

**SURVIVAL AND GROWTH OF
COLUMNAR CACTI SEEDLINGS UNDER
TWO OVER-HARVESTED NURSE
SPECIES IN SONORA, MEXICO.**



Humberto Suzán-Azpiri*, Vinicio Sosa Fernández**

* Escuela de Biología, Universidad Autónoma de Querétaro.

**Instituto de Ecología, Xalapa Veracruz.





**COMPARATIVE
PERFORMANCE OF
CARDON (*PACHYCEREUS
PRINGLEII*) SEEDLINGS
UNDER TWO LEGUME
TREE NURSE SPECIES**

The actors:

- ✦ Cardon (*Pachycereus pringleii*) a giant columnar cacti in southern Sonoran Desert.
- ✦ Palo Fierro or Ironwood (*Olneya tesota*) a semi-deciduous dominant xero-riparian facultative tree. Extremely important nurse plant for at least 90 species.
- ✦ Mesquite (*Prosopis velutina*) a deciduous important element in washes and riparian corridors.

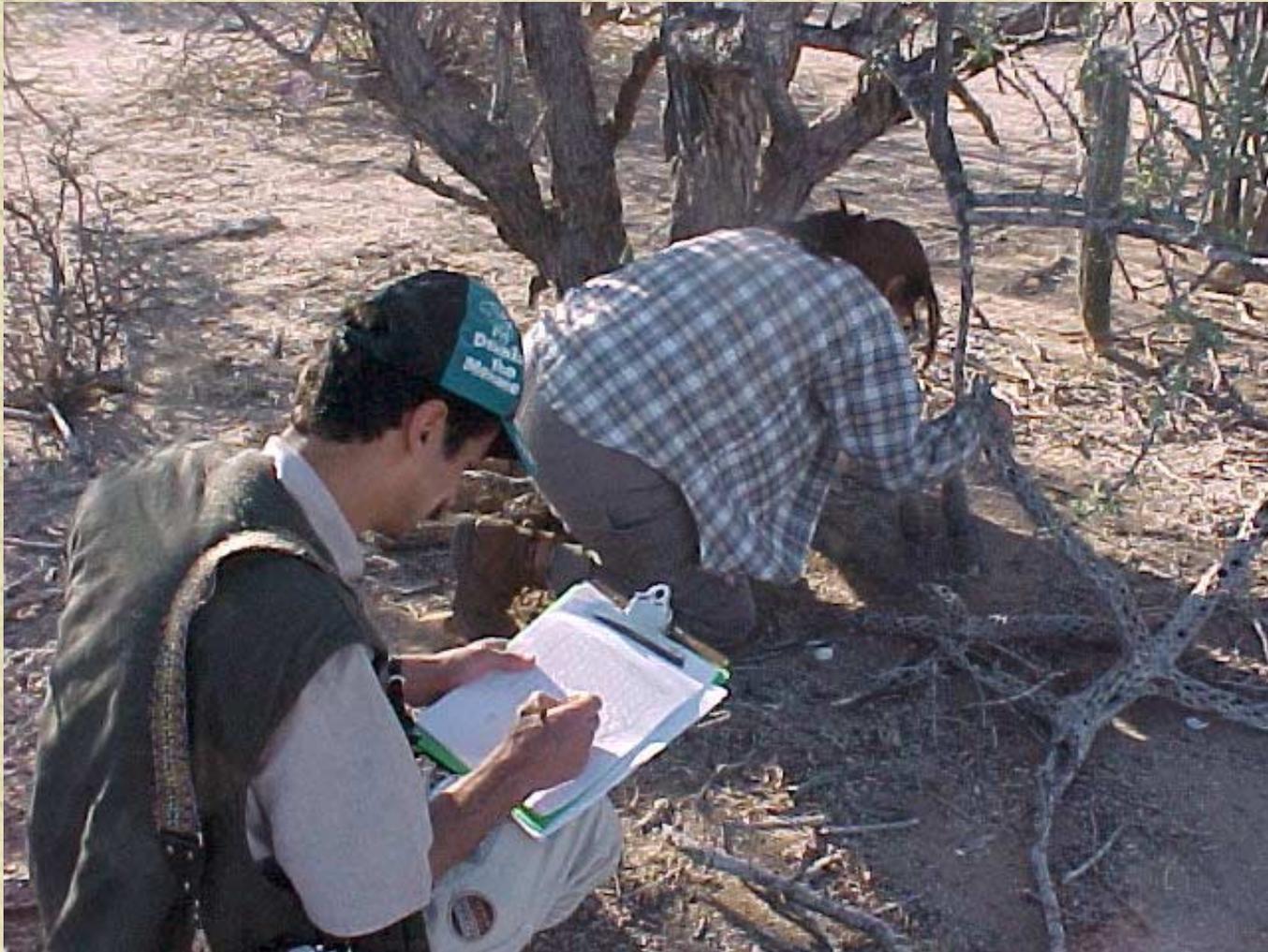
Cardon (*Pachycereus pringleii*) with researcher and students



