The Role of Nutrients for Improving Seedling Quality in Drylands

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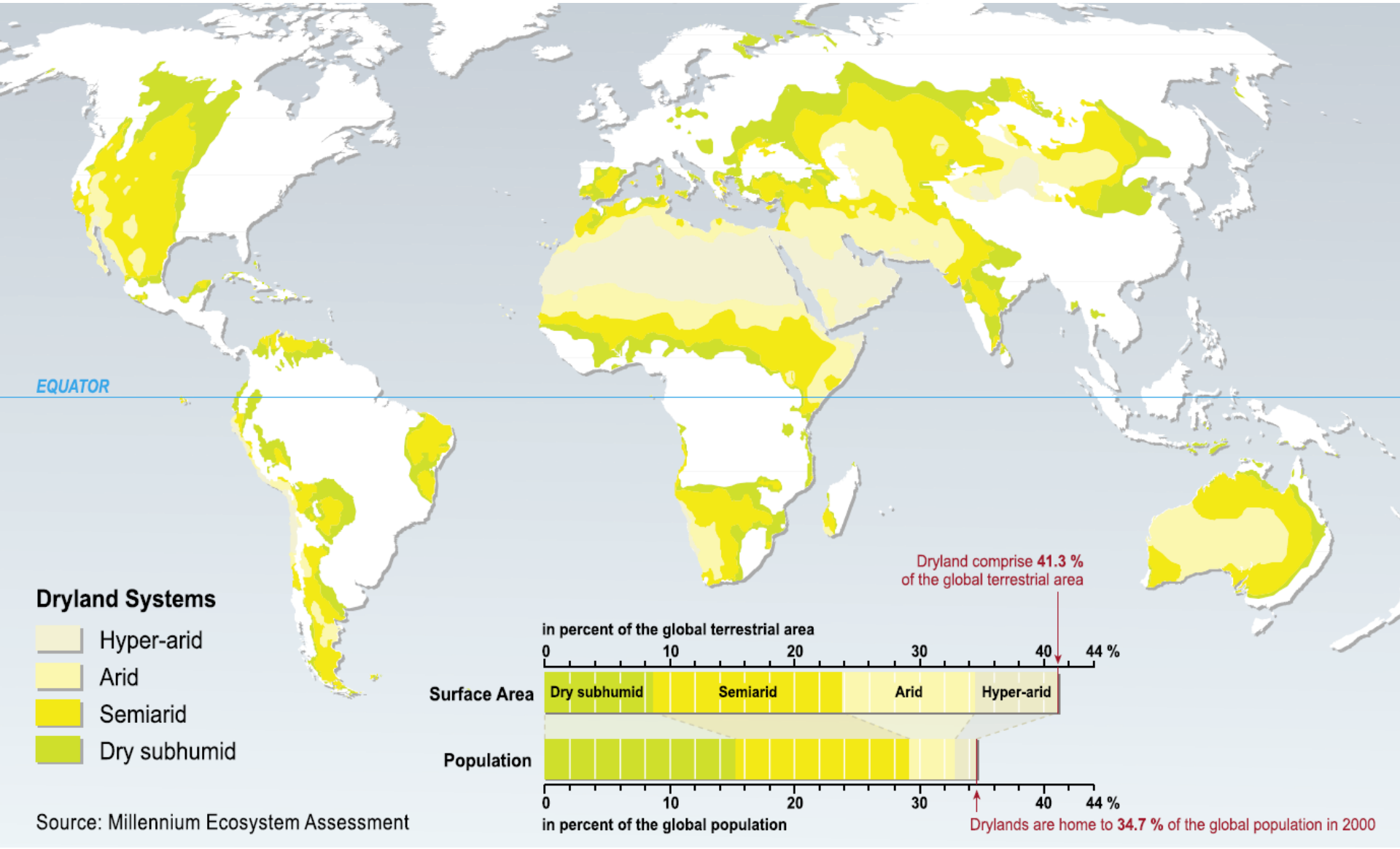
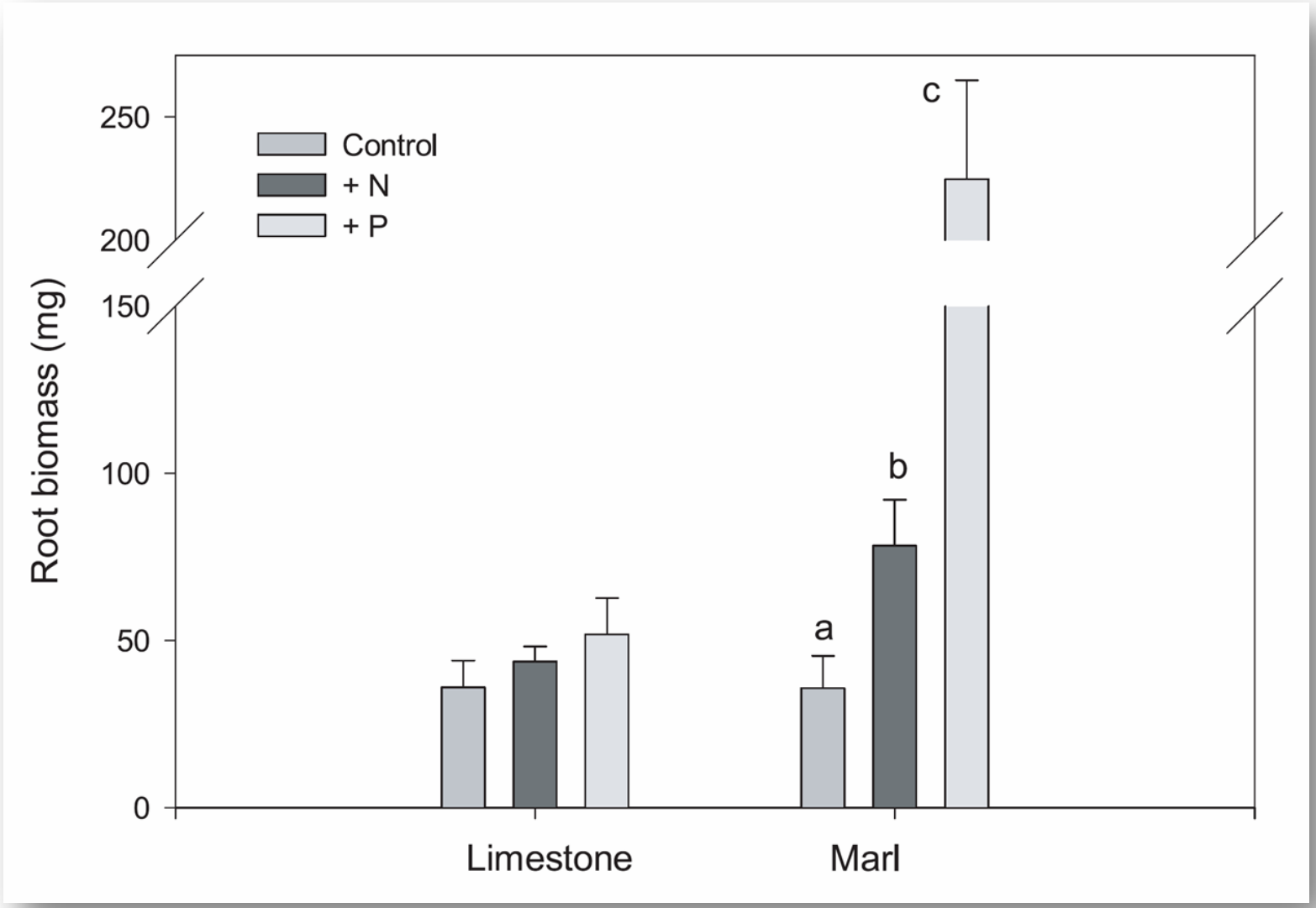

EQUATOR
Dryland Systems
Hyper-arid
Arid
Semiarid
Dry subhumid
Source: Millennium Ecosystem Assessment
Dryland comprise 41.3 % of the global terrestrial area
in percent of the global terrestrial area
0
10
20
30
40
44 %
Surface Area
Dry subhumid
Semiarid
Arid
Hyper-arid
Population
0
10
20
30
40
44 %
in percent of the global population
Drylands are home to 34.7 % of the global population in 2000

