United States Department of Agriculture

Tucson Plant Materials Center Annual Technical Report

2013

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Plant Materials Center Staff

Manuel Rosales	Manager
Heather Dial	Assistant Manager
Blase Evancho	Farm Manager
Leslie Glass	Secretary and National Plant Materials Program Webmaster
Jonathan Walther	Student Intern
Corey Picraux	Student Intern- Graduated
Erin Boyd	Student Intern- Graduated

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 erosion nurseries in critical areas throughout the United States. The Tucson Plant Materials Center (PMC) was one of the initial nurseries established in the southwest. Since 1935, the Plant Materials program has grown into a network of 27 centers located throughout the United States.

The Tucson PMC 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 Tucson PMC 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 40-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 Tucson PMC during fiscal year 2013. For further information please contact us at:

USDA-NRCS
Tucson Plant Materials Center
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Tucson, AZ 85705-9233
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Summary of 2013 Weather Conditions at the Tucson Plant Materials Center Tucson, Arizona

Month	Temperature (°F)		Precipitation (inches)
	Maximum	Minimum	
January	81	17	0.81
February	75	29	0.79
March	94	33	0.01
April	97	42	0.12
May	99	58	0.01
June	112	68	0.03
July	108	71	2.60
August	108	69	0.48
September	104	57	0.63
October	95	44	0.00
November	89	40	2.22
December	83	31	0.83

Frost Free Days	=	345
Days Above 100 ^{o}F	=	74
Coldest Temperature	=	17° (January 15)
Hottest Temperature	=	112° (June 29)
1st day 100 ^{o}F	=	June 1
1st day 32 (or Below) ^{o}F	=	January 1

Tucson Plant Materials Center Service Area

Tucson Plant Materials Center Studies

Development of a Sideoats Grama (Bouteloua curtipendula) Population for 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 1.1 Pastureland/hayland 2.1 Wildlife 1.1
Study Type	Population Development
Study Status	Active
Location	AZPMC
Study Leaders	Heather Dial
Duration	2006 through 2014
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 New Mexico 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-0601-CR) Plot Plan:

IRRIGATION DITCH

ACCESSIONS START ON THE EAST SIDE OF THE BORDER

PRIMARY PLOT
10 plants/unit
8 REPLICATIONS

SECONDARY PLOT
8 plants/unit

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

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

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 2008.

Growing season 2008:

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

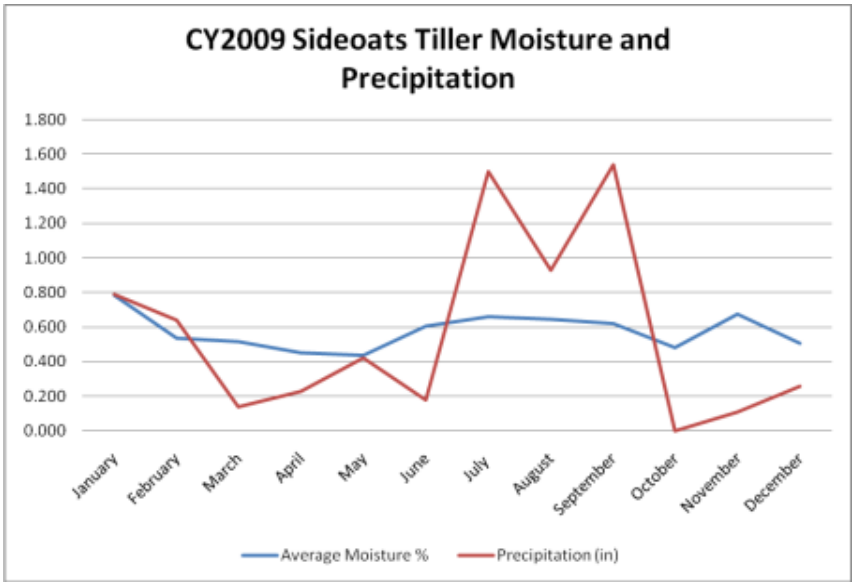
Growing season 2009:

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.

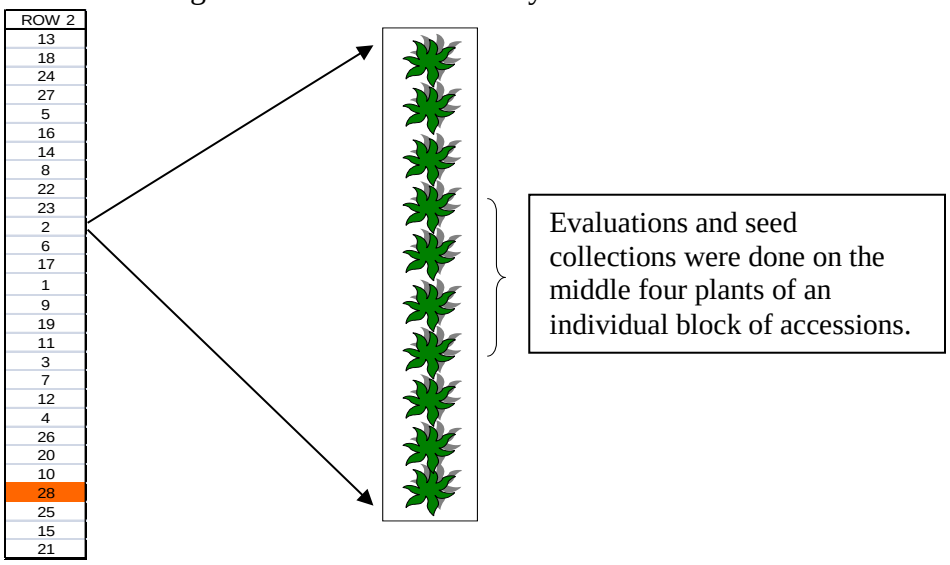
Graph of Average Tiller Moisture Percentages and Precipitation Totals for 2009



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. 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.

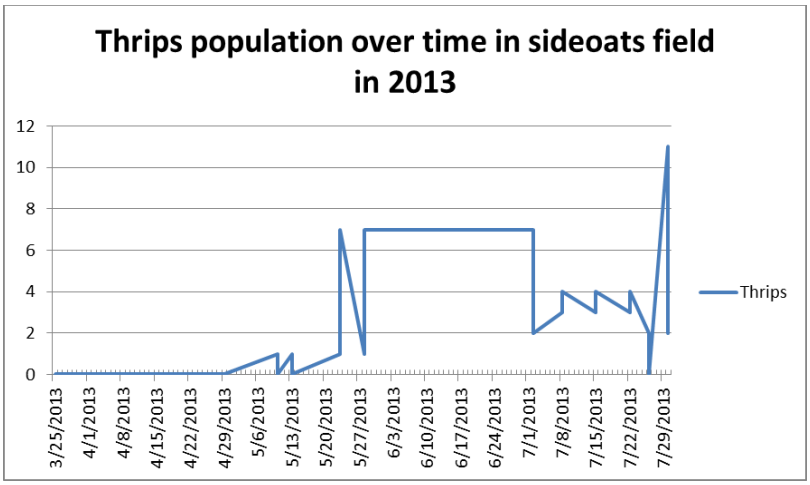
Sideoats field in January 2012 after dump truck damage

In July of 2012 a systemic insecticide, Malice®, was applied to the field. There was no appreciable immediate 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.

Growing season 2013:

Insect monitoring with 3” x 5” yellow sticky cards in the field began in March. Two cards were placed on stakes at the height of the sideoats canopy in the field. Insect counts were done approximately once per week. A flail-vac harvest was conducted in late June. The bulk amount of seed harvested from the field was substantially greater than amounts harvested in previous years. The increased seed yield was potentially a result of reduced thrips populations due to the spraying regimen of the previous year. The insecticide used in 2012 has residual activity whereas the insecticide used in 2011 does not. The increased yield could also be a result of the early harvest date. Thrips populations usually increase very slowly in the spring and spike in the summer months.

In early July, the third systemic insecticide selected for thrips control, Conserve®, was applied to the field three times (July 2, July 11, July 19). Insect monitoring showed an expected spike in adult thrips populations after the applications concluded. Populations fell shortly after the spike and a second harvest of sideoats was planned. The seed was not ready for harvest prior to the government shut-down and was lost during the two weeks of center closure. This study will continue in 2014.



Thrips population over time in the sideoats grama field at the AZPMC in 2013

Sideoats grama field in June 2013, monitoring stakes just visible in field foreground

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
Duration	2006 through 2013
Description	Develop agronomic protocols for seed production of the 1965 release 'Sonora' Black grama
Status of Knowledge	In an AZPMC 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.

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 during harvest. The small amount of seed collected was unrecoverable. 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. The 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. 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 AZPMC 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*

Growing season 2013:

In September, four randomly selected $1m^2$ frames were clipped from the black grama field. The seed heads in the samples were not filled. The study was discontinued due to heavy weed infestation of nutsedge (*Cyperus spp.)* and no appreciable increase in seed production from insecticide use.

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

Products

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/lathhouse. 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 a secondary plot. The secondary plot will be used for evaluation of growth characteristics.

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		

Growing season 2013:

In 2013, the crossing block for big galleta progressed very well. The block was evaluated four times. Out of the 10 populations, the entries Frontage Road and Rainbow Gardens exhibited the most mortality. Each dead entry was replaced with stock maintained in the greenhouse/lathhouse. By August 2013, the 12 replications for the 10 populations in the crossing block were complete. On June 12, 2013, four plants from each population in the crossing block were hand-harvested for seed from four rows. Tissue samples from the 10 populations were collected in July and sent to the Forage and Range Research Laboratory, USDA-ARS in Logan, Utah for genetic analysis. The secondary plot also progressed very well in 2013. All entries except Coyote Springs and Piute are growing in the secondary plot. Rhizomes from both populations will be collected from the crossing block in order to establish the populations in the secondary plot.

Clean hand harvested weights (g) of big galleta collected in 2013

		Row 4	Row 1	Row 9	Row 10	Average harvest weight (g)
Bitter Springs	1	0.99	0	0	0.08	0.27
Black Butte	2	0.48	0.14	0.13	0.31	0.27
Coyote Springs	3	0.04	0.14	0.21	0.61	0.25
Frontage Road	4	0.17	0.38	0	0.22	0.19
Gold Butte	5	0.68	0	0.18	0.08	0.23
Jean Dry Lake	6	0.23	0.2	0.02	0.42	0.22
Piute	7	0.15	0	0.14	0.28	0.14
Rainbow	8	0	0	0	0	0.00
Red Rock	9	0.2	0.16	0.23	0.01	0.15
Sandy Valley	10	0.15	0.17	0.21	0	0.13

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

Study ID Code	AZPMC-T-1004-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	Heather Dial, Manuel Rosales
Duration	2010 to 2015
Vegetative Practices	342 Critical Area Planting 550 Range Seeding 543 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 managers 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 AZPMC 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).
Literature Cited	1. Fehr, Walter R. 1987. Principles of Cultivar Development, Vol. 1 Theory and Technique. Macmillan Publishing Company, New York. 2. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol. 72. New York and Oxford. 3. Hickman, James C., ed. 1993. The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p. 4. Kearney, T.H. and R.H. Peebles. 1969. Arizona flora. University of California Press, Berkley, CA. 5. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Growing season 2010-2013:

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 (PMC) are collaborating on the development of native plant materials for use in the Mojave Desert. This report is for work conducted during Fiscal Years 2010-2013.

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 Tucson PMC 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:

The nine native species listed below 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 Tucson PMC in March 2010 from SoS.

Seed received at the Tucson PMC 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. Of the nine species, sufficient quantities of three species (*Encelia virginensis*, *Eriogonum fasciculatum*, and *Sphaeralcea ambigua*) survived and developed

sufficient growth to be outplanted. 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.

Germination trials and results conducted in 2010 at the Tucson PMC

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%

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.

Sphaeralcea ambigua

Eriogonum fasciculatum

Encelia virginensis

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 (0.01 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, hand rouging and with spot spraying of 2, 4-D to control broadleaf weeds. In late fall (November), a pre-emergent herbicide (oryzalin) was applied at a rate of 100 pounds per acre.

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

Growth data was collected in September 2011 from six randomly selected plants within the observational rows. *Encelia virginensis* showed the best survival and growth rates out of the three species.

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

***Encelia virginensis* in September 2011**

Harvesting trials of seed also began in 2011 and continued into 2012 and 2013. 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 from *Encelia virginensis*. However, the vacuum unit did not have enough strength to efficiently harvest seed from either *Eriogonum fasciculatum* or *Sphaeralcea ambigua*.

Harvesting data collected from observational rows 2011- fall 2013

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
		5/23/2013	hand	0.67	455.00	91.00	20%	rubbing board/blower	1.00	0.011	91.11
			Totals	**4.17**	**815.21**	**158.04**	**19%**		**1.80**	**0.011**	**163.24**
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
		12/11/2012	hand	0.50	226.00	96.00	42%	hammermill/ blower	0.50	0.011	45.25
		6/17/2013	hand	0.40	26.00				0.06	0.011	5.45
			Totals	**3.40**	**849.24**	**161.73**	**19%**		**1.87**	**0.011**	**170.05**
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
		10/23/2012	hand	1.00	66.00				0.15	0.009	16.15
			Totals	**7.08**	**1571.13**	**479.55**	**31%**		**3.46**	**0.009**	**384.52**

***Encelia virginensis* hand harvested seed**

In mid-October 2011, the Tucson PMC developed a new statement of work for this project that was approved by BLM personnel in January of 2012. The statement of work outlined three tasks.

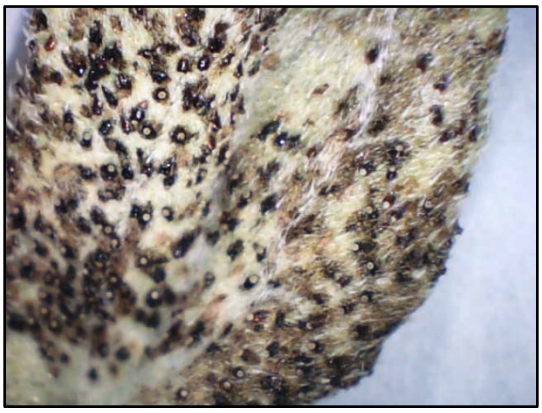
Task one:

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.

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. There was an excellent survival rate of transplants. The plants did not enter dormancy until late January and had resumed growth by March. The first harvesting trials with commercially available harvesting equipment (Woodward Flail-Vac and the Massey Ferguson MX-8 plot combine) were scheduled to be conducted in May.

In late April, field inspections revealed significant numbers of chrysanthemum lace bugs (*Corythuca marmorata*) feeding upon the foliage of *Encelia virginensis* in the increase field and the observational rows. Individual plants were sprayed with a mixture of soap and water the 1st of May in an attempt to control the lace bugs. The soap and water mixture was ineffective and on the 8th of May, plants were treated with a pyrethrum insecticide. The insecticide provided effective control of the lace bugs but the young plants in the increase field did not survive the insect predation. The adult plants in the observational rows survived although seed production was severely reduced. In June, seed harvested on December 20th, 2011 from the observational rows of *Encelia virginensis* was used to produce new transplants for the increase field. The increase field was re-established November 12th, 2013.

chrysanthemum lace bug



chrysanthemum lace bug feces on *Encelia virginensis* leaf

In June of 2013, transplants were germinated from seed collected from the observational rows of *Sphaeralcea ambigua* and *Eriogonum fasciculatum* for establishment of increase fields. The *Sphaeralcea ambigua* transplants were established from seed collected May 23rd, 2013. The *Eriogonum fasciculatum* transplants were established from seed collected June 18th, 2012 and December 11th, 2012. Neither species had sufficient growth for establishment of increase fields in 2013. It is anticipated that increase fields will be planted in the spring of 2014 for both species.

