

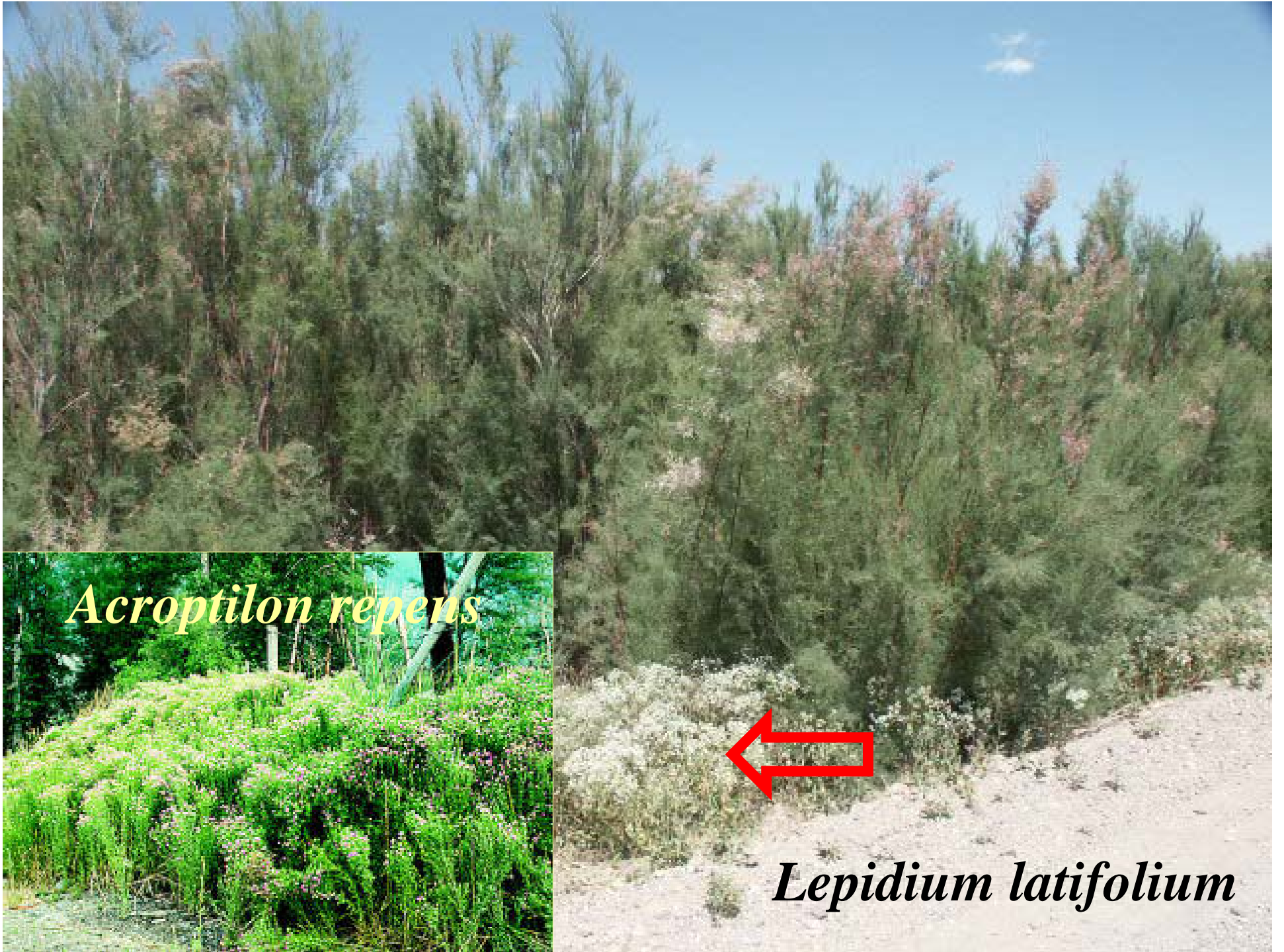
Restoration of Native Shrub/Grass Plant Communities on Xeric Saltcedar Infestation Sites

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Technical Service Center, Bureau of Reclamation, Denver









Acroptilon repens



Lepidium latifolium



Atriplex



Quailbrush
Atriplex lentiformis



Fourwing saltbush
Atriplex canescens

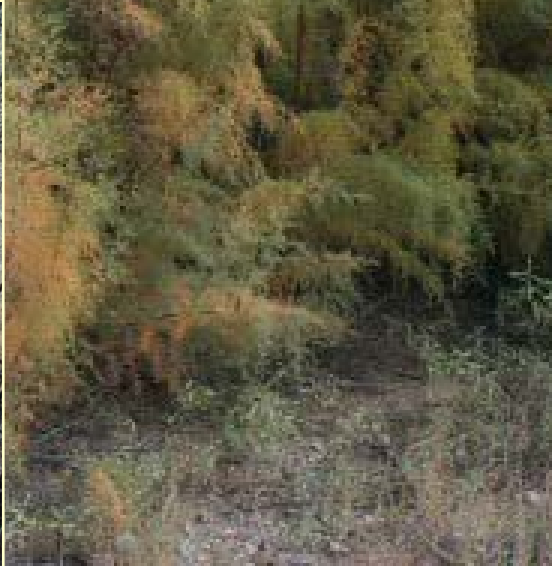
Prosopis



Screwbean mesquite
Prosopis pubescens



Honey mesquite
Prosopis juliflora glandulosa







Strategic Challenges

- **Innovative technologies for seedbed (microsite) access and preparation:**
 - **standing saltcedar biomass reduction;**
 - **moisture capture and conservation;**
 - **nutrient and C/N manipulation;**
 - **salinity remediation;**
 - **microbial augmentation.**
- (“designed disturbance” – Sheley et al. 1996)**