Ironwood (*Olneya tesota*)

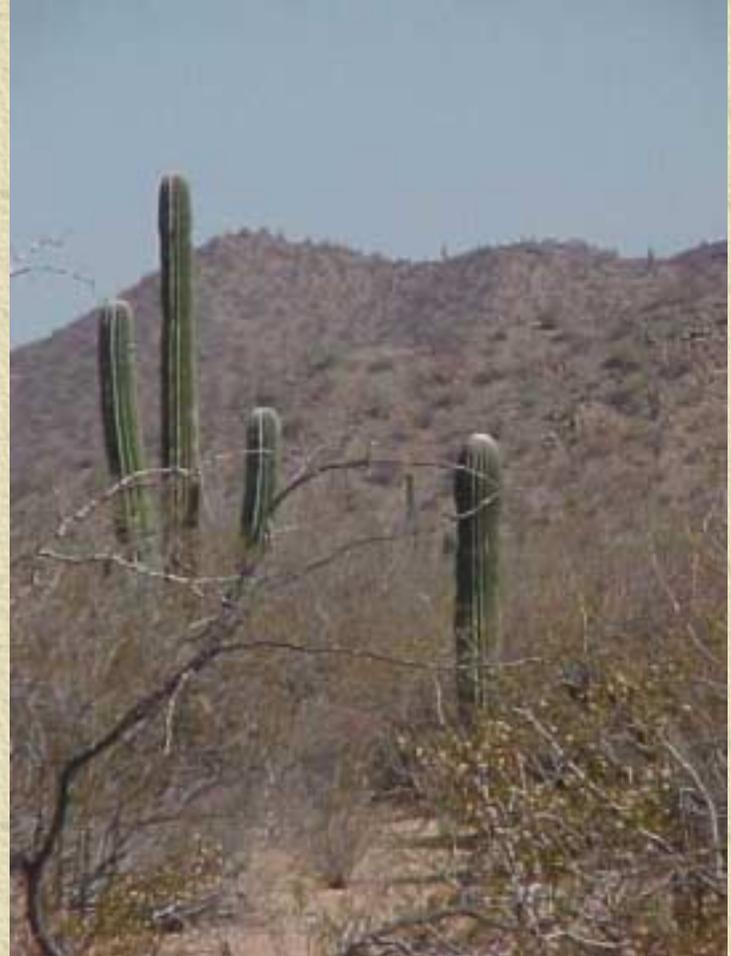


Coauthor, student, mesquite and seedlings



Long term study?

- ✦ Two mexican graduate students from Arizona (ASU) and Florida meet in Bahia Kino, Sonora (1991).
- ✦ V.Sosa was interested in seed mechanism dispersal and H. Suzán in the ecological importance of ironwood as a nurse plant.



Long term study?

- ✦ We decided to run a small experiment of seedling performance under two important nurse plants.
- ✦ Preliminary experiment (survival beneath nurses and open spaces) 1991.
- ✦ Results indicated non survival of seedlings in open spaces



Long term study?

✦ The experiment was designed to be a one to two year experiment of seedling survival under different nurse conditions (1992-1994).

✦ We detected an strong spatial association with ironwood.

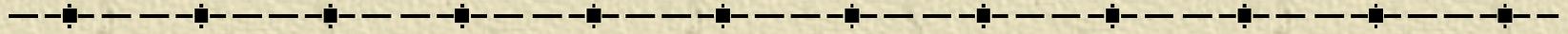


Long term study?