Encelia virginensis **seedlings in August 2012**

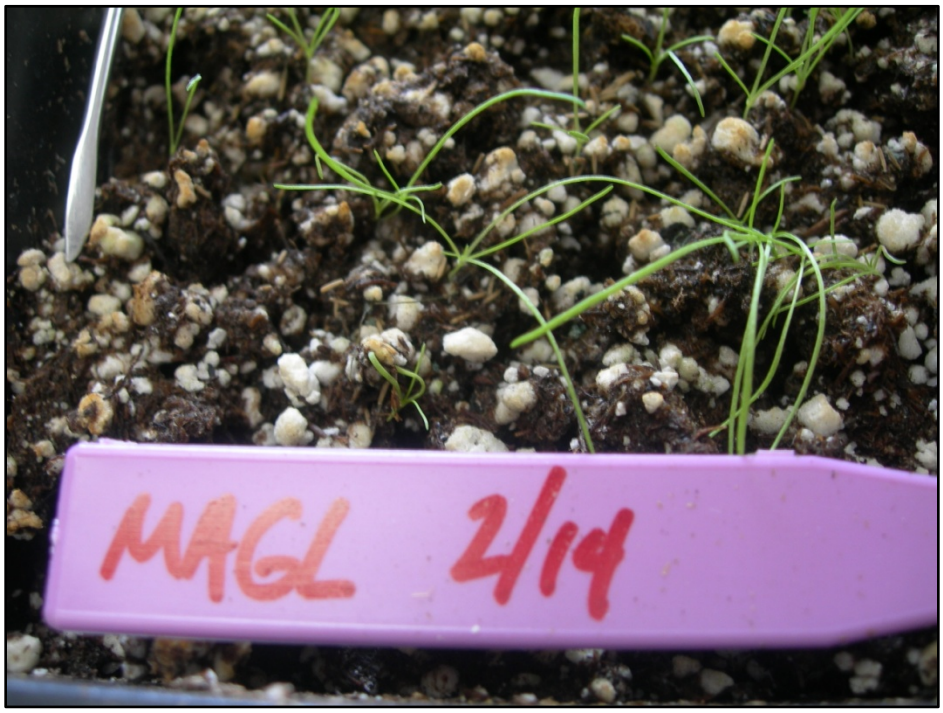
Task two:

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 Tucson PMC with poor results. Very small quantities of the seed originally received in 2010 still remained at the PMC. Additional germination and propagation trials with this seed were started in February of 2012. A Hoffman Manufacturing, Inc. SG30 controlled environment germination chamber had been purchased by the Tucson PMC 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.

Germination trials conducted in 2012 at the Tucson PMC

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



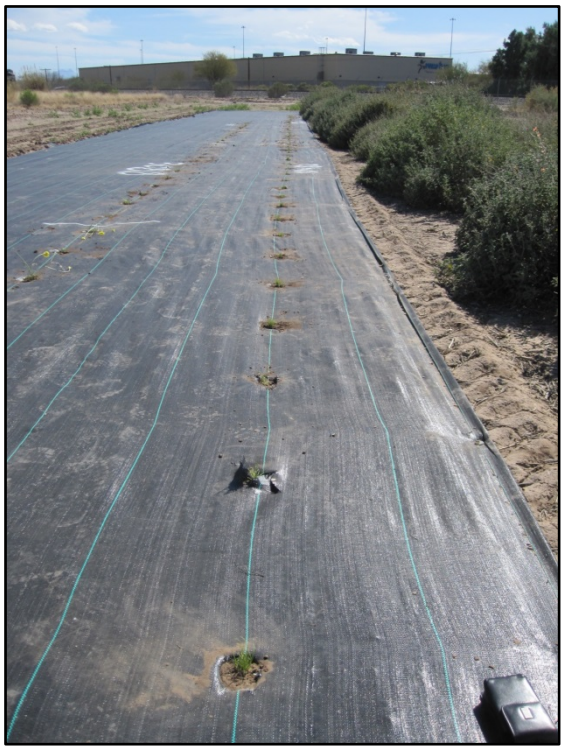
***Malacothrix glabrata* seedlings, February 2012**

Additional seed of these species was requested from the SoS program and received at the Tucson PMC in April of 2012. In September of 2012, germination trials were resumed with the newly received seed. By February of 2013, enough *Malacothrix glabrata* transplants were germinated for the establishment of observational rows. Due to the growth form and seed dispersal methods of *Malacothrix glabrata* species, weed barrier was installed to provide a smooth surface to collect seed from the low growing plants on March 1st.

Seed received at the Tucson PMC 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

The observational rows were established on the 4th of March with 86 plants grown from four separate collections. Each collection was labeled in the field. An evaluation conducted on March 11th, showed high survival rates but significant rabbit herbivory of all collections was apparent. The following day, fence installation plans were ceased when it was apparent that all of the transplants had been grazed to a point of non-recovery.



Newly established *Malacothrix glabrata* observational rows, March 2013

Herbivory of *Malacothrix glabrata* transplant

No further work with this species can be accomplished until further seed collections are obtained. However, introducing this species into commercial seed production will prove difficult due to its growth form and seed dispersal methodology. The plant is very low growing (< 1 ft. tall) making seed harvest with commercial equipment difficult. Additionally, the very light weight seed is covered in a feathery pappus to aid its dispersal by wind. To ensure the seed crop was not lost to weather events, the timing of harvests would have to be carefully monitored; more carefully than most commercial producers could do economically. Finally, because of its wind dispersal method, the plant could become a nuisance in other production fields. *Malacothrix glabrata* is also an annual plant which will render it undesirable for most native seed producers. Germination trials are ongoing for *Camissonia brevipes* subsp. *brevipes* and *Eriogonum wrightii* var. *subscaposum* although seed collections thus far have produced very few surviving transplants.

Task three:

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,* difficulty in influencing the commercial seed industry to produce seed.

An alternative task three was developed and approved by BLM personnel in March 2012. The approved alternative ceased work with *Baileya multiradiata* at the Tucson PMC. 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. Seed of all three species was shipped to the Tucson PMC from the BLM Las Vegas Field Office in April of 2012. In early October 2012, the seed was sent for purity and germination analysis to the Seed Lab at the New Mexico State University.

Seed received at the Tucson PMC in 2012 for task 3 of the 2011 statement of work

NRCS accession	Species	Common name	Pounds received	Collection date	Test completion date	Purity %	Germ %	Dormant %	PLS	PLS lbs
9106370	*Ambrosia dumosa*	white bursage	6.80	6/7/2010	11/9/2012	83.07	12	77	73.93	5.03
9106371	*Ambrosia dumosa*	white bursage	8.75	6/2/2010	11/9/2012	80.45	4	88	74.01	6.48
9106369	*Coleogyne ramosissima*	blackbrush	5	6/28/2008	4/24/2013	99.78	98		97.78	4.89
9106372	*Larrea tridentata*	creosote bush	35	unk	11/20/2012	94.67	9	66	71.00	24.85

Colegyne ramosissima, *Larrea tridentata,* and *Ambrosia dumosa* are species that occupy large areas of the Mojave Desert. Disturbance of Mojave Desert areas where these are the primary vegetative species comes from a variety of sources including fire, off highway vehicle traffic and pipeline construction. All three of these species will be difficult to introduce into agronomic production due to their slow growth. Therefore, task three primarily deals with the development of seeding technology to successfully establish these species from wildland collections.

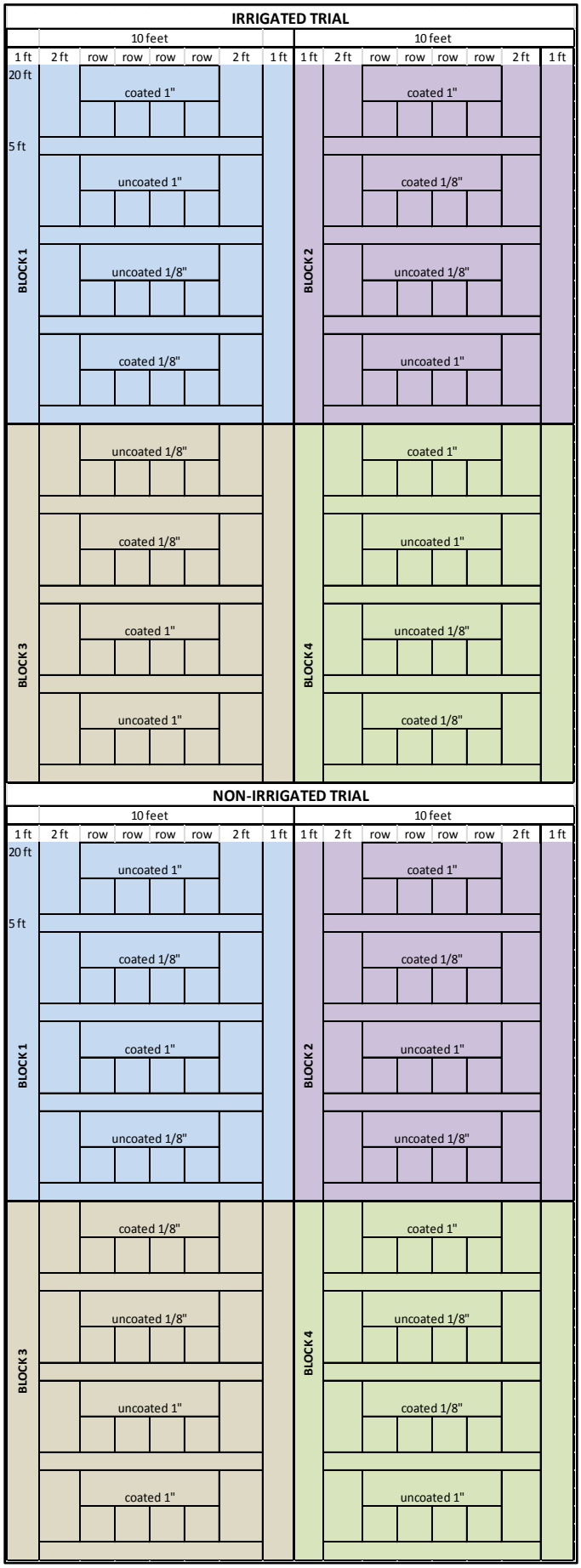
Seeding trials were designed to test planting depths and pre-treatment seeding methodologies after review of existing studies and restoration attempts. Two planting depths were used in these trials: 1/8” and 1”. The shallowest planting depth, 1/8”, was chosen to represent broadcast

seeding methods. All trials were established with a Kincaid No-Till Cone Plot Planter. Seed was either coated or non-coated. A commercial seed coating company was contacted and provided small batches of coated seed for these trials. The coating consisted of a proprietary mix of minerals and selected nutrients typically used for grass seed. Coated seed and uncoated seed per pound were counted with the Seedboro 801 Count-A-Pak Seed Counter in order to calculate seeding rates. All plots were seeded at 20 PLS per square foot into either an irrigated or non-irrigated trial. Each treatment was replicated four times. All trials were installed into fields with a Comoro sandy loam soil.

Trial installation dates were chosen to coincide with literature recommendations for successful seeding. On February 27th, 2013 Tucson PMC personnel installed the *Colegyne ramosissima* seeding trial into a field at the PMC.

***Coleogyne ramosissima* uncoated seed at 1/8" depth**

***Coleogyne ramosissima* coated seed at 1/8" depth**

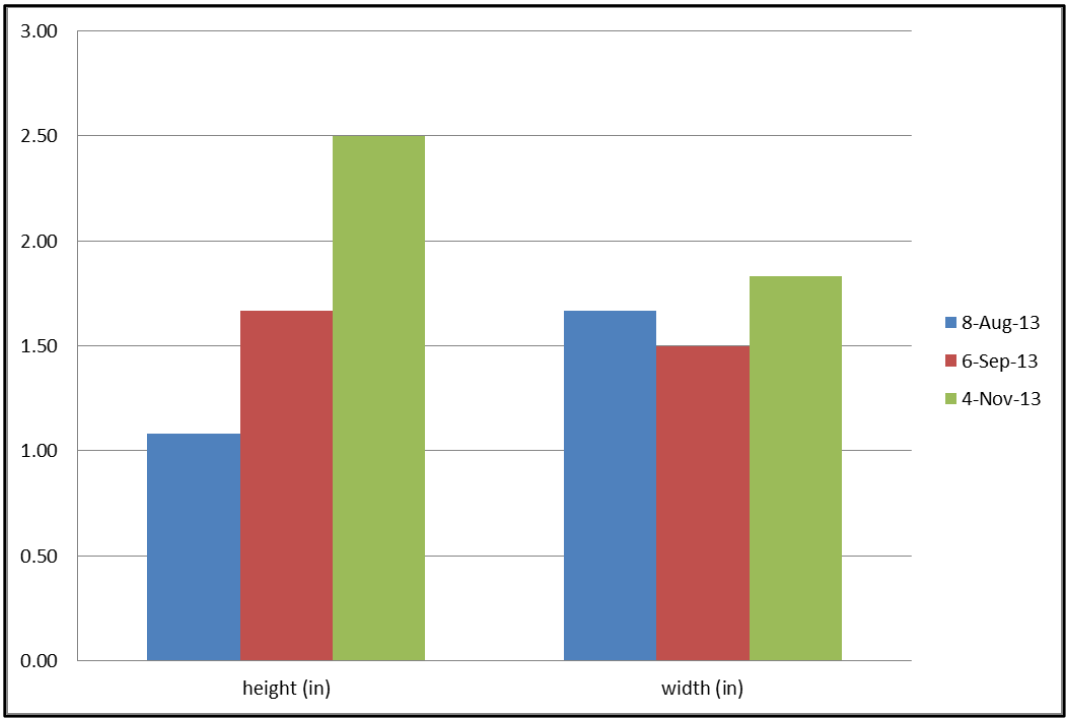


Plot plan for *Colegyne ramosissima* seeding trial

Marking of plots prior to *Colegyne ramosissima* seeding

The *Colegyne ramosissima* irrigated trial was irrigated on average once every two weeks after establishment for a total application of approximately 0.49 acre feet of water. The first emergence of seedlings was recorded on May 21, 2013. All but one of the 30 emerging seedlings were found in the 1" depth seeding plots. The uncoated seeds had slightly more germinated seedlings than the coated seeds. This is similar to findings reported in another *Colegyne ramosissima* restoration trial. Jones found that encapsulation or coating had negative effects in the first growing season but permitted the seeds to persist into the second growing season (Jones, 2012). The germinated seedlings had incredibly low survival rates; perhaps due to the unusual summer temperatures at the Tucson PMC. The National Weather Service Forecast Office reported that June 2013 was the hottest June on record with each day reaching triple digit highs. The consecutive triple digit streak was not broken until July 10th when temperatures fell back to 98°F. By August, only four seedlings remained in all of the plots.

