United States Department of Agriculture
Natural Resources Conservation Service

Tucson Plant Materials Center
Annual Technical Report

2012

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Plant Materials Center Staff

Manuel Rosales	Manager
Heather Dial	Assistant Manager
David Forestieri	Farm Manager- Resigned May 2012
Blase Evancho	Farm Manager- Hired August 2012
Leslie Glass	Secretary and National Plant Materials Program Webmaster
Jason Allen	Biological Science Technician- Resigned January 2012
Jonathan Walther	Student Intern
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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, Mojave, and Chihuahuan desert regions. The center works in partnership with NRCS field offices, 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 2012. For further information please contact us at:

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Summary of 2012 Weather Conditions at the Tucson Plant Materials Center Tucson, Arizona

Month	Temperature (°F)		Precipitation (inches)
	Maximum	Minimum	
January	80	32	0.14
February	80	34	0.08
March	91	29	0.34
April	101	40	0.12
May	105	53	0.00
June	108	62	0.34
July	105	68	4.13
August	109	71	1.17
September	103	63	0.38
October	99	44	0.00
November	90	35	0.03
December	81	30	1.18

Frost Free Days	=	358
Days Above 100 ^{o}F	=	73
Coldest Temperature	=	29° (March 3)
Hottest Temperature	=	109° (August 12)
1st day 100 ^{o}F	=	April 22
1st day 32 (or Below) ^{o}F	=	January 9

Tucson Plant Materials Center Service Area

Tucson Plant Materials Center Studies

Development of a Sideoats Grama (Bouteloua curtipendula) Population for a Major Land Resource Area 41

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 2012
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.

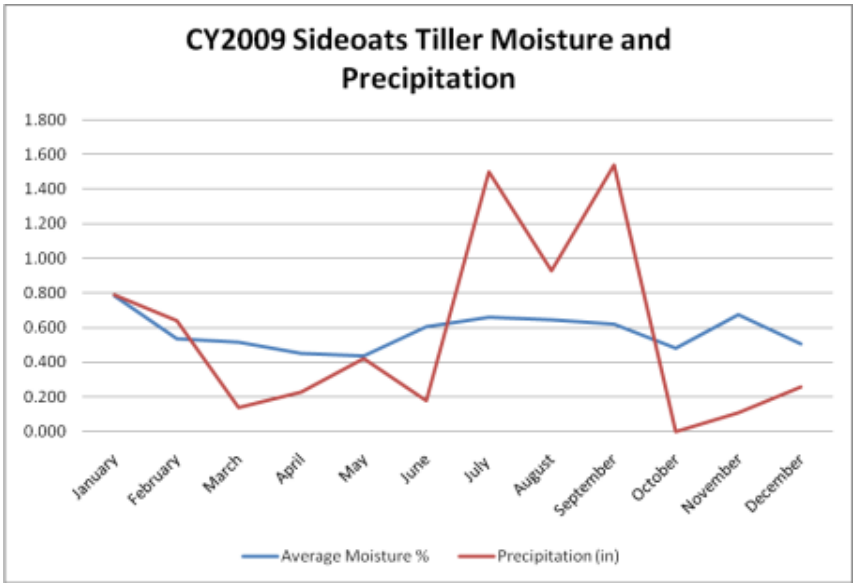
Growing season 2009:

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.

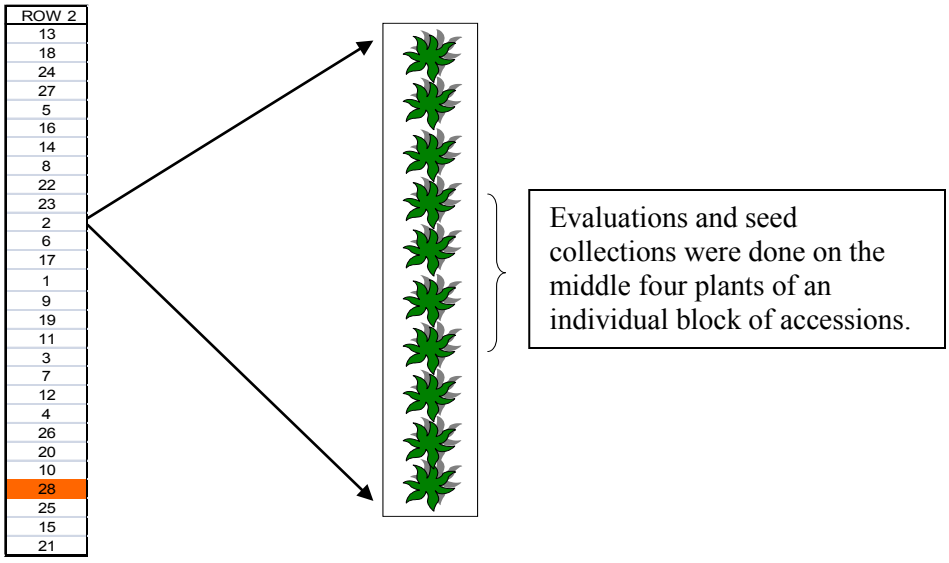
Graph of Average Tiller Moisture Percentages and Precipitation Totals for 2009



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.

Growing season 2011:

In late 2010, yellow sticky cards were placed in the border of sideoats to gauge the insect population of the field. An unusually high number of thrips (*Chirothrips spp.)* were found within the field. An insect control program was planned and implemented in May of 2011. Pyreth-it®, a highly concentrated pyrethrum insecticide, was sprayed approximately every two weeks from May until July 2011.

On July 28th and 29th, evaluations of individual accessions in replications 3, 4, 5 and 6 were conducted. Evaluations included seed harvest by accession, counting branches per panicle and noting anther color and any distinguishing characteristics of the individual accessions. 2011 seed yields were dramatically reduced when compared to the 2009 yields. It is believed that the Pyreth-it® applications were ineffective. Another insecticide spraying regimen is being developed for growing season 2012.

Growing season 2012:

On January 13, 2012 dump trucks delivering fill for the irrigation pipeline construction project drove over the western corner of the sideoats study plot. Due to the damage caused by the dump trucks, the secondary plot of the study was deemed a total loss. Replications one and two were also damaged. Efforts were made again to re-level the back half of the plot. The field received its first successful irrigation in April and the surviving plants recovered well.

Sideoats field in January 2013 after dump truck damage

In July of 2012 a systemic insecticide, Malice®, was applied to the field. There was no appreciable control of the thrips population. A harvest of the seed was accomplished in November. However, most of the harvested material was empty. A third insecticide has been selected for use during 2013.

Development of Technology for Seed Production of 'Sonora' Black Grama (Bouteloua eriopoda)

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 2012
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

Growing season 2011:

The samples collected during 2010 were processed with a Westrup Brush Machine and Office Clipper and evaluated for seed production in the winter of 2010. There was no appreciable seed found in any of the samples collected in 2010. During growing season 2011, the field was again sprayed with Pyreth-it® 5 times (5/17, 5/23, 6/1, 7/1, and 7/25), with no positive results in seed yield. A different insecticide will be applied during growing season 2012 to determine if seed yields can be increased.

Growing season 2012:

During the growing season of 2012 one application of the systemic insecticide, Malice®, was applied to the entire field and incorporated immediately with irrigation. The systemic insecticide was applied in an attempt to continue the search for a suitable insecticide for thrips control. Three 1- square meter random samples were harvested from each row on November 2. The table below presents the result of the harvest. The PMC is planning to do one more year of monitoring and application of a new insecticide during 2013, before making a decision to continue or discontinue the release of black grama.

2012 Sonora-Black Grama Harvest

Rows	***Bulk weight grams****	***Cleaned seed weight grams***	***% cleaned seed of total harvested***
1	136.1	32.97	24.2
2	113.4	24.97	22.0
3	136.1	22.56	16.6
4	90.72	20.42	22.5
5	113.4	32.98	29.1
6	113.4	13.00	11.5
Total	703.1	146.90	
Average	117.2	24.5	20.9

***** Total of 3 square meter samples

Development of Technology for Seed Production of Various Releases for First-Time Native Seed Farmers in Southern Arizona

Study ID Code	AZPMC-S-0602-CR
Title	Development of Technology for Seed Production of Various AZPMC Releases 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	Manuel Rosales, Heather Dial AZPMC
Duration	2006 through 2012
Vegetative Practices	342 Critical Area Planting 550 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 AZPMC Service 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 AZPMC would 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 AZPMC comparing 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. AZPMC releases are now developed from multiple collections across their intended region of use. Few AZPMC releases are commercially available, although the AZPMC has made an effort in recent years to work on species currently in demand. The AZPMC would 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 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 species not yet released but in development at the AZPMC have 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, AZPMC in 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

Growing season 2011:

On April 5, 2011, the AZPMC Manager, Manuel Rosales, visited the Schuk Toak Farm to evaluate the planting and to determine if the Schuck Toak Farm was still interested in proceeding with commercialization of the AZPMC releases. Rosales spoke with the farm supervisor, Brett Salvador. Brett indicated that Benito Alvarez Jr., Tohono O'odham Farming Authority, General Manager, was still interested. Rosales provided the contact information for a local native seed re-vegetation company as a possible customer for seed produced at the Shuck Toak Farm. The fields planted in 2010 were visited, and the planting is still in good condition.

Growing season 2012:

During 2012, Schuk Toak Farm hired a new farm supervisor, Fernando Valenzuela. The native grass fields of pima pappusgrass and Arizona cottontop are still viable and producing. Schuk Toak farm is still interested in growing native seed grass; however, they have yet to make a decision on how to proceed.

Development of Technology for Seed Production of Various Releases for First-Time Native Seed Farmers in California

Study ID Code	AZPMC-S-0803-CR
Title	Development of Technology for Seed Production of Various AZPMC Releases 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	343 Critical Area Planting 551 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 AZPMC Service 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 AZPMC would 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 AZPMC comparing 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. AZPMC releases are now developed from multiple collections across their intended region of use. Few AZPMC releases are commercially available, although the PMC has made an effort in recent years to work on species currently in demand. The AZPMC would 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, AZPMC in 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 to produce both Vegas germplasm alkali sacaton (*Sporobolus airoides*) and Moapa alkali muhly (*Muhlenbergia asperifolia*) seed. The plantings are part of a collaborative agreement between the PMC and the Bureau of Land Management (BLM) developed to address the need for locally adapted native plant materials for rehabilitation and restoration projects for the BLM Southern Nevada District.

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

Growing season 2011:

In mid December of 2010, approximately 28,000 plugs of Moapa germplasm alkali muhly (*Muhlenbergia asperifolia*) were seeded. In April 2011, five PMC personnel traveled to Needles, CA to plant the plugs. In addition to personnel from the Las Vegas BLM, Las Vegas High Desert RC&D and NRCS Kingman Field Office personnel were on hand to plant the alkali muhly plants. The plants established well throughout the growing season of 2011 and the first seed harvests are expected in late 2012.

PMC personnel also received and cleaned 911 bulk pounds of alkali sacaton harvested from the Needles, CA planting site during growing season 2011. The seed cleaning process included hammermilling raw material and air screen separation of hammermilled material with the Clipper Eclipse Model 324 Seed and Grain Cleaner. A table summarizing seed received and cleaned is below.

2010-2011 Harter Farms Harvests

Harter Farms SPAI #9094151	Growing Season 2010		Growing Season 2011	
received date	10-Nov-10	9-Mar-11	June	Nov
bulk pounds	230	99	394	188
cleaned pounds	101	2.6	322	87

Growing season 2012:

In July of 2012, PMC personnel received one alkali sacaton harvest from Needles, CA for cleaning. The total bulk pounds produced for this project were 1151 resulting in 696 of clean alkali sacaton seed. A summary of the alkali sacaton production is below:

2010-2012 Harter Farms Harvests

Harter Farms SPAI #9094151	**Growing Season 2010**		**Growing Season 2011**		**Growing Season 2012**
received date	10-Nov-10	9-Mar-11	Jun-11	Nov-11	Jul-12
bulk pounds	230	99	394	188	240
cleaned pounds	101	2.6	322	87	183

In November of 2012, the first harvest of alkali muhly from the Needles, CA planting site was received at the PMC for cleaning. It totaled 53 bulk pounds. The harvest was accomplished early and therefore had no viable seed.

PMC personnel also packaged and sent 216 pounds of cleaned alkali sacaton to BLM personnel in April of 2012. A summary of lot numbers and amounts shipped follows.

Cleaned alkali sacaton shipped to BLM personnel in 2012

Date packaged	2-Apr-12	2-Apr-12	2-Apr-12
Lot	SCO-10-HARTER-1	SCO-10-HARTER-2	SCO-11-HARTER-1
# bags	5 (20 lbs ea)	2	3 (40+43+30)
weight (lbs)	100	2.6	113
Total weight of seed delivered (lbs)	**215.6**		

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 per year 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	Technical note, fact sheet and internal reports.

Products

Literature Cited

1. Summers, G.H., and D.H. Putnam. 2008. Irrigated Alfalfa Management for Mediterranean and Desert Zones. University of California Agriculture and Natural Resources.
2. Tickes, B. and M. Ottman. 2008. Alfalfa Weeds Control in the Low Desert Deserts of Arizona. The University of Arizona Cooperative Extension.
3. Kemper, J. 2006. Transitioning to Organic Production. www.attra.nact.org/organic.html
4. USDA-NRCS-VT. 2007. Transition to Organic Production. Natural Resources Conservation Service Conservation Practice Standard-code 789

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 broadleaf 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

Growing season 2011:

The organic plot was treated with TeraGanix, Inc. EM-1®, a microbial inoculant soil conditioner, all season. Applications were done every other irrigation at the recommended label rate. No fertilizer or any other amendment was applied to the conventional plot. Irrigation was applied as needed resulting in a total application of approximately 4 acre foot per plot. The plots were clipped five times and mowed ten times during the growing season. Four square meter samples were hand clipped at each cutting from the conventional and organic plot. The samples were air dried and weighed. Forage yields are averaging 1.5 tons (100 % dry matter) per acre per cutting for both the conventional and organic plot. Results are presented in the following table.