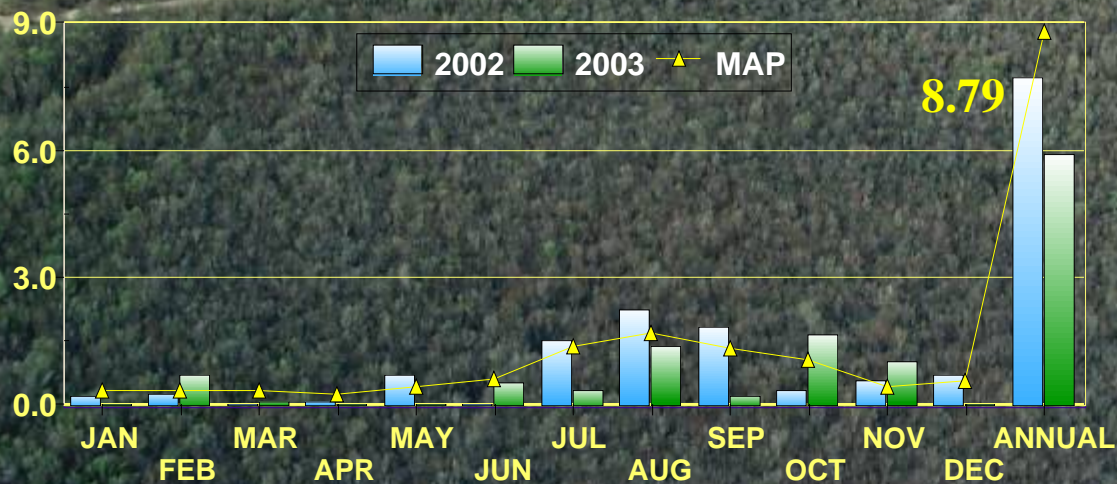
San Marcial, NM Study Site

(9.2 hectares)

Study 2

Study 1

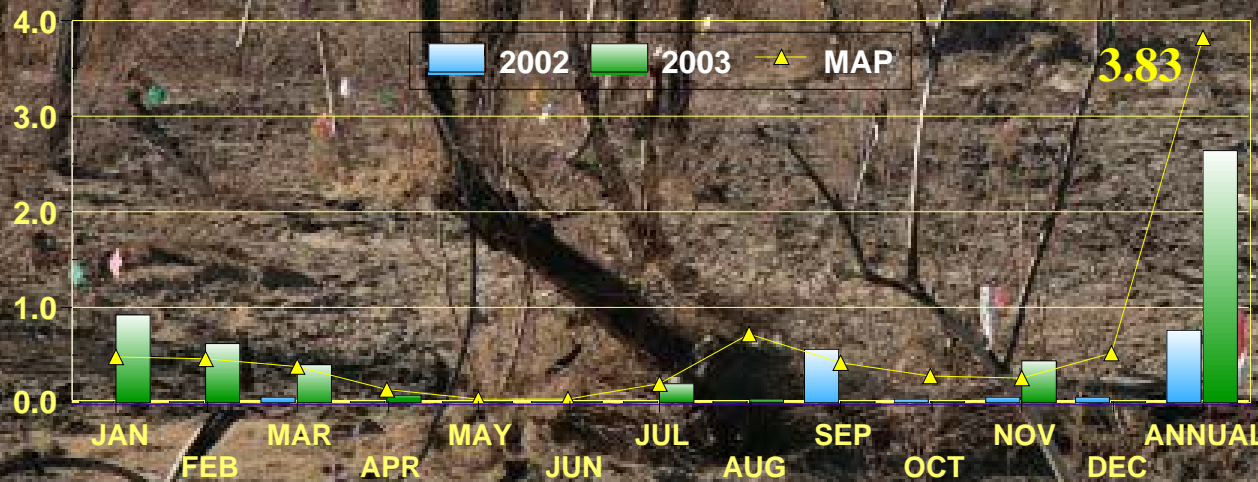
ANNUAL PRECIPITATION (inches)



Cibola, AZ Study Site

(3.4 hectares)