Average height and width measurements of surviving plants were begun in August. Measurements were taken from three plants each month, with the exception of October, to record growth rates. There is a noticeable dip of 0.5 inches in the measurements of width taken in September. This is likely due to the use of averages to create the graph. Measurements are ongoing at the time of this report. It is expected that with the cooler winter temperatures, growth of the plants will increase. Additionally, plots will be continuously monitored for further germination in 2014. No germination was recorded in any of the unirrigated plots. Precipitation events after trial establishment totaled approximately 3.95 inches which should have been enough for some germination (Baskin, 2000). However, the total precipitation was delivered by numerous, scattered events with very little precipitation per event.



Average height and width of *Colegyne ramosissima* seedlings over time

***Colegyne ramosissima* seedling in early July**

The *Ambrosia dumosa* seeding trial was installed on April 29th, 2013. The seed was unprocessed in both the coated and uncoated plots. Soil temperatures at planting were 84.4°F at the surface and 77.2°F at a 1" depth. The first emergence of 113 seedlings from the irrigated trial was recorded on July 10th. The treatment with the highest average emergence was the uncoated 1" planting depth followed by the coated 1/8", uncoated 1/8", and coated 1".

Average number of germinated *Ambrosia dumosa* seedlings in the irrigated trial on July 10th, 2013

Treatment	Block 1	Block 2	Block 3	Block 4	Average Germinated Seedlings
coated 1"	2	4	4	12	5.50
uncoated 1"	14	3	18	0	8.75
coated 1/8"	7	1	19	4	7.75
uncoated 1/8"	10	0	10	5	6.25

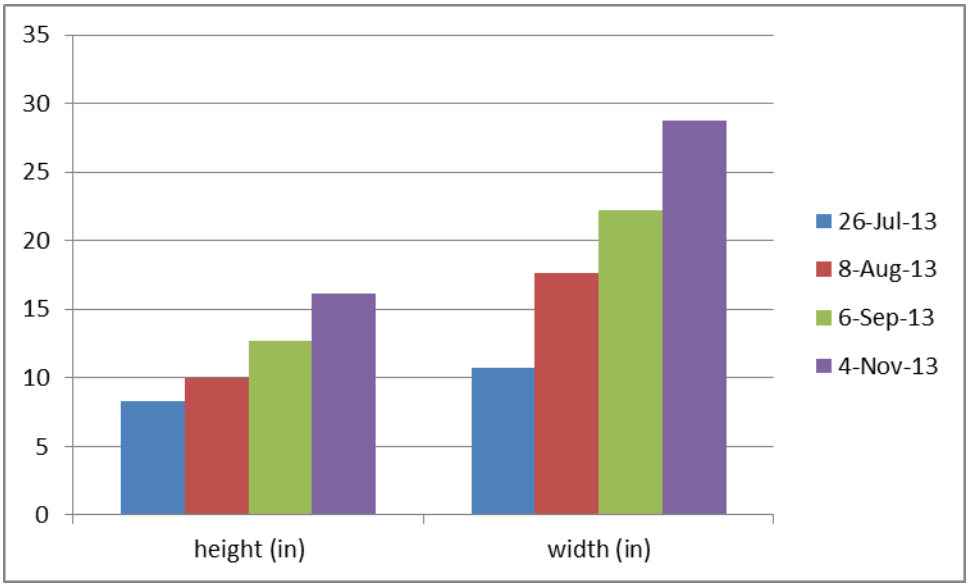
***Ambrosia dumosa* uncoated seed at the 1/8" planting depth**

The seedlings were evaluated monthly, with the exception of October, for growth and persistence. By November, 103 plants persisted in the irrigated plots and most had begun to produce seed themselves. Preliminary results indicate that the uncoated 1/8" planting depth treatment is the most successful for persistence of *Ambrosia dumosa* in irrigated plots. However, the differences between treatments are not significant. Therefore, these results likely do not warrant the increased cost of seed coating treatments.

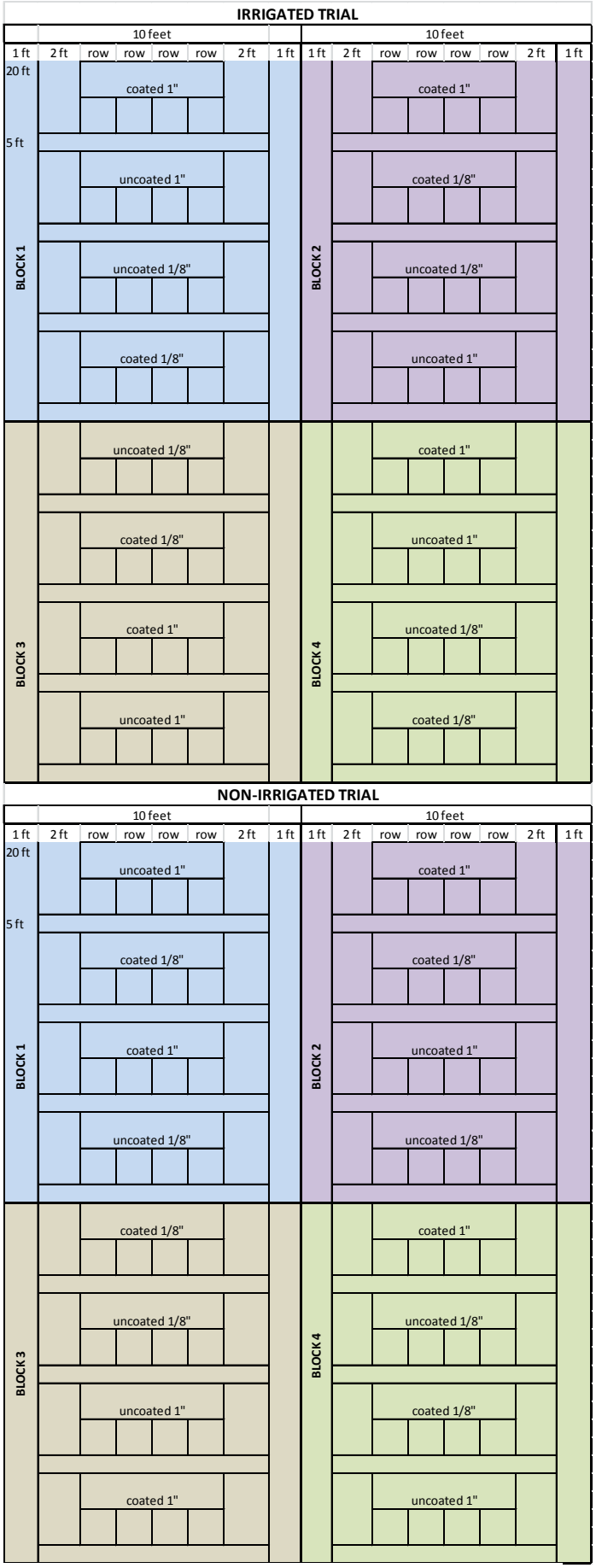
Average number of *Ambrosia dumosa* plants in the irrigated trial on November 4th, 2013

Treatment	Block 1	Block 2	Block 3	Block 4	Average Number of Plants
coated 1"	2	3	10	9	6.00
uncoated 1"	11	3	12	0	6.50
coated 1/8"	8	1	12	3	6.00
uncoated 1/8"	8	1	12	8	7.25

As in the *Colegyne ramosissima* trial, height and width were measured to estimate the growth rate of *Ambrosia dumosa*. Measurements were taken from ten randomly selected plants. The growth rate of these plants was influenced by the total amount of water applied to the irrigated trial. An estimated 0.74 acre feet of water was applied to the trial from March 2nd until November 16th. No germination was recorded in any of the unirrigated plots. Precipitation events after trial establishment totaled approximately 1.49 inches which is likely not enough for successful germination. Additionally, the events were scattered with less than 0.5 inches per event. All plots will continue to be monitored in 2014.



Average height and width of *Ambrosia dumosa* seedlings over time



Plot plan for *Ambrosia dumosa* seeding trial

Blocks 1 and 3 of the irrigated *Ambrosia dumosa* seeding trial in November of 2013

On June 21st, 2013 Tucson PMC personnel installed the *Larrea tridentata* seeding trial. The seed was unprocessed in both the coated and uncoated plots. Soil temperatures at planting were 78.8°F at the surface and 75.38° F at 1" deep. There was one seedling emerged on the 8th of August. By the 15th of August, a total of 30 seedlings had emerged and evaluations were conducted. There was an obvious increase in average number of emergent seedlings in the coated 1/8" treatment.

Average number of *Larrea tridentata* seedlings in the irrigated trial on August 15th, 2013

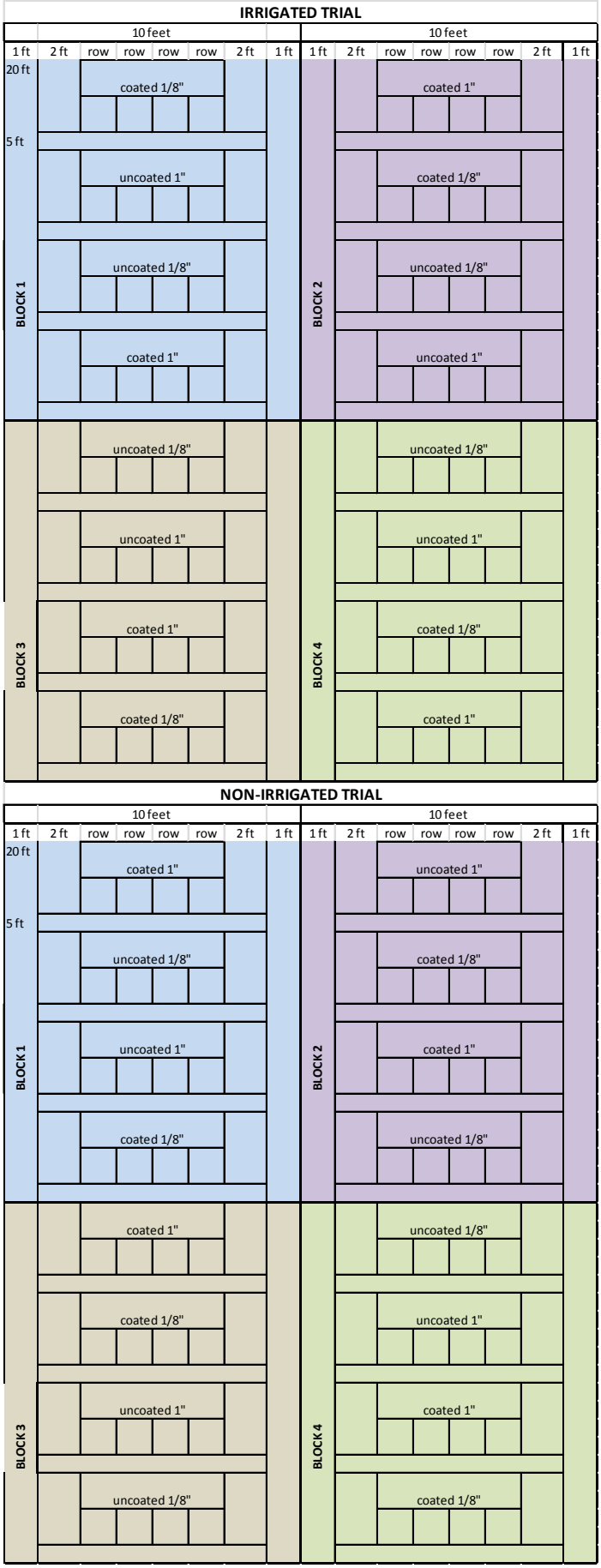
Treatment	Block 1	Block 2	Block 3	Block 4	Average Germinated Seedlings
coated 1"	0	0	0	0	0
uncoated 1"	0	1	0	0	0.25
coated 1/8"	0	6	4	9	4.75
uncoated 1/8"	0	7	1	2	2.5

***Larrea tridentata* seedling in August**

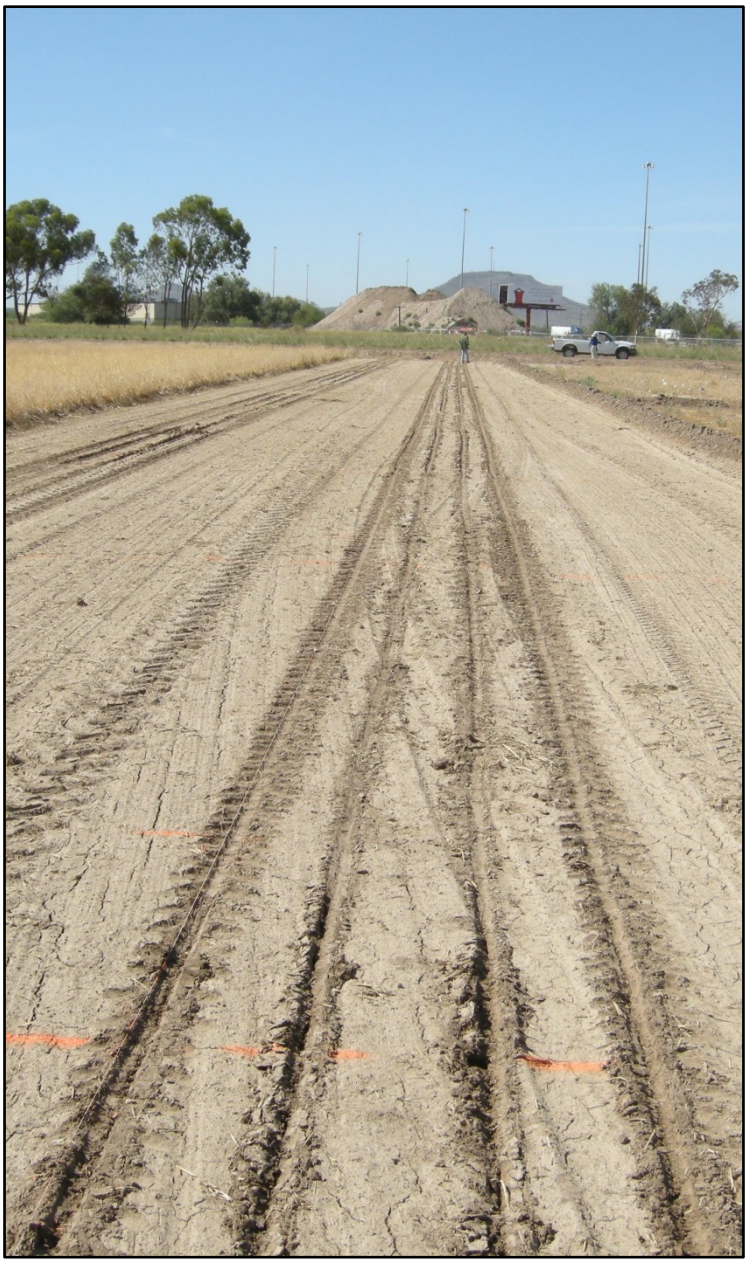
Evaluations were taken monthly with the exception of October. As of November 2013, a majority of the seedlings had expired for unknown reasons; bird herbivory of seedlings is a possibility but impossible to prove. However, the coated 1/8" treatment still showed the highest number of surviving plants. No germination was recorded in any of the unirrigated plots. Precipitation events after trial establishment totaled approximately 1.49 inches which is likely not enough for successful germination. Additionally, the events were scattered with less than 0.5 inches per event. All plots will continue to be monitored in 2014.