DESERTIFICATION: 10-20% = $6 \cdot 10^6$ KM^2

Overgrazed alfa grass steppes in Central Tunisia

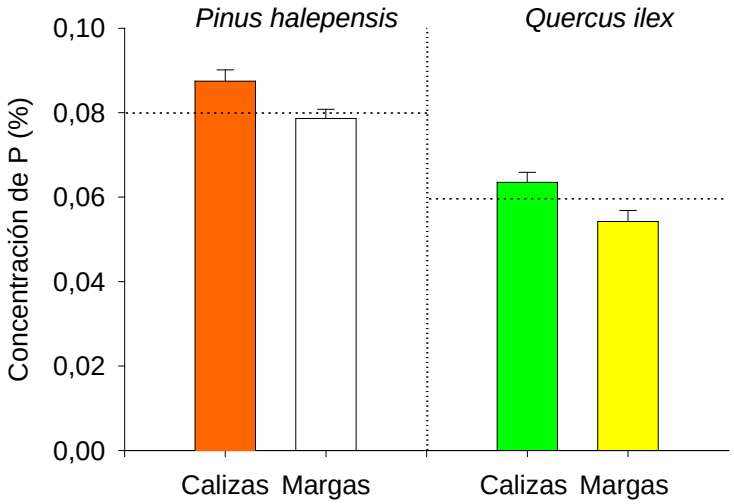
… and S Spain

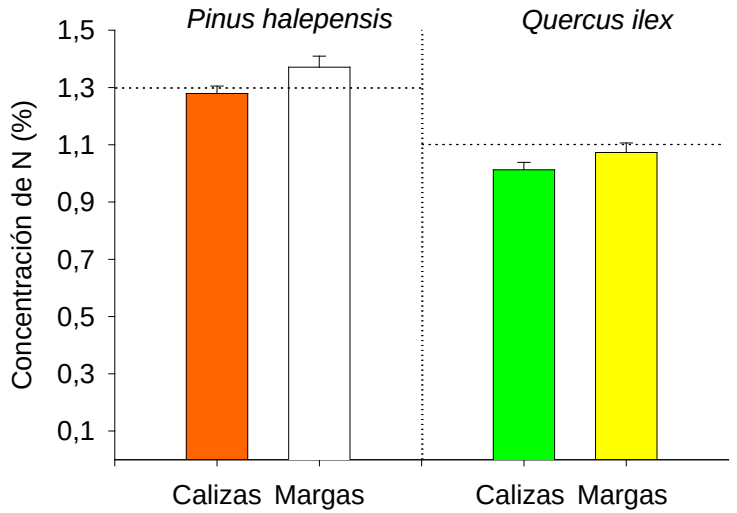
SOILS ARE OFTEN SHALLOW AND NUTRIENT-DEPLEATED

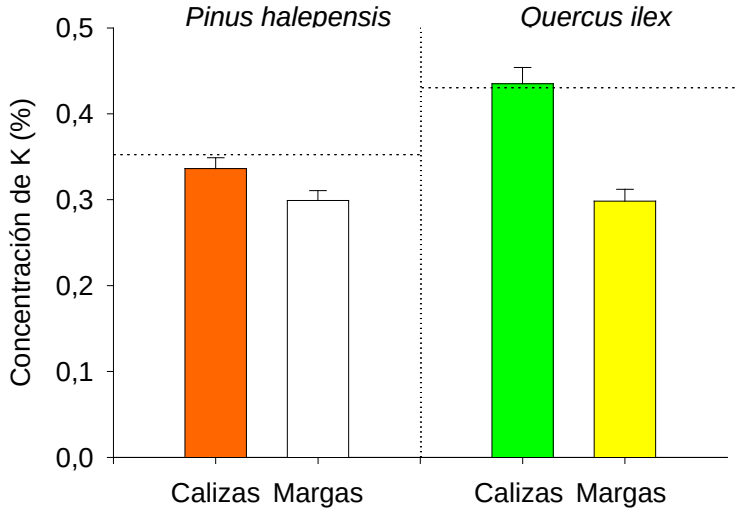


Valdecantos et al. (2006). *Annals For. Sci.* 63: 249-256

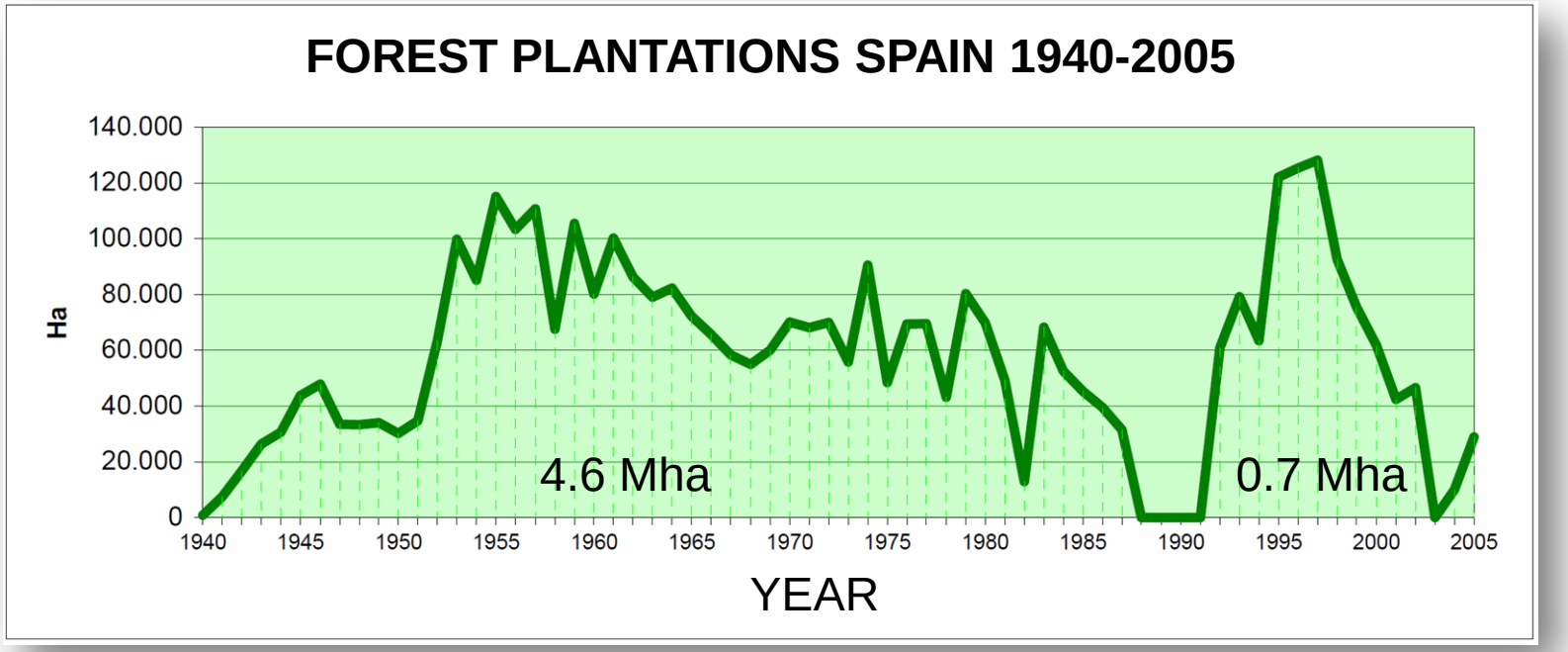
...AND SEEDLINGS ARE NUTRIENT-LIMITED







Valdecantos et al. (2006). *Annals For. Sci.* 63: 249-256



MMA (2005). Anuario de Estadística Forestal.

- Algeria Green Belt (1970-2000) – 122.680 ha (Bensaid, 2003)
- Forest and pastoral plantations PNDAR Algeria (2000-2007) – 390.900 ha (Terramed, 2009)
- Tunisia PN Reboisement (1990-2000) + PN Investissement dans le Secteur Forestier (2000-2011) – 885.000 ha (Larbi Chakroune, 2003)
- Morocco 20th century – 508.000 ha (Sabir, 2003)
- Total afforested/reforested Magreb – 2,000.000 ha (Le Houérou, 2000)

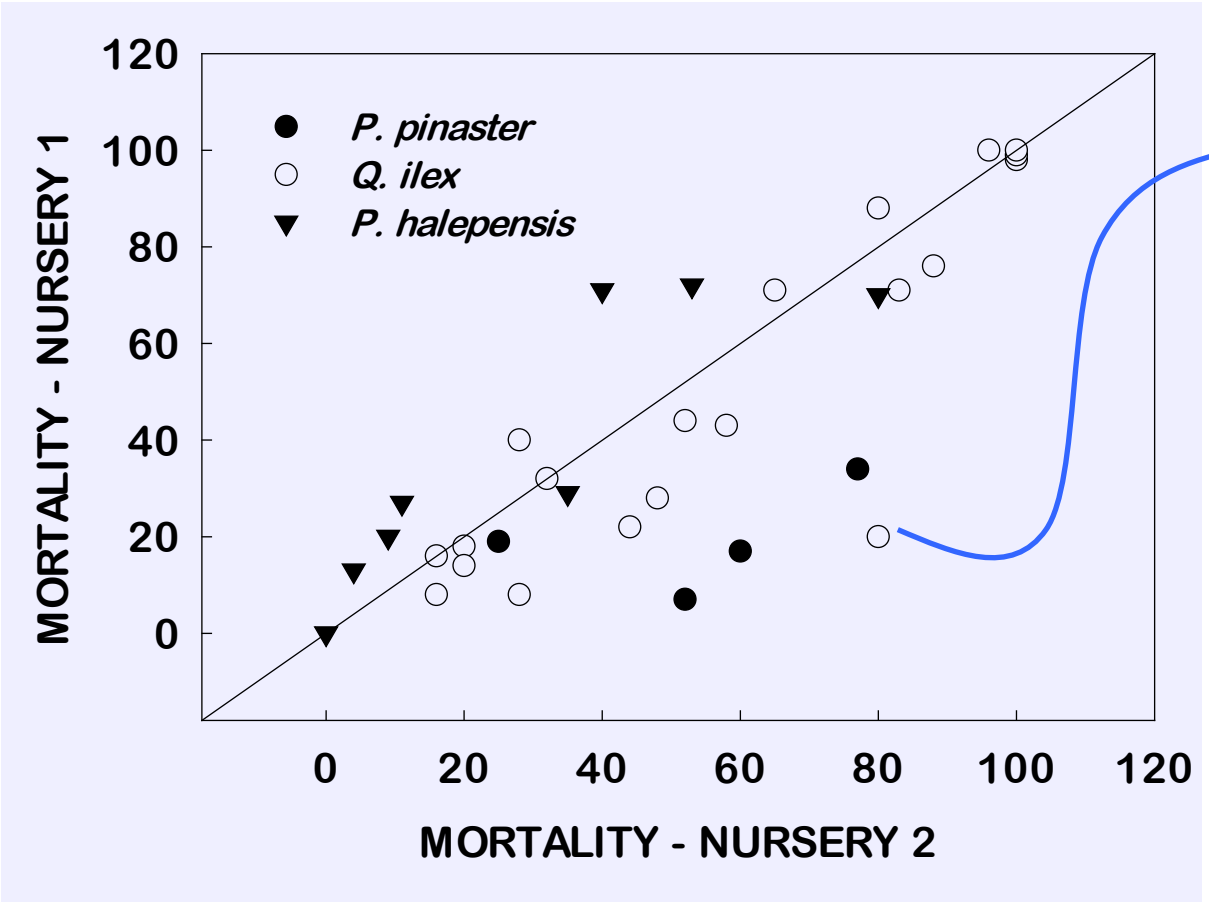
1927 **Ricote Valley (Murcia)** DGB-INIA

1994 **Ricote Valley (Murcia)**

Agost Site Indicators of Success

PARTICIPATIVE INTEGRATED EVALUATION	
1.	Aquifer recharge
2.	Biodiversity
3.	Soil conservation
4.	Soil quality
5.	Employment
6.	Plant cover
7.	C sequestration
8.	Fire risk
9.	Productivity value
10.	Touristic value
11.	Landscape aesthetic
12.	Cultural value
13.	Flood prevention

... SEEDLING QUALITY IS IMPORTANT



Same site

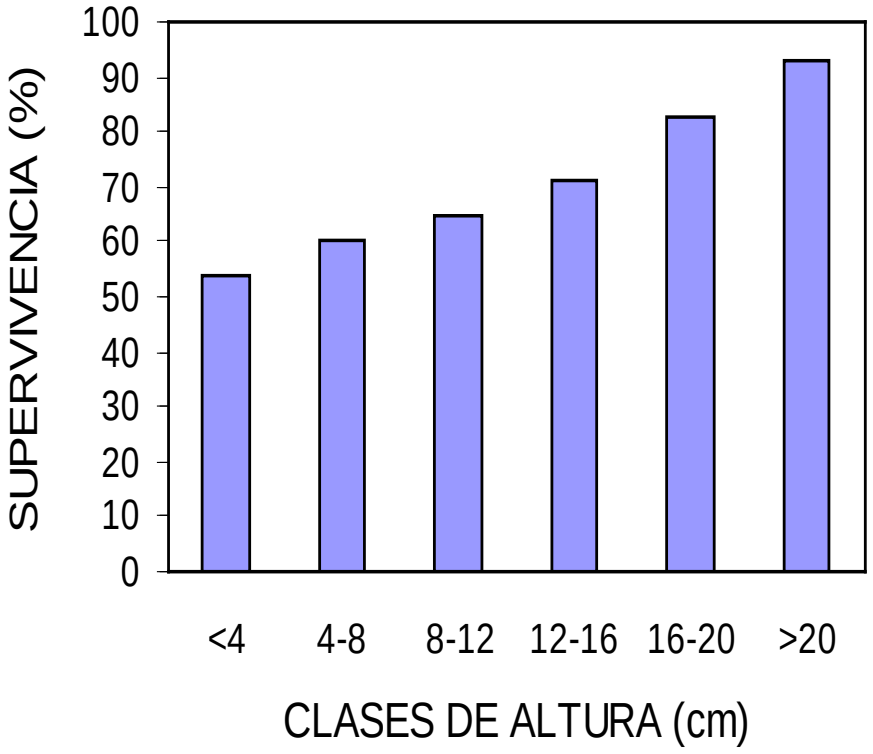
Same year

but...