- ✦ Preliminary results (1995) indicated non survival of seedlings in open spaces.
- ✦ Non differential growth and survival beneath both nurses.
- ✦ A second survey period 1998 to 2000 was conducted



Hypothesis:



- ✦ Recruitment, survival and growth rate of cardon seedlings are not equally expressed in different nurse species.
- ✦ Cardon seedlings require moderate light intensities.
- ✦ Mesquite and ironwood will have different soils and litter characteristics.

Methodology

- ✦ Seedlings from a 1992 cohort were sowed beneath ironwood and mesquite trees.
- ✦ Ten seedlings each were sowed in 24 chicken wired boxes, under six randomly selected trees per nurse species.
- ✦ A multivariate repeated measures analysis from a simple random design was conducted from 1992 to the year 2000.
- ✦ Initial diameter and height were considered as co-variables, the model considered trees nested in species, and boxes nested in trees

Methodology

- ✦ The experiment was conducted in Rancho San Germán, Bahía Kino, Sonora (Tortilla flats).
- ✦ The vegetation of the area was a xeric-shrubland dominated by *Olneya tesota* and *Prosopis velutina*.
- ✦ Annual measurements of growth (diameter, height), were collected between 1992-2000.

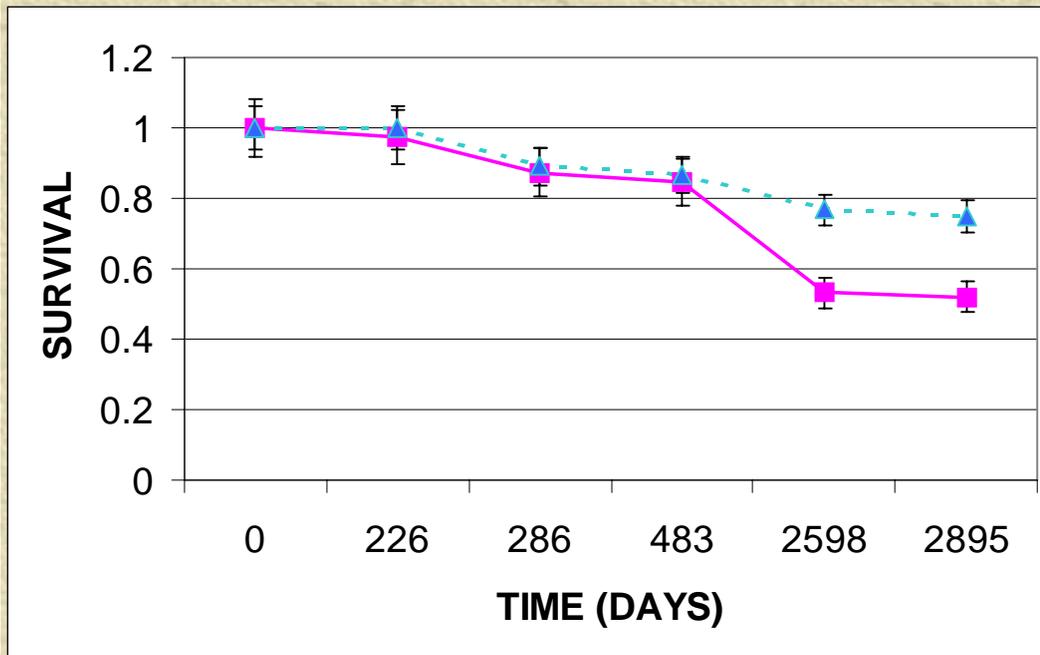
Methodology

- ✦ Soil surface temperature and photosynthetic active radiation data in winter and summer of 1993 and 2000 were collected with a LICOR 1000 data-logger.
- ✦ Leaf area indices were collected with a LICOR LAI 2000 data logger.
- ✦ Soil's chemical properties, litter depth, cover and weights were measured in four 50cm² quadrats beneath each tree.