Average number of *Larrea tridentata* plants in the irrigated trial on November 4th, 2013

Treatment	Block 1	Block 2	Block 3	Block 4	Average Number of Plants
coated 1"	0	4	0	0	1
uncoated 1"	0	1	0	0	0.25
coated 1/8"	0	7	0	1	2
uncoated 1/8"	0	0	0	2	0.5



Plot plan for *Larrea tridentata* seeding trial



***Larrea tridentata* seeding trials**

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Alkali Sacaton Salinity Trial

Study ID Code AZPMC-T-1301-CR

Title Alkali Sacaton (*Sporobolus airoides*) Salinity Trial

National Project No. Natural Areas 1.1

Study Type Initial Evaluation

Study Status Active

Location AZPMC

Study Leader Heather Dial, Erin Boyd AZPMC

Duration 2011-2013

Cooperators N/A

Description Alkali sacaton has multiple releases and accessions, either in commercial production, recently released or under current development. Recent studies comparing the forage production and seed harvests of four accessions of alkali sacaton developed for four different regions of the southwest have shown no significant differences between the varieties (Briggs and others 2010). Alkali sacaton has a high salinity tolerance (Mass 1990). This trial is designed to determine if there are significant differences in salinity tolerances between the four previously studied accessions of alkali sacaton.

Status of Knowledge *Sporobolus airoides* typically grows on dry, sandy to gravelly flats or slopes, at elevations from 50 to 2350 m. It is usually associated with alkaline soils. Alkali sacaton grows in saline and nonsaline soils, sometimes in dense, pure stands. Alkali sacaton has been reported from sites with soil salinity ranging from 0.003% to 3%. It grows in soil textures from sand to clay, usually with low organic matter. It is tolerant of both drought and inundation by water. Alkali sacaton has a wide range of distribution throughout most states west of the Mississippi river (USDA NRCS 2011).

Experimental Design Randomized complete block with 4 replications, 5 salinity treatments and 4 accessions (Attachment 1). Regression analysis will be considered depending on significance of results.

Materials & Methods This trial will be conducted in the greenhouse. 20 individual plants of the four accessions/releases to be used in the trial will be grown from seed in 24cm x 6.4cm Deepots using a peat and perlite growing medium. Once all plants reach a height of 14 cm, they will be trimmed and maintained at a height of 10 cm until treatments begin.

20 mL of 5 different salinity solutions will be applied to the soil surface of the potted plants weekly. The salinity solutions chosen for the trial are based upon the threshold and maximum salt tolerances for alkali sacaton (Majerus 1996). The salinity solutions will be mixed in the AZPMC lab using NaCl. The EC of each solution will be checked before use with a Hanna Instruments EC meter.

EC (ds/M)	Molarity	Grams of NaCl per liter
0	0	0
15	0.15 M	0.88
25	0.25 M	1.46
35	0.35 M	2.05
45	0.45 M	2.63

A petri dish will be placed under each pot to collect any solution that may run through the potted soil. Collected solution will be left in place for re-adsorption. Plants will be watered with tap water as needed.

Salinity solution application will continue until all plants are dead. Plant height will be measured weekly (mm) after treatments begin. Visual scores of foliage health will be taken weekly beginning one week after the first salinity solutions application to gauge the response of the plants. Visual scoring will be 1-10 with 1 indicating that all foliage of the plant is green and healthy and 10 indicating all foliage brown and dead. At the conclusion of the trial, (once all plants within a specified treatment are dead or 60 days have elapsed) biomass from each plant will be harvested, weighed, dried, and weighed again.

Final Evaluations

Salt tolerance of the accessions will be measured by comparing biomass yield and foliage scores against the EC of the salinity solutions used.

Technology Transfer Products

Internal reports, research article

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Introduction

Alkali sacaton (*Sporobolus airoides*) is a perennial warm-season bunch grass. It is native to the southwest United States and grows in saline and non-saline coarse, medium, and fine textured soils. Alkali sacaton is a facultative halophyte, with a wide tolerance to salinity. The purpose of this trial is to determine if there are differences in salinity tolerances between four accessions of alkali sacaton.

'Vegas germplasm' alkali sacaton was developed using nine different accessions collected in southern Nevada. 'Vegas' alkali sacaton's defined area of use is Major Land Resource Area (MLRA) 30. MLRA 30 is in the Mojave Desert and receives 5 to 20.5 centimeters of precipitation annually. The material that became 'Saltalk' alkali sacaton was collected from a native stand in Beckham County, near Erick, Oklahoma. This release was selected for its use in revegetation of saline and alkaline sites, among other uses. This grass is able to tolerate higher levels of salinity than other species. 'Salado' alkali sacaton was collected near Claunch, New Mexico. Saltalk and Salado releases come from places where precipitation and winter temperatures are similar. Annual precipitation is 30-48 cm and the winters have lows of -17 to -15 C. The California experimental line, 9083020, was collected near the Kern National Wildlife Refuge in Wasco, Kern County, California. Average annual precipitation is 30 to 76 cm. The summers are long, dry, and hot, while winters are cool and rainy.

Materials and Methods

The experiment was set up as a randomized complete block with 4 replications, 5 salinity treatments, including a distilled water control, and 4 alkali sacaton accessions. Twenty individual plants of each accession were grown in a greenhouse using 24cm x 6.4cm Deepots with a peat and perlite medium. The plants were grown from seed in May until they reached a height of 14 cm. They were trimmed to a height of 10 cm before the salinity applications began on May 29.

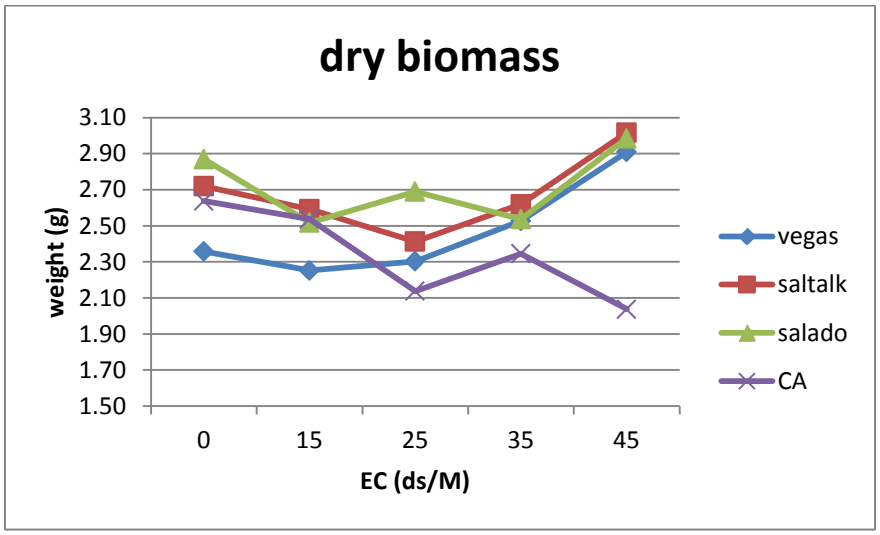
Five salinity solutions were prepared weekly using sodium chloride and distilled water. The electrical conductivity (EC) of each solution was measured using a Hanna Instruments EC meter to ensure that solutions were 0, 15, 25, 35 and 45 ds/M, respectively, after their preparation. 20 mL of each solution was applied to each plant weekly from May 29 through June 19. On June 26, the salinity solution amount was increased to 60 mL per plant per week and remained that amount through the end of the trial. After the experiment began, the plants were hand watered twice weekly with tap water to ensure that their performance was unaffected by drought stress.

Approximately 150 mL of water was applied to each plant on Mondays and Fridays. The plants were evaluated weekly based on their heights and condition. Each week the average height of each plant was recorded. A visual score was also given to each plant with 1 indicating that the plant was green and healthy and 10 indicating that the plant was brown and dead. The experiment ended on August 7 after 60 days had elapsed. The plants were clipped, weighed, and put in a forced air oven to dry for 5 days. Their wet and dry weights were recorded and used to estimate biomass production.

Trial set up in the greenhouse.

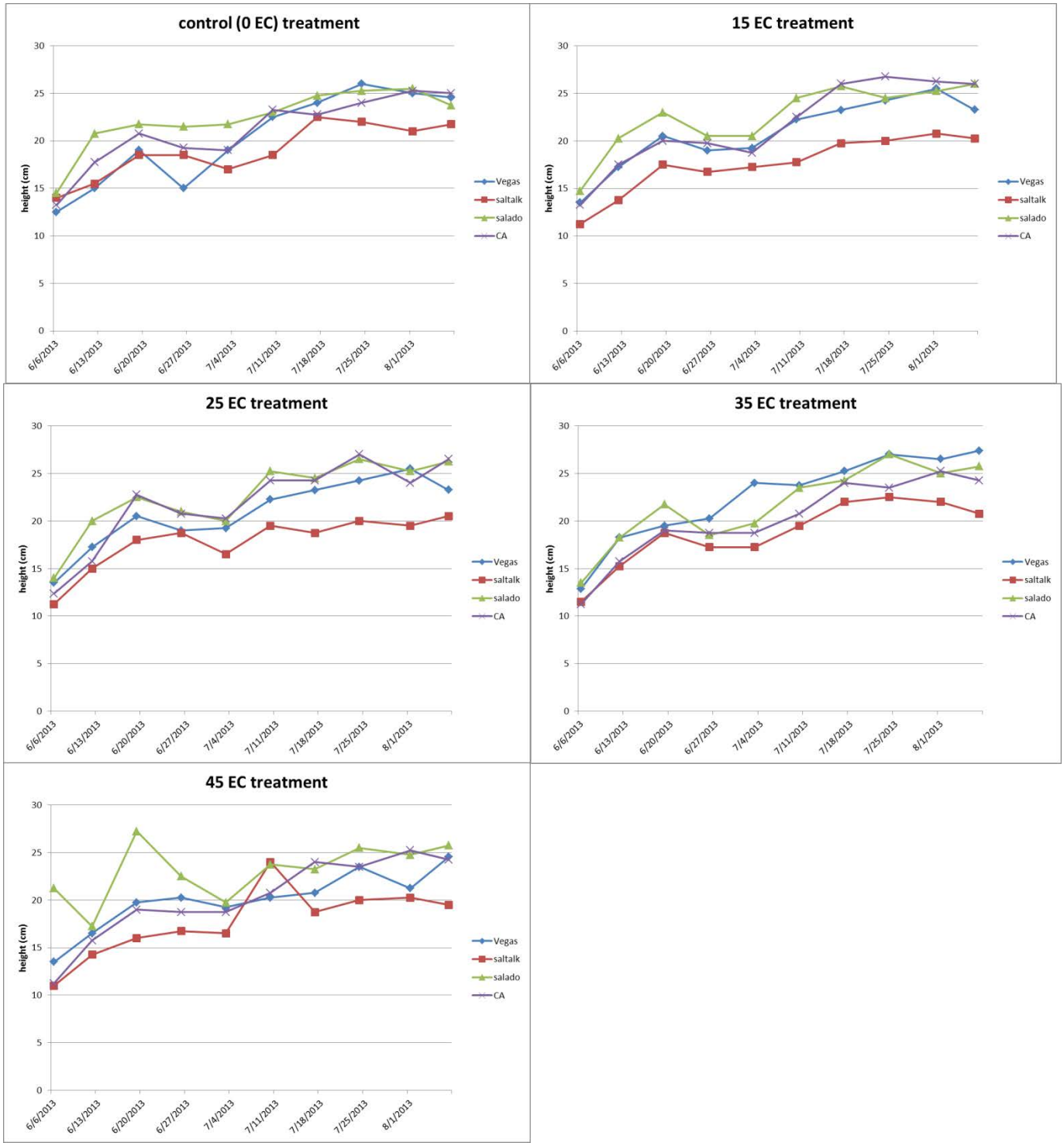
Results

The dry biomass production weights indicate that the accessions did not differ from each other, with the exception of California. The Vegas, Saltalk and Salado accessions showed growth, even as the salinity solution concentrations increased. Salado seemed to perform best at an EC of 25 ds/M. The growth of the California accession decreased as the concentration of the salinity solutions increased.



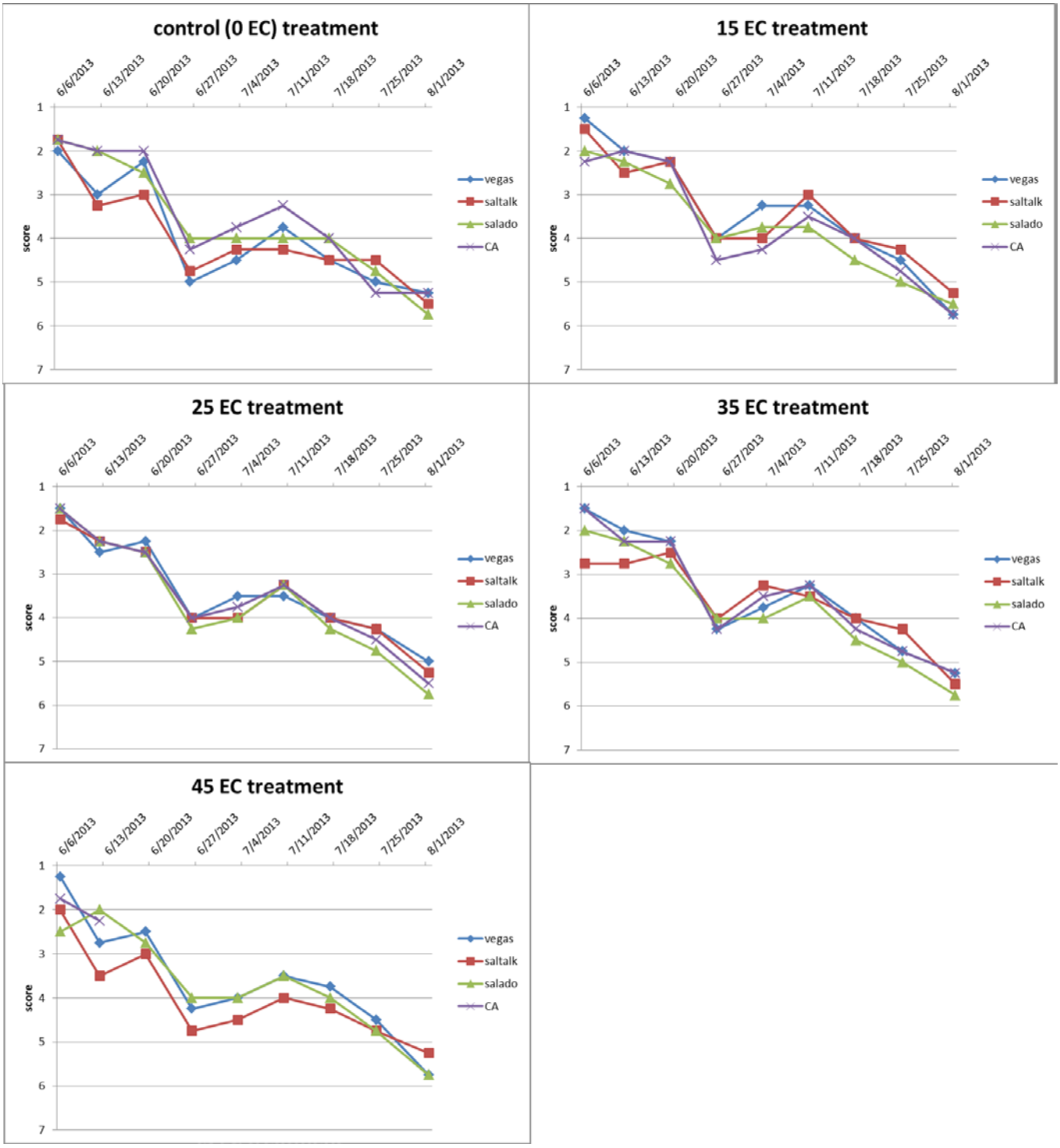
Average dry biomass in grams for each accession after samples were oven-dried

Analyses of the average heights by salinity solution applied show no differences between the accessions. The general trend indicates that the plants increased in height, even in the plants that received treatments with higher concentrated salinity solutions. All accessions grew taller over time.