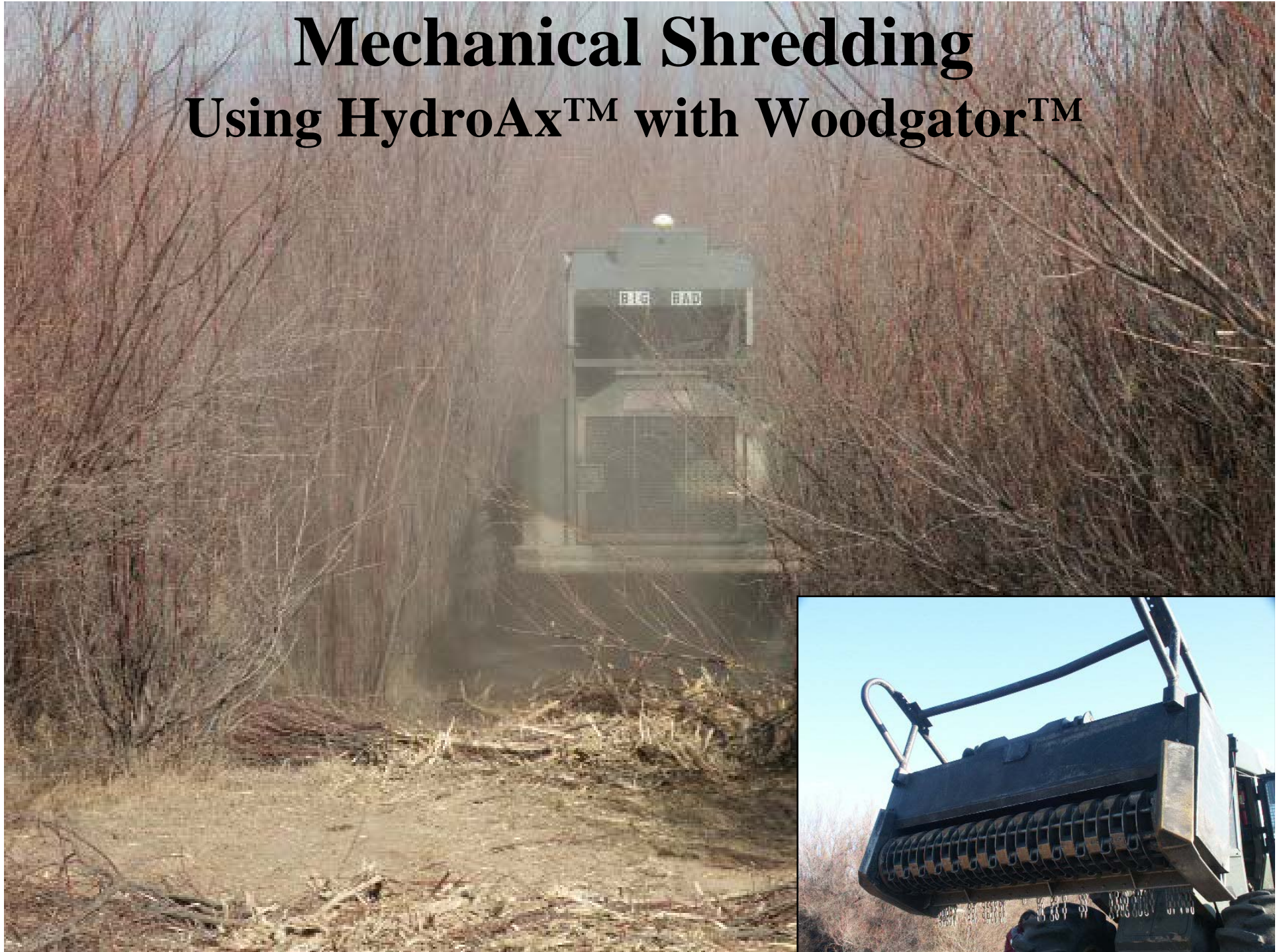
ANNUAL PRECIPITATION (inches)



2002 = 20% of MAP

2003 = 69% of MAP

Mechanical Shredding Using HydroAx™ with Woodgator™



San Marcial, NM



July 2002

Saltcedar shredding / mulching benefits:

- **Weed suppression**
 - ✓ Minimal soil disturbance (surface only)
 - ✓ Reduction of bare ground
 - ✓ Elevated C/N ratios (successional trajectory)
- **Moisture conservation**
- **Moderation of temperature / wind extremes**
- **Salinity moderation; reduced capillary rise of salts**
- **Microsite environment for seedlings**
- **Younger (aboveground) stands amenable to mulching by roller chopping alone**
- **Cost savings**

Moisture Capture / Conservation



Roller chopping



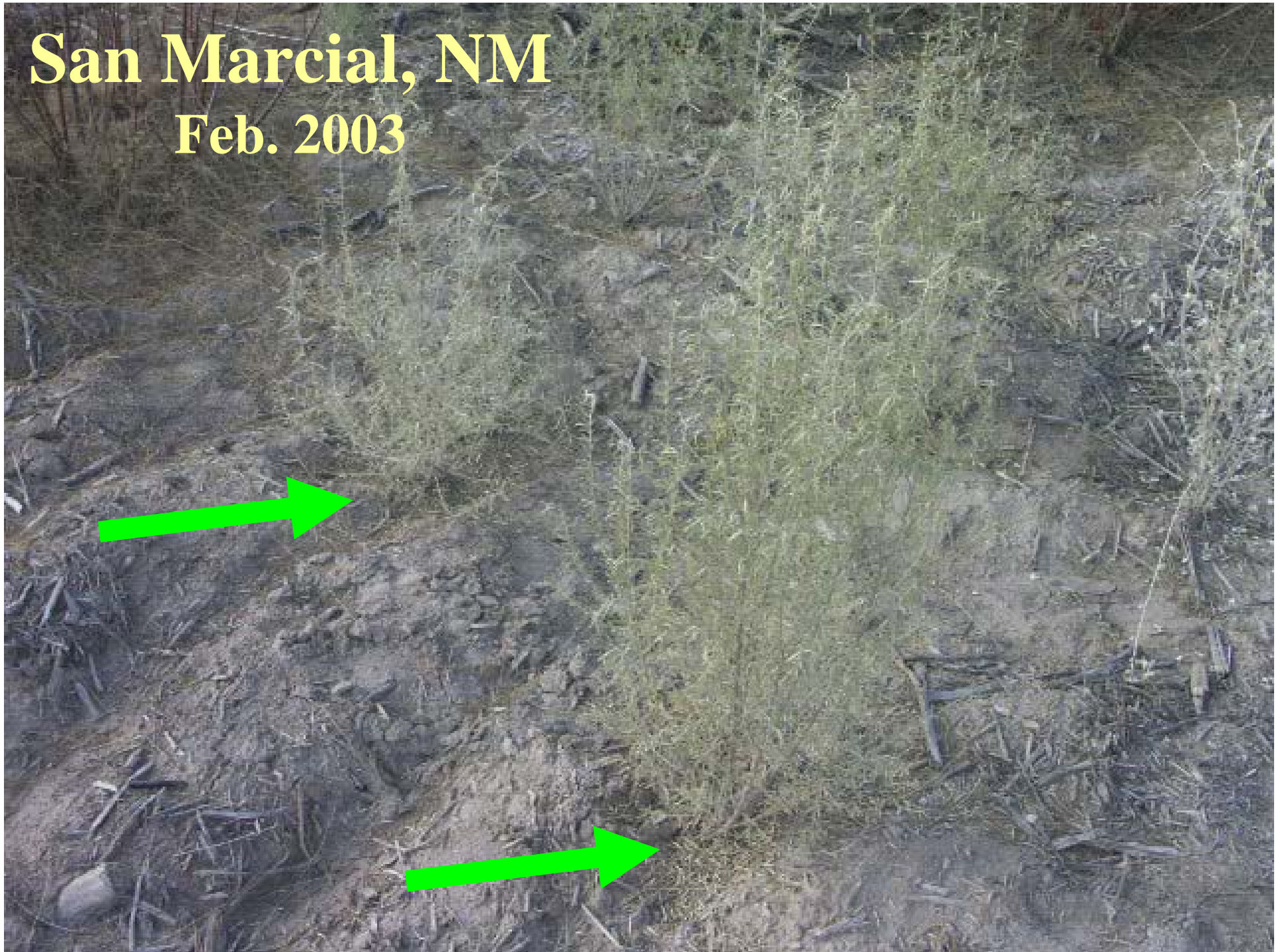
- seed and inoculum incorporation;
- enhance moisture capture and retention;
- reduce surface soil salinity impacts.