Cardon (*Pachycereus pringleii*) seedlings



Seedling survival



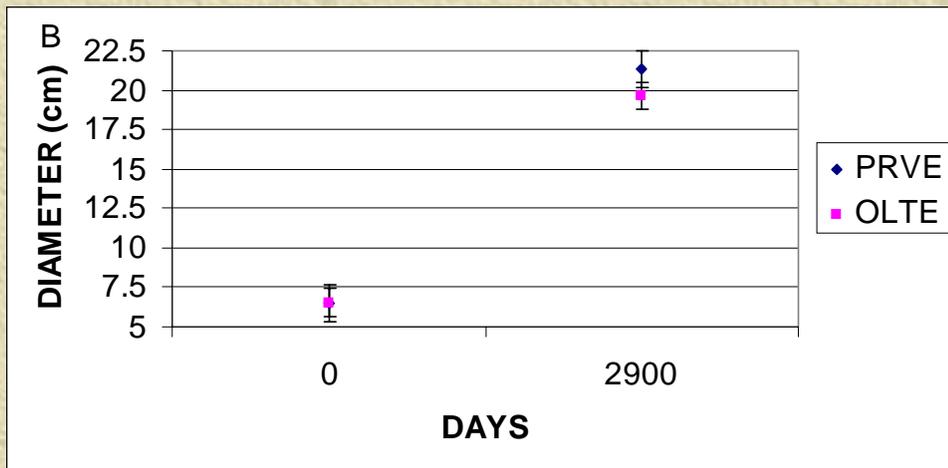
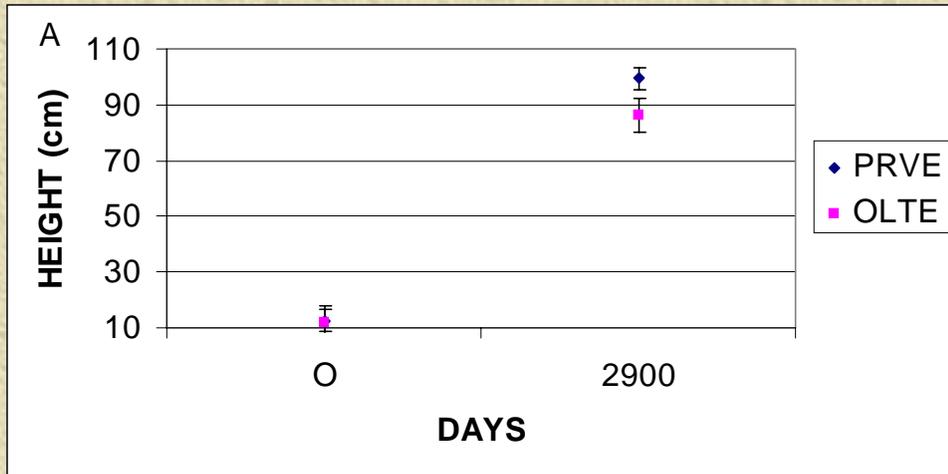
Mesquite: blue, ironwood: pink

✦ Kaplan-Meier Weibull method indicates significant survival differences with the Log-Rank test: $P(\chi^2 = 11.3940/1 \text{ d.f.}) = 0.0007$; and with the Wilcoxon test: $P(\chi^2 = 10.0769/1 \text{ d.f.}) = 0.0015$.

Multivariate analysis of variance

Source of variation	Wilks' λ	Exact F	D.F.	Prob > F
Whole model	0.6906	3.3475	19/142	<0.0001**
Intercept	0.9987	0.1740	1/142	0.6772
Height	0.9719	4.095	1/142	0.024*
Diameter	0.9923	1.102	1/142	0.3424
Species	0.9716	4.1472	1/142	0.0426*
Trees (species)	0.8985	1.640	10/142	0.1111
Box (trees)	0.8529	4.087	6/142	0.0008**

Growth comparisons

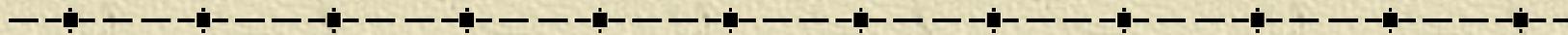


Comparisons of seedling height and diameter in plants located beneath
OLTE = *Olneya tesota*; and