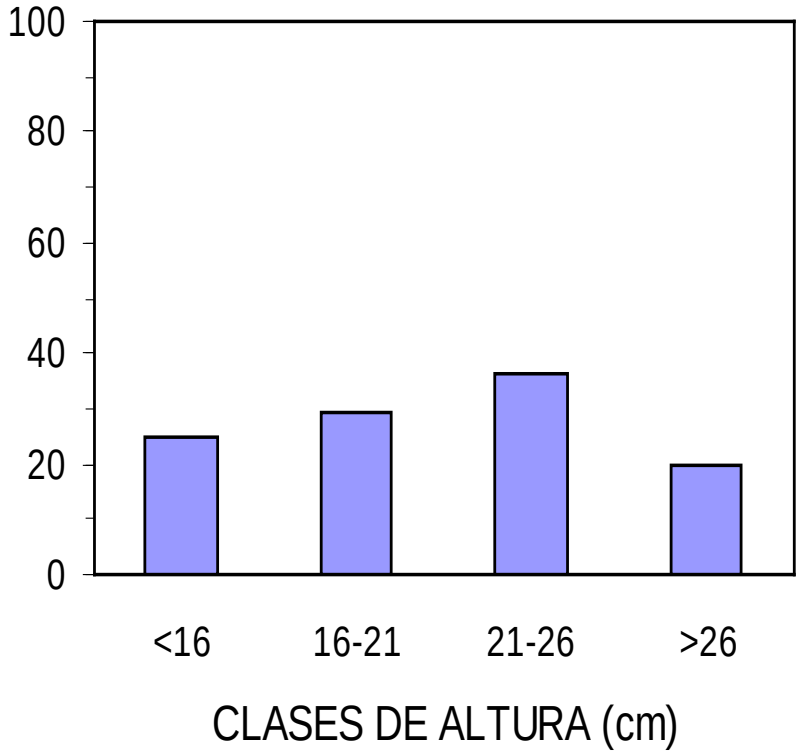
Cortina et al. (2006). *MMA*

BIGGER SEEDLINGS PERFORM BETTER, BUT NOT ALWAYS

Quercus ilex ballota

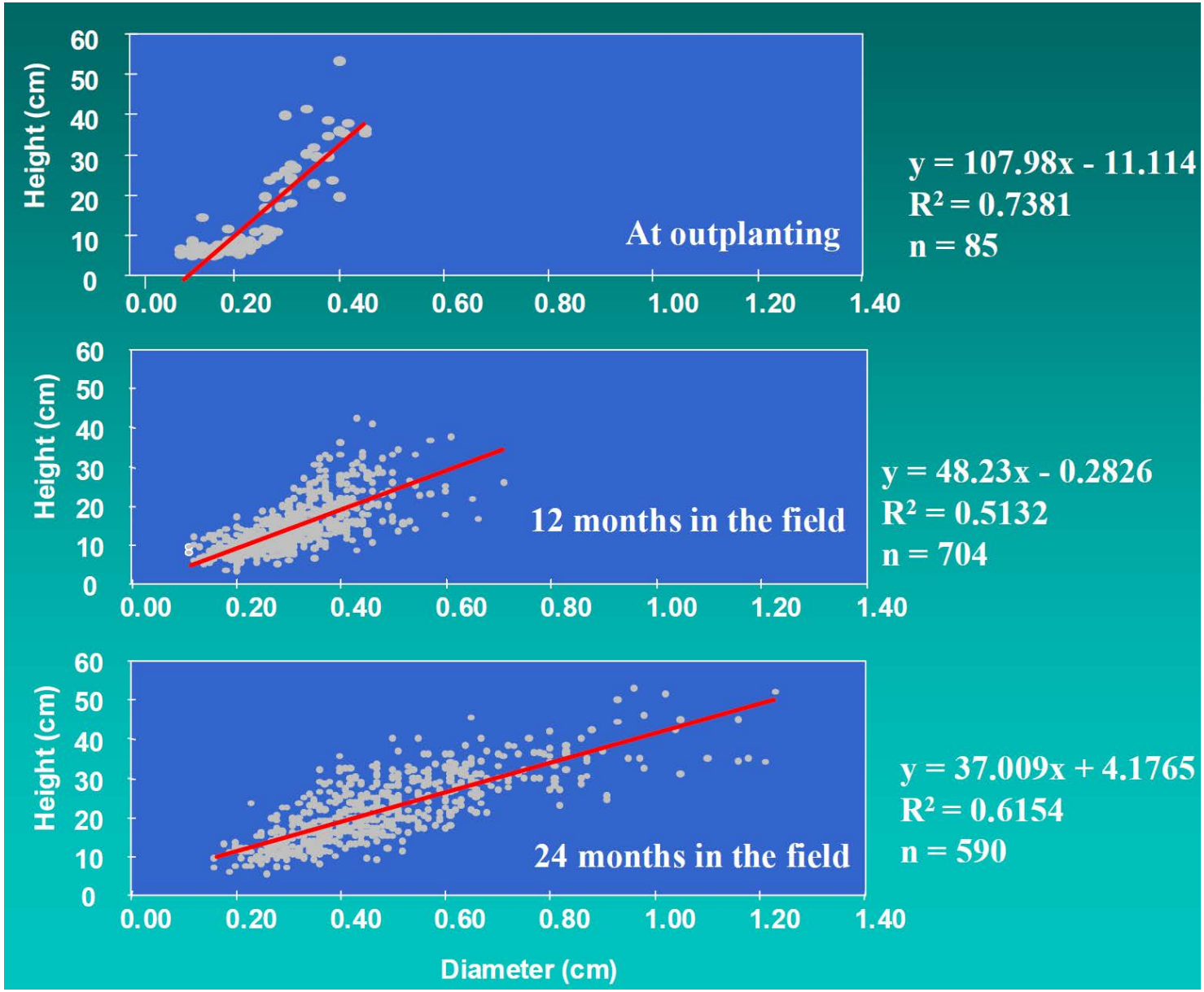


Quercus coccifera



Cortina et al. (2000). *EC Report EUR 19303.*

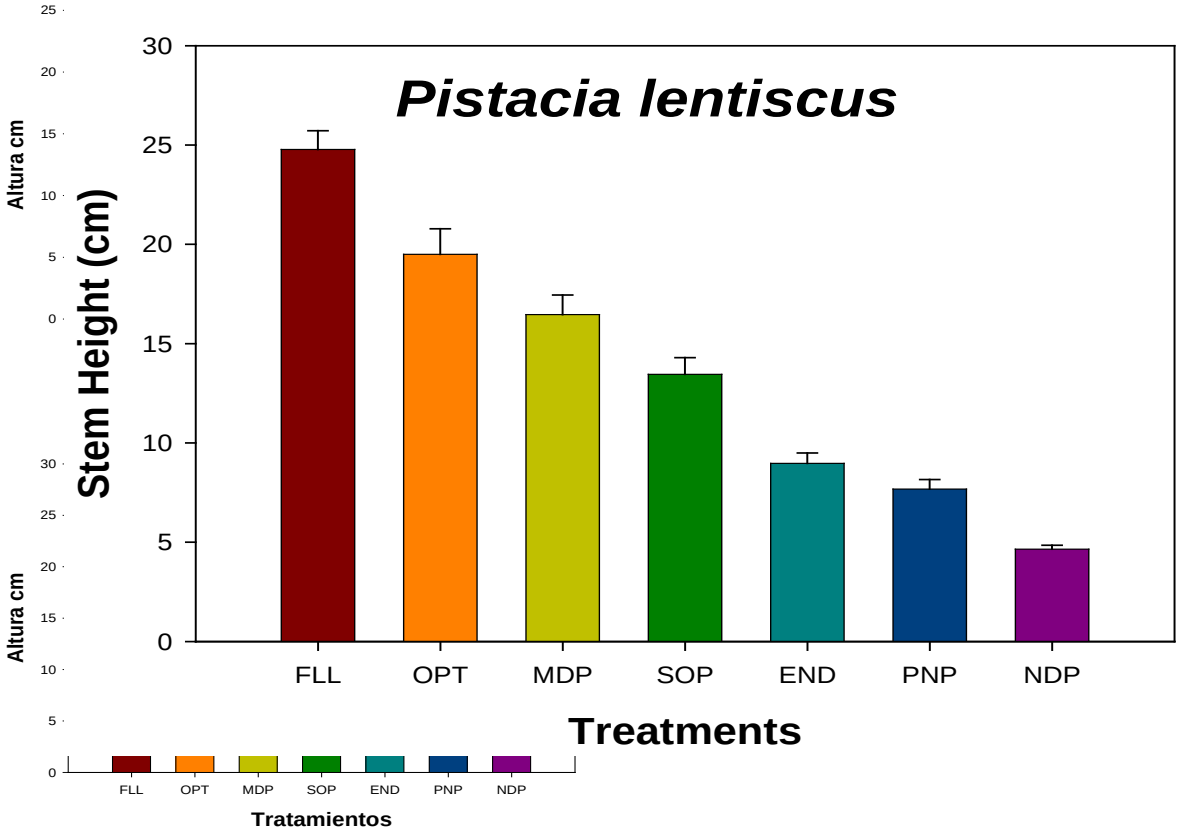
SEEDLINGS FREQUENTLY ADJUST IN THE FIELD