Imprinting following roller chopping to further enhance moisture capture and microsite availability



San Marcial, NM
Feb. 2003



Cibola, AZ

Lower Colorado

Texture = SCL, CL, SIL

EC_e = range 54.5 - 115.1,

μ = 84 mmhos cm^{-1}

SAR = range 66.6 - 113.0,

μ = 86 meq L^{-1}

pH = 7.5



Tranquillity, CA

MAP = 17.4 cm

2002: 4.5 cm (26%)

2003: 10.2 cm (58%)

Texture = Clay

EC_e range = 7.7 – 15.4 mmhos cm⁻¹

μ = 11.2

SAR range = 7.7 – 20.1 meq L⁻¹

μ = 13.2

pH = 8.0



Phacelia ciliata

Middle Rio Grande

Texture = SCL, CL

EC_e = range 12.8-19.4,

$\mu = 16 \text{ mmhos cm}^{-1}$

SAR = range 16.5-21.2,

$\mu = 19 \text{ meq L}^{-1}$

pH = 8.4

Lower Colorado

Texture = SCL, CL, SIL

EC_e = range 54.5 - 115.1,

$\mu = 84 \text{ mmhos cm}^{-1}$

SAR = range 66.6 - 113.0,

$\mu = 86 \text{ meq L}^{-1}$

pH = 7.5

Salinity / Sodicity



Seed Mixture

Seeded July 16-17, 2002

Scientific Name	Common Name	Culivar or Pre-Release	Mixture Rate
			(%)
<u>STANDARD MIXTURE</u>			
<i>Bouteloua curtipendula</i>	Sideoats grama	Niner	10.0
<i>Elymus trachycaulus</i>	Slender wheatgrass	Pryor	11.0
<i>Panicum virgatum</i>	Switchgrass	Blackwell	15.0
<i>Pascopyrum smithii</i>	Western wheatgrass	Arriba	10.0
<i>Sporobolus airoides</i>	Alkali sacaton	Salado	15.0
<i>Sporobolus giganteus</i>	Giant dropseed		5.0
<i>Anemopsis californica</i>	Yerba mansa		2.0
<i>Plantago insularis</i>	Wooly plaintain		2.0
<i>Sphaeralcea coccinea</i>	Scarlet globemallow		2.0
<i>Atriplex canescens</i>	Fourwing saltbush		12.0
<i>Baccharis glutinosa</i>	Seep willow		3.0
<i>Atriplex lentiformis</i>	Quailbush		4.0
<i>Lycium andersonii</i>	Anderson's wolfberry		7.0
<i>Chrysothamnus nauseosus graveolens</i>	Rubber rabbitbrush		2.0
TOTALS =			100.0



Panicum obtusum



Atriplex lentiformis

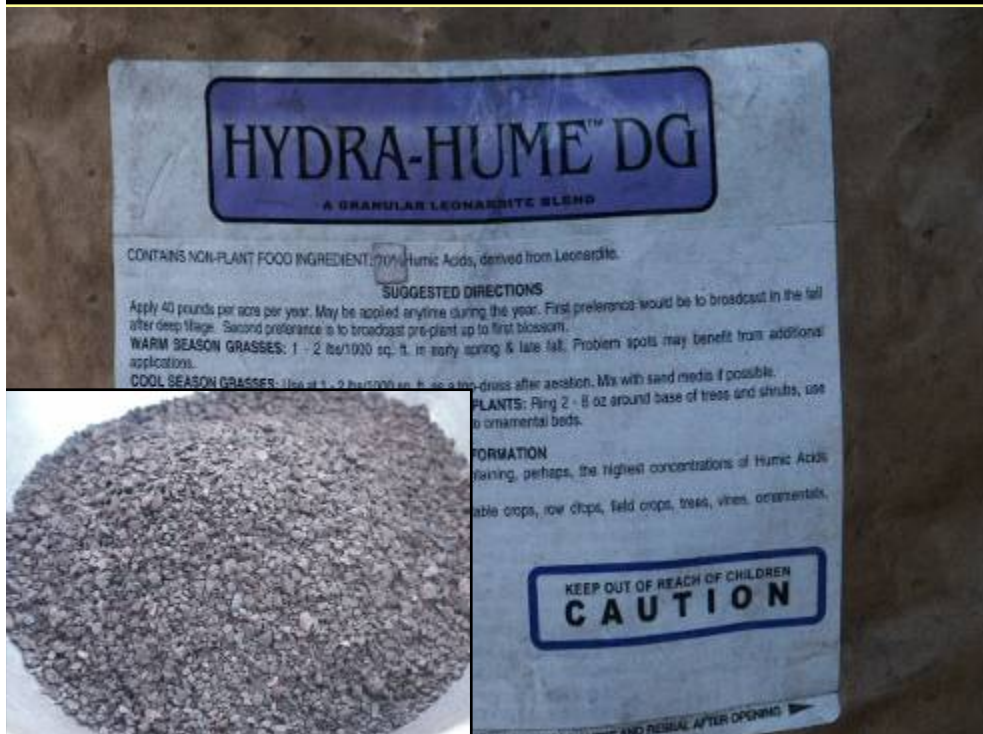


Heliotropium curassavicum



Atriplex canescens

HYDRAHUME









Middle Rio Grande

Texture = SCL, CL

EC = range 2 - 6,

$\mu = 4 \text{ mmhos cm}^{-1}$

SAR = range 2 - 7,

$\mu = 4-5 \text{ meq L}^{-1}$

pH = 8.4





Mycorrhizal presence = 0

Glomus

- *intraradices*
- *mosseae*
- *aggregatum*

Enhance capture of:

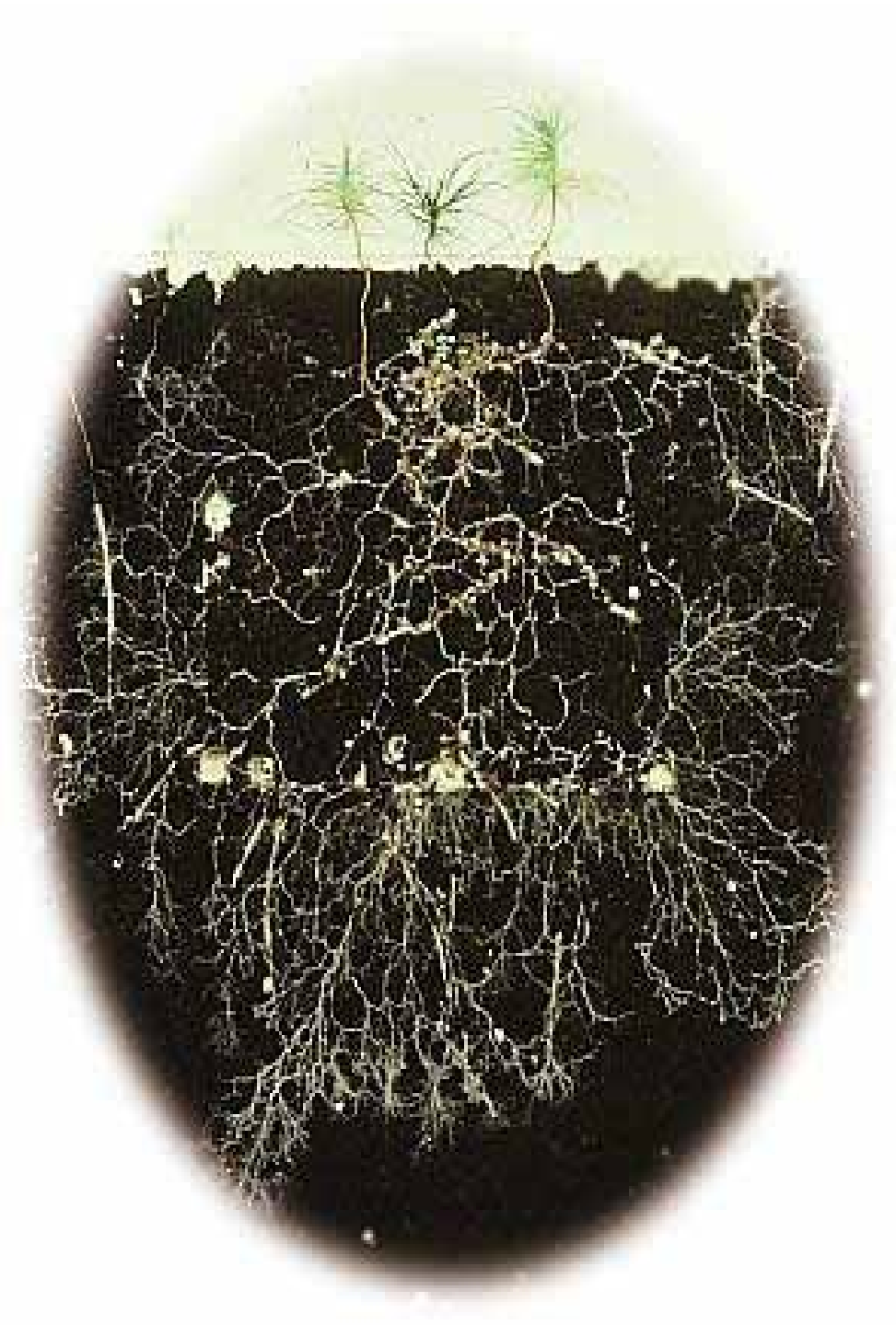
Soil moisture

Phosphorous

NH_4^+

Salt tolerance?

(Lab / Greenhouse Studies)





