS –In late July 2010, Tucson Plant Materials Center (AZPMC) personnel traveled to Montezuma Well National Monument to seed approximately six acres of native grasses within a mesquite bosque and pasture along Beaver Creek. Park Service staff spot sprayed and mowed the former pasture to treat invasive weeds prior to seeding and provided a mix of seed including: Western Wheatgrass (*Pascopyrum smithii*), Sideoats Grama (*Bouteloua curtipendula*), Green Sprangletop (*Leptochloa dubia*), 'Salado' Alkali Sacaton (*Sporobolus airoides*), Sand Dropseed (*Sporobolus cryptandrus*) and 'Grant' Cane Beardgrass (*Bothriochloa barbinodis*).
The seed mix was planted at 16 lbs/acre with a Truax FLXII86 grass drill set for a planting depth of approximately ¼ inch.

In February of 2011, AZPMC personnel traveled to Montezuma Well National Monument to deliver a second batch of containerized plants. Table 1 provides the list of species grown for the agreement and the number of plants delivered in both 2010 and 2011. For some of the species, seed provided by the park germinated poorly. In order to meet contract numbers, alternative species were grown and/or numbers of other species were increased.

Table 1. Species Grown and Delivered to Montezuma Well National Monument

Shrub Species	Planned number	Feb 2010 Number Delivered	Feb 2011 Number Delivered
Atriplex canescens	295	304	48
Baccharis pteronioides	95	25	3
Mahonia haematocarpa	106	0	6
Encelia frutescens	84	128	16
Ephedra viridis	84	0	0
Lycium pallidum	167	0	195
Purshia mexicana	128	0	1

Rhus trilobata	128	0	1
Ribes aureum	106	0	227
Yucca elata	84	167	32
Celtis reticulata	16	0	160
Chilopsis linearis	184	195	32
Frangula californica	94	0	1
Fraxinus veluntina	25	0	88
Ziziphus obtusifolia	0	0	12
Platanus wrightii	0	0	80
Total Shrub/Trees	***1596***	***819***	***902***

Montezuma Well National Monument Pasture August 2010

Montezuma Well National Monument Pasture September 2010

SAGUARO NATIONAL PARK

FY2010 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project involves the production of 690 containerized plants to be used for the revegetation of two disturbed areas of Saguaro National Park: Hope Camp and Scenic Drive. The last signature on the agreement was the 17th of May 2009, with the project extending until the 30th of September, 2011. Plant Materials personnel provided expertise on growing methods for multiple species of plants, as well as the maintenance, inputs and space for the growing plants.

ACCOMPLISHMENTS – Plant materials personnel provided assistance to park personnel in the selection and purchase of growing mediums and containers in early July 2009. Park personnel and volunteers arrived at the Plant Materials Center (PMC) in late July to begin work on the propagation of the forb and grass species listed in table 1. In September, park personnel returned to the PMC to propagate the tree and shrub species listed in table 2. In both instances, seed was placed in trays, allowed to germinate, and transplanted into pots when at the appropriate growth stage.

Some of the species propagated by park personnel exhibited very low germination rates. Those species included cane beardgrass, creosote bush, odora, paperflower, and Desert globemallow. To compensate for the lower germination rates, park personnel increased the transplanted numbers of some of the other species. Additionally, in mid-August, park personnel propagated two additional species, *Digitaria californica* and *Dyssodia tenuloba*, to ensure enough plants were available for revegetation.

All of the species listed in table one were outplanted by park personnel in January/February of 2010. Approximately half of the species listed in table two were picked up by park personnel in February of 2011 while the others remain in holding at the PMC.

Table 1. Species started in July 2009

Common name	Scientific name	Number propagated
Purple threeawn	*Aristida purpurea*	30
Cane beardgrass	*Bothriochloa barbinodis*	30
Creosote bush	*Larrea tridentata*	80
Menadora	*Menadora scabra*	80
Odora	*Porophyllum gracile*	80
Paperflower	*Psilostrophe cooperi*	80
Desert senna	*Senna covesii*	30
Desert globemallow	*Sphaeralcea ambigua*	80
Totals		**490**

Table 2. Species started in September 2009

Common name	Scientific name	Number
Whitethorn acacia	*Acacia constricta*	30
Catclaw acacia	*Acacia greggii*	40
Fairy duster	*Calliandra eriophylla*	10
Foothills paloverde	*Cercidium microphyllum*	50
Ocotillo	*Fouquieria splendens*	20
Mesquite	*Prosopis velutina*	50
Totals		**200**

Fouquieria splendens, *Cercidium microphyllum* and others in early April 2010

Field Plantings

Vaca Ranch in the San Raphael Valley of Santa Cruz County (AZPMC-F-0602-CR)

The Tucson NRCS Field Office assisted with this planting in July of 2006. This site was selected because sections of the ranch, which is dominated by exotic Lehmann lovegrass, had burned that summer. The hope is that by planting native species, using seed harvested from a local site, natives may have a higher rate of germination versus the invasives. The planting was conducted using the Truax II Seed Drill. A variety of species were planted, including: *Eragrostis intermedia, Bouteloua gracilis, B. hirsuta, B. eriopoda, B. curtipendula, B. chondrosioides, Bothriochloa barbinodis, Digitaria californica, Lycurus phleoides, Leptochloa dubia, Aristida spp., Sida filicaulis, Ipomoea coccinea, Viguiera annua, convolvulus equitans*. The seed mix was from a native harvest from the nearby Appleton-Whittell Research Ranch of the Audubon Society. This planting will be evaluated for persistence and species composition during the growing season of 2010.