Average height in centimeters over time for each accession

Condition was scored according to greenness and health, with 1 being green and healthy and 10 being brown and dead. In the Saltalk, Salado and California accessions, there was no difference between the condition score and concentration of salinity solution applied. However, it can be observed in the Saltalk graph that the 15, 25 and 35 EC solution treatments were in better condition than the 0 and 45 EC treatments. In the Vegas accession, all of the treated plants did better than the control plants. All of the plants decreased in score over time.



Average condition over time

Discussion

Based on the results, there is no appreciable difference in the salinity tolerances of the Vegas, Salado and Saltalk accessions. In fact, with the exception of California, they generally seemed to produce more biomass, grow taller, and be in better condition when salinity solutions were applied. The California accession decreased in biomass as the concentration of salinity solutions increased. The conditions for all of the plants declined over time. It was expected that the

condition scores for the control group would improve or remain constant over time; however, they declined as well. This may be attributed to continued drought stress.

There were some variables that could have been better planned for. The plants became drought stressed at the beginning of the trial, so water was applied in fixed amounts twice a week. The tap water that was applied may have flushed out the salts and since that water was not reabsorbed, it evaporated. Instead of using standard petri dishes, it would have been beneficial to have taller containers to catch the salinity solutions to allow the plants to reabsorb the solutions and not have to be watered. Higher concentrations of salinity solutions could be applied because the plants did not reach their permanent wilting points and die. Biomass analysis for significant differences in nutrients between the cultivars could also be done. This analysis would have applications in rangeland settings.

This trial shows that the Vegas, Saltalk and Salado accessions are salt tolerant once they are established. The implication is that they would be tolerant on saline irrigation water for producers who may establish fields for seed production.

Evaluation of Pollinator Specific Seeding Mixes

Study ID Code	AZPMC-T-1303-OT
Title	Evaluation of Pollinator Specific Seeding Mixes
National Project No.	Natural Areas 1.1
Study Type	Initial Evaluation
Study Status	Active
Location	AZPMC
Study Leader	Heather Dial, AZPMC
Duration	2012-2014
Cooperators	Xerces Society
Description	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. These seeding trials 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. 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 & Methods	Seed will be purchased by the Xerces Society and sent to the Tucson PMC. Two mixes will be drill seeded into separate locations within one 0.2 acre field border. The mixes will be evaluated monthly for establishment, bloom phenology and plant health. The seed mixes are comprised of species predicted to do well in the understory of vineyards in Arizona. As such, the field will require irrigation at least monthly. 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 be used minimally in order to best protect pollinator habitat. Species to be used: *Achillea millefolium, Cleome serrulata, Dalea candida, Eschscholzia californica, Gaillardia aristata, Linum lewisii, Mondarda fistulosa, Penstemon eatonii, Penstemon palmeri, Ratibida columnifera, Phacelia tanacetifolia** **Phacelia* will only be planted into one mix to evaluate its ability to suppress weeds.
Final Evaluations	Plant emergence, performance, bloom periods and irrigation required
Technology Transfer Products	Internal reports, updated pollinator planting guide specifications
References	

Growing season 2013:

The trial was seeded in December of 2012. A total of 1.16 acre foot of irrigation water was applied to the trial in 2013 in addition to 6 inches of precipitation. Several of the planted species never emerged including: *Dalea candida*, *Linum lewisii*, and *Monarda fistulosa*. Bloom phenology and plant health were monitored during the year and are reported below. In 2014, irrigation frequency and amount will be reduced substantially to monitor how well the emerged species perform under drought stress.

Bloom phenology of species planted into the pollinator seeding trial at the Tucson PMC in 2013

			Date and Bloom (assess % bloom of each species over entire planted area)								
Latin Name	Common Name	Date Planted	21-03-13 % Bloom	04-04-13 % Bloom	26-04 -13 % Bloom	13-05-13 % Bloom	17-06-13 % Bloom	09-07-13 % Bloom	09-08-13 % Bloom	12-09-13 % Bloom	31-10-13 % Bloom
Achillea millefolium	Common yarrow	12/4/2012	0	0	0	25-50%	75-100%	1-25%	0	0	0
Cleome serrulata	Rocky Mountain beeplant	12/4/2012	1-25%	75-100%	50-75%	25-50%	1-25%	1-25%	1-25%	1-25%	0
Dalea candida	White prairie clover	12/4/2012	0	0	0	0	0	0	0	0	0
Eschscholzia californica	California poppy	12/4/2012	75-100%	25-50%	75-100%	50-75%	1-25%	0	0	0	0
Gaillardia aristata	Blanketflower	12/4/2012	0	0	0	50-75%	50-75%	75-100%	75-100%	50-75%	50-75%
Linum lewisii	Lewis' flax	12/4/2012	0	0	0	0	0	0	0	0	0
Monarda fistulosa	Wild bergamot	12/4/2012	0	0	0	0	0	0	0	0	0
Penstemon eatonii	Firecracker penstemon	12/4/2012	0	0	0	0	0	0	0	0	0
Penstemon palmeri	Palmer's penstemon	12/4/2012	0	0	0	0	0	0	0	0	0
Phacelia tanacetifolia	Lacy phacelia	12/4/2012	75-100%	1-25%	0	0	0	0	0	0	0
Ratibida columnifera	Upright coneflower	12/4/2012	0	0	0	0	0	1-25%	75-100%	50-75%	50-75%

0% (no bloom); 1 to 25%; 25 to 50%; 50 to 75%; 75 to 100% (peak bloom)

Plant health of species planted into the pollinator seeding trial at the Tucson PMC in 2013

		Months							
Latin Name	**Common Name**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**
Achillea millefolium	Common yarrow								
Cleome serrulata	Rocky Mountain beeplant								
Dalea candida	White prairie clover								
Eschscholzia californica	California poppy								
Gaillardia aristata	Blanketflower								
Linum lewisii	Lewis' flax								
Monarda fistulosa	Wild bergamot								
Penstemon eatonii	Firecracker penstemon								
Penstemon palmeri	Palmer's penstemon								
Phacelia tanacetifolia	Lacy phacelia								
Ratibida columnifera	Upright coneflower								

Color blocks indicate plant present in trial; darker color indicates peak bloom/abundance

Summer Cover Crops Trial

Study ID Code AZPMC-T-1305-CP

Title Summer Cover Crops Trial

National Project No.

Study Type Initial Evaluation

Study Status Active

Location AZPMC

Study Leader Manuel Rosales, Heather Dial, Blase Evancho

Duration 2013-2018

Cooperators Tucson Soil Survey Office

Description There is a need to determine which cover crops currently available in the market will work best in common crop rotations used in the AZPMC service area. Within Pima County, AZ, a typical cotton rotation follows a two year pattern:

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Year 1	Small Grains					Fallow						
Year 2	Fallow	Seed bed prep		Cotton								

Our goal is twofold, we want to test the performance of warm season cover crops planted during the months that fields would typically be fallow and we want to measure the effects of the cover crops on soil quality and health.

Status of Knowledge Cover crops help improve soil health by reducing erosion, increasing soil organic matter content, improving air and water movement through soil, reducing soil compaction, capturing and recycling nutrients in the soil profile, managing soil moisture and promoting biological nitrogen fixation by using leguminous cover crop species.

Experimental Design Randomized complete block with 4 replications, 3 entries

Materials & Methods In early June, four half acre fields will be planted to the following cover crops: 'Iron and Clay' cowpeas (50 PLS lbs/acre), 'Stonewall' soybeans (77 PLS lbs/acre), 'OK2000' mungbeans (19 PLS lbs/acre) and 'Sordan 79 headless' sorghum-sudan grass (37 PLS lbs/acre).

Prior to planting the cover crops, we will work with the Tucson Soil Scientists to test the chemical, physical and biological properties of the soil. We will also use the Soil Quality Test kit to test for the following properties: soil respiration, infiltration, bulk density, electrical conductivity, soil pH, soil nitrate, aggregate stability and soil slaking. We will also measure soil compaction prior to planting using the Dickey-john penetrometer. Soil samples will be taken and sent to a local lab for analysis for plant available nutrient levels, salinity, and exchangeable cations.

These properties will be measured again at the conclusion of the growing season of the cover crops.

In addition to the soil health measurements the following data will be collected:

- Water use will be recorded and monitored for each species. Soil moisture will be estimated with soil tensiometers. Water will be applied to the fields when soil moisture is at 50 percent of field capacity.

- Incidence of pests and disease will also be recorded for each species.
- Biomass production will be estimated monthly during the growing period of the cover crops. Four, randomly selected, 1 meter x 1 meter samples from each field will be clipped. Fresh and dry weight of clipped sample will be recorded.
- Prior to or after clipping, weed pressure will be measured by counting/identifying the weed species present in each 1 meter x 1 meter frame.

Leguminous cover crops will not be cut and will be terminated with a roller-crimper at the stage recommended in the published literature for the most benefit to soil health. Sorghum-sudan grass will be cut during the growing season to encourage deeper root growth and for manageability. Sorghum-sudan grass will also be terminated with a roller-crimper. Soil tests for available nitrogen will be conducted 30, 60 and 90 days after incorporation.

Final Evaluations

Biomass production; weed suppressive potential; soil biological, chemical and physical properties; evaluation of soil quality test kit results against lab results

Technology Transfer Products

Internal reports, research articles, training opportunities for field office personnel on the soil quality test kit

References

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Creamer, N.G. and K.R. Baldwin. 2000. An Evaluation of Summer Cover Crops for Use in Vegetable Production Systems in North Carolina. Hort. Science 35: 600–603.

Growing season 2013:

Composite soil samples comprised of four 0-6" depth randomly sampled areas were taken from each border to be planted in early June for laboratory analysis. On the 18th of June, Tucson PMC personnel used the soil quality test kit to perform soil respiration, infiltration, bulk density, pH, EC and nitrate tests at two locations in the fields to be planted to the summer cover crop trial. Results are summarized in the table below and indicate there are slight differences between the western (border 10) and eastern (border 16) borders in the field although all borders are classified as Comoro-sandy loam. Based on these results, the soil in border 16 had higher biological activity, a higher infiltration rate, lower bulk density and fewer salts than the soil in border 10. These tests will be performed again at the conclusion of the study to gauge changes in soil quality.

Soil quality test kit results prior to establishment of warm season cover crop trial in 2013

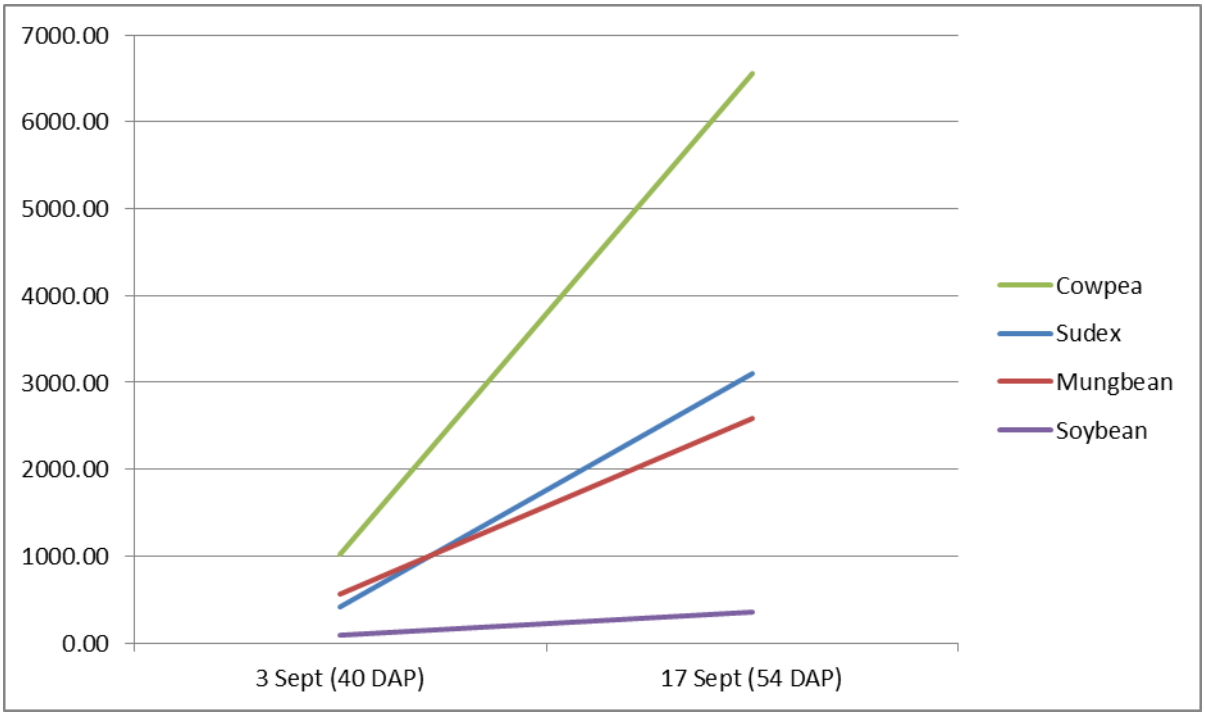
	Soil Respiration (lbs CO2-C/acre/day)	Infiltration (in/hr)	Soil Bulk Density (g/cm3)	pH	EC (dS/m)	Estimated Soil NO3-N (ppm)
Border 16	8.5	1.9	1.33	8.3	0.79	30
Border 10	2.0	1.1	1.47	8.0	1.21	30

On July 10th, Tucson Soil Survey personnel dug two 60" pits in the fields to develop two soil pedon descriptions. The pit locations were in the western and eastern most borders in the field. Similar to the soil quality test kit results, the pedon descriptions indicate slight differences between two field locations. These pedons will again be described at the end of the study to determine if the cover crops affected soil quality to include root quantity, size and location, quantity and size of pores.

On the 25th of July, 'Iron and Clay' cowpeas (50 PLS lbs/acre), 'Stonewall' soybeans (77 PLS lbs/acre), 'OK2000' mungbeans (19 PLS lbs/acre) and 'Sordan 79 headless' sorghum-sudan grass (37 PLS lbs/acre) were planted into borders 9-16 in field four. Tensiometers were installed in each planting after the initial irrigation. When tensiometers read approximately 50 centibars of soil suction, the plantings were irrigated.