2011Alfalfa forage yield in tons/acre (100% dry matter)

	Harvest Date						
	May -27	**June-28**	**Sep-1**	**Oct-18**	**Nov-23**	**Total Production**	**Average Production /Cutting**
Organic	1.34	1.72	1.62	1.30	1.54	7.52	1.50
Conventional	1.40	1.82	1.64	1.50	1.17	7.53	1.51

**All yields are an average of four replications*

Square meter before harvest

Square meter after harvest

Growing season 2012:

During the growing season of 2012, the treatments of EM-1®, a microbial inoculant soil conditioner, were continued in the organic plot. No fertilizer or any other amendment was applied to the conventional plot. The plots were harvested 4 times during 2012. Four replicates, 1 square meter in size, were sampled at each harvest date from the organic and conventional plots. Harvest results are presented in the following table.

2012 Alfalfa forage yield* in tons/acre (100% dry matter)

	Harvest Date					
	May -22	**July-20**	**Sep-19**	**Oct-12**	**Total Production**	**Average Production /Cutting**
Organic	1.16	1.64	0.97	1.03	4.8	1.2
Conventional	1.16	1.56	1.27	1.07	5.1	1.3

**All yields are an average of four replications*

Summary:

The observations and data collected during the 3 year duration of the study indicate that there are very small differences between the conventional and organic plots. The addition of EM-1® to the organic plot in our site and with the environmental conditions of this area does not merit the additional costs of the product and labor.

The overall average for the two years of production from the conventional and organic plot was 1.4 tons (100 % dry matter) per acre per cutting. The study will be discontinued in 2013.

Control of Buffelgrass (Pennisetum cilicare) at Santa Rita Experimental Range

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	344 Critical Area Planting 645 Wildlife Upland Habitat Management 543 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	• 2006 and 2007 PMC Annual Technical Reports • Financial evaluation of spray equipment

Accomplishments/Results:

The following report is a synopsis of PMC activities concerning AZPMC-T-0612-IN from 2006-2012.

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 AZPMC agreed 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 smaller patches.

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

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.

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

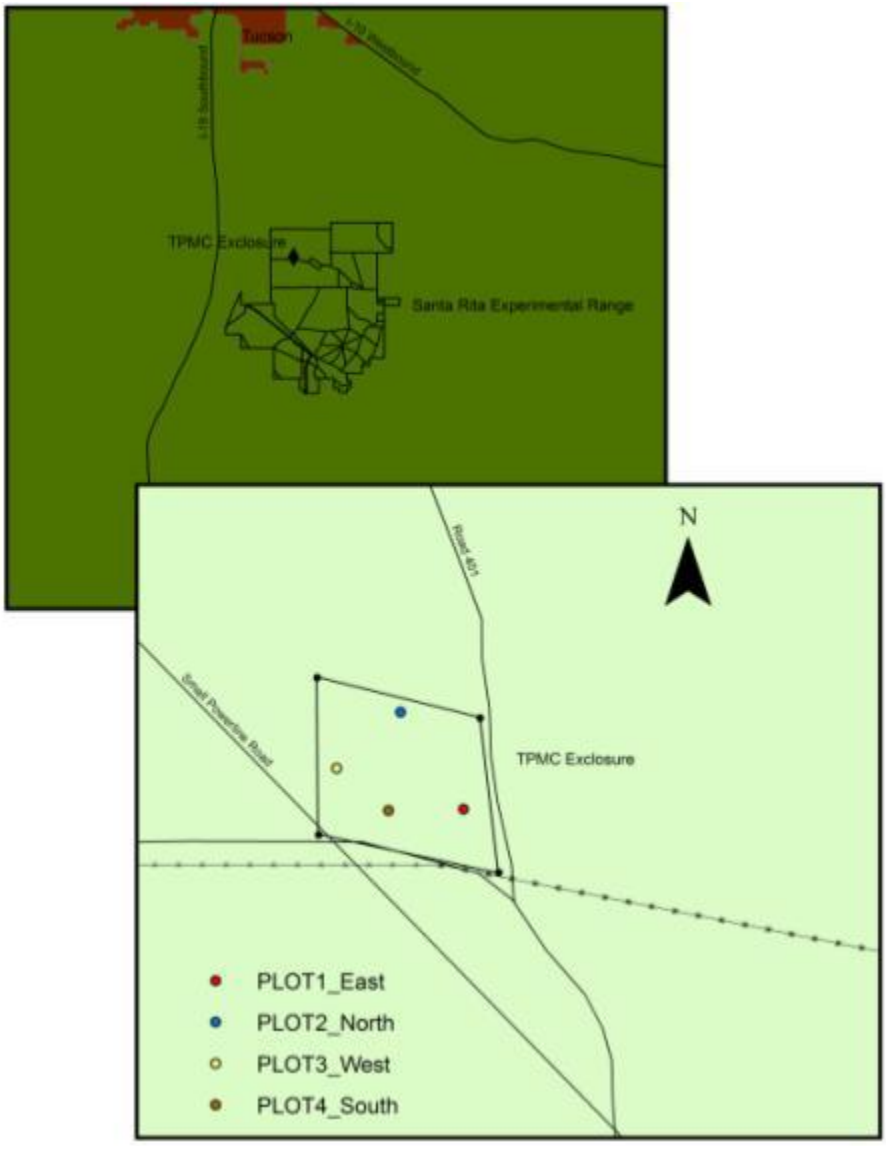
A scouting trip was conducted in April 2009 to plan for the year's control efforts. No significant "greening-up" was observed during this trip. A second trip to the site took place on June 29th. Plants were beginning to show their first growth and control efforts were scheduled for early July. A trip 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

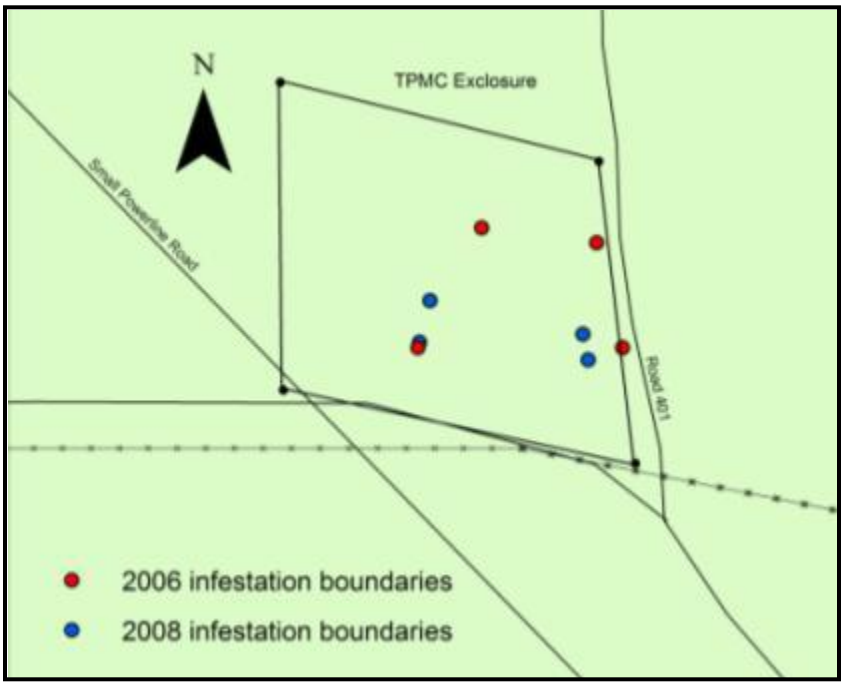
*Plot size = 20 feet X 20 feet ** Visual estimate of buffelgrass cover



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.

2011 Buffelgrass Control

A scouting trip was conducted in February 2011 to plan for the year's control efforts. There were no buffelgrass plants greening up within the exclosure. Additional site visits were made in May, July and August. During the mid-August visit, it was determined that a full spraying trip should be made as soon as possible.

On August 25th, 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 were 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 9th of September. The herbicide application appeared to be effective. Scouting, mapping, and spray treatments will continue in 2012. In addition, SRER personnel will be contacted regarding future plans for the exclosure including seeding trials involving PMC releases in development.

2012 Buffelgrass Control

On May 1, PMC personnel met with Dr. Mitch McClaran, Research Director of the Santa Rita Experimental Range, to discuss future opportunities for the exclosure. As a result, a new range use application was filed with the University of Arizona and plans were made to graze the exclosure. On June 11th, Heather Dial and Alisha Phipps of the Tucson Field Office, set up and read four 100 foot transects within the exclosure. The exclosure was then left open to cattle. As expected, the cattle did not spend much, if any time in the exclosure while in the 5Mid pasture.

The exclosure was visited again by PMC personnel on September 27. Green buffelgrass plants were spot sprayed with a 5% glyphosate solution. PMC personnel continue to work with TFO personnel, the rancher, and the University of Arizona to get cattle into the exclosure to graze the remaining buffelgrass plants.

Development of a Big Galleta (Pleuraphis rigida) Population for Major Land Resource Area 30

Study ID Code	AZPMC-P-1101-RA
Title	Development of a Big Galleta (*Pleuraphis rigida*) Population for Major Land Resource Area 30
National Project No.	Natural Areas 1.1 Rangeland 1.1 Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Population development
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial
Duration	2011 through 2016
Description	To facilitate preliminary agronomic research and development of a pre-varietal release of *Pleuraphis rigida* and assist with its transition into the commercial market
Status of Knowledge	The Bureau of Land Management (BLM) Southern Nevada District and other land managers are in need of locally adapted native plant materials for rehabilitation and restoration projects. Limited availability, coupled with the need for large quantities of seed, has forced the BLM to rely on non-native species, cultivars, seed from outside of the Mojave Desert, or do nothing at all. There is currently no commercially available germplasm of *Pleuraphis rigida.*
Experimental Design	Randomized complete block with 20 replications.
Materials & Methods	Ten populations (seven from rhizomes and three from seed) will be hand transplanted to a flood irrigated field. Rows will be approximately 38 inches apart and spacing between plants will be approximately 24 inches. A secondary and primary plot is planned. The primary plot will be composed of 20 replications of a single plant of each accession. The secondary plot is not replicated and will be composed of ten plants of each accession. Cultural practices may include mechanical and chemical weed control, fertilization, and chemical control of pests. A genetic analysis of the populations will be conducted by USDA-ARS, Forage and Range Research Laboratory at Logan, Utah. Tissue from plants established in the

	field will be sampled to conduct the genetic analysis.
Final Evaluations	A composite seed harvest from the 10 populations will be assembled as a potential release depending on the results of the genetic analysis. Data on growth parameters such as flowering date, plant height, plant spread, seed yield and seed maturity date will be collected from ten replications within the crossing block.
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.

Growing season 2011:

Out of the 10 populations collected from the Mojave Desert, seven were started from rhizomes and three from seed. Rhizomes and seed collections were received from BLM personnel in the spring of 2010. Vegetative increase of rhizomes was started in April 2010 and continued throughout the spring of 2011. Collected rhizomes were cloned by layering each accession in separate propagation flats. When sufficient root growth was obtained, rhizomes were clipped at the nodes and transferred into one gallon pots and/or other containers. Seed collections were germinated and grown in Jiffy Propagation Plugs. The plants are scheduled to be outplanted in the summer of 2012.

Big galleta populations

Population	Accession #	BLM Number	Location Description	UTM
1	9106356	Un1	Rainbow Gardens	4006436N 683983E
2	9106357	Un2	Bitter Springs	4024188N 715563E
3	9106358	361	Black Butte	4043620N 750949E
4	9106359	363	Frontage Road	4033657N 691381E
5	9106360	Un3	Jean Dry Lake	3960809N 660471E
6	9106361	Un4	Red Rock	3997525N 639552E
7	9106362	Un5	Sandy Valley	3984183N 625562E
8	9094137	*	Coyote Springs	4045659N 686292E
9	9094134	*	Piute Valley	3904828N 693755E
10	9094139	*	Lincoln	4071670N 727445E

*** Populations in yellow (8-10) were established from seed versus the other populations (1-7) which were established from vegetative cuttings (rhizomes).**

Galleta rhizomes

Galleta plugs from seed

Growing season 2012:

On August 18, 2012, the field selected for the crossing block of big galleta was roto-tilled, laser leveled and pre-irrigated in preparation for the transplants. A gas powered hand -driven auger was used to drill eight inch diameter holes for each 1 gallon transplant. The plants were hand transplanted on September 18, 2012 into a randomized complete block design. Ten populations were installed in the study. The Lincoln population was omitted from the study as it performed poorly in the greenhouse/shadehouse. Due to insufficient numbers of plants, 12 replications were planted instead of the 20 replications planned. On September 28, 2012, five populations of big galleta were hand transplanted into nursery rows in the secondary plot.