This planting was evaluated on August 24, 2010. Two 100 foot transects were ran in the seeded plot and two were ran in an unseeded area. Dry weight rank was used to determine the percent species composition in the transects. Based on the results for the top three species (see below), the seeded plots had an almost 20% reduction in *Eragrostis lehmanniana* versus the unseeded areas. This field planting will be monitored again in 2011.

VACA: Treated

Species	1	2	3	*7	*2	*1	Weighted	% Comp
Lehmann lovegrass (*Eragrostis lehmanniana*)	50	25	18	350	50	18	418	0.42
Sprucetop grama (*Bouteloua chondrosioides*)	13	14	6	91	28	6	125	0.13
Cane bluestem (*Bothriochloa barbinodis*)	12	4	5	84	8	5	97	0.10
Blue grama (*Bouteloua gracilis*)	9	9	9	63	18	9	90	0.09
Spidergrass (*Aristida ternipes*)	5	20	10	35	40	10	85	0.09
Woolystar (*Eriastrum sp.*)	4	5	14	28	10	14	52	0.05
Curly mesquite (*Hilaria belangeri*)	3	5	4	21	10	4	35	0.04
Aster sp.	2	3	9	14	6	9	29	0.03
Arizona muhly (*Muhlenbergia arizonica*)	1	5	6	7	10	6	23	0.02
Hairy grama (*Bouteloua hirsuta*)	1	1	1	7	2	1	10	0.01
Purple mat (*Nama demissum*)		2	7	0	4	7	11	0.01
Annual three awn (*Aristida sp.*)	1	1		7	2	0	9	0.01
Arizona blue eyes (*Evolvulus arizonicus*)			6	0	0	6	6	0.01
Rosary bean (*Rhynchosia senna*)		1		0	2	0	2	0.00
Arizona cottontop (*Digitaria californica*)		1		0	2	0	2	0.00
hog potato (*Hoffmannseggia glauca*)			2	0	0	2	2	0.00

chinchweed (Pectis sp.)			1	0	0	1	1	0.00
Green sprangletop (*Leptochloa dubia*)			1	0	0	1	1	0.00
goldenrod (*Oligoneuron sp.)*			1	0	0	1	1	0.00
morning glory (*Ipomoea sp.)*			1	0	0	1	1	0.00