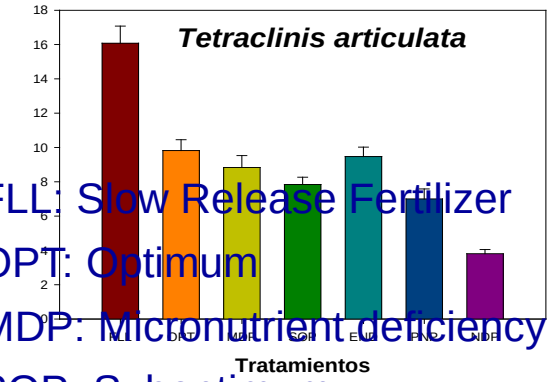


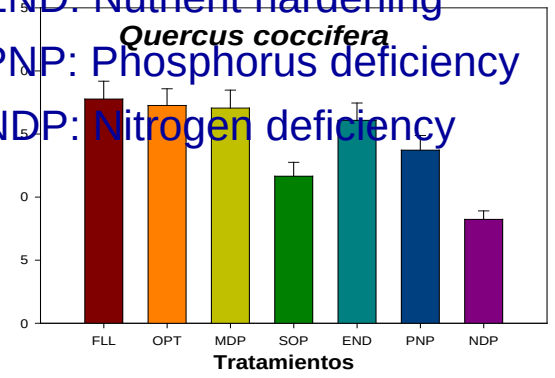
STRONG MORPHOLOGICAL RESPONSES TO NUTRIENT REGIMES

SRF (0'8 g L^{-1})	160 ppm N	80 ppm N	Micro def	Harden	P def	N def

STRONG MORPHOLOGICAL RESPONSES TO NUTRIENT REGIMES







FLL: Slow Release Fertilizer

OPT: Optimum

MDP: Micronutrient deficiency

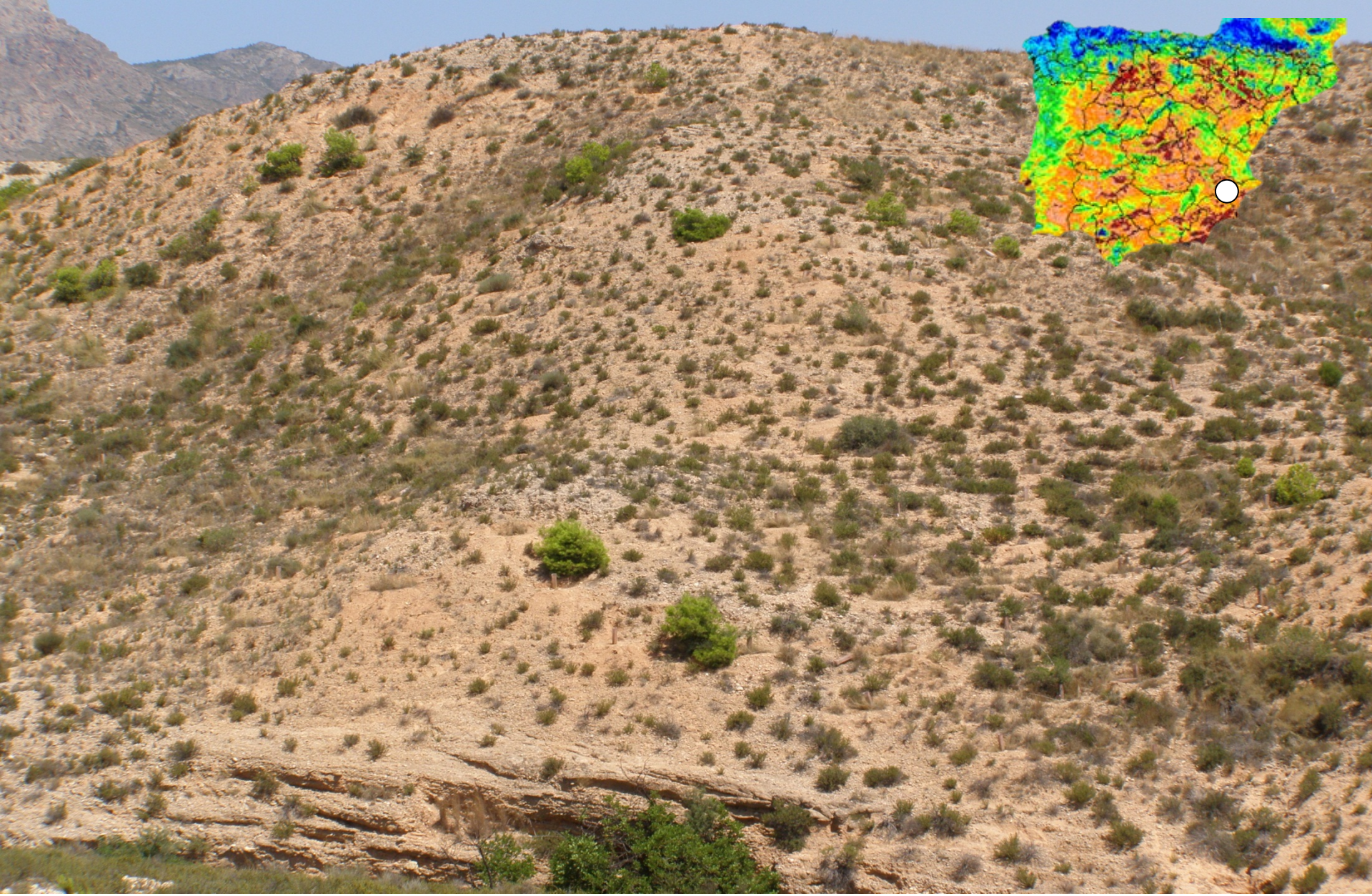
SOP: Suboptimum

END: Nutrient hardening

PNP: Phosphorus deficiency

NDP: Nitrogen deficiency

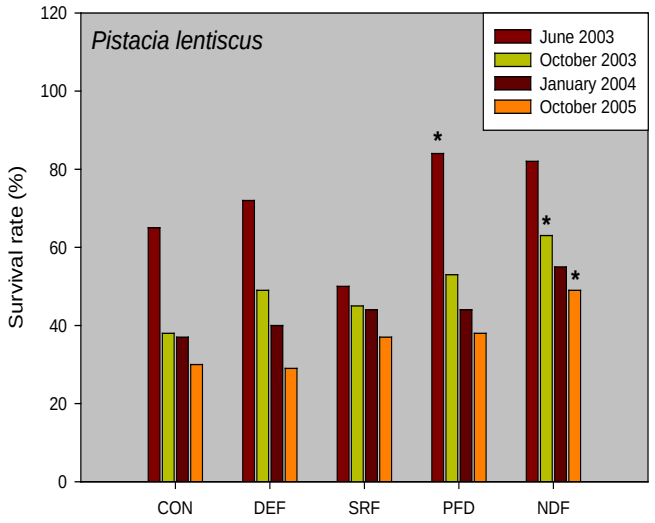
Trubat et al. (2011). *Ecol. Eng.* 37: 1164–1173

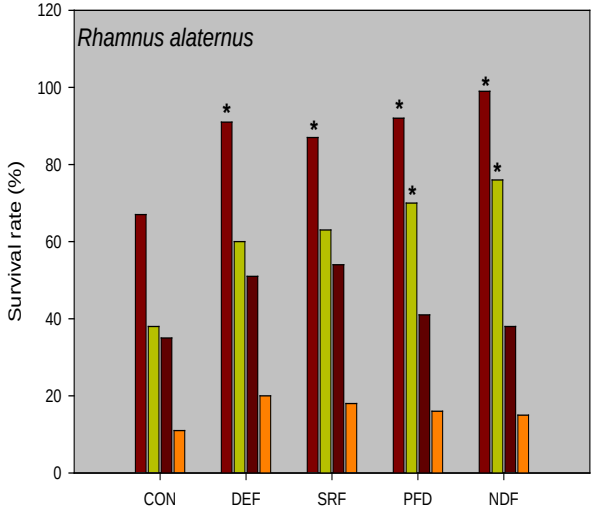


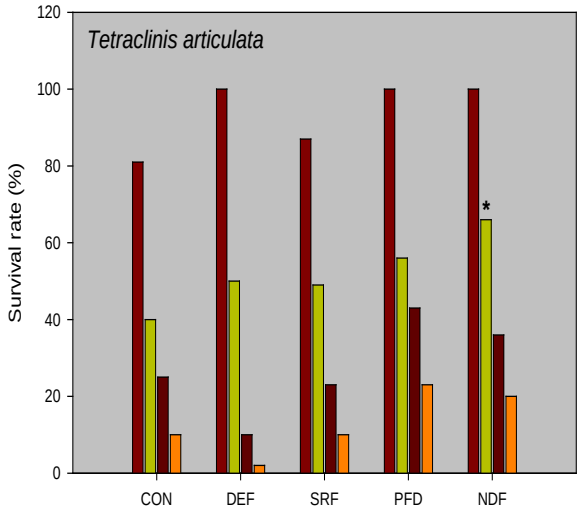
Albatera (Alicante, SE SPain). Semiarid

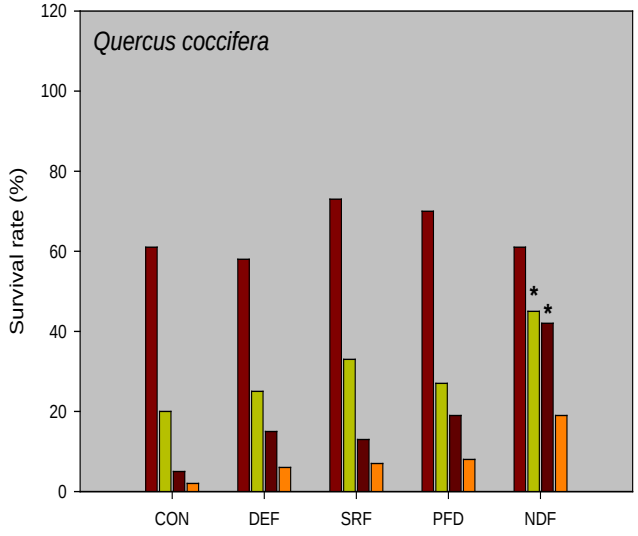
1000 plants ha^{-1} - 40 x 40 x 40 cm planting holes – backhoe spider