During the trial, biomass production was estimated by clipping all vegetation to 6" in four randomly selected $1m^2$ frames in each planting 40, 54 and 113 days after planting (DAP). The clippings were weighed for a wet weight and then dried in a forced air oven until weights were stable. Dry weights were used to calculate average dry matter yield. Weed pressure was evaluated in the four frames as percent ground cover prior to clipping in each planting. Percentages from each frame were averaged to obtain an average percent ground cover. Termination dates of each planting varied according to seed set. The soybean and mungbean fields were roller crimped on the 17th of September. The cowpea field was roller crimped on 30 September and the sorghum-sudex was roller-crimped on 21 November.

The cowpeas, mungbeans and sorghum-sudan grass established full stands. The soybeans did not germinate well and never reached a full stand. As termination dates varied between the species, comparisons of all four species can only be made before the termination of the soybean and mungbean plantings 54 DAP. Cowpea produced far more biomass (6551 lbs/acre) than sorghum-sudan (3101 lbs/acre), mungbean (2582 lbs/acre) and soybean (353 lbs/acre). All plantings received the same amount of water (0.28 acre feet) and the same precipitation input of 0.73".



2013 Biomass production (lbs/acre) 40 and 54 DAP in the warm season cover crop trial at the Tucson PMC

Using the biomass production numbers and input costs of seed and irrigation water, it is possible to estimate the price per pound of biomass produced of each cover crop species planted. Using cowpea biomass production as an example, at the Tucson PMC, it cost 0.004 cents to produce one pound of cowpea biomass.

Price per pound of biomass produced at the Tucson PMC during the 2013 summer cover crop trial

Seed Price/lb	Acres	Seeding rate (PLS lbs/acre)	Price/acres seeded	Total Acre feet of water applied	Cost/acre ft.	Total cost of water	Biomass (dry lbs/acre) 54 DAP	Price/lb of biomass
Sudex								
1.05	0.5	37	19.43	0.28	3.00	0.84	3100.71	0.0065
Mungbean								
1.1	0.5	19	10.45	0.28	3.00	0.84	2582.26	0.0044
Cowpea								
0.88	0.5	50	22.00	0.28	3.00	0.84	6551.41	0.0035
Soybean								
0.65	0.5	77	25.03	0.28	3.00	0.84	352.58	0.0734

The biomass production of cover crops can increase organic matter in the soil whether it is incorporated or left on the soil surface. Organic matter improves the biological, chemical and physical properties of soil, provides readily available nutrients for plant and microbial uptake and is a key component of soil pH. Additionally, leguminous cover crops such as cowpea are significant because of their potential to add nitrogen to the soil through biological nitrogen fixation. Cowpeas can provide over 100 lbs of nitrogen per acre to the soil (http://ucanr.org/sites/ce_riverside/files/96022.pdf).

Cowpea also provided superior weed suppression during the trial compared with the other plantings. However, it was planted at a higher seeding rate than other species with the exception of soybean. Soybean did not germinate well at the Tucson PMC.

Percent of ground cover provided by warm season cover crop trial species at the Tucson PMC in 2013

	avg % cover	avg % cover weeds	avg bare ground
Sudex			
3-Sep-13	47.50%	6.00%	46.50%
17-Sep-13	75.00%	5.25%	19.75%
Soybean			
3-Sep-13	11.25%	37.75%	51.00%
17-Sep-13	7.50%	35.00%	57.50%
Mungbean			
3-Sep-13	60.00%	22.75%	17.25%
17-Sep-13	50.00%	17.50%	32.50%
Cowpea			
3-Sep-13	86.25%	4.00%	9.75%
17-Sep-13	80.00%	0.50%	19.50%

Roller-crimping was not an effective method of termination for any of the plantings. The roller crimper flattened the plants to the ground but in general, did not snap the stems of the cover crops. As a result, 30 and 60 days after termination (DAT) soil samples were not scheduled until the plantings winter killed. The soybean field never reached full cover and was omitted from soil sampling.

30 DAT samples were taken from the cowpea and mungbean fields in late December with 60 DAT samples taken in January 2014. The sorghum-sudex field did not winter kill until late December. Only one 30 DAT sample was taken in January due to the time needed to prepare the field for the following cash crop. Individual samples were composites of four 0- 6” depth samples taken randomly within each planting

The soil samples show increases in organic matter from just one year of cover cropping. As expected with increased organic matter, the samples also show an increase in soil pH and the concomitant increase of cation exchange capacity (CEC). Conversely, the electrical conductivity (EC) of all plantings decreased over time. However, sodium levels in all plantings increased. Micronutrient levels varied over time depending on the crop planted.

In 2014, the cover crop fields and an adjacent fallow field will be planted to a cash crop, ‘Orita’ durum wheat. Wheat seed yields will be compared between the cover crop fields and the fallow field to gauge what effect the individual cover crops have on yields.

Pre and post soil sample results for three species of summer cover crop planted at the Tucson PMC in 2013

cowpea	pH	EC (dS/m)	Nitrate (ppm)	Phosphorus (ppm)	Potassium (ppm)	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	CEC (cmolc/kg)	%Organic matter	Sulfur (ppm)	Copper (ppm)	Iron (ppm)	Manganese (ppm)	Zinc (ppm)
pre-plant	7.96	1.58	14.1	15.6	411	2400	112	112	14.99	0.66	36.6	3.8	2.4	2.6	2.8
30 DAT	8.5	0.39	6.8	15	295	3342	164	115	19.3	1.3	21	5.6	21.4	3.2	3.6
60 DAT	8.5	0.45	15.1	18	373	3563	174	131	20.8	1.4	21	5.9	18.3	4.2	4.3
mungbean															
pre-plant	7.97	1.29	14.3	21.4	479	2260	103	113	14.37	0.49	28.9	6.5	4.2	2.1	7
30 DAT	8.7	0.44	8.4	16	395	3260	144	169	19.2	1.3	22	7.8	21.9	3.2	6.5
60 DAT	8.6	0.5	16.2	19	501	3320	156	184	20	1.4	25	7.8	18.8	4.3	7
sorghum															
pre-plant	8.01	1.41	11.8	10.3	352	2200	100	91	13.59	1.18	35.3	3	2.8	3.2	2.7
30 DAT	8.3	0.4	12.8	32	356	3246	166	109	19	1.7	17	3.4	19.6	4.2	4.6

Planting plan of 2013 warm season cover crop trial in field four at the Tucson PMC; all fields are approximately 0.5 acres.

FALLOW Borders 7 & 8	Iron and Clay' cowpeas Borders 9 & 10	'OK2000' mungbeans Borders 11 & 12	'Stonewall' soybeans Borders 13 & 14	'Sordan 79 headless' sorghum-sudan grass Borders 15 & 16

Evaluation of the Ability of Three Plant Materials Center Releases to Suppress Invasive Buffelgrass (Pennisetum ciliare)

Study ID Code	AZPMC-T-1306-IN
Title	Evaluation of the Ability of Three Plant Materials Center Releases to Suppress Invasive Buffelgrass (*Pennisetum ciliare*)
Study Type	Initial Evaluation
Study Status	Active
Location	AZPMC
Study Leader	Heather Dial, Blase Evancho
Duration	2013-2018
Cooperators	Tucson NRCS Field Office
Description	Chemical control of a significant population of buffelgrass has taken place within the 13 acre Tucson PMC exclosure at the Santa Rita Experimental Range, as well as associated satellite infestations, since 2006 (AZPMC-T-0612-IN). The majority of the infestation has been controlled since 2009. Spot spraying has been used in subsequent years to maintain control of buffelgrass. There is a need to determine appropriate methods of preventing re-infestation of sites where chemical control of buffelgrass has been successfully accomplished (http://www.buffelgrass.org/content/research-needs).
Status of Knowledge	There has been significant research into the competitive ability of native, perennial, warm season grasses against invasive, perennial, warm season buffelgrass. Most research seems to indicate buffelgrass is disturbance dependent and unable to penetrate areas that are densely vegetated. Current research also suggests that buffelgrass may outcompete native plants when emergence times are similar.
Experimental Design	Randomized complete block with 5 replications, 3 entries
Materials & Methods	Three releases, 'Loetta' Arizona cottontop, Cochise Germplasm spike dropseed and Pima Germplasm Pima pappusgrass, will be tested in a 0.10 acre area of the Tucson PMC exclosure for their ability to emerge, persist and suppress buffelgrass seedlings in an area known to have supported buffelgrass plants in the recent past. As soil disturbance has been found to be key for buffelgrass establishment, traditional seedbed preparation methods (tilling, harrowing, etc.) will not be used. The entire 0.10 acre area will be mowed with a hand held weed eater and sprayed with a 5% solution of glyphosate prior to establishing the study. The three releases will be drill seeded into five, 50 ft x 10 ft plots. Again, in an effort to minimize soil disturbance, a Truax No-Till Grass Drill will be used. This equipment prepares the planting bed and ensures high seed to soil contact without the need for traditional seed bed preparation. Two passes will be made with the drill in each plot resulting in twelve seeded rows per plot. Each release will be seeded at a rate of 25 pure live seed per square foot. The fifteen plots will be monitored with two 50 ft long point intercept transects per plot after monsoon events for up to three years. Three years is the estimated life of buffelgrass seed in the seed soil bank. The point intercept transects will

allow estimates of cover for individual species, total cover, and species composition by cover.

Final Evaluations Suppressive potential of native species versus invasive species.

Technology Transfer Products Internal reports, research articles

References

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Fernandez-Gimenez, Maria E., and Steven E. Smith. 2004. Research Observation: Nitrogen effects on Arizona cottontop and Lehmann lovegrass seedlings. Journal of Range Management. 57: 76-81.

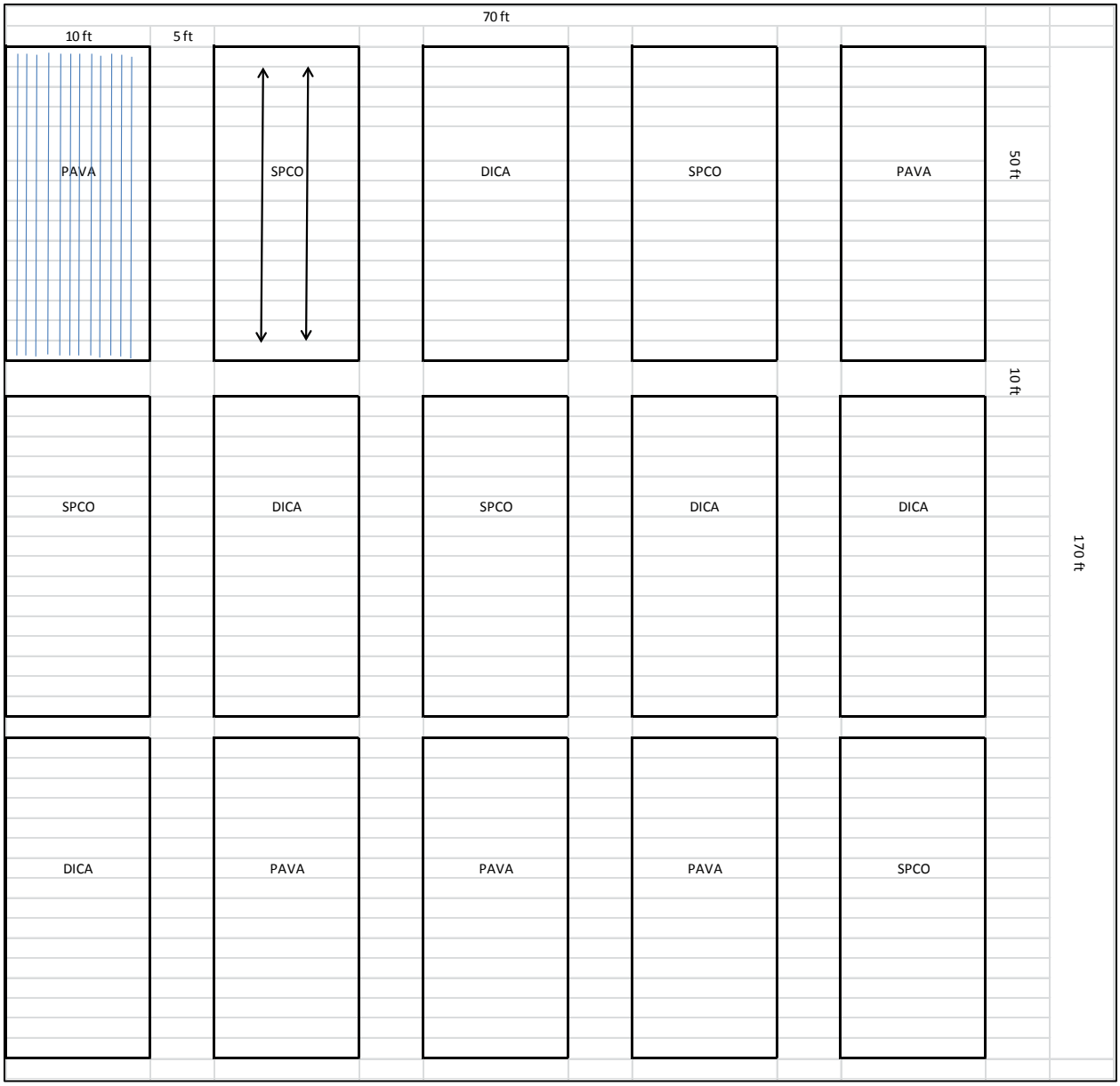
Smith, Forrest S., William R. Ocumpaugh, Paula D. Maywald and Jim Mutz. 2009. Effects of Seeding Rate and Season of Seeding on Establishment of Ten Native Grasses in the Rio Grande Plain of Texas. 62nd Society for Range Management Annual Meeting. Paper No. 1030-27.

Stevens, Jason M., and Jeffrey S. Fehmi. 2009. Competitive Effect of Two Nonnative Grasses on a Native Grass in Southern Arizona. Invasive Plant Science and Management. 2(4): 379-385.

Stevens, Jason M., and Jeffrey S. Fehmi. 2011. Early Establishment of a Native Grass Reduces the Competitive Effect of a Non-Native Grass. Restoration Ecology. 19(3): 399-406.

Growing season 2013:

The seeding trial was established August 22-23. A 0.10 acre area of the Tucson PMC exclosure known to have supported buffelgrass plants in the recent past was mowed with a hand held weed eater and sprayed with a 5% solution of glyphosate on the 22nd of August. Five, 50 ft. x 10 ft. plots of each species were drill seeded at 25 PLS seed/sq. ft. with a Truax Grass Drill on the 23rd of August.



Santa Rita seeding trial plot plan

The plots were evaluated on September 18th after approximately 2.5 inches of precipitation fell on the area. Within each plot, two 50' point intercept transects were run and read to determine species composition and percent cover. 'Loetta' Arizona cottontop had excellent emergence in its plots comprising over 59% of all species detected. Buffelgrass made up 0.39% of detected

species in the cottontop plots. Cochise Germplasm spike dropseed and Pima Germplasm Pima pappusgrass were detected at 2.05% and 7.2% respectively. Buffelgrass in the spike dropseed and pappusgrass plots were detected at 5.60% and 2.74% respectively. The poor emergence of the spike dropseed is likely a result of being planted too deeply. The soil at the site was not firm and depth bands on the drill sunk below the 0.25" depth recommended for the species. The pappusgrass used for the trial was unclean and may not emerge until more significant rainfall events occur. The plots will be similarly monitored in 2014.