Big galleta plot plan

	Big Galleta Grass For BLM-Nevada					**Date Transplanted:**		9/18/2012
			East					
	Row-6-VII	**Row-5-V**	**Row-4-IV**	**Row-3-III**	**Row-2-II**	**Row-1/I**	Entry #	**Name**
	1	10	8	10	3	6-JEAN	1	**Bitter Springs**
	3	9	6	2	9	7-PIUTE	2	**Black Butte**
	6	4	4	4	10	4-Frontage	3	**Coyote Springs**
North	10	5	7	3	2	10-Sandy	4	**Frontage Road**
	5	1	2	8	4	5-Gold B	5	**Gold Butte**
	2	2	9	1	1	8-Rainbow	6	**Jean Dry Lake**
	7	6	1	5	6	2-Black B	7	**Piute**
	9	7	3	9	5	1-Bitter S	8	**Rainbow**
	8	8	10	6	7	9- Red rock	9	**Red Rock**
	4	3	5	7	8	3-Coyote	10	**Sandy Valley**
Alley	**XII**	**XI**	**X**	**IX**	**VIII**	**VII**		
	1	6	10	6	4	6		
	10	7	8	5	7	3		Lincoln was
	5	8	1	8	9	8		not planted
	6	3	3	2	6	1		in crossing block
	2	9	9	9	3	9		
	4	5	7	1	8	4		
	3	1	4	4	10	2		
	9	2	6	7	2	7		
	8	4	5	3	5	5		
	7	10	2	10	1	10		

Development of Technology for the Establishment of Bush Muhly (Muhlenbergia porteri) With Hay Bales

Study ID Code	AZPMC-T-0502-CR
Title	Development of Technology for the Establishment of Bush Muhly (*Muhlenbergia porteri*) With Hay Bales
National Project No.	Natural Areas 1.1 Rangeland 1.1 Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Technology
Study Status	Active
Location	AZPMC
Study Leaders	Heather Dial, Manuel Rosales
Duration	2005-2015
Description	Research and study to aid in the development of technology to establish bush muhly from hay bales rather than seeding. Evaluation of the performance of bush muhly releases in both MLRA 40 and 41.
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 may in part be due to the difficulties encountered in the bush muhly seed cleaning process.
Experimental Design	Replicated plots representing various application rates (pounds/acre) depending upon the size available for the planting and hay bale quantities.
Materials & Methods	There are currently two bush muhly releases in development at the TPMC; one for MLRA 40 and the other for MLRA 41. Both of these research plots will be cut and baled at least once per growing season. Potential field planting locations will be identified and selected with the assistance of field office personnel within the TPMC service area. When a location is identified, a field planting of bush muhly will be established using hay bales. Bush muhly hay bales will be applied to plots representing both MLRA 40 and 41at varying rates with either a mulcher and/or flaked out over a set area and crimped in. Evaluations will be conducted annually for up to five years to determine the emergence and persistence of bush muhly using this method. The plots will also be evaluated to determine whether or not a particular bush muhly pre-release performs better in one location versus another.

Final Evaluations Data from at least three field planting locations across the TPMC service area will be compiled to determine whether or not bush muhly can be successfully established with bush muhly hay bales and at what application rates prove most efficient. Collected data will also be used to determine whether MLRA specific releases of bush muhly provide any appreciable advantage.

Technology Transfer Products Technical notes, Updated Plant Guides

Literature Cited

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Accomplishments/Results:

Growing season 2011:

The identification of appropriate field planting locations within the TPMC service area proved difficult during growing season 2011. A potential field planting plan was developed for land near Chandler, AZ but as the land was unable to be protected from grazing, the field planting was not accomplished. The planting plan developed for the site is below. This plan will be used in future field trials.

Bush muhly trials plot plan

<table>
<tr><td>0.10 acre ~200 lbs of MUPO (41)= ~2000 lbs/acre</td><td rowspan="2">TRIAL 1 = 0.20 acres MLRA 40 vs MLRA 41</td></tr>
<tr><td>0.10 acre ~200 lbs of MUPO (40) = ~2000 lbs/acre</td></tr>
<tr><td>0.15 acre ~600 lbs of MUPO = 4000 lbs/acre</td><td rowspan="2">TRIAL 2 = 0.3 acres varying pounds/acre</td></tr>
<tr><td>0.15 acre ~300 lbs of MUPO = 2000 lbs/acre</td></tr>
</table>

Growing season 2012:

In February of 2012, PMC personnel visited The Nature Conservancy's San Pedro River Reserve (SPRR) to provide technical assistance and to evaluate potential field planting locations. The SPRR is located in Dudleyville, AZ. We visited a site on the reserve that would be ideal for conducting a field planting of bush muhly. The land owners were willing to sign a field planting agreement and work with the TFO and PMC personnel for at least 5 years of monitoring.

On June 12th, Heather Dial and Katie Cline, Tucson Field Office, met with the land owner and discussed the planting site. The NRCS-ECS-9, Planting Plan for Field, Special and Increase Plantings was completed. On August 6th, the planting was established. Four separate plots were setup on the land using the aforementioned plot plan. Hay bales were flaked out over the plots at the specified rates. After the bales were distributed, the land owner used a cultipacker to crimp the lose material into the soil. The planting will be evaluated for the next five years.

A joint ARS-NRCS effort to collect plant attribute data on
western grazing lands to support ALMANAC and CEAP

A Pilot Project of the NRCS Plant Materials Program
June 2009

Agency Context

NRCS initiated the Conservation Effects Assessment Project (CEAP) in 2003 with the intent to develop science supported methodologies that will allow NRCS to better estimate environmental benefits and effects attributable to NRCS conservation practices. Following discussions in 2006, CEAP efforts were expanded to go beyond estimating effects of practices to include developing new or improved tools and methodologies to enhance the effectiveness of conservation planning in meeting environmental goals. One of the specific objectives identified for CEAP is "reduce uncertainty in model estimates of conservation benefits" (Maresch et. al., 2008) which is the thrust of this proposal.

To assess the environmental benefits and effects of grazing lands practices the Rangeland Hydrology and Erosion Model (RHEM) is being developed as the tool to measure impacts and benefits of grazing lands practices (prescribed grazing; prescribed burning; brush management; rangeland seeding; pest management) within the CEAP. A model known as ALMANAC (Agricultural Land Management Alternative with Numerical Assessment Criteria) is an important component of RHEM. Plant communities represented by functional plant groups (short grass, tall grass, shrub, etc.) and their biophysical outputs (canopy cover, plant height, standing biomass, root distribution and mass, ground cover, etc.) (Weltz et. al., 2008) are the major drivers of the ALMANAC model and are key to accurate predictions of effects and ultimately better up-front conservation planning. The biophysical component requires attribute data over the many ecological zones found throughout the United States, at the Ecological Site Descriptions (ESD) scale, to be efficient and accurate.

In addition to providing good data to measure conservation practice impacts through CEAP, the field scale ALMANAC model could prove useful to NRCS field office staff, providing improved estimates of forage availability, potential wildfire fuel loads, and wildlife habitat suitability, as well as erosion potential on ecological sites. The data provided for use in the ALMANAC model is also expected to be of value in other modeling efforts such as SWAT (Soil and Water Assessment Tool), WEPS (Wind Erosion Prediction System) and assessment efforts such as those required in the Soil and Water Resources Conservation Act (RCA) of 1977.

Rationale for National Plant Materials Program Effort

The national network of 27 Plant Materials Centers (PMCs) are uniquely suited to undertake studies to measure and quantify plant growth parameters of various herbaceous and woody plant materials for various soil, plant, and water models due to having many of the desired species already growing at our facilities, a trained technical staff, and the ability to implement and complete these studies across a wide geographic area in a relatively short time. The Plant Materials Program has been collecting similar plant growth attributes of grasses, forbs, legume and woody plants through its network of PMCs to support conservation plant releases for over 70 years. By increasing the number of measured plant parameters, conservation planning

tools or models developed by the ARS can improve the accuracy and predictability of the conservation effects of conservation practices applied by NRCS through Farm Bill programs.

Initial efforts covered by this proposal are focused on the arid and semi-arid inter-mountain portions of the west, but it is anticipated that the project will be expanded. For the Plant Materials Program, this proposal represents a pilot effort to utilize the nationwide network of PMCs to directly contribute to improving NRCS technical vegetative recommendations and support the effects of conservation activities. It is proposed that PMCs located within the arid west 1) obtain data from existing plots where feasible and, 2) install new 3-5 year studies as required to collect accurate plant data. Plant growth parameter data would be provided to ARS staff in Temple, TX for inclusion in the ALMANAC model. PMCs located in Arizona, New Mexico, Nevada, Washington, Idaho, California, Colorado, and Montana are expected to participate.

Proposed Plant Materials Program Activities

PMCs will collect data using the following ARS protocols (Kiniry, 2009), summarized below, for selected species:

-Utilize existing fields or stands of grasses, legumes, forbs, and shrubs when possible:
-Subdivide field into irrigated and non-irrigated block (if feasible)
-Establish 4 replicated blocks in each subplot from which the following data will be obtained:
-Record date of growth initiation
-Record Leaf Area Index at 2 week intervals until 100% canopy closure. (Decagon ceptometer)
-Harvest biomass and obtain weights at specific plant growth stages
-Prepare and send tissue or biomass samples to ARS for wet chemistry analyses.
-Obtain and transmit weather data (temperature, solar radiation, and precip).

New plots as needed would be established to allow the same degree of data collection as described above which would begin in the second growing season.

Selected PMCs may undertake studies to determine effectiveness of remote photography to measure plant growth rates.

Time Line

May 2009: Basic needs, protocols, and equipment requirements identified
June 2009: ARS convene joint meeting with grazing lands experts and PM Representative to identify species to be measured.
June 2009: Equipment purchased
Summer 2009: PMC staff trained in protocols
Summer 2009 – 2011: Implement protocols

References

Kiniry, Jim. 2009. Personal communication. USDA Agricultural Research Service. Temple, Texas.

Maresch, Wayne, Mark Walbridge, and Daniel Kugler. 2008. *Enhancing conservation on agricultural landscapes: a new direction for the Conservation Effects Assessment Project*. Journal of Soil and Water Conservation. 63(6):198A-203A.

Weltz, Mark, Leonard Jolley, Mark Nearing, et.al. 2008. *Assessing the benefits of grazing land conservation practices.* Journal of Soil and Water Conservation. 63(6):214A-217A.

Accomplishments/Results:

Growing season 2011:

During growing season 2011, Leaf Area Index (LAI) data, clippings and photos of two AZPMC releases, 'Loetta' Arizona cottontop and Moapa Alkali muhly, were collected in support of CEAP. Data was submitted to ARS staff in Temple, TX for inclusion in the ALMANAC model. Additionally, AZPMC staff were responsible for grinding all cuttings from other participating PMCs and forwarding them to NYPMC for processing.

Growing season 2012:

Samples were not taken from AZPMC releases in support of the CEAP during 2012. However, samples from other PMCs were ground at AZPMC and forwarded to NYPMC for processing. 2012 is the last year of this project.

Development of Technology for Containerized Agave (Agave palmeri) Production

Study ID Code	AZPMC-T-0901-CR
Title	Development of Technology for Containerized *Agave palmeri* Production
National Project No.	Natural Areas 1.1
Study Type	Technology study
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales and, Heather Dial AZPMC
Duration	2009 to 2013
Vegetative Practices	345 Critical Area Planting 544 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management
Description	*Agave palmeri* belongs to the Agavaceae family. This family is characterized by succulent or semi-succulent leaves that form rosettes. These rosettes can range in size from a few inches to several feet in diameter. In *A. palmeri* the rosettes can be up to 3 feet tall by 4 feet wide. The leaves are lance shaped, about 2 feet long by 4 inches wide, with a terminal spine at the leaf tip up to 2 inches long. The flower stalk can range from 10 to 18 feet in height. Flowers are greenish yellow and clustered at the ends of the lateral branches. Full bloom usually occurs in midsummer.
Status of Knowledge	*Agave palmeri* is found on rocky hillsides and mesas in the Sonoran Desert zone from Southeastern Arizona into adjacent New Mexico and southward into Sonora, Mexico. *A. palmeri* has been reported in the literature with the common name "Palmer's Century Plant". This name implies that the plant life span is 100 years; however, the plant life span can range from 5-25 years. Agaves (including *A. palmeri)* are monocarpic, meaning that the plant flowers once and then dies. Most agaves have been used as sources of food, fences, rope, medicine, and liquor. Two species of bats, the lesser long nose bat *(Leptonycteris yerbabuenae)* and the Mexican long tongued bat (*Choeronycteris mexicana*) rely on the agave nectar on their migration route from Mexico to the Sonoran desert. A. palmeri can reproduce by offsets (commonly called pups) or by seeds. Limited information is found in the literature regarding *Agave palmeri* propagation under nursery conditions. This study was designed to collect information on the culture and propagation of A. *palmeri* from seed, under nursery conditions, in the initial 3 years of growth and development.
Experimental Design	Randomized complete block with 3 replications

Materials & Methods

A greenhouse /shade house study was initiated in July 2009 in cooperation with the Coronado National Memorial. Seed collected by the Memorial will be germinated and transplanted to 45 in^3 wax containers. Containers will then be placed in trays holding 16 plants each. Three trays will be used to conduct the experiment. Each tray will serve as a replication and treatments (plants) will be assigned to each tray at random. Data will be collected from each plant at weekly or monthly intervals, depending on growth rate. Growth parameters such as rosette diameter, color of leaves, and other pertinent data associated with the culture of the plants will be recorded. Additional observational trials such as growing medias, watering schedules, pest control, etc., will be conducted to complement the data gathered from the growth rate study.

Final Evaluations

The total growth of the agave rosettes will be taken at the end of the experiment. The irrigation schedules, fertilizers applied, and pesticides used during this period will be recorded and evaluated.

Technology Transfer Products

Technical reports, growing protocols, and popular journal article.