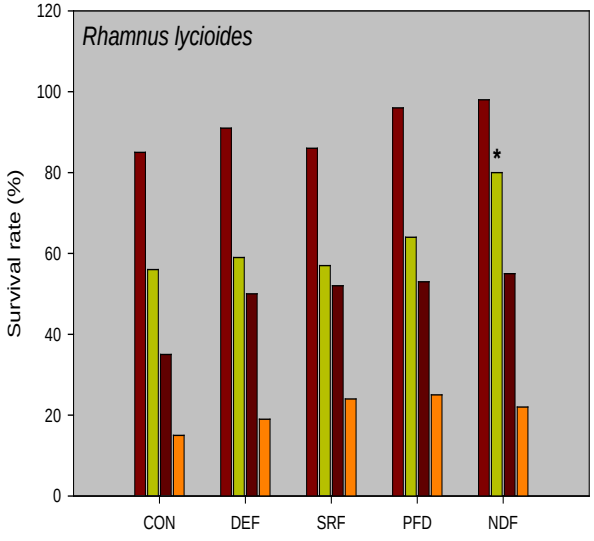
SMALLER SEEDLINGS PERFORMED BETTER





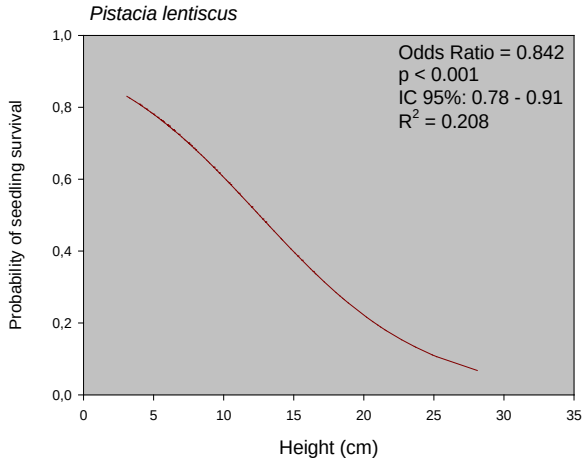


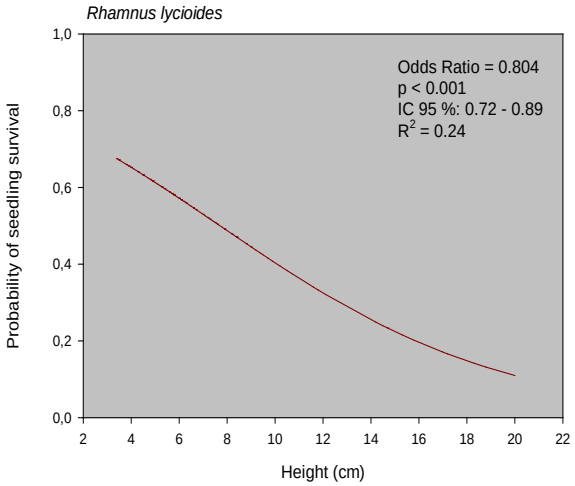


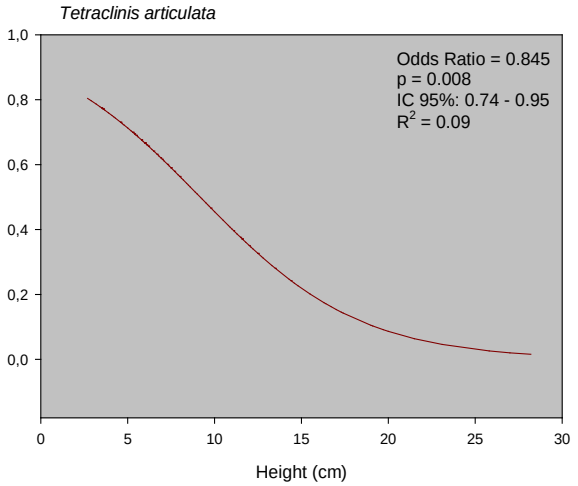


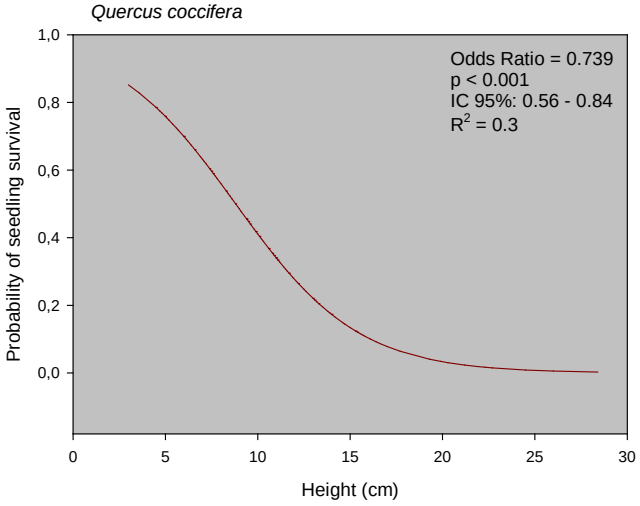
Trubat et al. (2011). *Ecol. Eng.* 37: 1164–1173