Seed Coatings



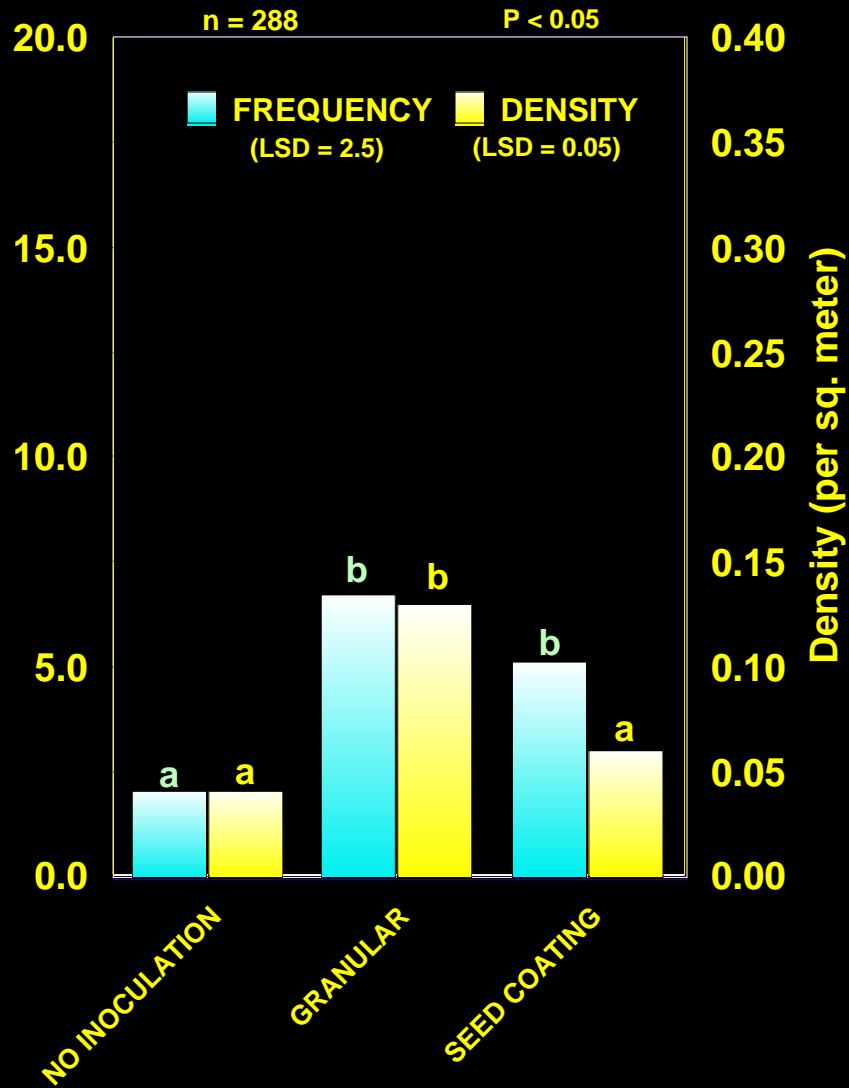
**Endomycorrhizal
Inoculant (BEI)**

3-LB. JAR



Bouteloua curtipendula

San Marcial, NM
2003



Sideoats grama

MYCORRHIZAL INOCULATION

Mycorrhizal inoculum



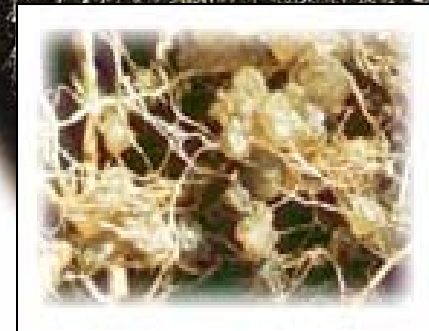
*BioNet, LLC*TM



TM


RTI

AM 120

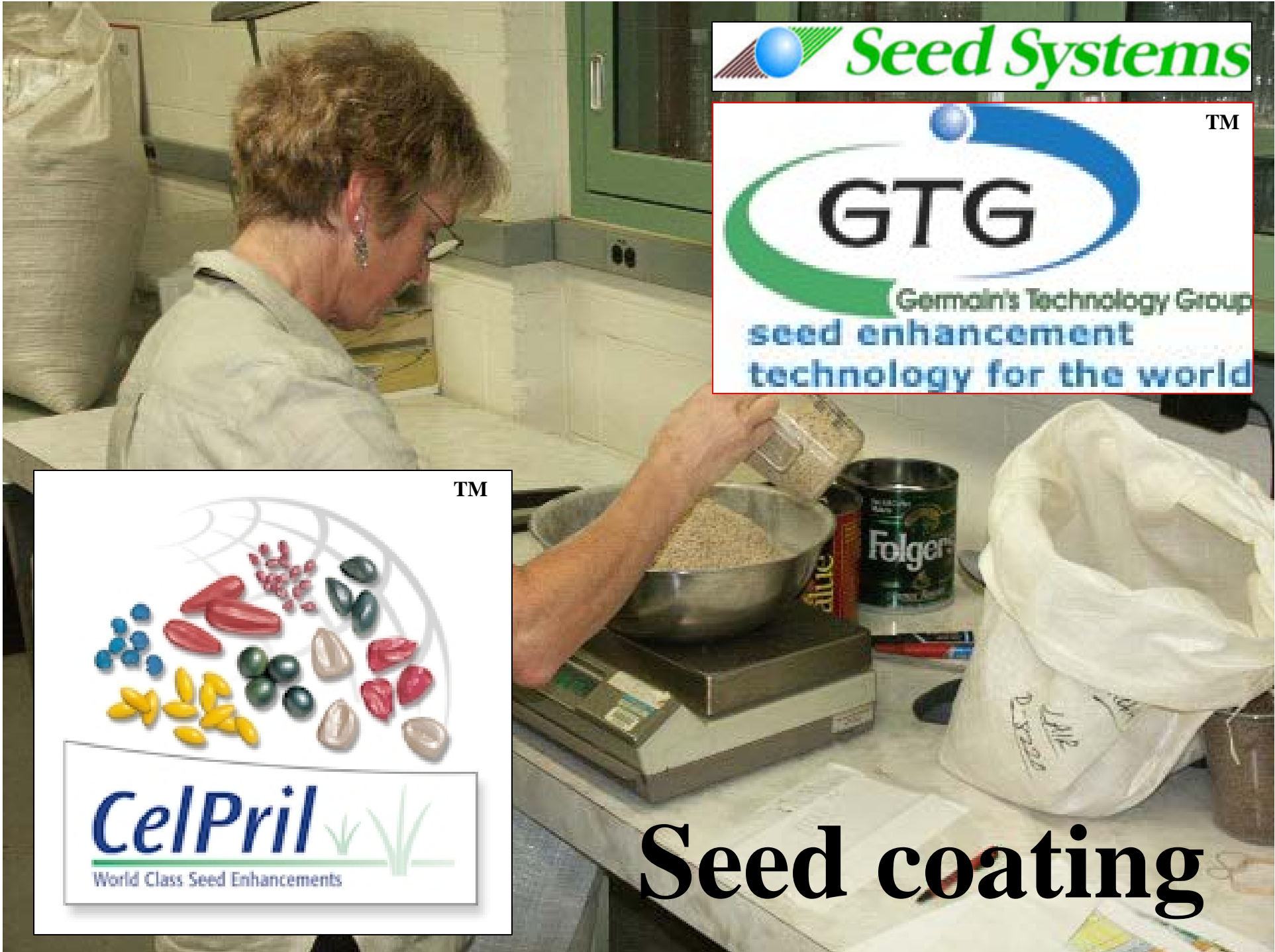


 **Seed Systems**

 **GTG** TM
Germol's Technology Group
seed enhancement
technology for the world

 TM
CelPril
World Class Seed Enhancements

Seed coating



Treatment Prioritization and Habitat Response



Heliotropium curassavicum