Literature Cited

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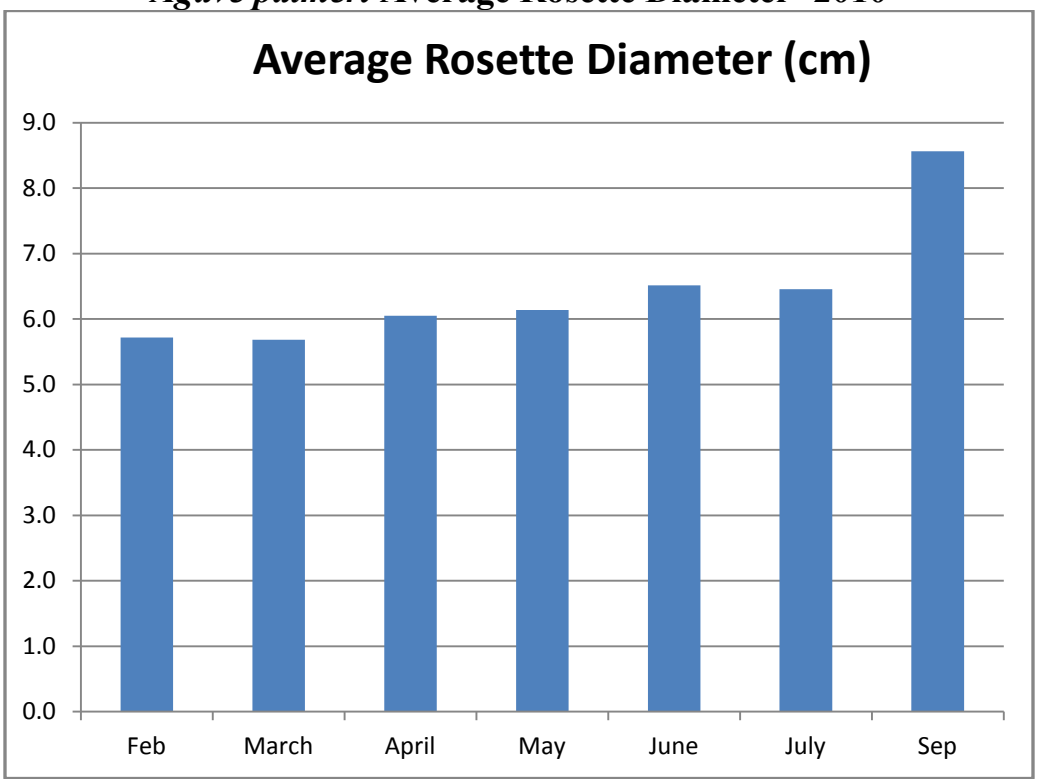
Accomplishments/Results

Growing seasons of 2010-2011:

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 -2010**



These results indicate that *Agave palmeri* has an increased growth rate in the summer months when temperatures are above 90 F^0.

Agave palmeri grew faster in its second year and doubled its root mass (see pictures below). Plants initiated production of pups and increased the number of leaves from 6 the first year to 14 at the end of the second year. The average rosette diameter at the end of two years was 3.3 inches. Twelve of the two-year plants were transplanted into one-gallon containers to measure stem collar growth during the third year of growth.

A one year old agave plant in 2010

A two year old agave plant in 2011

Other observations:

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 determine the optimum watering frequency for growth. 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 ten minute watering per day per week provided sufficient water for plant growth and reduced the fungus gnat infestation

Growing season 2012:

The twelve two-year old plants that were grown in 3" X 5" containers were transplanted into one-gallon containers on April 29, 2011. They were evaluated January 30, 2013 (20 months after being transplanted into 1-gallon containers). These agave plants averaged 8.6 inches in rosette diameter, 2.1 inches collar stem diameter and 20 leaves per plant. Below are pictures of the results.

Figure A. One gallon- three-year agave plants

Figure B. Agave rosette diameter

Figure C. Agave rosette height

Figure D. Agave roots and pups

Development of Technology for Production of Nine Mojave Desert Forbs and Shrubs: BLM National

Study ID Code	AZPMC-T-1001-RA
Title	Development of Technology for Production of Nine Mojave Desert Forbs and Shrubs
National Project No.	Natural Areas 1.1
Study Type	Technology study
Study Status	Active
Location	AZPMC
Study Leaders	Manuel Rosales, Heather Dial
Duration	2010 to 2015
Vegetative Practices	346 Critical Area Planting 552 Range Seeding 545 Land Reclamation, Abandoned Mine Land 645 Wildlife Upland Habitat Management
Objective:	Preliminary research and development for the production of priority species beneficial to the Bureau of Land Management (BLM) and other land mangers for pre-varietal release into the commercial market.
Status of Knowledge	BLM and other land managers are in need of native species for restoration in the Desert Southwest. The availability of desired species in the commercial market is negligible. When available species are found in the market, they are extremely expensive, and the source of origin is unknown. The NRCS and BLM will conduct studies to determine the potential for commercialization of various priority species (grasses, forbs, shrubs) under agronomic conditions, as well as to develop propagation/establishment protocols to improve the availability and use of native species in the commercial market for restoration purposes.
Experimental Design	Observational screening trials
Materials & Methods	Nine native species: *Encelia virginensis*, *Camissonia brevipes* Subsp. Brevipes, *Eriogonum fasciculatum*, *Eriogonum wrightii*, *Eriogonum wrightii* var. Subscaposum, *Malacothrix glabrata, Colegyne ramosissima, Baileya multiradiata* and *Sphaeralcea ambigua*, were selected for this study. Due to the small amount of seed available, preliminary germination tests will be conducted to determine the viability of the seed (seed source: BLM Seeds of Success germplasm program) and to determine the best germination protocol for each species..After a suitable amount of seed has been germinated, seedlings will be transferred into individual plugs/containers for mechanical transplanting into TPMC fields. A target of 200 plants of each species of each species will be transplanted into a flood irrigated field. The plants will be transplanted in nursery rows, spaced at 38 inches between the rows and 24 inches between each plant within the row. A 5 ft buffer will be left between each species. The buffer will facilitate mechanical harvest and minimize seed mixing between species. The buffer will also facilitate application of pesticides or herbicides per species. The species will be harvested mechanically using the Woodward Flail-Vac seed stripper, a plot combine (Massey Ferguson MX-8) , a hand-held vacuum or hand

harvested

Final Evaluations

Survivability of plants after transplanting will be recorded. Growth parameters such as flowering date, seed maturity date, height & spread of plant and seed yield will be evaluated for each species. Incidence of pests and diseases will be monitored and recorded. Applicability of mechanical harvest for each species will also be evaluated. Methods to process the seed after harvesting will also be evaluated and recorded. Seed quality after harvest will be determined by a qualified lab and documented. Any other criteria that will help in determining the feasibility of each species as potential candidates for commercialization will be evaluated.

Technology Transfer Products

Planting guide, internal reports, and commercial grower information (planting requirements, yield and number of years of production).

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Accomplishments/Results

Growing season 2010-2012:

A report summarizing the work done on this project follows:

INTRODUCTION:

The United States Department of the Interior Bureau of Land Management (BLM) and the Natural Resources Conservation Service Tucson Plant Materials Center (TPMC) are collaborating on the development of native plant materials for use in the Mojave Desert. This report is for work conducted during Fiscal Years 2010-2012.

OBJECTIVE:

We are conducting preliminary research and development for the production of species beneficial to the BLM and other land managers for pre-varietal release into the commercial market.

BACKGROUND:

Ecosystems in the Mojave Desert are increasingly challenged by a number of factors including frequent fire cycles, invasive species, energy development projects, and climate change. The BLM and other land managers are in need of native seed and technology to rehabilitate areas affected by these and other factors. Currently, reliable commercial availability of affordable, genetically appropriate native seed is negligible.

The BLM has recognized this fact and leads the interagency Native Plant Materials Development Program (NPMDP) in response. The TPMC is working in collaboration with the BLM through the NPMDP to study the biological growth, developmental characteristics, and potential for agronomic production of seed from species native to the Mojave Desert.

MATERIALS & METHODS:

Nine native species: *Encelia virginensis*, *Baileya multiradiata*, *Camissonia brevipes* subsp. *brevipes*, *Coleogyne ramosissima*, *Eriogonum fasciculatum*, *Eriogonum wrightii*, *Eriogonum wrightii* var. *subscaposum*, *Malacothrix glabrata* and *Sphaeralcea ambigua*, were selected for this study. The selection was based upon BLM personnel input and the current seed inventory of the Seeds of Success (SoS) germplasm program. Small quantities of seed of each species were received at the TPMC in March 2010 from SoS (table 1).

Table 1: Seed received at the TPMC in March 2010 through the Seeds of Success Program

Species	ID	weight (g)	received from	Additional ID
Baileya multiradiata	AZ-930-0068; 257402	1.40	ARS North Central Regional Plant Introduction Station	Ames 29879, lot # 09ncwo01
Encelia virginensis	ENVI-SOSAZ-930-256-08	9.08	USFS Bend Seed Extractory	SOSAZ-93008-18
Eriogonum fasciculatum	AZ930-252	2.10	USFS Bend Seed Extractory	W6 35316
Coleogyne ramosissima	NV052-178-R	33.00	USFS Bend Seed Extractory	W6 35376
Sphaeralcea ambigua	SOSAZ-93004-05	4.54	USFS Bend Seed Extractory	SPAM2-SOSAZ-930-0015R-04
Camissonia brevipes	SOSAZ-93005-02	1.41	USFS Bend Seed Extractory	W6 32525
Malacothrix glabrata	264918	1.20	USFS Bend Seed Extractory	W6 30818
Eriogonum wrightii	278065	2.12	USFS Bend Seed Extractory	W6 30992
Eriogonum wrightii var. subcaposum	234454	3.55	USFS Bend Seed Extractory	W6 30333

Preliminary research and germination tests on all nine species were conducted to determine the viability of seed and the best protocols to germinate the individual species during the months of May and June in 2010 (table 2). Of the nine species, sufficient quantities of three species (*Encelia virginensis*, *Eriogonum fasciculatum*, and *Sphaeralcea ambigua*) survived and developed sufficient growth to be outplanted.

Table 2: Germination trials and results conducted in 2010 at the TPMC

Species	Date started	Protocol	Date of germination	Percentage germination
Baileya multiradiata	17-Jun-10	400 seeds placed in moist soil (peat/perlite mix), placed in Hoffman germinator at 60°F	25-Jun-10	11%
Camissonia brevipes	17-Jun-10	400 seeds placed in moist soil (peat/perlite mix), placed in Hoffman germinator at 60°F	24-Jun-10	3%
Malacothrix glabrata	17-Jun-10	400 seeds placed in moist soil (peat/perlite mix), placed in Hoffman germinator at 60°F	22-Jun-10	3%
Sphaeralcea ambigua	27-May-10	400 seeds added to boiling water, soaked for 1 hour, seed transferred to moist soil (peat/perlite mix) and placed in greenhouse	2-Jun-10	4%
Coleogyne ramosissima	27-May-10	400 seeds placed in moist soil (peat/perlite mix), placed in Hoffman germinator at 60°F	11-Jun-10	50%
Encelia virginensis	27-May-10	100 seeds placed in moist soil (peat/perlite mix) and placed in greenhouse	27-May-10	53%
Eriogonum fasciculatum	27-May-10	100 seeds place in moist soil (peat/perlite mix) at 40°F	2-Jun-10	75%
Eriogonum wrightii	27-May-10	200 seeds place in moist soil (peat/perlite mix) at 40°F	2-Jun-10	9%

In mid October 2010, the field selected for the outplanting was roto-tilled, laser leveled and pre-irrigated in preparation for planting. The soils within the field are classified as Comoro sandy loam. On November 10, 2010, varying numbers of plants of each species were transplanted into nursery rows using a Holland mechanical transplanter. Within row spacing was 24 inches from plant to plant while rows were planted 40 inches apart. Individual species were separated from one another within the field by five feet. The five feet between individual species was planted to alfalfa using a drill seeder. The field was irrigated immediately after transplanting and once more in 2010 for a total application of 0.049 acre feet of water. Weed control was accomplished with hand hoeing.

Figure 1: *Sphaeralcea ambigua*

Figure 2: *Eriogonum fasciculatum*

Figure 3: *Encelia virginensis*

Figure 4: Overview of nursery rows of *Sphaeralcea ambigua* in November 2010, 40" spacing between rows

In 2011, the observational rows progressed well. Irrigation frequency was approximately once per month (0.007 acre feet/application) for a total of approximately 0.10 acre feet of water applied during the year. The field was fertilized once in early May with ammonium sulfate at a rate of 20 pounds of nitrogen per acre. Weed control during 2011 was primarily done with mechanical cultivation, rouging and with spot spraying of 2, 4-D. In late fall (November), a pre-emergent herbicide (oryzalin) was applied at a rate of 100 pounds per acre.
Growth data was collected in September 2011 from six randomly selected plants within the

Figure 5: Observational rows in May 2011. L-R, *Sphaeralcea ambigua, Eriogonum fasciculatum, Encelia virginensis*

observational rows (table 3). *Encelia virginensis* showed the best survival and growth rates out of the three species.