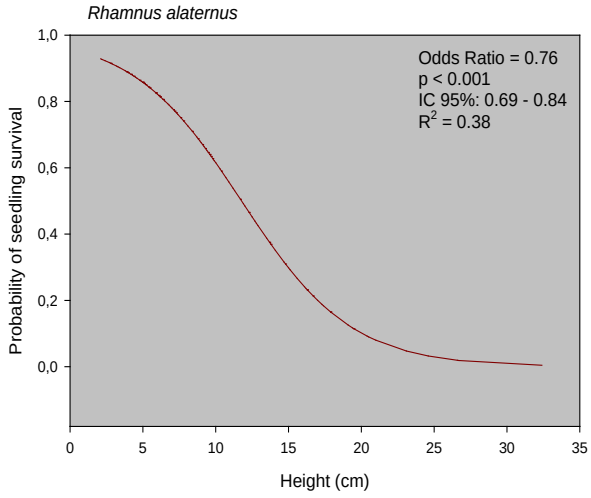
SMALLER SEEDLINGS PERFORMED BETTER





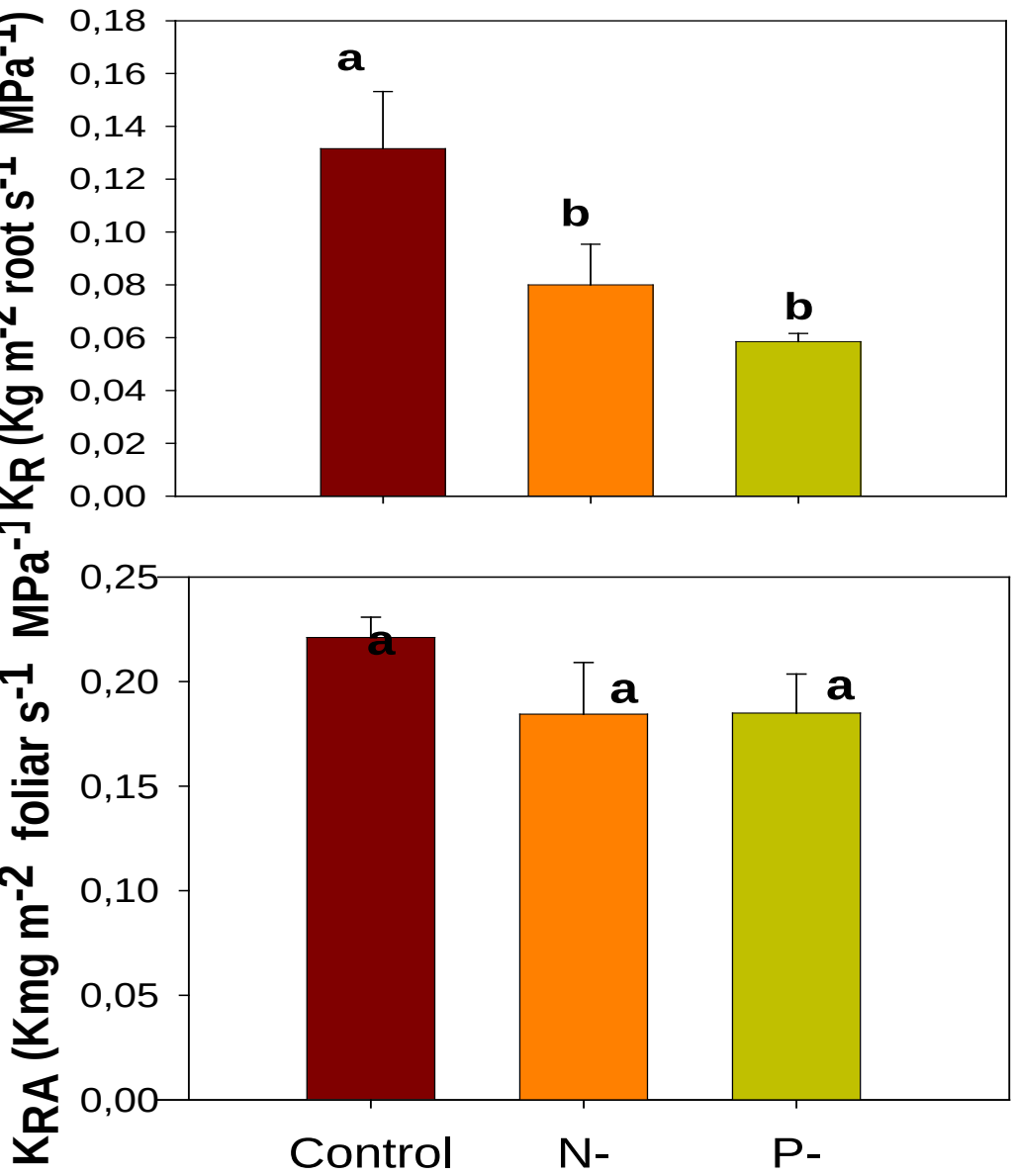




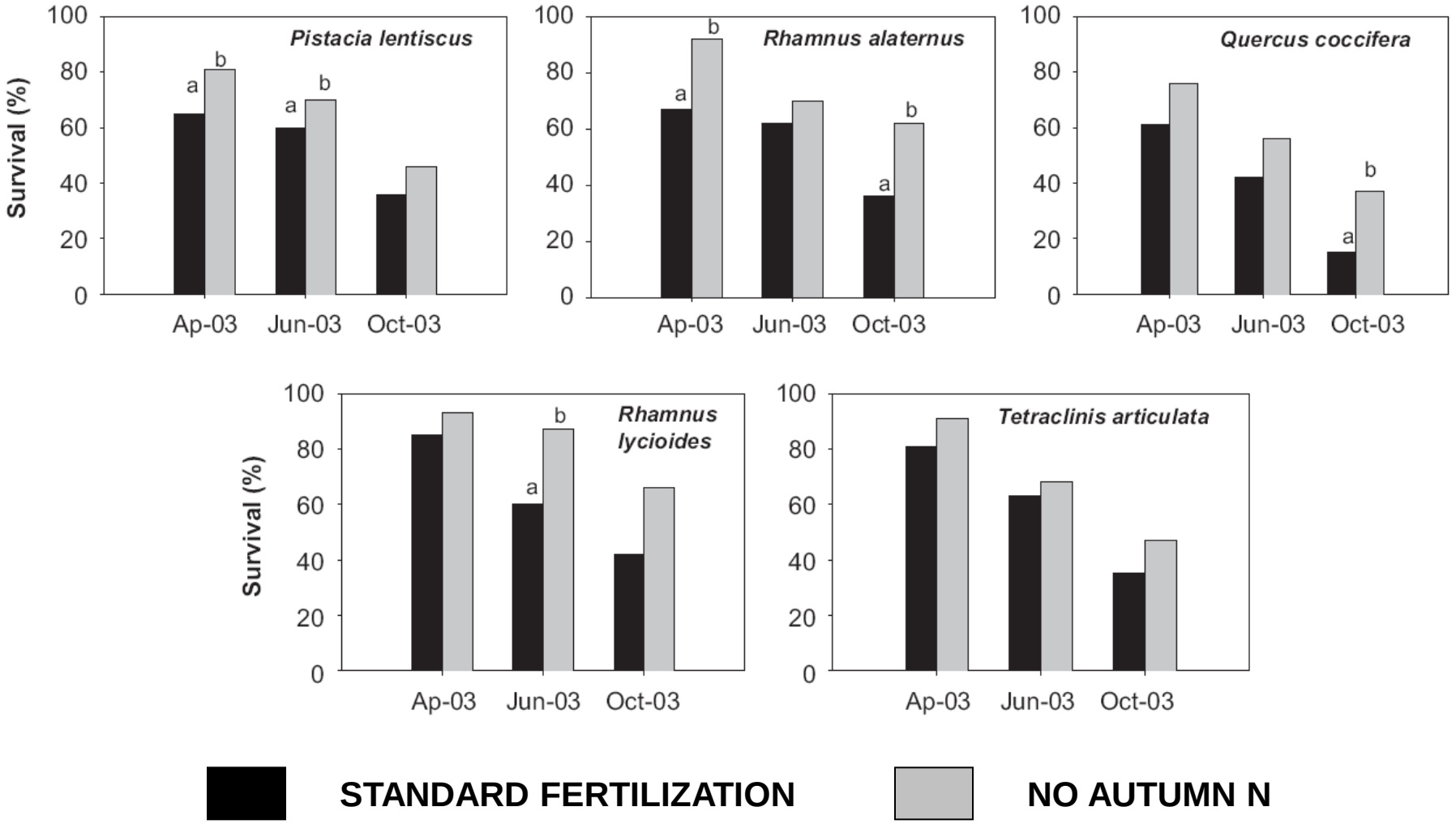


Trubat et al. (2011). *Ecol. Eng.* 37: 1164–1173

HYDRAULIC ARCHITECTURE DOES NOT SEEM TO BE THE CAUSE

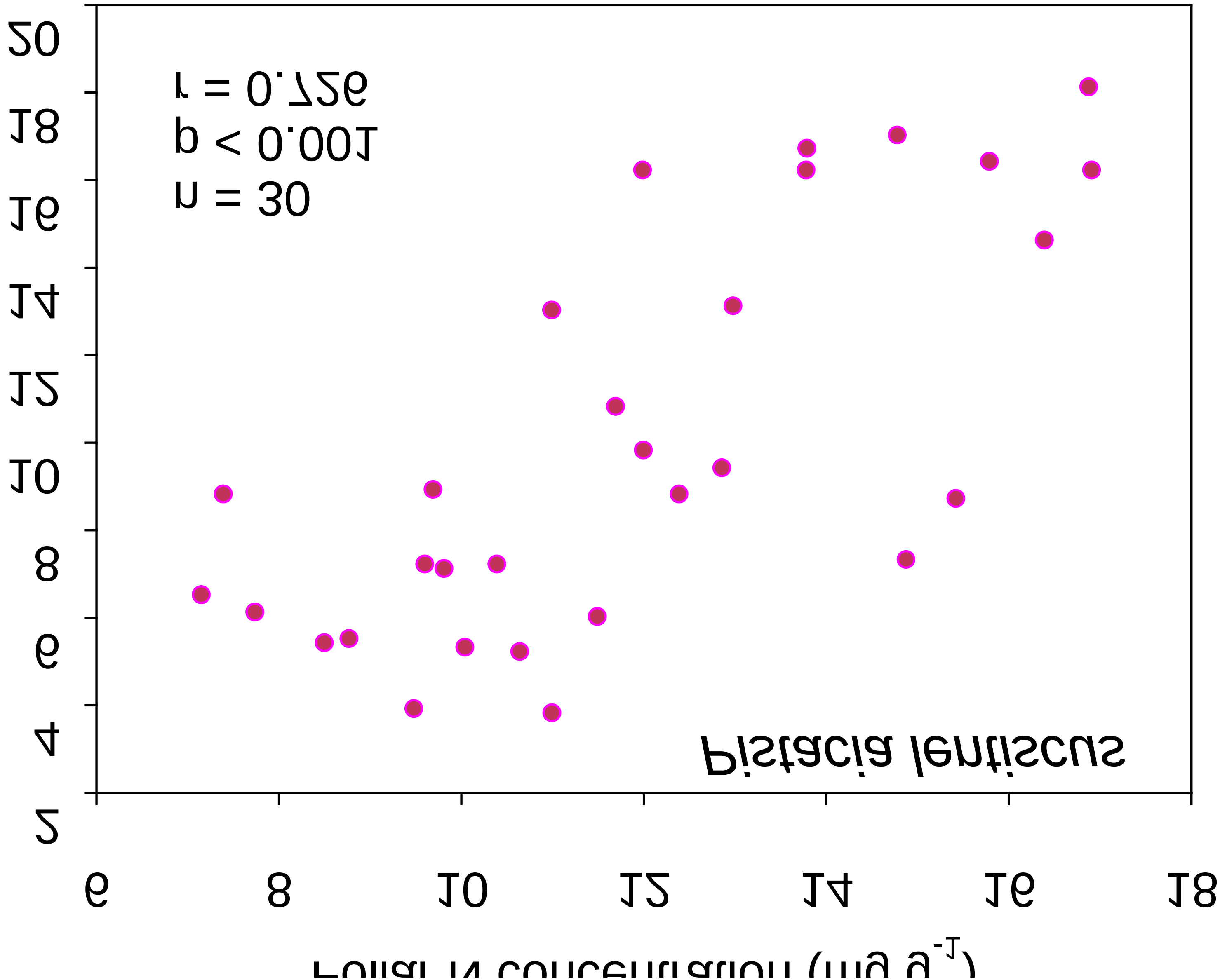


NUTRIENT HARDENED SEEDLINGS PERFORMED BETTER TOO



Trubat et al. (2007). *J. Arid Environ.* 72: 879-890

CONFOUNDING FACTORS: SIZE VS. NUTRITIONAL STATUS



THE IMPORTANCE OF NUTRIENT STATUS: LATE SEASON FERTILIZATION

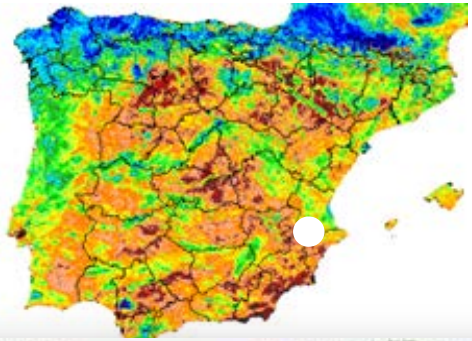
Quercus ilex – Nursery, 1-year-old seedlings

100 mg L^{-1} N : 44 mg L^{-1} P : 83 mg L^{-1} K

	NF	LF	$F_{1.18}$	p
Stem height (cm)	7.8±0.6	7.3±0.4	0.40	**0.533**
Root collar diameter (mm)	3.2±0.1	3.3±0.2	0.40	**0.536**
Number of active root tips (RGP)	45.3±4.8	34.3±9.3	1.10	**0.307**
SPAD (rel. units)	34.9±2.2	41.3±1.4	5.88	**0.026**
Leaf N (mg g^{-1})	9.4±0.5	15.7±0.8	44.7	**<0.001**
Leaf P (mg g^{-1})	0.37±0.03	1.46±0.20	30.4	**<0.001***
Leaf K (mg g^{-1})	2.3±0.3	2.4±0.3	0.04	**0.853**
Leaf soluble carbohydrates (mg g^{-1})	76.3±3.1	75.8±3.6	0.01	**0.926**
Leaf starch (mg g^{-1})	62.1±8.24	34.9±5.8	7.46	**0.013**
Stem N (mg g^{-1})	3.5±0.3	8.5±0.7	46.6	**<0.001**
Stem P (mg g^{-1})	0.23±0.01	1.19±0.15	38.8	**<0.001***
Stem K (mg g^{-1})	2.9±0.4	2.9±0.2	0.01	**0.949**
Root N (mg g^{-1})	5.3±0.3	8.0±1.0	23.8	**<0.001**
Root P (mg g^{-1})	0.29±0.01	1.07±0.17	20.3	**<0.001***
Root K (mg g^{-1})	2.2±0.2	3.8±0.5	9.4	**0.007**
Root soluble carbohydrates (mg g^{-1})	46.8±2.6	45.42±5.3	0.05	**0.826**
Root starch (mg g^{-1})	284.2±9.0	318.6±19.8	2.49	**0.132**