Seeding rates and PLS values for the species used in the Santa Rita exclosure seeding trial

	PLS	Seeds/lb.	PLS lbs./acre	PLS (g)/plot	bulk lbs. for trial
Arizona cottontop	0.51	300000	3.63	29.67	0.33
spike dropseed	0.4	1750000	0.62	6.49	0.07
Pima pappusgrass	0.22	322000	3.38	64.09	0.71

SRER PLOT 1 PAVA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	4	19%		BOAR	4	4%
BOWR	10	48%		HL	35	35%
PECI	1	5%		BOWR	10	10%
CHMI	3	14%		PECI	1	1%
SPCO	1	5%		CHMI	3	3%
TILA	1	5%		SPCO	1	1%
MUVE	1	5%		TILA	1	1%
				WL	3	3%
				MUVE	1	1%
				BARE	41	41%
Total	**21**	100%				
				Total	**100**	100%

SRER PLOT 2 SPCO

Species	Hits	% Species Comp		Species	Hits	% Cover
BOWR	15	68%		BOWR	15	15%
UNK	1	5%		UNK	1	1%
SPCO	2	9%		SPCO	2	2%
PECI	1	5%		PECI	1	1%
CHMI	1	5%		CHMI	1	1%
BOAR	2	9%		BOAR	2	2%
				HL	45	45%
				BARE	33	33%
Total	**22**	100%				
				Total	**100**	100%

SRER PLOT 3 DICA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	5	13%		BOAR	5	5%
DICA	24	60%		DICA	24	24%
MUVE	4	10%		MUVE	4	4%
CHMI	5	13%		CHMI	5	5%
BOWR	1	3%		HL	29	29%
PECI	1	3%		BARE	30	30%
				WL	1	1%
				BOWR	1	1%
				PECI	1	1%
Total	**40**	100%				
				Total	**100**	100%

SRER PLOT 6 SPCO

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	2	9%		BOAR	2	2%
BOWR	9	41%		BOWR	9	9%
CHMI	10	45%		CHMI	10	10%
TILA	1	5%		TILA	1	1%
				HL	13	13%
				BARE	65	65%
Total	**22**	100%				
				Total	**100**	100%

SRER PLOT 7 DICA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	7	13%		BOAR	7	7%
BOWR	19	37%		BOWR	19	19%
PECI	0	0%		PECI	0	0%
CHMI	2	4%		CHMI	2	2%
DICA	23	44%		DICA	23	23%
MUVE	1	2%		MUVE	1	1%
				HL	11	11%
				BARE	37	37%
Total	**52**	100%				
				Total	**100**	100%

SRER PLOT 8 SPCO

Species	Hits	% Species Comp		Species	Hits	% Cover
BOWR	5	15%		BOWR	5	5%
UNK	3	9%		UNK	3	3%
SPCO	2	6%		SPCO	2	2%
PECI	3	9%		PECI	3	3%
CHMI	10	29%		CHMI	10	10%
BOAR	10	29%		BOAR	10	10%
GUSA	1	3%		GUSA	1	1%
				BARE	41	41%
				HL	25	25%
Total	**34**	100%				
				Total	**100**	100%

SRER PLOT 11 DICA

Species	Hits	% Species Comp		Species	Hits	% Cover
DICA	42	68%		DICA	42	42%
CHMI	3	5%		CHMI	3	3%
BOWR	8	13%		BOWR	8	8%
BOAR	9	15%		BOAR	9	9%
				BARE	37	37%
				RF	1	1%
Total	**62**	100%				
				Total	**100**	100%

SRER PLOT 12 PAVA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOWR	16	48%		BOWR	16	16%
CHMI	5	15%		CHMI	5	5%
BOAR	8	24%		BOAR	8	8%
MUVE	1	3%		MUVE	1	1%
UNK	1	3%		UNK	1	1%
TILA	2	6%		TILA	2	2%
				BARE	53	53%
				HL	14	14%
Total	**33**	100%				
				Total	**100**	100%

SRER PLOT 13 PAVA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	9	30%		BOAR	9	9%
MUVE	2	7%		MUVE	2	2%
TILA	1	3%		TILA	1	1%
PECI	3	10%		PECI	3	3%
SATR	1	3%		SATR	1	1%
CHMI	6	20%		CHMI	6	6%
UNK	1	3%		UNK	1	1%
BOWR	6	20%		BOWR	6	6%
AN. PAN	1	3%		AN. PAN	1	1%
				BARE	29	29%
Total	**30**	100%		HL	40	40%
				WL	1	1%
				Total	**100**	100%

2013 Point intercept transect data from Santa Rita seeding trial

SRER PLOT 4 SPCO

Species	Hits	% Species Comp		Species	Hits	% Cover
BOWR	2	*10%*		BOWR	2	*2%*
BOAR	4	*20%*		BOAR	4	*4%*
CHMI	4	*20%*		CHMI	4	*4%*
SPCO	4	*20%*		SPCO	4	*4%*
MUVE	2	*10%*		MUVE	2	*2%*
PECI	3	*15%*		PECI	3	*3%*
UNK	1	*5%*		UNK	1	*1%*
				BARE	38	*38%*
				HL	42	*42%*
Total	**20**	*100%*				
				Total	**100**	*100%*

SRER PLOT 9 DICA

Species	Hits	% Species Comp		Species	Hits	% Cover
DICA	32	*63%*		DICA	32	*32%*
CHMI	9	*18%*		CHMI	9	*9%*
BOWR	9	*18%*		BOWR	9	*9%*
BOAR	1	*2%*		BOAR	1	*1%*
				BARE	37	*37%*
				RF	2	*2%*
				HL	10	*10%*
Total	**51**	*100%*				
				Total	**100**	*100%*

SRER PLOT 14 PAVA

Species	Hits	% Species Comp		Species	Hits	% Cover
MUVE	6	*25%*		MUVE	6	*6%*
BOAR	5	*21%*		BOAR	5	*5%*
CHMI	5	*21%*		CHMI	5	*5%*
BOWR	1	*4%*		BOWR	1	*1%*
TRTE	1	*4%*		TRTE	1	*1%*
UNK	4	*17%*		UNK	4	*4%*
BOWR	2	*8%*		BOWR	2	*2%*
				RF	6	*6%*
				HL	33	*33%*
				BARE	34	*34%*
Total	**24**	*100%*		WL	3	*3%*
				Total	**100**	*100%*

SRER PLOT 5 PAVA

Species	Hits	% Species Comp		Species	Hits	% Cover
BOWR	7	*18%*		BOWR	7	*7%*
BOAR	13	*34%*		BOAR	13	*13%*
CHMI	6	*16%*		CHMI	6	*6%*
PAVA	3	*8%*		PAVA	3	*3%*
MUVE	8	*21%*		MUVE	8	*8%*
HAPA	1	*3%*		HAPA	1	*1%*
				RF	53	*53%*
				HL	9	*9%*
Total	**38**	*100%*				
				Total	**100**	*100%*

SRER PLOT 10 DICA

Species	Hits	% Species Comp		Species	Hits	% Cover
DICA	35	*66%*		DICA	35	*35%*
CHMI	7	*13%*		CHMI	7	*7%*
BOWR	4	*8%*		BOWR	4	*4%*
BOAR	7	*13%*		BOAR	7	*7%*
				BARE	38	*38%*
				RF	6	*6%*
				HL	3	*3%*
Total	**53**	*100%*				
				Total	**100**	*100%*

SRER PLOT 15 SPCO

Species	Hits	% Species Comp		Species	Hits	% Cover
BOAR	15	*56%*		BOAR	15	*15%*
BOWR	6	*22%*		BOWR	6	*6%*
CHMI	4	*15%*		CHMI	4	*4%*
MUVE	1	*4%*		MUVE	1	*1%*
SPCO	1	*4%*		SPCO	1	*1%*
				BARE	51	*51%*
				HL	22	*22%*
Total	**27**	*100%*				
				Total	**100**	*100%*

2013 Point intercept transect data from Santa Rita seeding trial (cont)

Development of an Indian Ricegrass (Achnatherum hymenoides) Composite Population for Major Land Resource Area 30

Study ID Code	AZPMC-T-1304-CR
Title	Development of an Indian ricegrass (*Achnatherum hymenoides*) composite population for Southern Nevada
National Project No.	Natural Areas 1.1
Study Type	Initial Evaluation
Study Status	Active
Location	AZPMC
Study Leader	Manuel Rosales, Heather Dial, AZPMC
Duration	2012-2015
Cooperators	BLM-Nevada

Description

To facilitate preliminary agronomic research and development of a pre-varietal release of *Achnatherum hymenoides* 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. At present there is no commercially available germplasm of *Achnatherum hymenoides* for the Mojave Desert.

Materials & Methods

Twenty populations of Indian ricegrass (ten populations collected from the Southern Nevada Mojave Desert, five to seven populations collected from the Californian Mojave Desert and three available varieties from the Colorado Plateau) will be prepared for germination at the Tucson Plant Materials Center greenhouse. Populations that successfully germinate will be out-planted to a field using the Holland Mechanical Transplanter.

To determine genetic variation within and between populations of Indian ricegrass and available varieties from the Colorado Plateau, a genetic analysis of the populations will be conducted by the staff of the USDA-Agriculture Research Service, Forage and Range Research Laboratory located in Logan, Utah. Tissue from plants established in the field will be sampled to conduct the test.

Data on growth parameters such as flowering date, plant height, seed maturity date, and seed yield will be recorded for each population annually.

Incidence of pests and diseases will be monitored and recorded.

Seed production from each population will be harvested with a Woodward Flail-Vac seed stripper as needed. Equal amounts of each population's seed will be mixed to form a multi-origin selected class germplasm release if applicable. The planting will be flood irrigated and maintained weed free using chemical,

mechanical and cultural methods as needed.

Seeds will be cleaned and stored at the AZPMC.

Final Evaluations Plant emergence, performance, bloom periods and irrigation required

Technology Transfer Products Internal reports, Selected Class Germplasm Release

References

Growing season 2011-2013:

BLM personnel collected seed from ten populations of Indian ricegrass in support of this project. The seed was received at the Tucson PMC on July 25, 2011. The collections were processed with an electric seed huller/scarifier to loosen the seeds from seed heads. The collections were then hand screened to bare caryopsis.

***Achnatherum hymenoides* Southern Nevada seed collections**

Population	Location	Bulk Weight (g)	Clean Weight (g)	Location UTMs
1	Jean Dry Lake	98	51	3958252N 658183E
2	Kane Springs	264	158.7	4116692N 697307E
3	Khota Circus	504	135.4	4041799N 750971E
4	Kyle Canyon	70	35.4	4015657N 633680E
5	Lovell Canyon	527	182	3987009N 629841E
6	Mormon Mesa	559	285.6	4070606N 727791E
7	Paiute Valley	69	22.5	3929693N 667482E
8	Riverside Road	275	46.1	4072370N 746550E
9	Sandy Valley	50	14.3	3984183N 625562E
10	St. Thomas Gap	159	48.3	4033107N 760800E

Germination trials to determine the most successful protocol to germinate Indian ricegrass were conducted from January to April of 2012. Existing protocols in published literature were used to conduct the trials. Three populations were chosen for the trials based upon the quantities of seed available. Ten gram seed samples of Khota Circus, Lovell Canyon and Mormon Mesa were treated with concentrated sulfuric acid for approximately 30 minutes to scarify the seed coat. Seeds were then rinsed; air dried and planted into a moist 1:1 mixture of sunshine mix #1 and perlite. The samples were placed in a cold germinator at 59F. Three 10 gram samples of unscarified seed of the three populations were also placed in the germinator to serve as controls. All six samples were removed from cold germinator after one month and placed in a Hoffman germinator set to alternate between 12 hours of light at temperature of 77F and 12 hours of dark at a temperature of 68F.

Within one week of placement in the Hoffman germination cabinet, all three of the unscarified control samples had germinated. There were no germination results in any of the scarified samples. Based on this preliminary test, the collected Indian ricegrass seed for the study plot will be cold stratified for propagation.

In 2013, the populations of Indian ricegrass were cold stratified and germinated in a Hoffman germinating chamber with various degree of success, depending on the individual collection. In

addition, two commercial varieties of Indian Ricegrass (Paloma & Nezpar) and an experimental entry from Los Lunas Plant Materials Center have been germinated to use as standards of comparison against the populations collected in the Mojave Desert. After germination, seedlings were transplanted into one gallon containers and placed in the Tucson PMC greenhouse. These plants are scheduled to be transplanted in spring of 2014.

Population	Accession #	Location Description
1	9106342	Paiute Valley 1
2	9106343	St. Thomas Gap 1
3	9106344	Khota Circus 1
4	9106345	Lovell Canyon
5	9106346	Jean Dry Lake
6	9106347	Morman Mesa
7	9106348	Kane Springs
8	9106349	Kyle Canyon
9	9106354	Riverside Road
10	9106355	Sandy Valley
Releases		
11	476997	Paloma
12	469230	Nez Par
13	9065428	CSU-10

Indian ricegrass collections to be planted in 2014

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	AZPMC and Douglas Field Office
Duration	2010 through 2015
Vegetative Practices	343 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 Tucson PMC 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 PMC 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 AZPMC Annual Technical Report. Newsletter articles on the progress of the planting will be published by the Douglas Field Office and the Tucson PMC. 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 AZPMC staff.