Table 3: Growth data collected from observational rows in September 2011

Sphaeralcea ambigua		***Eriogonum fasciculatum***		***Encelia virginensis***	
transplanted	105	transplanted	92	transplanted	59
survived	75	survived	46	survived	47
survival rate	71%	survival rate	50%	survival rate	80%
Height (in)	**Spread (in)**	**Height (in)**	**Spread (in)**	**Height (in)**	**Spread (in)**
19	41	15	24	26	42
17	30	13	16	23	42
18	30	10	14	17	33
19	35	14	13	22	35
23	34	17	18	23	36
23	28	16	15	21	34
Average height and spread (in)		**Average height and spread (in)**		**Average height and spread (in)**	
20	33	14	17	22	37

Figure 6: *Encelia virginensis* in September 2011

Harvesting trials of seed also began in 2011 and continued into 2012 (table 4). A small hand held vacuum unit, the ECHO ES-250 Shred 'N' Vac, was purchased in 2011 to conduct preliminary evaluations of the efficiency and capability of vacuum harvesting seed from these three species. Vacuum harvests significantly decreased the man hours needed for seed collection. *Encelia virginensis* proved to have the greatest and most consistent seed production during the harvesting trials.

Table 4: Harvesting data collected from observational rows 2011- fall 2012

Accession	Species	Date Harvested	Harvest Method	Man hours	Bulk weight (g)	Cleaned weight (g)	Percent trash	Cleaning Method	bulk pounds	Harvest area (acres)	Bulk Harvest/acre
9106375	*Sphaeralcea ambigua*	10/24/2011	hand/clipped	1.00	9.56	2.39	25%	rubbing board/blower	0.02	0.011	1.91
		12/20/2011	hand	0.75	235.00	45.76	19%	rubbing board/blower	0.52	0.011	47.06
		3/2/2012	hand	0.75	15.70	4.2	27%	rubbing board/blower	0.03	0.011	3.14
		10/1/2012	hand	1.00	99.95	14.69	15%	rubbing board/blower	0.22	0.011	20.01
			Totals	**3.5**	**360.21**	**67.04**	**19%**		**0.79**	**0.011**	**72.13**
9106374	*Eriogonum fasciculatum*	3/8/2012	hand	0.50	70.15	24.57	35%	hammermill/ blower	0.15	0.011	14.05
		6/18/2012	hand/clipped	1.00	298.56	N/A*			0.66	0.011	59.78
		6/18/2012	vacuum/ground	1.00	228.53	41.16	18%	hammermill/ blower	0.50	0.011	45.76
			Totals	**2.50**	**597.24**	**65.73**	**11%**		**1.32**	**0.011**	**119.59**
9106373	*Encelia virginensis*	10/24/2011	hand/clipped	1.00	548.52	103.55	19%	rubbing board/blower	1.21	0.009	134.24
		10/28/2011	vacuum	0.08	32.00	5.57	17%	rubbing board/blower	0.07	0.009	7.83
		11/4/2011	hand/pulled	1.50	169.50	76.98	45%	rubbing board/blower	0.37	0.009	41.48
		11/9/2011	hand	1.00	155.63	67.77	44%	rubbing board/blower	0.34	0.009	38.09
		11/18/2011	hand	1.50	466.24	199.94	43%	rubbing board/blower	1.03	0.009	114.11
		12/20/2011	hand	1.00	133.24	25.74	19%	rubbing board/blower	0.29	0.009	32.61
			Totals	**6.08**	**1505.13**	**479.55**	**32%**		**3.32**	**0.009**	**368.36**

Figure 7: *Encelia virginensis* hand harvested seed

In mid October 2011, the TPMC developed a new statement of work for this project (attachment 1) that was approved by BLM personnel in January of 2012. The statement of work outlined three tasks. Task one in the statement of work consisted of the establishment of production fields of *Sphaeralcea ambigua, Eriogonum fasciculatum and Encelia virginensis* in order to evaluate the use of large commercially available harvesting equipment. In June of 2012, seed from the 24 October 2011 harvest of *Encelia virginensis* was used to produce transplants for the establishment of an approximately 0.25 acre increase field. Additional increase fields for the remaining two species will be established in 2013.

The field selected for the *Encelia virginensis* increase is of the same soil type as the observational nursery rows field: Comoro sandy loam. In early September 2012, the field was roto-tilled, laser leveled and an application of pre-emergent herbicide (oryzalin) at a rate of 150 pounds per acre was irrigated in to prepare for planting. The field was established on September 24th. Within row spacing was 24 inches from plant to plant. Rows were planted 80 inches apart to allow for the use of various harvesting equipment per row. The field was irrigated immediately after establishment and weekly for three weeks. As of October 2012, 0.40 acre feet of water has been applied to the field (approximately 0.10 acre feet per application). The first harvesting trials with commercially available harvesting equipment (Woodward Flail-Vac and the Massey Ferguson MX-8 plot combine) will be conducted in the spring of 2013.

Figure 8: *Encelia virginensis* seedlings in August 2012

Task two in the 2011 statement of work defined work to be done with some of the remaining species of the originally selected nine: *Camissonia brevipes* subsp. *brevipes*, *Eriogonum wrightii*, *Eriogonum wrightii* var. *subscaposum*, and *Malacothrix glabrata.*

Seed of these species was germination tested in 2010 at the TPMC with poor results. Very small quantities of the seed originally received in 2010 still remained at the TPMC. Additional germination and propagation trials with this seed were started in February of 2012 (table 5). A Hoffman Manufacturing, Inc. SG30 controlled environment germination chamber had been

purchased by the TPMC in 2011 and was used to conduct the trials. Individual seeds per species were not counted. Therefore, individual germination percentage rates were not calculated. However, germination results using this protocol were successful. On the 28th of February, the germinated seedlings were transplanted and grown successfully in the greenhouse/lathhouse until June. During a weekend in mid-June 2012, the automatic watering system in the lathhouse had an electrical failure and all of the plants originally germinated in February were killed.

Table 5: Germination trials conducted in 2012 at the TPMC

Species	Date started	Protocol	Date of germination	# of plants grown
Camissonia brevipes	14-Feb-12	Seeds were scattered on top of a moist 1:1 peat/perlite mix. Cabinet settings: alternating between 12 hours of light at a temperature of 77°F and 12 hours of dark at a temperature of 68°F	17-Feb-12	14
Malacothrix glabrata	14-Feb-12		17-Feb-12	40
Eriogonum wrightii	14-Feb-12		16-Feb-12	120
Eriogonum wrightii var. *subscaposum*	14-Feb-12		21-Feb-12	40

Figure 9: *Malacothrix glabrata* seedlings, February 2012

Additional seed of these species was requested from the SoS program and received at the TPMC in April of 2012 (table 6). In September of 2012, germination trials were resumed with the newly received seed. Assuming the new seed collections produce sufficient quantities of transplantable individuals, observational nursery rows will be established at the TPMC in the summer of 2013. Data and seed will be collected from these rows. If the rows produce enough viable seed, larger plots of each species will be established in 2014 from harvested seed. Large scale harvesting trials, similar to those planned for the *Sphaeralcea ambigua, Eriogonum fasciculatum, and Encelia virginensis* could then be conducted.

Table 6: Seed received at the TPMC in April 2012 in support of task two

Species	ID	weight (g)	received from	Additional ID
Camissonia brevipes	CABR23-SOS-CA930A-35-10	0.78	ARS West Regional Plant Introduction Station	W6 39556
	CABR23-SOSAZ-930-0045R-05	0.97	ARS West Regional Plant Introduction Station	W6 32525
	CABR23-SOS-CA930A-69-10	0.62	ARS West Regional Plant Introduction Station	W6 39557
	BMP-06	0.13	ARS West Regional Plant Introduction Station	W6 29954
Malacothrix glabrata	MAGL3-SOS-ID931-282-11	0.50	ARS West Regional Plant Introduction Station	W6 43567
	NV030-107	0.39	ARS West Regional Plant Introduction Station	W6 30818
	MAGL3-SOS-ID931-105-09	0.40	ARS West Regional Plant Introduction Station	W6 37482
	MAGL3-SOS-CA930C-4-10	0.22	ARS West Regional Plant Introduction Station	W6 41331
Eriogonum wrightii var. subcaposum	ERWRS-SOS-NV030-528-10	0.24	ARS West Regional Plant Introduction Station	W6 43111

Task three in the 2011 statement of work outlined potential options for the last two species out of the original nine, *Baileya multiradiata,* and *Coleogyne ramosissima*. Task three was originally rejected by BLM personnel due to concerns of duplicated work in the case of *Baileya multiradiata* and in the case of *Coleogyne ramosissima* and its slow growth, difficulty in influencing the commercial seed industry to produce seed.

An alternative task three was developed and approved by BLM personnel in March 2012 (attachment two). The approved alternative ceased work with *Baileya multiradiata* at the TPMC. However, further work with *Coleogyne ramosissima* was agreed upon and two new species important to the Mojave Desert, *Larrea tridentata,* and *Ambrosia dumosa* were added. All three of these species will be difficult to introduce into agronomic production. Therefore, task three primarily deals with the development of seeding technology to successfully establish these species in the Mojave Desert from wildland collections. Seed of all three species was shipped to the TPMC from the BLM Las Vegas Field Office in April of 2012 (table 7). In early October 2012, the seed was sent for purity and germination analysis to the Seed Lab at the New Mexico State University. At the time of this report, germination results have not been reported for the samples. The pure live seed (PLS) totals in table 7 are estimated from tetrazolium testing results. Seeding trials with these species will commence in the winter of 2012.

Table 7: Seed received at the TPMC in 2012 for task 3 of the 2011 statement of work

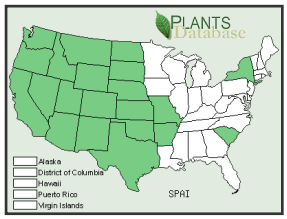
Species	ID	Accession	Bulk pounds	PLS pounds
Coleogyne ramosissima	SOSNV-05208-04	9106369	50	44.9
Larrea tridentata	LATR-37215	9106372	50	38.34
Ambrosia dumosa	NV052Z86R	9106370	15.55	11.76
	NV052283R	9106371		

REFERENCES:

United States. Dept. of Agriculture. *The Woody Plant Seed Manual, July 2008*. Ed. Franklin Bonner and Robert Karrfalt. Agricultural Handbook No. 727. Washington: GPO, 2008. Print.
Native Plant Network. **Propagation Protocol Database**. 2009. University of Idaho. Web. 3 Dec. 2010.

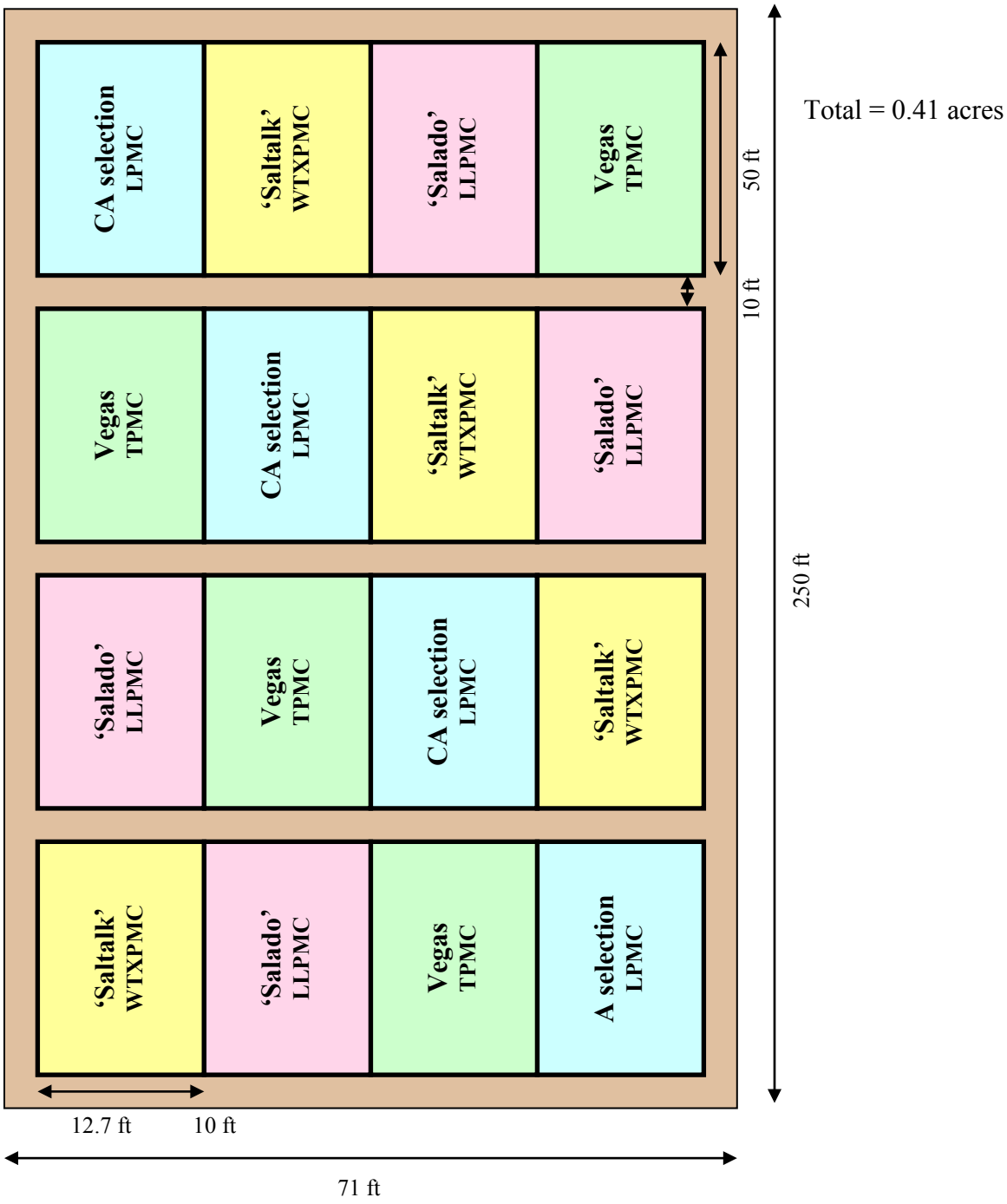
Inter-center Trials

Alkali Sacaton (Sporobolus airoides)

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 non-saline 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 AZPMC and 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



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 AZPMC release, Vegas, were then counted, packaged, and distributed by AZPMC personnel to cooperating Plant Materials Centers for planting. The trial will be planted at the AZPMC during 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 seasons 2010-2012:

An interim report for the data collected during 2010-2011 at each participating PMC follows. At the time of this report, 2012 data had not been summarized.