PRVE = *Prosopis velutina*

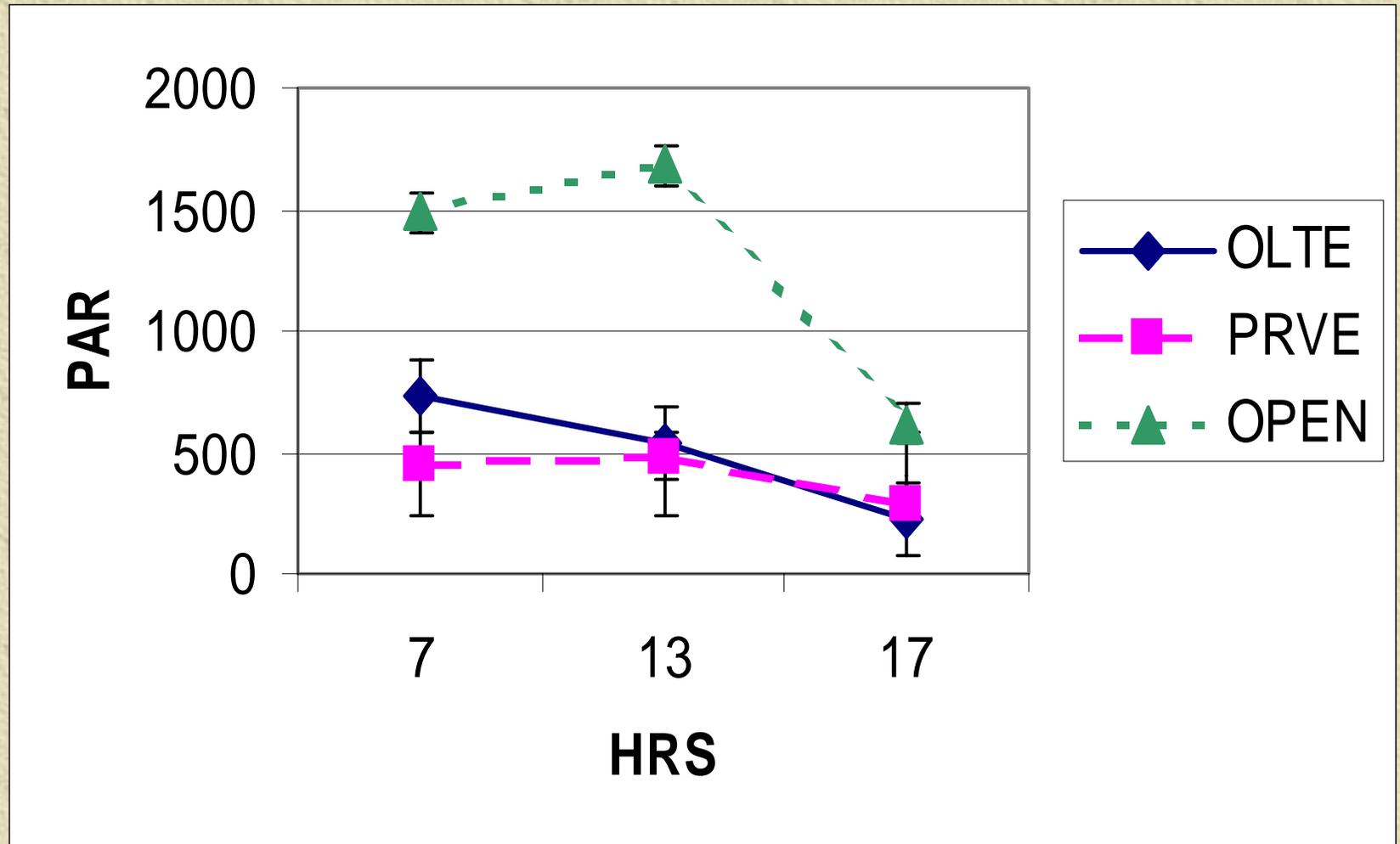
at time 0 (day of sowing), and at 3000 days after sowing

Canopy structure conditions



	LAI	DIFN	C.D.	HEIGHT	H.B.	B.A.
OLTE	0.76±0.07	0.53±0.03	6.54±0.23	3.65±0.36	1.032±0.2	683.9±74.2
PRVE	0.93±0.13	0.47±0.04	6.08±0.31	2.9±0.37	0.67±0.05	235.71±57
F/ d.f.	1.36/1,10	1.40/1,10	1.43/1,10	2.1/1,10	4.83/1,10	22.74/1,10
P(F)	0.269	0.263	0.2583	0.17	0.050*	0.0008**