Jan. 23, 2004



Jan. 23, 2004

4 P's of Revegetation

- Planning
- Persistence
- Patience



• *PRECIPITATION!!!*



**Bureau of
Reclamation**



Managing Water In The American West



Saltcedar Revegetation Research Sites



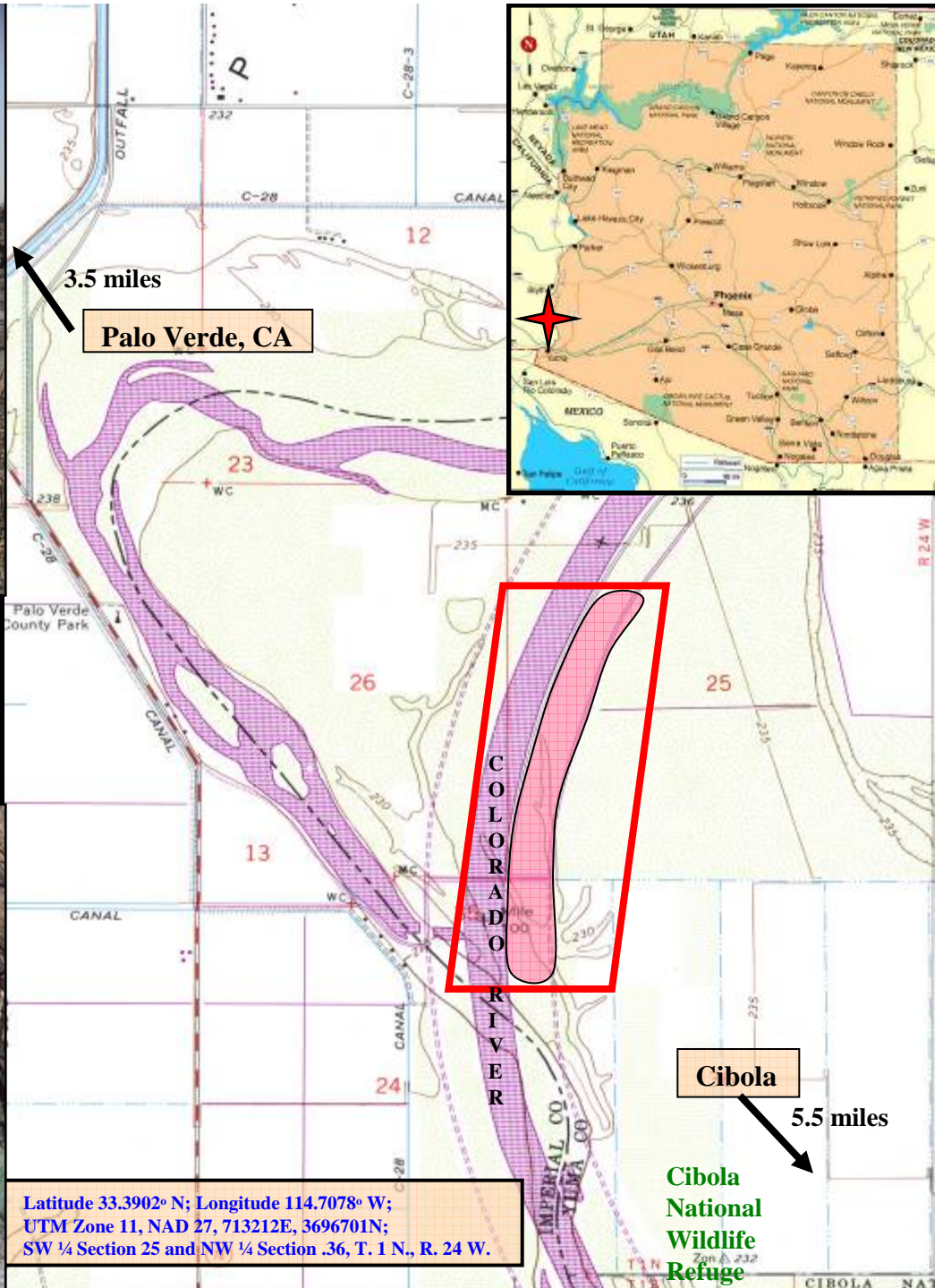
Monotypic *Tamarix ramosissima*



Tamarix ramosissima
Atriplex lentiformis
Atriplex polycarpa
Baccharis spp.

April 7, 2001

Cibola burn site (~45 miles N. of Yuma, AZ)



Latitude 33.3902° N; Longitude 114.7078° W;
UTM Zone 11, NAD 27, 713212E, 3696701N;
SW ¼ Section 25 and NW ¼ Section .36, T. 1 N., R. 24 W.