2011 Interim report of the evaluation of four alkali sacaton selections in four common gardens

November 2011

James Briggs[1/], H. Dial[2/], C. Smith[3/], G. Fenchel[4/], M. Smither-Koppperl[5/], B. Carr[6/]

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, California, New Mexico trials shows no significant ($P < .05$) difference in yield among accessions. Vegas Germplasm and accession 9083020 did have the highest dry wt. biomass yield at the Arizona and California PMCs. Onset of active spring growth patterns at the Arizona PMC may indicate the ability of Vegas Germplasm and accession 9083020 to be able to better utilize limited soil moisture.

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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 non-saline 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 EC_e 6-10 dS/m without reduction in yield and EC_e 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, Arizona, Knox City, Texas; Lockeford, California, and Los Lunas, New Mexico 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 Tucson PMC is 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 (Table 1) were not significantly different ($P < .05$) among accessions and averaged 1.3 tons/ac for Salado to 2.2 tons/ac for Vegas Germplasm. 2010 results at the Arizona PMC 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 ($P < .05$).

In 2011 plots in Arizona and California were not irrigated during the growing season in an effort to evaluate accession performance under natural rainfall conditions (Table 1). Early spring moisture prior to active growth appeared to have little impact on performance of accessions as the Arizona PMC received less than 0.5 inches of rainfall prior to active growth and the California PMC received 8.5 inches during the same period, yet biomass yields were similar at both locations. Precipitation during the active growing period, April through July and August, depending on location, was 1.6 and 2.4 inches at the Arizona and California PMCs respectively.

Table 1. Average monthly precipitation during growing season at the Arizona, New Mexico, and California Plant Material Centers in 2011.

Month	Arizona PMC	California PMC	New Mexico PMC
	----------Inches----------		
Jan	0.0	1.0	0.1
Feb	0.3	3.2	0.0
Mar	0.1	4.3	0.0
Apr	0.0 – Growth begins	0.2 – Growth Begins	0.0
May	0.4	1.2	0.1
June	0.0	1.0	0.0
July	1.2 - Harvest	0.0	0.8
Aug	N/A	0.0 - Harvest	0.4
Sep	N/A	N/A	0.4
Oct	N/A	N/A	Harvest
Nov	N/A	N/A	
Dec	N/A	N/A	
Season total	2.0	10.9	
Active growing season total	1.6	2.4	

Initial spring growth at the Arizona PMC varied by accession. Vegas Germplasm began growth the earliest at mid-March, 9083020 late March, Saltalk mid-April, and Saltalk not fully showing active growth until late May. In California none of the accessions became fully dormant; however, active spring growth began uniformly among all accessions beginning late in March through mid April. The trigger for the larger variation in spring growth in the Arizona plots is likely due to the ability of the Vegas Germplasm and accession 9083020 to utilize very low amounts of moisture; they are better adapted to low moisture conditions. Saltalk and Salado sources come from regions with more precipitation (12-19 inches) and more severe winters 0-5^{o} degrees F (zone 7a) while Vegas Germplasm and accession 9083020 are from regions with very little precipitation (2-8 inches) and mild winters with low temperatures of 20-25^{o} F. (zone 9A) (USDA4, 2011). All the sources are from similar latitudes Saltalk and accession 9083020 are from sites at 35 ^{o} N. latitude and Salado is from 33^{o} N, and Vegas is composed of material collected from locations at 37^{o} N latitude.

Yields (Table 2) in 2011 were not significantly different (P <.05) between accessions at the Arizona, New Mexico, or California PMCs. Accession 9083020 and the Vegas Germplasm had the greatest biomass yield at 2.4 and 1.6 tons per acre, respectively, at the Arizona and California PMCs under non-irrigated conditions. Accession 9083020 and Vegas Germplasm appear stemmier which may provide greater drought tolerance, but may have less value as a livestock forage than the cultivars Salado or Saltalk, which had the same mean yields, 1.2 tons/acre, in 2011 at the Arizona and California PMCs under non-irrigated conditions. The New Mexico plots received three irrigations in 2011 (April, May, and June) which resulted in larger yields than at Arizona and California.

Table 2 . Mean yields of Vegas Germplasm, 'Salado', 'Saltalk', and 9083020 alkali sacaton accessions at the Arizona, New Mexico, and California Plant Materials Centers 2010-2011.

Accession	Tucson, AZ PMC		Lockeford, CA PMC		Los Lunas, NM PMC		Mean Yield	
	----------tons/acre (dry wt.) ----------							
	2010*	2011**	2010	2011**	2010*	2011*	Irrig.	Non-Irrig.
Salado	1.3	1.1	-	1.2	2.0	2.6	2.0	1.2
Saltalk	1.9	1.6	-	0.7	1.8	3.2	2.3	1.2
Vegas Germplasm	2.2	2.4	-	0.8	1.7	2.7	2.2	1.6
9083020 (Casel)	1.9	2.1	-	1.2	2.7	4.0	2.9	2.4
LSD (P=<.05)	NS	NS		NS	NS	NS		

*Irrigated throughout growing season as needed **No irrigation through growing season.

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USDA Miscellaneous Publication No. 1475, Issued January 1990.

Conservation Trials

Native Seed Growers Demonstration; Douglas, AZ

Study ID Code	AZPMC-F-1001-RA
Title	Educational & promotional planting for new native seed growers
National Project No.	Range Land 2.1
Study Type	Conservation Field Trial
Study Status	Active
Location	Cochise County
Study Leaders	TPMC and Douglas Field Office
Duration	2010 through 2015
Vegetative Practices	347 Critical Area Planting 552 Range Planting 645 Wildlife Upland Habitat Management
Purpose	Field planting for field demonstration and education
Status of Knowledge	The Tucson Plant Materials Center has released various native grasses to be used in restoration/revegetation projects throughout the service area which includes parts of the Chihuahuan, Sonoran, and Mojave Deserts. However, these releases are not being fully utilized by land managers because of the lack of available commercial seed and native seed growers. This field planting is an initial step to motivate interested growers, as well as land managers to start using some of these available native grass releases.
Materials & Methods	Five releases from the TPMC will be compared to commercially available seed of the same species purchased from well known seed producers in the Southwest (some of the commercially available native species are of unknown origin). The seed will be direct seeded into ¼ acre plots. The plots will be irrigated and cared for by the local cooperator.
Evaluations	The plots will be evaluated from 2011 to 2015. Evaluations will be conducted by the TPMC in cooperation with field office personnel and the local cooperator. Evaluations will include: plant stand, vigor, incidence of pests, and seed yield (if available). A representative sample of 1 square meter will be hand-clip from each plot to estimate seed yield.
Technology Transfer Products	Annual reports on data collection will be included in the TPMC Annual Technical Report. Newsletter articles on the progress of the planting will be published by the Douglas Field Office and the TPMC. At least one tour and/or field day for local growers and land managers will be arranged by the Douglas field office and the local cooperator during the study years (2011-2015). A plant materials technical note summarizing the findings will be prepared by the Arizona Plant Materials Specialist or the TPMC.

Accomplishments/Results

Growing season 2011:

On July 1, 2011, TPMC personnel visited the site and met with the cooperator. The purpose of the visit was to evaluate the performance of the newly planted species which were established on August 27, 2010. Plots are flood irrigated as needed during the growing season. A visual estimation of the plant stand for each plot was conducted. Most of the grass species germinated well, however, the forb desert zinnia, had almost no germination. The table below summarizes the evaluation results.

Plot Number[1] (North-South)	**Entry**	**Seeding Rate Lb/acre (PLS)**	**TPMC Release or Commercial[3] Name**	**Percent Plant Stand[2]**
1	Desert zinnia(*Zinnia acerosa*)	2.2	Batamote Germplasm	1
2	Desert zinnia(*Zinnia acerosa)*	2.2	Batamote Germplasm	2
3	Pima pappusgrass(*Papophorum vaginatum*)	3	Pima Germplasm	75
4	Pima pappusgrass(*Papophorum vaginatum*)	3	Pima Germplasm	75
5	Spike dropseed(Sporobolus contractus)	1	Cochise Germplasm	65
6	Spike dropseed(Sporobolus contractus	1	Commercial	65
7	Arizona cotton top(*Digitaria californica*)	4	'Loetta'	60
8	Arizona cotton top(*Digitaria californica*)	4	Commercial	55
9	Plains lovegrass(*Eragrostis intermedia*)	1	Bonita Germplasm	35
10	Plains lovegrass(*Eragrostis intermedia*	1	Commercial	40

1. Plot size is approximately 0.25 acre
2. Visual plant stand based on entire plot
3. Commercial seed available in the market with no specific variety name (common seed)

General view of plots

Growing season 2012:

On the 21st of August 2012, Corey Picraux and Heather Dial evaluated the Native Seed Growers Demonstrational Field Planting near McNeal, AZ. The planting is located south-east of Tombstone near the intersection of N. Central Hwy and W. Noble Road (31.6125°N, 109.6953°W). Our primary point of contact for the planting is Art Meen.

Figure 2: McNeal field planting location

BACKGROUND: Five releases from the TPMC were broadcast seeded into 0.25 acre plots on August 27, 2010 to evaluate their performance in MLRA 41. When commercially available seed of the same species was available, it was also broadcast seeded into adjacent plots to provide a standard of comparison. Species and seeding rates used are detailed in table one. A plot map is provided in figure 2. The plots are flood irrigated and maintained by the local cooperator.

The plots are also to be used as a native seed production demonstration to encourage further development of the commercial native seed production industry in Southern Arizona.

Evaluation criteria includes: plant stand, vigor, incidence of pests, and seed yield. To estimate seed yield, seed will be hand harvested from three square meter plots in each 0.25 acre plot. Harvested material will be cleaned, weighed, analyzed for germination and purity, and compared at the Tucson Plant Materials Center.

Plot Number (North-South)	Species	Seeding Rate PLS lb/acre
1	Batamote Germplasm *Zinnia acerosa*	2.2
2	Batamote Germplasm *Zinnia acerosa*	2.2
3	Cochise Germplasm *Sporobolus contractus*	1
4	commercial *Sporobolus contractus*	1
5	'Loetta' *Digitaria californica*	4
6	commercial *Digitaria californica*	4
7	Bonita Germplasm *Eragrostis intermedia*	1
8	commercial *Eragrostis intermedia*	1
9	Pima Germplasm *Pappophorum vaginatum*	3
10	Pima Germplasm *Pappophorum vaginatum*	3

Table 1: Species and Seeding Rates used for the McNeal Field Planting

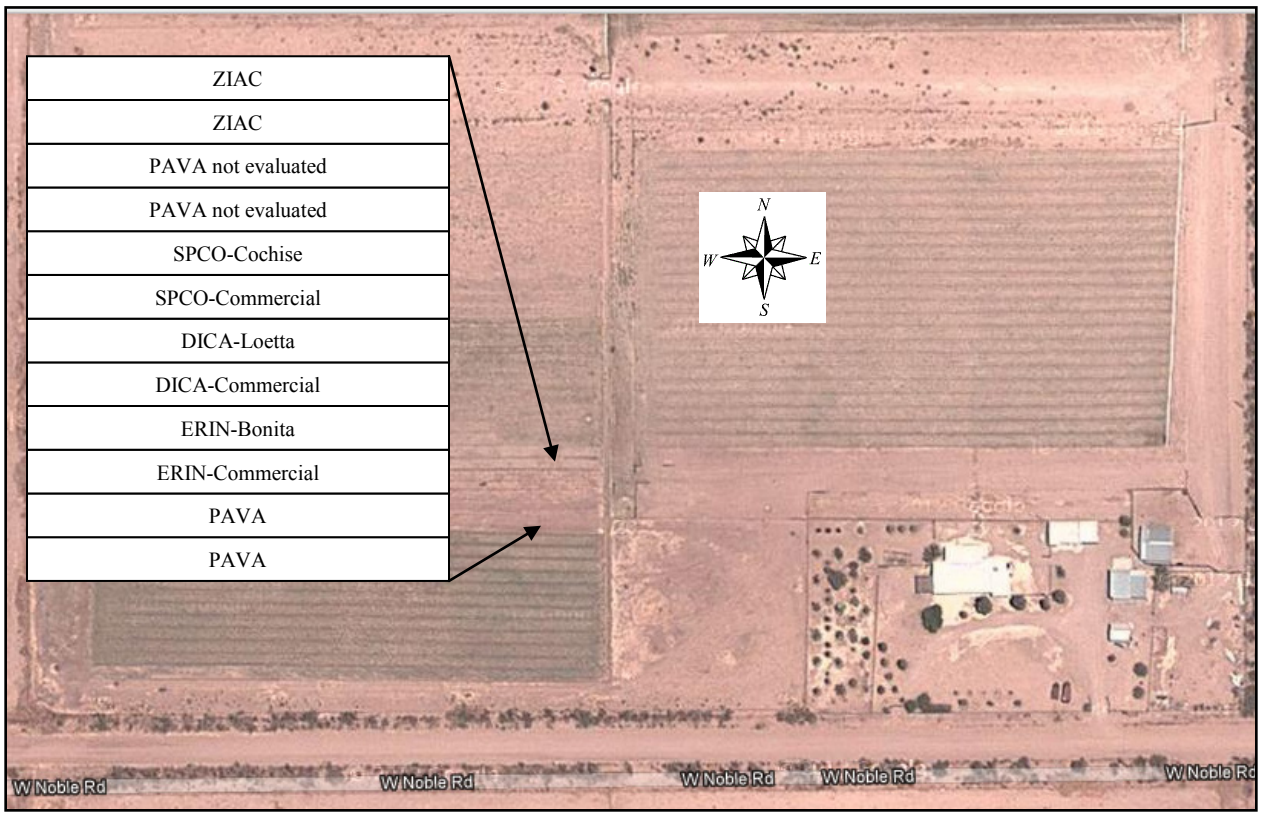


Figure 3: Plot plan for the McNeal Field Planting

EVALUATION: As in the previous year's evaluation, Pima Germplasm pappusgrass remains the most well established release with approximately 75-80% plant stand. I suspect this is largely the result of the quantity of seed broadcasted. Using the recommended seeding rate for PAVA in table one of 3 PLS lbs/acre, 0.75 PLS lbs would have been necessary for each of the 0.25 acre plots equaling a total need of 3 PLS lbs for the planting. There were no seed test results for germination and/or purity available for the seed lot used for this planting. Therefore, it is impossible to know exactly what PLS lbs were used for the plot establishment. However, a total of 6.28 bulk pounds was used during the planting. This amount is double the PLS lbs needed and well exceeds the bulk pounds applied in any of the other plots.