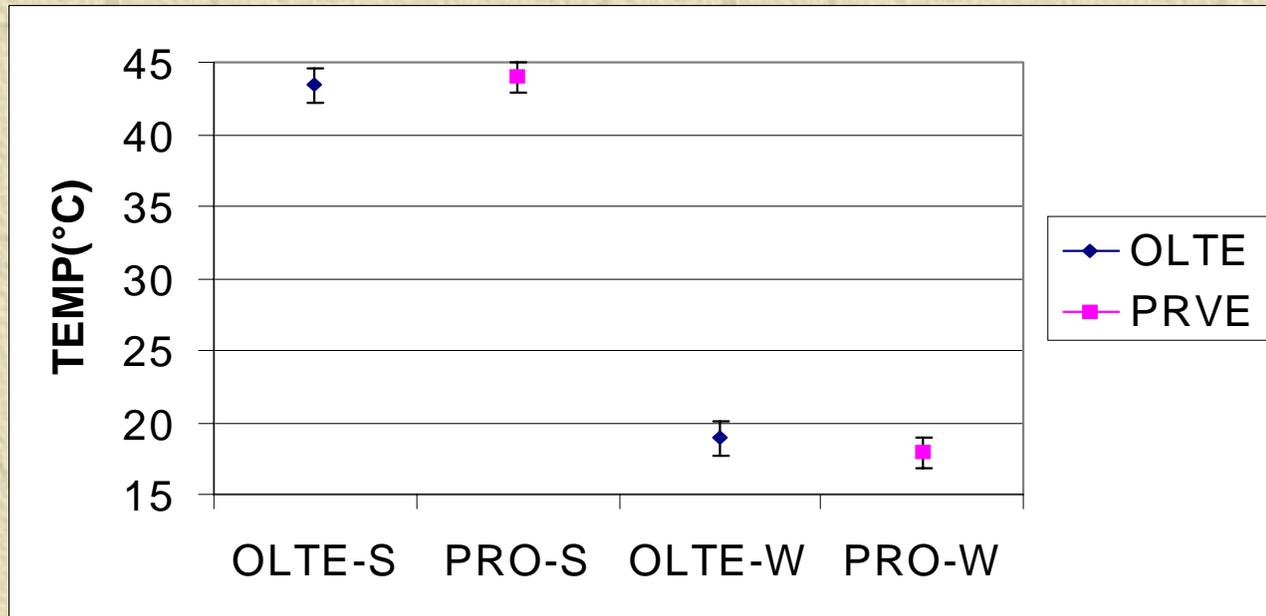
PAR measurements (summer)



Soil characteristics (10 d.f. each)