VACA: Untreated

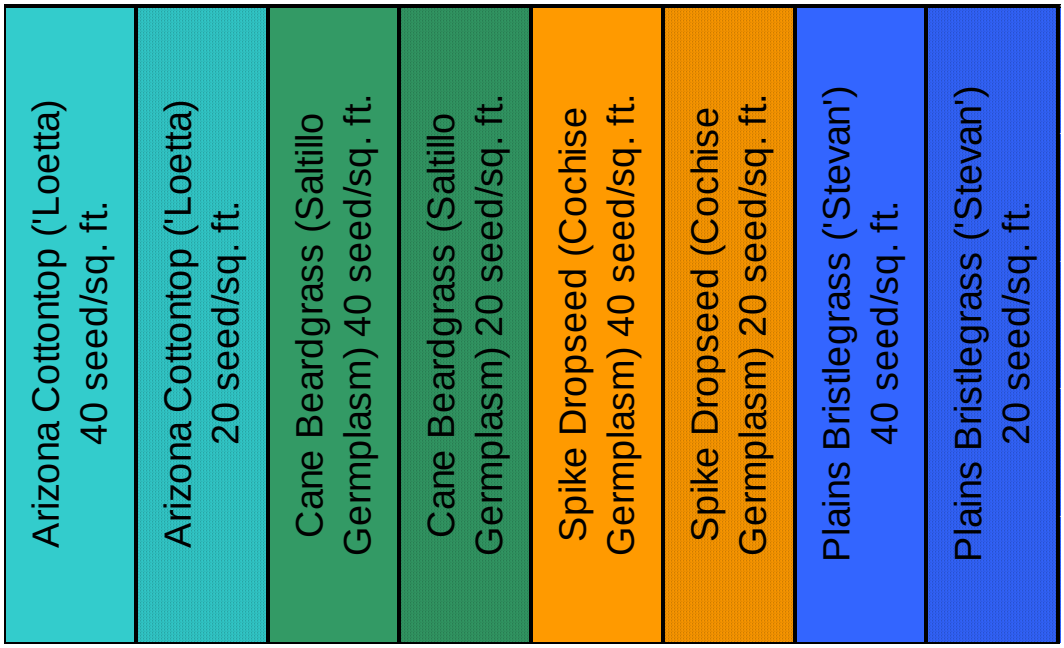
Species	1	2	3	*7	*2	*1	Weighted	% Comp
Lehmann lovegrass (*Eragrostis lehmanniana*)	75	36	12	525	72	12	609	0.61
Sprucetop grama (*Bouteloua chondrosioides*)	10	23	3	70	46	3	119	0.12
Arizona muhly (*Muhlenbergia arizonica*)	5	10	4	35	20	4	59	0.06
Blue grama (*Bouteloua gracilis*)	4	8	6	28	16	6	50	0.05
Woolystar (*Eriastrum sp.)*		8	17	0	16	17	33	0.03
Spidergrass (*Aristida ternipes*)	3	4	2	21	8	2	31	0.03
hog potato (*Hoffmannseggia glauca)*			20	0	0	20	20	0.02
Weeping lovegrass *(Eragrostis curvula)*	2	3		14	6	0	20	0.02
Cane bluestem (*Bothriochloa barbinodis*)	1		3	7	0	3	10	0.01
Sida (*Sida abutifolia*)		1	8	0	2	8	10	0.01
Purple mat (*Nama demissum*)		1	8	0	2	8	10	0.01
Wolfstail (*Lycurus phleoides*)	1	1		7	2	0	9	0.01
Arizona blue eyes (*Evolvulus arizonicus*)			4	0	0	4	4	0.00
Aster sp.			3	0	0	3	3	0.00
Rosary bean (*Rhynchosia senna)*		1	1	0	2	1	3	0.00
Sideoats grama (*Bouteloua curtipendula*)		1	1	0	2	1	3	0.00
Talinum sp.			2	0	0	2	2	0.00
silverleaf nightshade (*Solanum elaeagnifolium*)			2	0	0	2	2	0.00
ragweed (*Ambrosia cordifolia*)			1	0	0	1	1	0.00
Hairy grama (*Bouteloua hirsuta*)			1	0	0	1	1	0.00
blazing star (*Liatris sp.*)			1	0	0	1	1	0.00
matweed (*Guilleminea densa*)			1	0	0	1	1	0.00

Flying W Ranch near Winkleman, AZ (AZPMC-F-0703-CR)

The Tucson Field Office assisted with this planting in August of 2006. The site chosen for planting has been used for years for NRCS plantings. Vegetation was removed prior to planting and the 3 to 5 acre plot has been fenced to protect it from grazing. The plantings were conducted using the Truax II Seed Drill. Four AZPMC releases were tested in plots at this site at two rates, the standard rangeland rate of approximately 20 seed/ac (the rate the drill was set) and a doubled rate, where the drill was passed through the plot twice. Species planted include: 'Loetta' Arizona Cottontop (*Digitaria californica*), Pima germplasm Pima pappusgrass (*Pappophorum vaginatum*), 'Stevan' Plains bristlegrass (*Setaria leucopila*) and Cochise germplasm Spike dropseed (*Sporobolus contractus*). The 8 plots were marked with GPS and observed that fall. Visual observations immediately following the summer rains determined that Arizona cottontop at the double rate had good germination. This planting will be evaluated for persistence and species composition during the growing season of 2010.

This planting was visited August 27, 2010. It was not possible to find any persisting plants from the 2006 seeding. The landowner reported that the seedlings emerged well and survived until the following year (2007) when drought conditions were believed to have resulted in the loss of the seeding. This field planting will no longer be monitored and has been discontinued.

Plot Plan for the Flying W Ranch Seeding Trial



Sierra Vista School Planting (AZPMC-S-0802-UR)

In May 2008, the AZPMCwas invited by the Hereford Conservation District and NRCS Soil Conservationist, Art Meen, to assist Apache Middle School in Sierra Vista, AZ with a native plant demonstration. The goal was multifaceted: to enhance the school's grounds, teach the students about conservation, and provide examples of native grasses to the community as alternatives for landscaping. Placed at the entrance of the school, it is an ideal location for showcasing eight of the most common native grasses found in southeast Arizona: Blue grama, Arizona cottontop, Sideoats grama, Plains lovegrass, Pima pappusgrass, Bush muhly, Cane beardgrass, Spike dropseed and Alkali sacaton. Several teachers and staff, members of the Conservation District and thirty students participated in the planting of grass plugs into eight distinct plots, as well as seeding a mixed species plot. This planting will continue to be monitored by Art Meen.

This planting was visited in April of 2010. It continues to be well cared for and has an almost 100% survival of all plants. The planting will continued to be monitored in 2011.