Both plains lovegrass plantings have very thin establishment with Bonita performing better than the commercially available lot. Bonita germplasm has an approximately 35% plant stand. The commercially available plains lovegrass stand is 20-25% of the plot. In the case of Bonita, I believe this is a result of under application of viable seed. A total of 0.25 bulk pounds of seed was used for the establishment of the 0.25 acre Bonita germplasm plot. However, there were no seed test results for germination and/or purity available for the Bonita germplasm seed lot used for this planting. Therefore, it is impossible to know exactly what PLS lbs were used for the establishment of the Bonita plot.

The PLS of the commercially available plains lovegrass seed lot was 88% meaning the 0.25 lbs applied was less than the needed 0.28 lbs necessary for meeting the recommended seeding rate. However, this very minor difference in needed pounds versus applied is not likely the cause of the poor stand establishment of the commercial plains lovegrass. Plains lovegrass is found naturally occurring in California, Texas, New Mexico, Arizona and several southeastern states.

The collection and/or production location of the commercially available plains lovegrass is unknown. Therefore, this particular lot of commercially available plains lovegrass may be poorly adapted to the unique environment of southeastern Arizona.

The cottontop stands are the second best plots in terms of percent stand. The 'Loetta' cottontop has an approximately 60% stand with the commercially available cottontop performing better with a stand of 65-70%. The difference in plot performance of the cottontops is unlikely to be a result of seed application as both plots were underseeded equivalently. The 'Loetta' 0.25 acre plot would have required the application of 1 PLS lb of seed when instead 0.7 PLS lbs was applied. The commercial cottontop PLS lbs applied were also less than the recommended seeding rate by 0.3 lbs. The collection and/or production location of the commercially available cottontop is unknown. However, 'Loetta' is a single source cultivar of cottontop developed from a collection originating in MLRA 40 and may not be as well adapted to MLRA 41 as the commercial cottontop.

The spike dropseed plots had a significant population of sand dropseed plants. Sand dropseed is a common contaminant of spike dropseed in both PMC and commercial seed. Nevertheless, I estimate the plant stand of both spike dropseed plots to be approximately 50%. The PLS lbs of Cochise germplasm spike dropseed applied is unknown. A total of 1.25 bulk pounds of seed was applied to the plot. The commercially available spike dropseed (92% PLS) was applied at 0.25 lbs per 0.25 acre in accordance with the recommended seeding rate of 1 PLS lb/acre. The cause of the poor plant stand establishment of both types of spike dropseed is likely due to the soil type of the planting site. Spike dropseeds prefer sandy soils whereas; the soil type at the planting site is a heavier clay loam.

The zinnia plantings established very poorly with less than 1% plant stand. Again, I believe this is a result of under application of viable seed. A total of 1.1 bulk pounds of seed was used for the establishment of the two 0.25 acre Batamote germplasm plots. However, there were no seed test results for germination and/or purity available for the Batamote germplasm seed lot used for this planting. Therefore, it is impossible to know exactly what PLS lbs were used for the establishment of these plots.

All of the plots were well cared for with minor weed incursions (yellow bluestem, milkweed, etc.). There were necessarily other plants surviving in the plots without full stands however, these were primarily natives (plains bristlegrass, sideoats, cane bluestem, etc.) moving in from other areas on the cooperator's land. I did not observe any appreciable disease and/or insect pressure on the plots. Irrigation and/or fertilization records were not available at the time of this evaluation but would be helpful for seed production technology development in the future.

Seed was not collected to estimate yields during this visit as the stands were well past prime harvesting dates. The cooperator has agreed to provide regular updates to PMC personnel during the 2013 growing season in order to schedule more appropriate evaluation/harvest dates.

Pollinator Garden

Study ID Code	AZPMC-T-0901-OT
Title	Pollinator garden
Project Number	National Action Plan: Pollinators
Study Type	Initial
Study Status	Active
Location	AZPMC
Study Leader	Bruce Munda, Heather Dial
Duration	2009 through 2014
Cooperators	North American Pollinator Protection Campaign (NAPPC)
Land Use	Cropland 2.1 Natural Areas 1.1
Vegetative Practices	Primary Field border Secondary Conservation Cover
Resource Concern(s)	Resource: Pollinator habitat Consideration/Problem: Information is needed on native plants that will provide pollinator habitat on/in agricultural lands and complement the bloom of insect-pollinated crops
Long Range Plan	Objective 2.3: Increase the alternative and specialized uses of conservation plant releases to meet emerging needs.
Description	Demonstration/study of native plants that can be used to provide pollinator habitat. One barrier to pollinator conservation identified by many who work in the field with landowners is the need for tested prescriptions for how to incorporate diverse plant mixes in different regions and different cropping systems (National PMP Pollinator Conservation Action Plan). Our demonstration planting will provide data on potentially suitable native plants for pollinator habitat and a visual reference for those landowners looking for ways to increase pollinator habitat.
Status of Knowledge	Native pollinators provide pollination services estimated to be worth about $3 billion dollars/year. However, many agricultural areas today lack sufficient habitat to support native pollinators. The need for this habitat is well documented as are the ways to increase it: increase foraging habitat, create nesting sites, and reduce risk to pollinators from the use of insecticides and herbicides (Farming for Pollinators, pg. 13). The knowledge that is lacking is that of native plants that will be conducive to providing pollinator habitat in agricultural areas of the desert Southwest.
Materials and Methods	Native plants (forbs and shrubs) purchased by NAPPC will be planted in a 0.13 acre border on the Tucson Plant Materials Farm in the summer of 2009. The plants will be chosen based upon their potential and/or documented attractiveness to pollinators and their commercial availability. The plantings will follow a hedgerow design (see attached plot plan). Between the forbs and shrubs

hedgerows, native grasses will be planted to provide habitat for pollinators and potentially food for certain species of moths native to the Sonoran desert (Farming for Pollinators, pg. 13).

The planting will be flood irrigated as needed for plant establishment.
Irrigation during the life of the planting will be minimal and directed to best mimic water availability of Southwestern agricultural lands. Flood irrigation is not recommended for pollinator plantings due to its potential to saturate ground nesting bee nests. However, adjacent fallow fields, ditch banks, and/or farm lands not used for cultivation within the average foraging distance of native bees (50 feet to a half-mile) may provide ground nesting bee habitat.
-Weed control during the life of the planting will be hand rouging and/or mowing. Chemical and/or mechanical control of weeds (cultivating, rotovating) will not be used in order to best protect pollinator habitat.

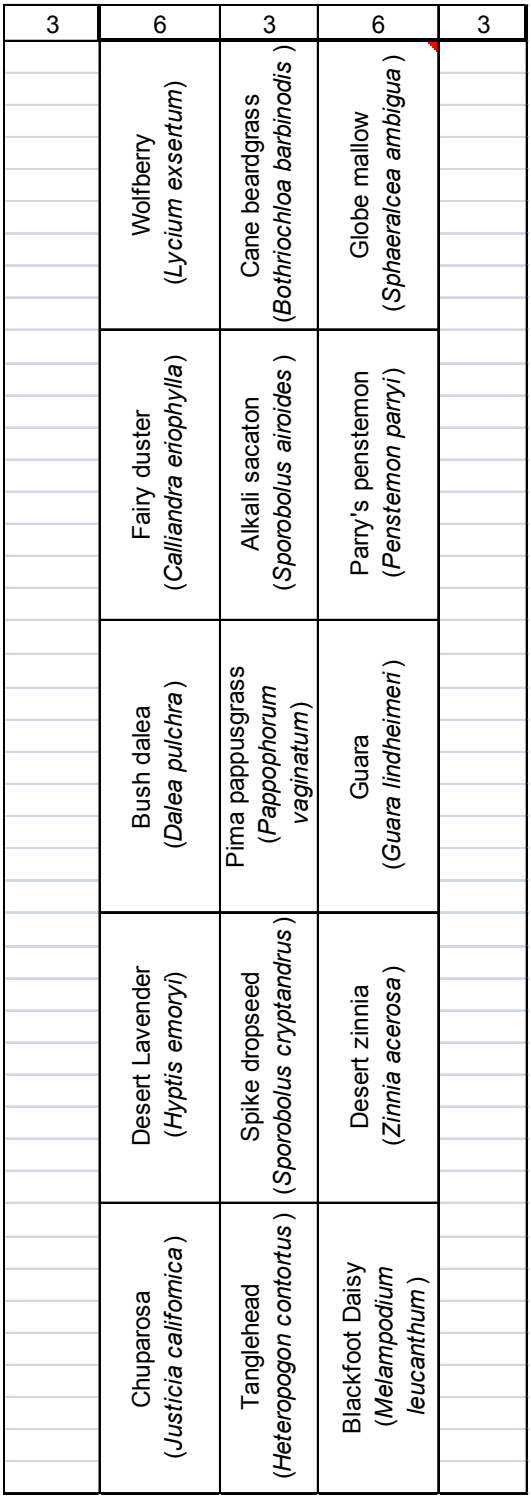
PMC data collection will include amount of water applied for establishment, time spent on weed control during establishment, flowering date, drought resistance, and dates of use of the plants by pollinators. PMC personnel do not have the expertise to identify native pollinators by species however, we can document whether or not the plant is being visited by pollinators.

In the future, an adjacent border may be planted to a common Southwestern crop (cotton, chili, etc) to gauge the effect of native pollinators. In this scenario, one part of the crop field would be protected from use by all but the European honey bee while the second part of the crop field would be left open to any native pollinators. This project would be conducted with support/assistance from NAPPC.

Literature Cited

Farming for Bees; Pollinators of the Sonoran Desert; USDA NRCS National Pollinator Conservation Action Plan; Selecting Plants for Pollinators, American Semidesert and Desert Province; Southern Arizona Nature Almanac, Native Arizona Plants, Steve Buchmann

Pollinator Garden (AZPMC-T-0901-OT) Plot Plan:



Growing Season 2010-2011:

The pollinator garden was established in October 2009 in field one, border four. Field preparation consisted of cultivation, herbicide control of emerging weeds and laser leveling. The field was pre-irrigated before planting. Approximately 50 one gallon containerized plants of each forb species, 7 one gallon containers of each shrub species, and 20 jiffy plugs of each grass species were used for the initial planting. In growing seasons 2010 and 2011, approximately 1 acre foot of water was applied. The flowering periods of the shrub and forb species were recorded in 2010 and are shown below.

Observed Flowering Periods of AZPMC Pollinator Garden Species 2010

	Flowering Period											
Species	January	February	March	April	May	June	July	August	September	October	November	December
Desert lavender (*Hyptis emoryi*)												
Chuparosa (*Justicia californica*)												
Bush dalea (*Dalea pulchra*)												
Wolfberry (*Lycium exsertum*)												
Guara (*Guara lindhiemeri*)												
Blackfoot Daisy (*Melampodium leucanthum*)												
Parry's penstemon (*Penstemon parryi*)												
Desert zinnia (*Zinnia acerosa*)												
Globe mallow (*Sphaeralcea ambigua*)												
Fairy Duster (*Calliandra eriophylla*)												

At the end of 2010, all species present in the garden had an approximately 95% survival rate. Guara was the highest performer and had filled in all interspaces in the plot by June of 2010. Desert lavender, bush dalea, chuparosa, and wolfberry had extensive growth while the fairy duster, zinnia, and chuparosa exhibited much slower growth rates.

In February 2011, the unusually cold temperatures (18°F) resulted in a die-off of all planted desert lavender and a majority of the blackfoot daisy, guara, and chuparosa. Throughout growing season 2011, weed control became difficult due to the large holes left in the planting block by the plant die-off. In the late summer of 2011, all dead material was pulled from the garden and pre-emergent (3 quarts/acre pendimethalin) was applied. Additionally, containerized *Lotus rigidus* and *Eriogonum fasciculatum* were started in the greenhouse to serve as replacements for the guara and blackfoot daisy.