Growing season 2011:

On July 1, 2011, Tucson PMC 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)**	**PMC 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)

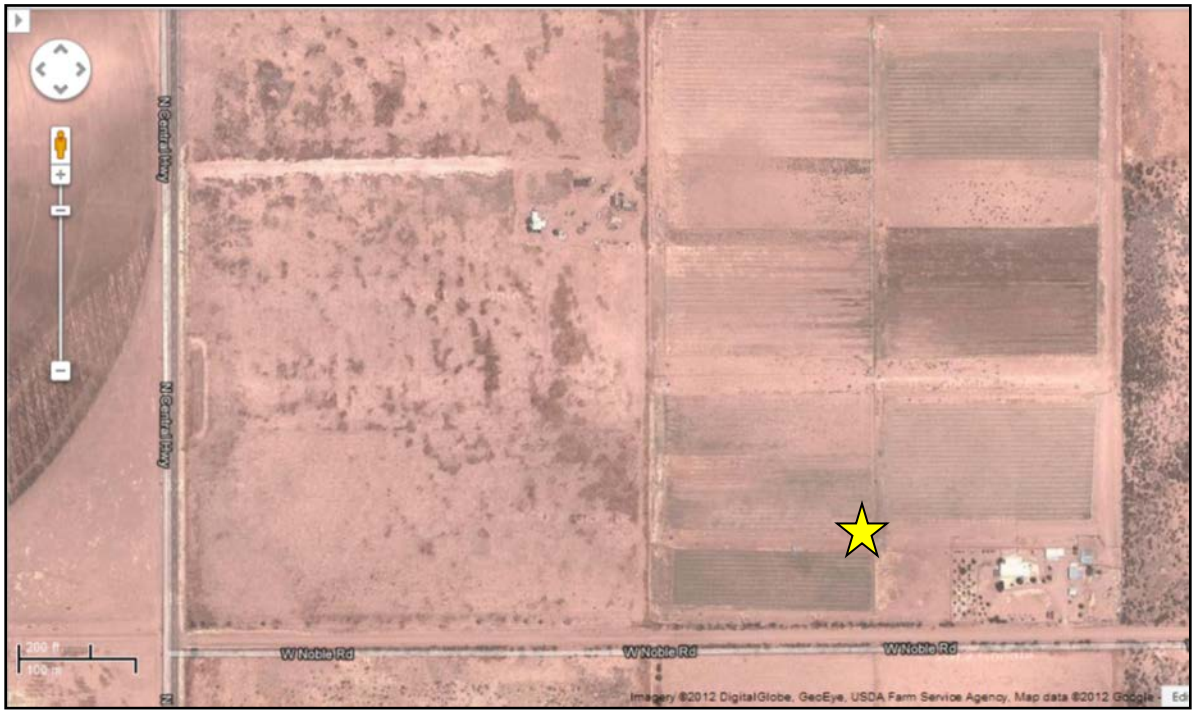
General view of plots

Growing season 2012:

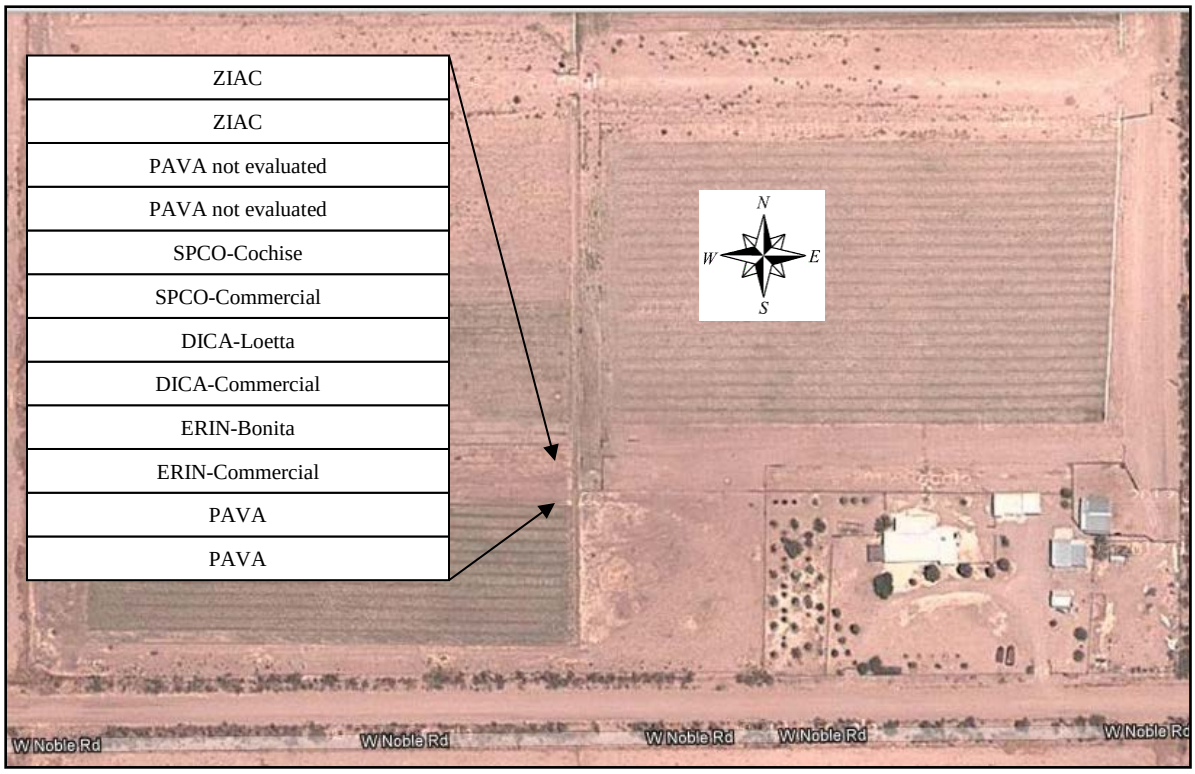
On the 21st of August 2012, Corey Picraux and Heather Dial evaluated the Native Seed Growers Demonstrational Field Planting near McNeal, AZ. The planting is located south-east of Tombstone near the intersection of N. Central Hwy and W. Noble Road (31.6125°N, 109.6953°W). Our primary point of contact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

Species and Seeding Rates used for the McNeal Field Planting

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



McNeal field planting location



Plot plan for the McNeal Field Planting

As in the previous year's evaluation, Pima Germplasm pappusgrass remains the most well established release with approximately 75-80% plant stand. This could largely be a 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, this is potentially 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, the plant stand of both spike dropseed plots is estimated 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, this could primarily be 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. There was not 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 Tucson PMC personnel during the 2013 growing season in order to schedule more appropriate evaluation/harvest dates.

Growing season 2013:

The plots were visited on July 30th. The fields were well cared for but the majority of the stands had declined considerably for unknown reasons. Seed was not harvested from the fields as a result. It is recommended that further evaluation of this planting be discontinued and that the study be closed.

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.

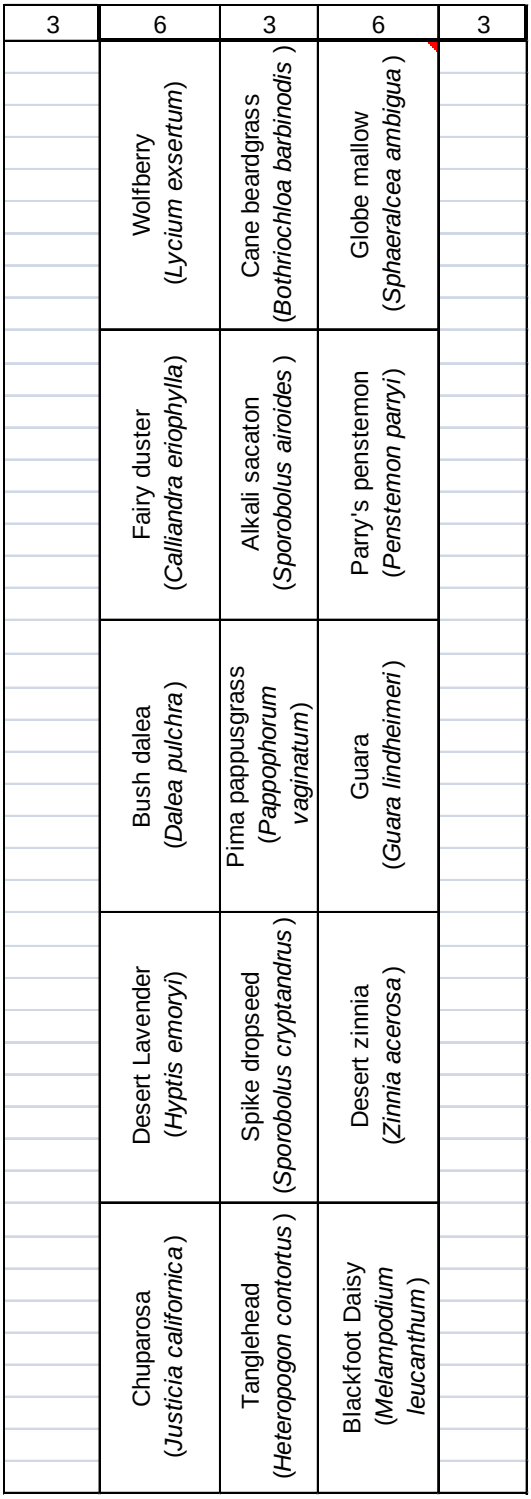
Tucson PMC data collection will include amount of water applied for establishment, time spent on weed control during establishment, flowering date, drought resistance, and dates of use of the plants by pollinators. AZPMC personnel do not have the expertise to identify native pollinators by species however, 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 Tucson 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.

Growing season 2013:

In early January, shrub species in the garden were trimmed and all grass species originally planted were removed. The grasses, while providing habitat for wildlife, were spreading through the plot and made establishment of additional species difficult. Survival of the shrubs originally planted in the garden in 2009 is 100% with the exception of the desert lavender and chuparosa which died in the 2011 hard freezes. On the 3rd of May, *Lotus rigidus* and *Eriogonum fasciculatum* containerized plants were outplanted into the pollinator garden. By July, the survival rate of the transplants was approximately 50% for both species. The forbs remaining in the garden are Parry's penstemon, desert zinnia, guara, globemallow and the newly planted deer vetch and buckwheat. The garden will receive a final evaluation in late 2014 before its removal.

National Parks Agreements Progress Reports

SAGUARO NATIONAL PARK

FY2013 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. Five harvests of the field were conducted in 2013 (table 1). A sixth and final harvest will take place in 2014. This will fulfill the agreed upon obligations specified in the agreement.

Table 1: *Aristida purpurea* harvests conducted at the Tucson PMC in 2013

	Harvest Dates				
	5/15/2013	**5/30/2013**	**6/26/2013**	**7/14/2013**	**12/17/2013**
Bulk lbs.	60.50	20.00	39.00	30.00	31.00
Germination %	58	45	49	55	11
Dormant %	16	28	24	24	40
Purity %	93	94	79	94	46
PLS %	69	68	58	74	23
PLS lbs.	41.51	13.69	22.49	22.20	7.25

Figure 1: *Aristida purpurea* harvest in May 2013.

Figure 2: *Aristida purpurea* field in September 2013.

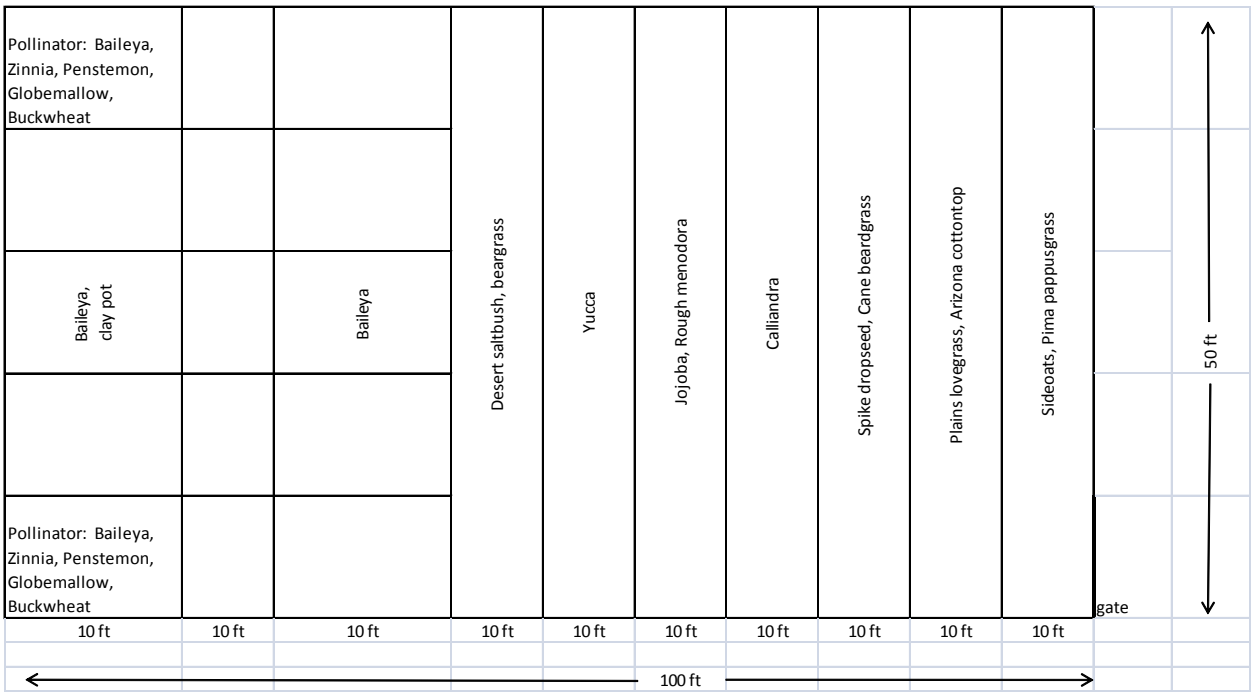
Field Plantings

Sells Demonstration Garden

In late May 2011, AZPMC 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.

Growing season 2013:

AZPMC personnel, in cooperation with Sells FO personnel, visited the garden on February 20th to evaluate survival of planted species and conduct maintenance. A push roto-tiller was used between the rows of planted grasses in addition to light hand weeding around the fence. Glyphosate was used in two areas in an effort to control Bermuda grass. All grass species previously planted showed significant growth compared to the previous season. The demonstration garden will be maintained and enhanced in 2014 with additional grass species.

San Pedro River Reserve Bush Muhly (Muhlenbergia porteri) Field Planting

Study ID Code	AZPMC-F-1201-RA
Title	San Pedro River Reserve Bush Muhly (*Muhlenbergia porteri*) Field Planting
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
Duration	2012-2017
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(AZPMC-T-0502-CR).
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 AZPMC; 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 Tucson PMC 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 will be compiled to determine whether or not bush muhly can be successfully established with 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

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8. Jones, T.A. and D.A. Johnson. 1998. Integrating genetic concepts into planned rangeland seedings. Journal of Range Management 51: 594-606.
9. Kearney, T.H. and R.H. Peebles. 1969. Arizona flora. University of California Press, Berkely, CA.
10. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Accomplishments/Results:

Growing season 2012:

In February of 2012, AZPMC 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. A site on the reserve that was ideal for conducting a field planting of bush muhly was visited. The land owners were willing to sign a field planting agreement and work with the Tucson FO 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 according to the site 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.

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>

Bush muhly hay bale planting site after establishment in 2012

Growing season 2013:

AZPMC personnel, in cooperation with Tucson Field Office personnel, visited the planting site on 9 April to conduct an evaluation. The cooperator had fenced the site to prevent grazing in the area. No germination and/or establishment was apparent within the site. However, precipitation in the area after the planting date was scattered and sparse. A second visit was planned in October to coincide with the end of the summer monsoon season. The AZPMC was closed during the first two weeks of October and the site was not visited again in 2013.

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2012	0.85	0.71	1.22	0.25	0	0	1.17	4.74	0.86	0	0	2.02
2013	1.98	0.68	-----	0.25	0	0	0.69	0.39	0.43	0.05	1.84	0.28

Average monthly precipitation records for Kearny, AZ from the University of Arizona (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?az4590)

Herbaceous Wind Barrier Demonstration Planting

The AZPMC established a herbaceous wind barrier on May 31, 2013, as a demonstration planting. Herbaceous wind barriers can be applied for a variety of conservation purposes including reduction of wind erosion, reduction of soil particulate emissions to the air, and protection of growing crops from wind and/or wind born soil particles. The Tucson PMC used the Los Lunas PMC release 'Windbreaker' big sacaton (*Sporobolus wrightii*) to establish the demonstration planting.

Two rows of big sacaton were hand transplanted in a staggered arrangement at 5 foot centers. One hundred thirty five seedlings were planted in an area 10' wide x 340' in length. The seedlings were grown in 1.5 x 8.25" Ray Leach cone-tainers. The seedlings were 57 days old at transplanting. A gas powered hand -driven auger was used to drill eight inch diameter holes for each transplant. The planting was flood irrigated immediately after transplanting.

On August 14, 2013, seventy five days after transplanting, the planting was evaluated for survivability. All 135 plants were alive and growing.

Big sacaton (*Sporobolus wrightii*) 75 days after transplanting

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