Cibola
5.5 miles

Cibola
National
Wildlife
Refuge

Lower Rio Grande:

- Big Bend National Park (NPS)
- Big Bend Ranch State Park (TP&W)
- Santa Elena Canyon Protected Area, Mexico
- Maderas del Carmen Protected Area, Mexico



Tamarix ramosissima
Arundo donax
Prosopis spp.
Acacia spp.

Carlsbad, NM:

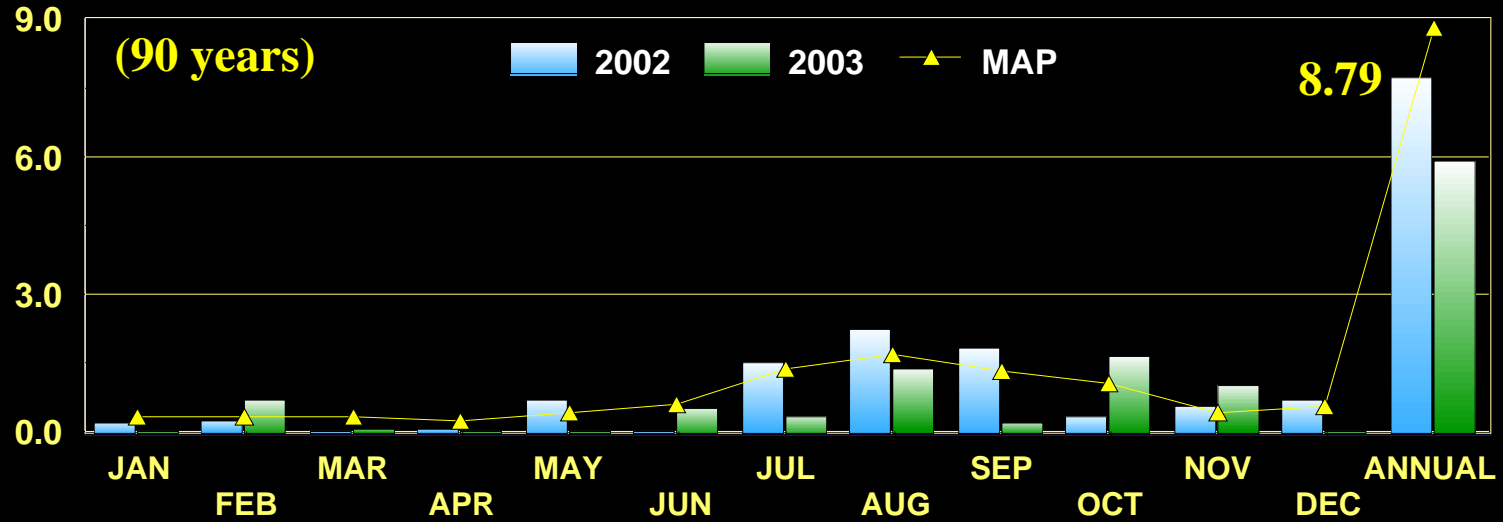
- McMillan Reservoir
- Brantley Lake

Tamarix ramosissima
Kochia scoparia

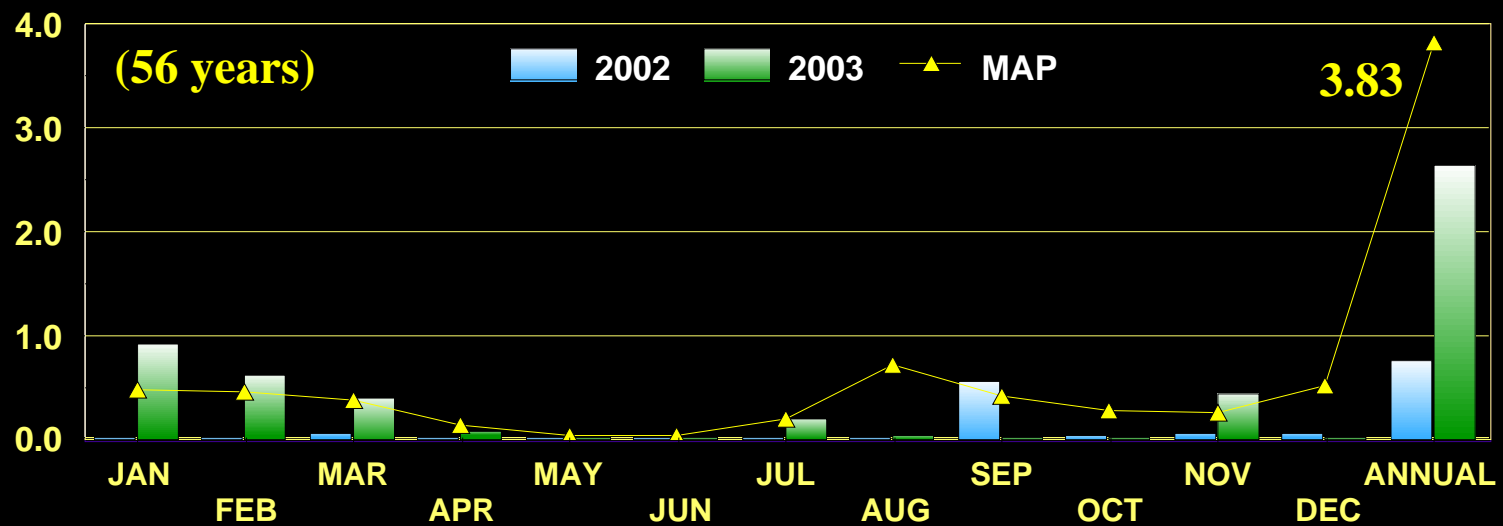


Annual Precipitation (inches)

SAN MARCIAL, NM



CIBOLA, AZ



No seedbed preparation



Added carbon, reduced N?



Minimal litter disturbance

**Shredding
constraints**