Two separate pollinator friendly seeding trials were also established in June of 2011. The mixes used are shown in the table below. Approximately one week after the seed for the trials was broadcasted into the end of field one, border four and watered, emergence of *Lotus rigidus* was seen in trial one. However, in July of 2011, the trials were destroyed when PMC personnel unintentionally drove over the seeding location. The trials will be re-established in 2012.

Pollinator Friendly Seeding Trial One 2011

	Trial 1			
	Seeds/lb	Seeding rate, 100% of mix (PLS lbs/acre)	Percentage of mix	Seeding rate, percentage of mix (PLS lbs/acre)
SHRUBS				
fairy duster (*Calliandra eriophylla*)	16400	3.5	0.03	0.105
bush dalea (*Dalea pulchra*)	290000	8	0.03	0.24
FORBS				
Parry's penstemon (*Penstemon parryi*)	500000	2.2	0.1	0.22
desert zinnia (*Zinnia acerosa*)	392500	0.6	0.25	0.15
globe mallow (*Sphaeralcea ambigua*)	500000	2.2	0.1	0.22
shrubby deervetch (*Lotus rigidus*)	428324	2.5	0.25	0.625
desert senna (*Senna covesii*)	62000	2	0.03	0.06

Pollinator Friendly Seeding Trial Two 2011

	Trial 2			
	Seeds/lb	Seeding rate, 100% of mix (PLS lbs/acre)	Percentage of mix	Seeding rate, percentage of mix (PLS lbs/acre)
SHRUBS				
wolfberry (*Lycium exsertum*)	250000	11	0.03	0.33
buckwheat (*Eriogonum fasciculatum*)	300000	3.6	0.03	0.108
FORBS				
Parry's penstemon (*Penstemon parryi*)	500000	2.2	0.1	0.22
desert zinnia (*Zinnia acerosa*)	392500	0.6	0.25	0.15
globe mallow (*Sphaeralcea ambigua*)	500000	2.2	0.1	0.22
desert marigold (*Baileya multiradiata*)	1060000	1	0.25	0.25

Growing season 2012:

The pollinator friendly seeding trials were not re-established in 2012 due to difficulty in acquiring seed. Additionally, the containerized *Lotus rigidus* and *Eriogonum fasciculatum,* grown for the pollinator demonstration garden, were not outplanted because of insufficient root growth. The outplanting is planned for 2013.

National Parks Agreements Progress Reports

FY2012 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project involves the production of 145 lbs of *Sporobolus airoides* and 140 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 2008-12 are shown in table 1.

Table 2: *Sporobolus airoides* harvest totals 2008-2012

	2008	2009		2010		2011		2012
Bulk lbs.	15.00	29.30	19.25	10.84	5.96	31.88	2.44	11.50
Cleaned lbs.	5.06	20.87	12.46	9.38	1.38	21.13	0.37	0.41
Germination %	84	74	58	83	50	79	79	70
Purity %	99.20	84.47	99.4	94.57	23.23	90.58	90.58	91.86
Test date	3/19/2012	3/19/2012	3/16/2012	3/19/2012	3/19/2012	3/19/2012	3/19/2012	3/28/2013
PLS %	83.33	62.51	57.65	78.49	11.62	71.56	71.56	64.30
PLS lbs.	4.22	13.05	7.18	7.36	0.16	15.12	0.26	0.26

In March of 2010, approximately 3,700 *Aristida purpurea* plants were started from seed received at the center in 2009. In June 2010, these plants were used to establish a 0.54 acre seed production field. Harvest totals for years 2010-2012 are shown in table 2. The total pounds of seed produced in support of this agreement are 126 bulk pounds of *Sporobolus airoides* and 225 bulk pounds of *Aristida purpurea.*

Table 3: *Aristida purpurea* harvest totals 2010-2012

	2010		2011				2012			
Bulk lbs.	11.00	11.82	62.94	29.13	21.12	11.75	15.20	14.31	18.00	30.00
Cleaned lbs.	10.58		20.35	20.55	5	0.5	9.63	13.00	14.25	27.00
Germination %	86		75	75	75	75	39	33	39	22
Purity %	88.73		88.68	88.68	88.68	88.68	28.37	18.77	19.50	20.34
Test date	3/13/2012		3/13/2012	3/13/2012	3/13/2012	3/13/2012	3/27/2013	3/27/2013	3/27/2013	3/27/2013
PLS %	76.31		66.51	66.51	66.51	66.51	11.06	6.19	7.61	4.47
PLS lbs.	8.07		13.53	13.67	3.33	0.33	1.07	0.81	1.08	1.21

TECHNOLOGY DEVELOPMENT – The center purchased a high capacity Westrup Brush Machine which was installed and used to clean the 2012 *Aristida purpurea* harvests. Seed processed through this machine was significantly easier to handle, store and clean further when necessary, than seed processed with other methods. In 2012, it was decided that seed processed with the Westrup Brush Machine would not receive further cleaning treatments as the resulting bare caryopsis of *Aristida purpurea* is too fragile for the needs of the park.

Figure 4: Freshly harvested *Aristida purpurea*.

Figure 5: *Aristida purpurea* cleaned with the Westrup Brush Machine.

FY2013 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 by September 30, 2013. The Tucson Plant Materials Center (TPMC) 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 TPMC has initiated studies to collect data on optimal propagation techniques

ACCOMPLISHMENTS - Seed collected at the Memorial in October 2008 was cleaned with a South Dakota seed blower 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 at 70 ^{0}F to germinate. Germination took place over 7-14 days with excellent results. Approximately 1700 seedlings were transplanted into 3" X 5'' Zipset Plant Band containers (45 cubic inches in volume) during the first production year, 2010. The procedure was repeated for production years 2011 and 2012. See table 1 for the total number of plants delivered each year. The final delivery was completed on August 9, 2012. The **TPMC delivered a total of 5100 containerized agave plants to the Coronado National Memorial. Therefore, the production requirements of this agreement have been completed.**

Table 1: Total Number of Plants Delivered to Coronado National Memorial

Delivery Date	Number of Plants	Container size (inches)	Average Rosette Diameter (inches)
July 16, 2010	1600	3 X 5	2.5-3.5
August 9, 2011	1900	3 X 5	2.5-3.5
August 9,2012	1600	3 X 5	2.5-3.5
Total Delivered	**5100**		

TECHNOLOGY DEVELOPMENT – Limited information is available in the literature regarding *Agave palmeri* culture under nursery conditions. The TPMC initiated observational trials and a growth rate study to investigate the cultural requirements for this plant. The following are some of the observations recorded during the first, second and third 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 determine the optimum watering frequency for growth. 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 ten minute watering per day per week provided sufficient water for plant growth and reduced the fungus gnat infestation.

Fertilization: Plants were fertilized approximately once per month with 200 parts per million of 20-20-20 Peters Professional® Water Soluble Fertilizer.

Growth Rate Study: A greenhouse/shade house growth rate study was initiated soon after the agave plants were transplanted into individual containers. Observations and data collected indicated that *Agave palmeri* has an increased growth rate in the summer months when temperatures are above 90 F^0. *Agave palmeri* grows faster in its second year and doubles its root mass (see pictures below). Plants initiated production of pups and increased the number of leaves from 6 the first year to 14 at the end of the second year. The average rosette diameter at the end of two years was about 3.3 inches.

Twelve two-year old plants that were grown in 3" X 5" containers were transplanted into one-gallon containers on April 29, 2011. They were evaluated January 30, 2013 (20 months after transplanted into 1-gallon containers and 3 years and 5 months after they were initially transplanted). The agaves averaged 8.6 inches in rosette diameter, 2.1 inches collar stem diameter and 20 leaves per plant. Below are pictures of the results.

Figure 6: A one year old agave plant in 2010

Figure 7: A two year old agave plant in 2011

Figure 8: One gallon- three-year agave plants

Figure 9: Agave rosette diameter

Figure 10: Agave rosette height

Figure 11: Agave roots and pups

FY2012 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
TUCSON, ARIZONA

INTRODUCTION - This project originally involved the establishment of 0.5 acres of *Aristida purpurea* and 0.25 acres of *Abutilon incanum*. In May of 2012, the agreement was amended to remove the production requirement of *Abutilon incanum* due to insufficient viable seed. Seed harvested from the *Aristida purpurea* field will be used in revegetation projects within Saguaro National Park. The final signature on the amendment was in May of 2012 with the agreement continuing until September 30, 2015.

ACCOMPLISHMENTS - PMC personnel received the *Aristida purpurea* seed for this project in March of 2011. There were 35 individual *Aristida purpurea* collections with varying collection years (1999-2010). The total seed received was 519 grams. Approximately 1900 plugs of *Aristida purpurea* were started in July of 2011 using 26 of the individual seed collections. A 0.5 acre field of *Aristida purpurea* was established in September of 2011. Individual collections were planted into known distinct locations within the field. Field observations in late 2011 indicated that collections 825 and 865, both collected in 2002, were heartier with more vegetative production than the other collections. The remaining accessions died in the field during the winter of 2011.

In late April of 2012, additional plugs of *Aristida purpurea* were planted and grown for re-establishment of the field. The majority of the seed used for the re-plant were the accessions 825 and 865. Planting of additional plugs using additional accessions continued through July to ensure adequate plants were available for full re-establishment of the production field. The field was replanted in September 2012. Harvests of the field are expected in early 2013.

Figure 12: A portion of the *Aristida purpurea* plugs grown for field re-establishment, July 2012.

Figure 13: *Aristida purpurea* field freshly planted, September 2012.

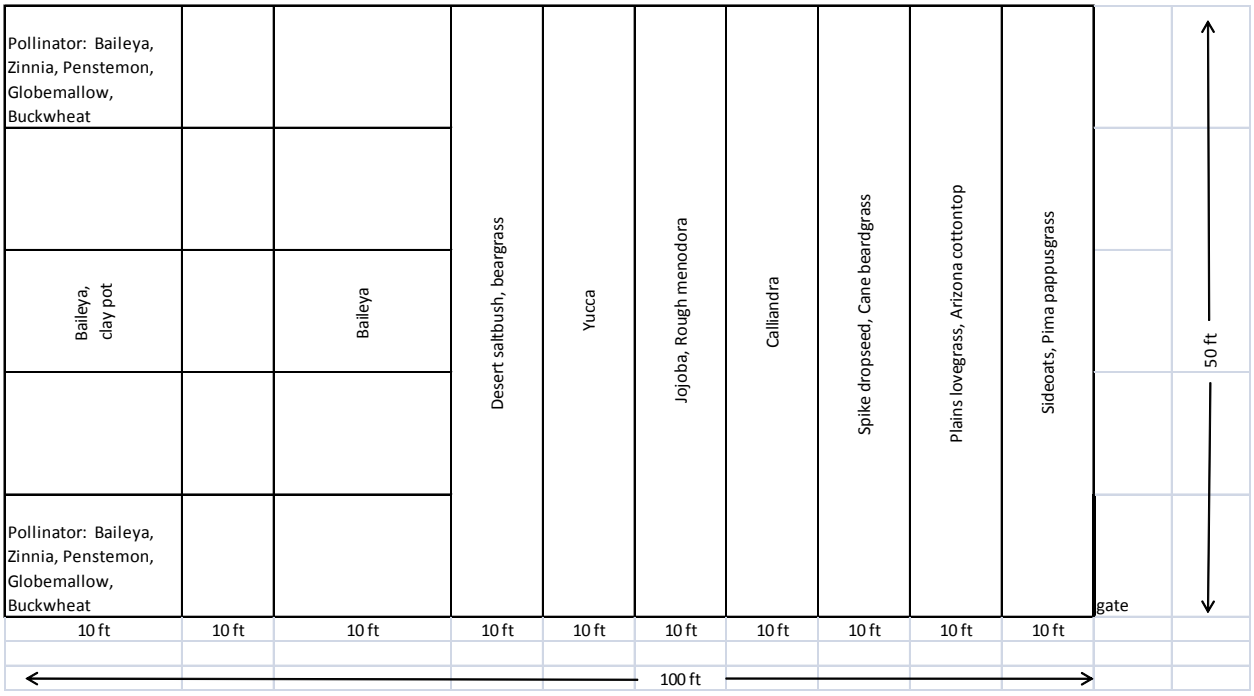
Field Plantings

Sells Demonstration Garden

In late May 2011, PMC staff traveled to Sells, Arizona on the Tohono O'odham Indian Reservation to plant six native grass species, (*Bouteloua curtipendula*, *Papphophorum vaginatum*, *Eragrostis intermedia*, *Digitaria californica*, *Sporobolus contractus*, and *Bothriochloa barbinodis*) and one native forb (*Baileya multiradiata*) as part of a demonstration garden. The planting date coincided with a mini-workshop on backyard garden irrigation systems hosted by the Farm and Food Group. Workshop participants planted the native grasses and forb and laid the drip irrigation line to water the garden. The garden area was originally fenced and installed in 1997 with 18 native species. Over the years, most of the native grass species initially planted had died out. The garden is frequently used by the Tohono O'odham Nation Soil and Water Conservation District during their annual Range Day celebration to illustrate what native plants can be found on the range in Sells. With the re-establishment of the native grasses, the plant identification skills of Range Day participants will be enhanced.

The demonstration garden will be monitored and expanded in future years.

Sells Demonstration Garden Plot Plan



Growing season 2012:

The planting was evaluated in February of 2012. All releases performed well in the garden with the exception of the plains lovegrass which had a 0% survival rate. The garden is maintained by Sells Field Office personnel.