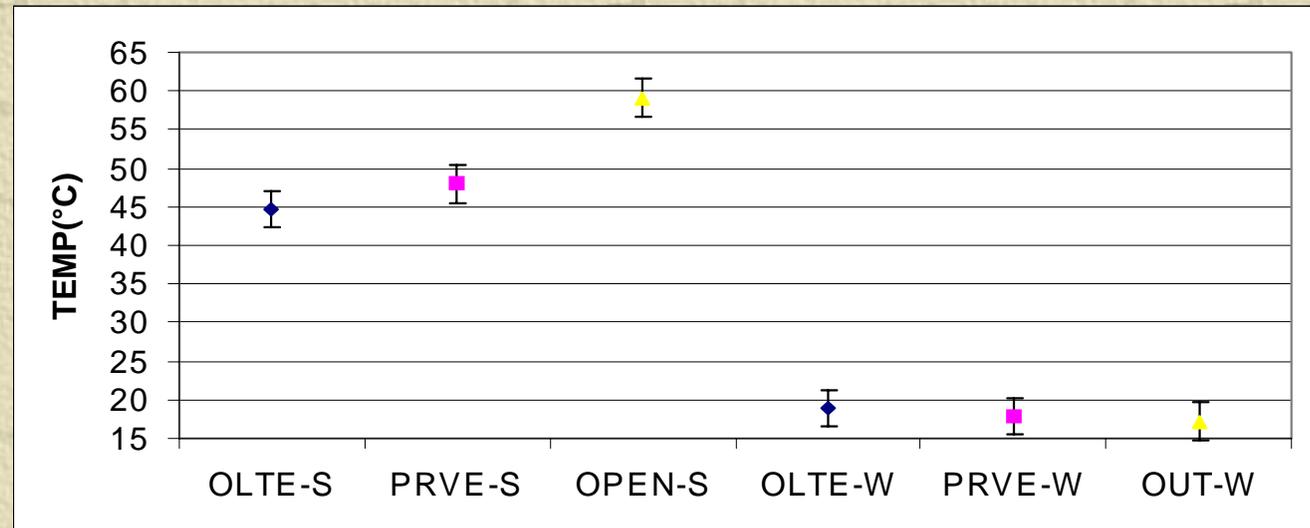
Variable	Ironwood	Mesquite	P(t)
pH	7.21	6.87	0.0090**
Org. Ma.(%)	0.90	0.85	0.7685
N (%)	0.80	0.80	0.8860
P (ppm.)	34.66	32.33	0.1400
K (Meq/100 g)	1.02	0.83	0.0460*
Na (Meq/100 g)	0.27	0.25	0.520
Mg (Meq/100 g)	1.28	1.64	0.001**
Ca (Meq/100 g)	5.24	4.23	0.104

Stem temperatures (1993)



- ✦ Maximum summer temperatures on 25-06-93 at 14.00 hrs
- ✦ Winter temperatures on 07-12-93 at 7.00 hrs
- ✦ Summer: $P(F=2.55/ 1,18 \text{ d.f.})=0.61$.
- ✦ Winter: $P(F= 0.703/ 1,22 \text{ d.f.})= 0.41$.

Soil surface temperatures



- ✦ Data recorded the 25-06-1993 at 14.00 hrs (summer: -S) and the 07-12-93 at 7.00 hrs (winter:-W).
- ✦ Significant differences were detected in summer $P(F=46.48/2,37 \text{ d.f.}) < 0.0001$.
- ✦ Non significant differences in winter with $P(F=1.121/2,45 \text{ d.f.})=0.332$.

Litter results (nested design)

✦ Litter depth: $P(f=5.50/10 \text{ d.f.})= 0.0246^*$

✦ Litter cover (ARCSINE transformed):

◆ $P(f=11.35/10 \text{ d.f.})=0.018^*$

✦ Litter weight:

◆ Fresh: $P(t=0.5/10 \text{ d.f.})=0.1175$

◆ Dry: $P(t=0.051/10 \text{ d.f.})= 0.959$

Role of seed dispersers

- ✦ Suzán et al (1996) reported that ironwood is the main nurse for columnar cacti including cardon.
- ✦ If seedlings beneath mesquite exhibited better growth rates, why in the field cardon seedlings are strongly associated to ironwood?
- ✦ Possible answer: seed dispersers.
- ✦ Sosa (2002) reported the importance of seed dispersers: five birds and one lizard.

Seed dispersers in B. Kino with intense activity beneath perennials

-
- ✦ Verdin (*Auriparus flaviceps*), **
 - ✦ Ash-throated flycatcher (*Myarchus cinerascens*), **
 - ✦ Curve-billed thrasher (*Taxostoma curvirostre*)*
 - ✦ Catus wren (*Campylorhynchus brunneicapillus*)*
 - ✦ Lloyd's bushtit and desert iguana*.

Comparison of factors that might influence association of cardon with two nurse plants

Factor	ironwood	mesquite	
Roost selection	++	-	*
Seed germination	=	=	
Seed predation	=	=	*
temperature	=	=	
Light availability	=	=	
Litter standing crop	-	+	
Soil fertility	=	=	
Competition with nurse	=	=	

Conclusions

- ✦ Mesquite a deciduous tree provided better conditions for cardon growth and survival.
- ✦ Litter beds beneath mesquite trees enhance seedling survival.
- ✦ Chemical and physical factors alone did not explained growth and survival of cardon seedlings
- ✦ Seed dispersers could be the key to understand natural relationships. (Tewksbury et al 1999).

Thank you.