Planted on 16 plots

Mediterranean dry sub-humid conditions



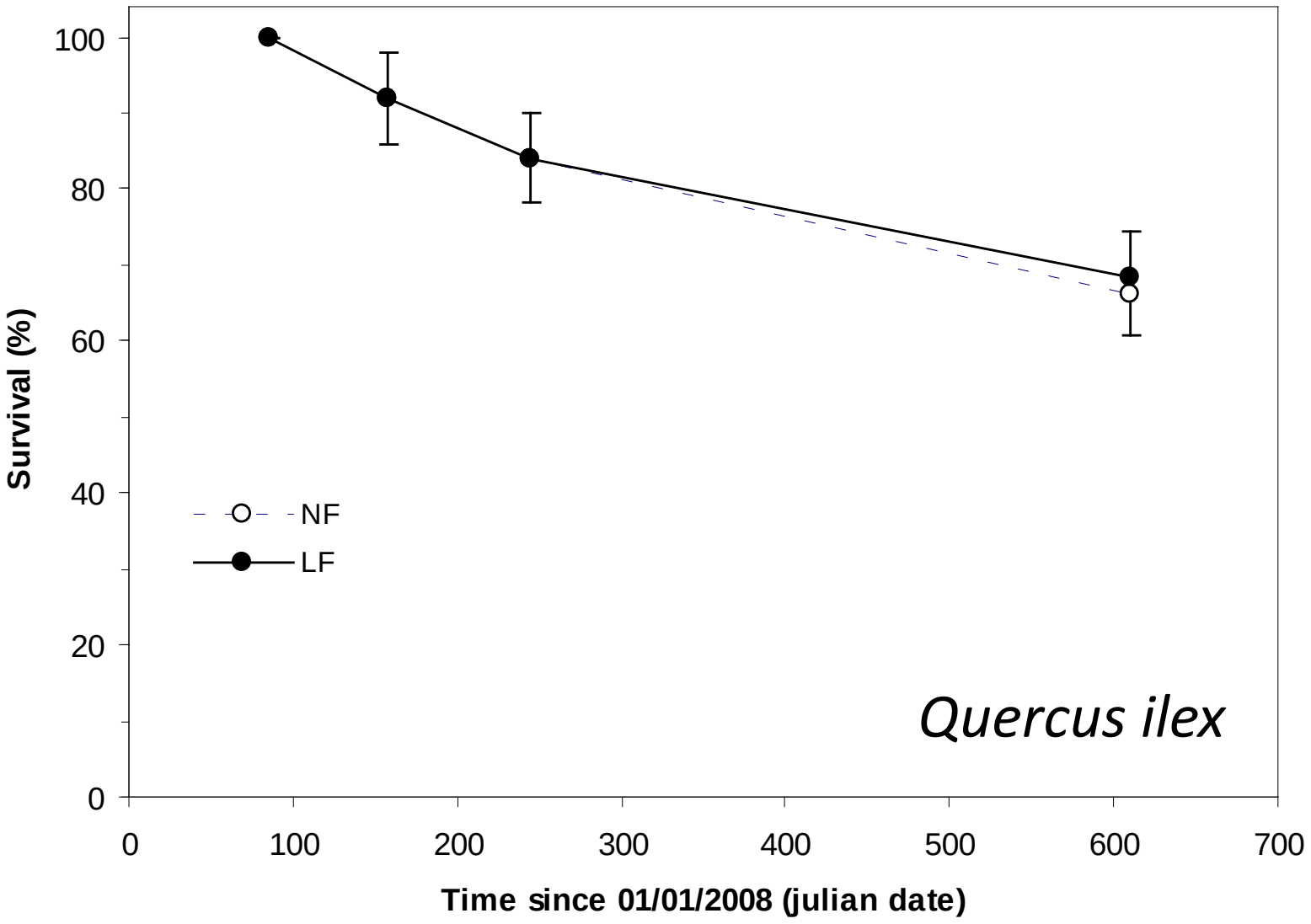
Gallinera, Alcalà, Ebo Valleys

c. 2,000 ha

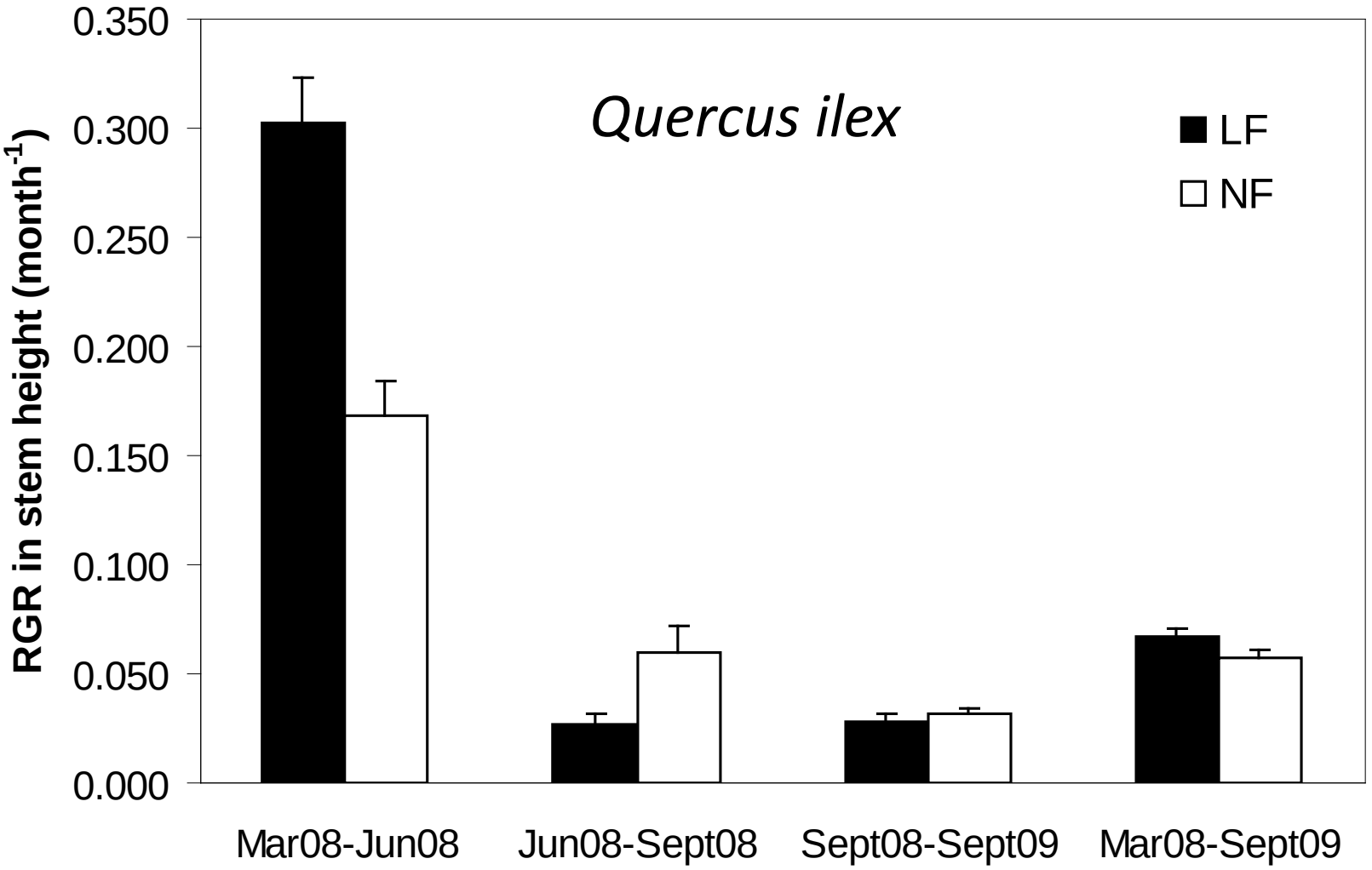
N Alicante, SE Spain

521-990 mm, 17ºC

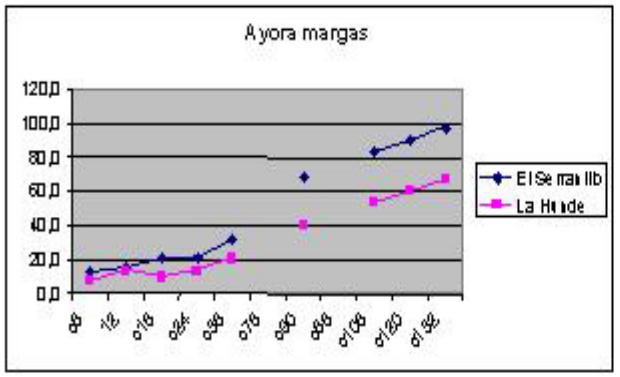
NUTRIENT STATUS HAD NO EFFECT ON SURVIVAL

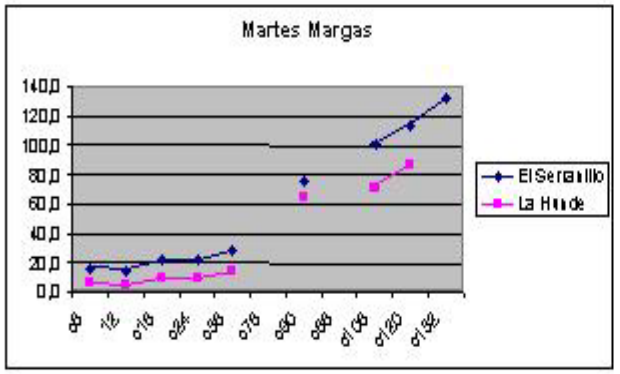


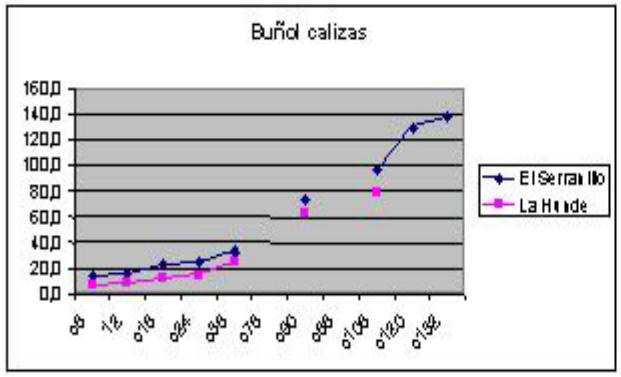
NUTRIENT STATUS HAD A STRONG EFFECT ON EARLY GROWTH



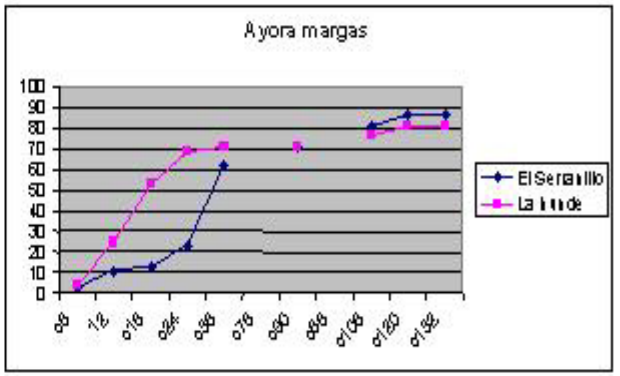
EFFFECT OF SEEDLING QUALITY EXTENDED +10 YEARS

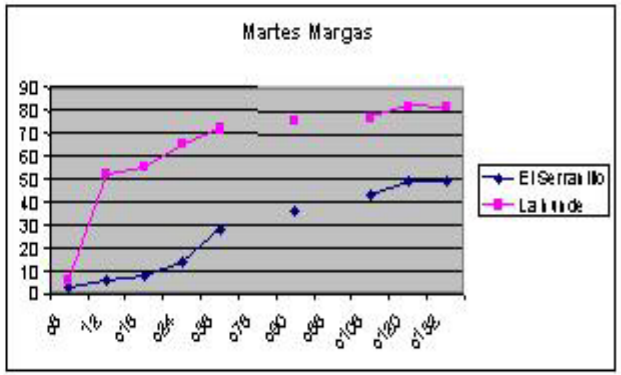


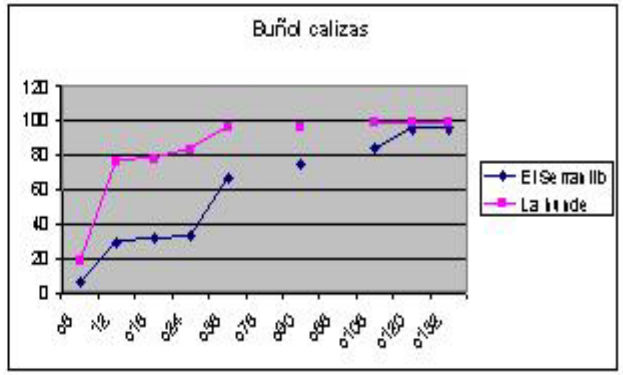




Crecimiento (altura cm)



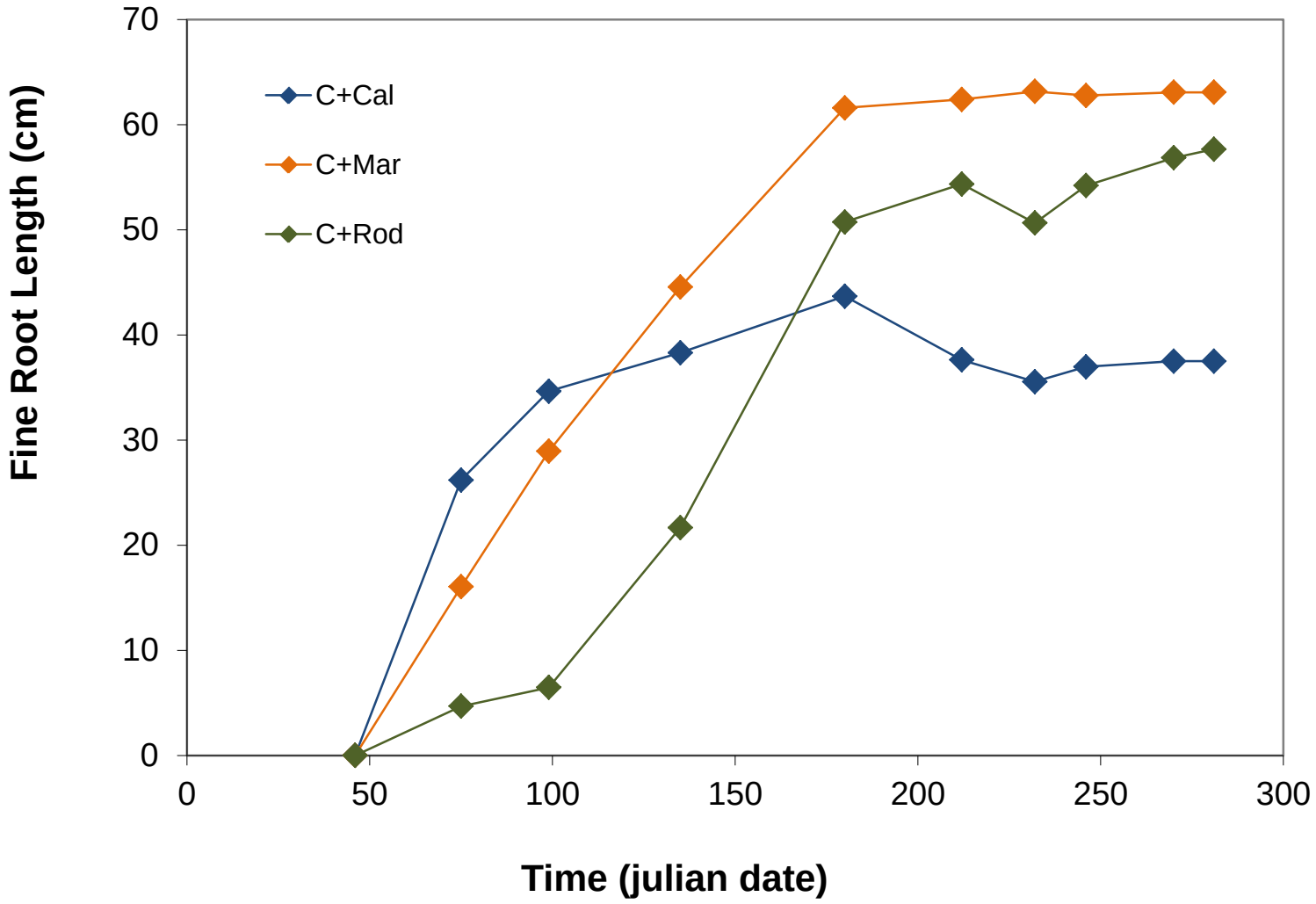




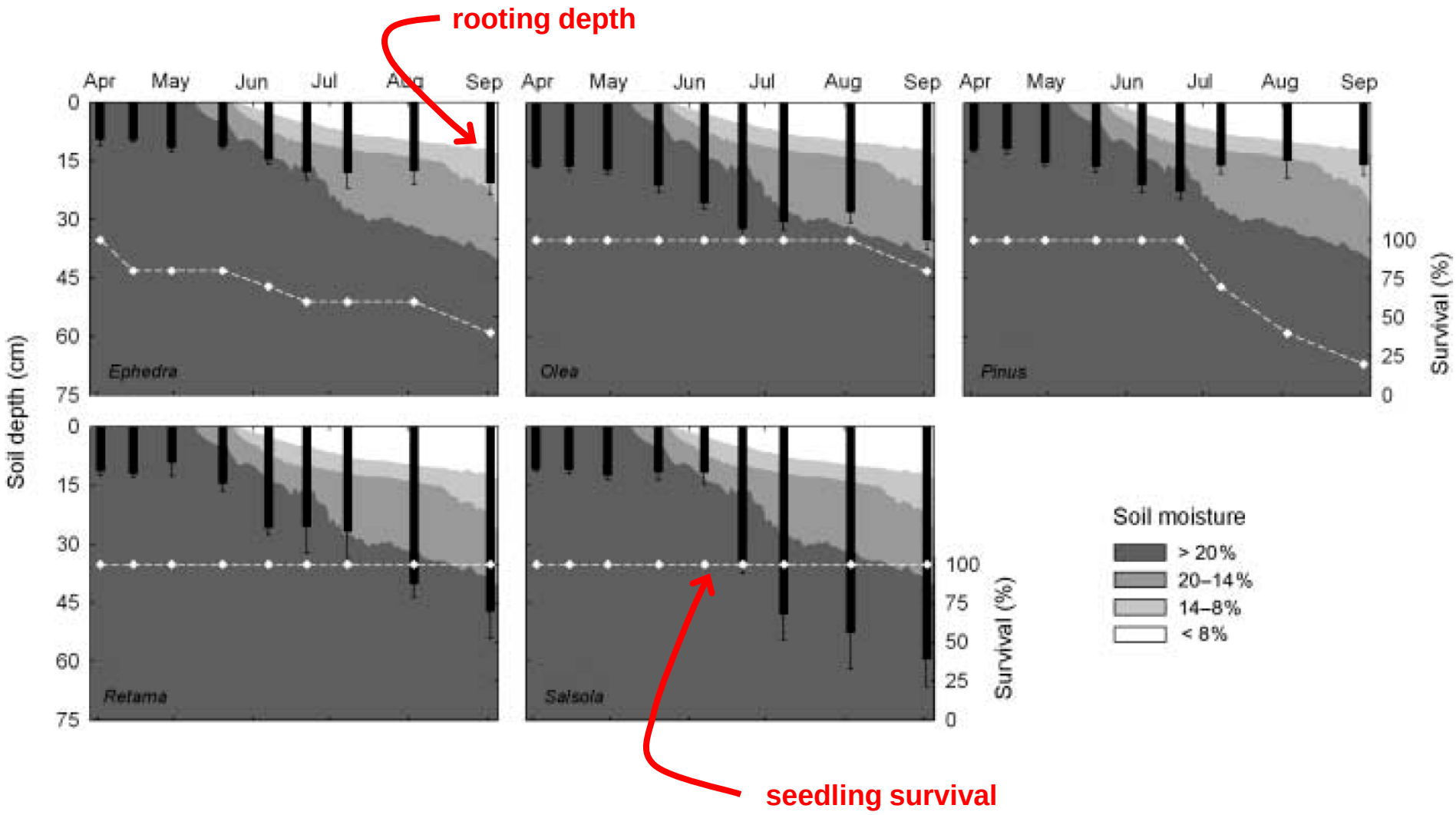
Mortalidades

J.A. Alloza
CEAM Foundation
1992-1994
(unpubl.)

ROOTS GROW SOON AFTER PLANTING

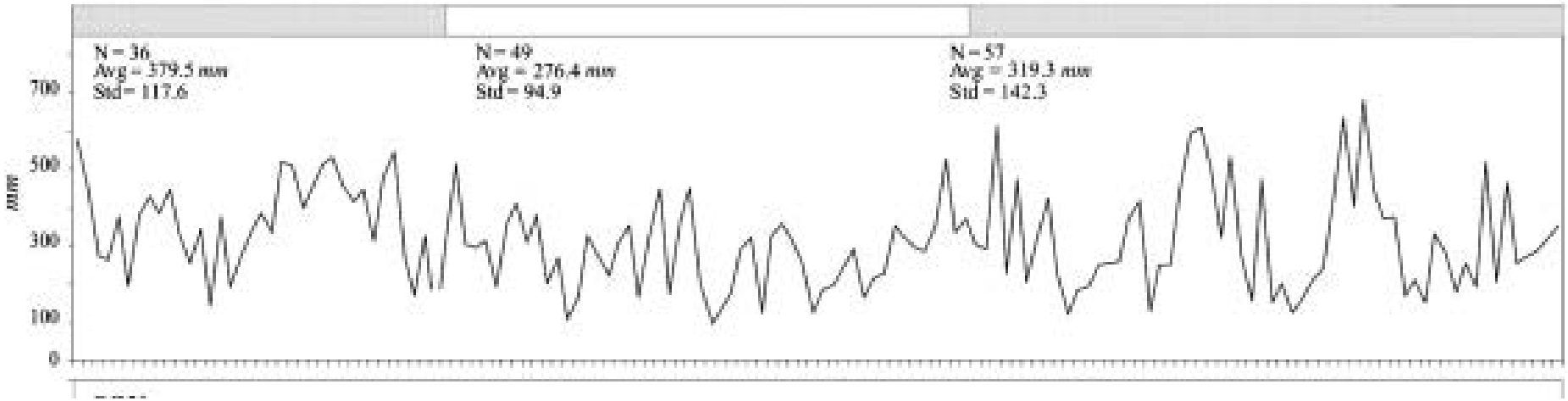


ROOTING DEPTH >30-40 CM BEFORE SUMMER DROUGHT



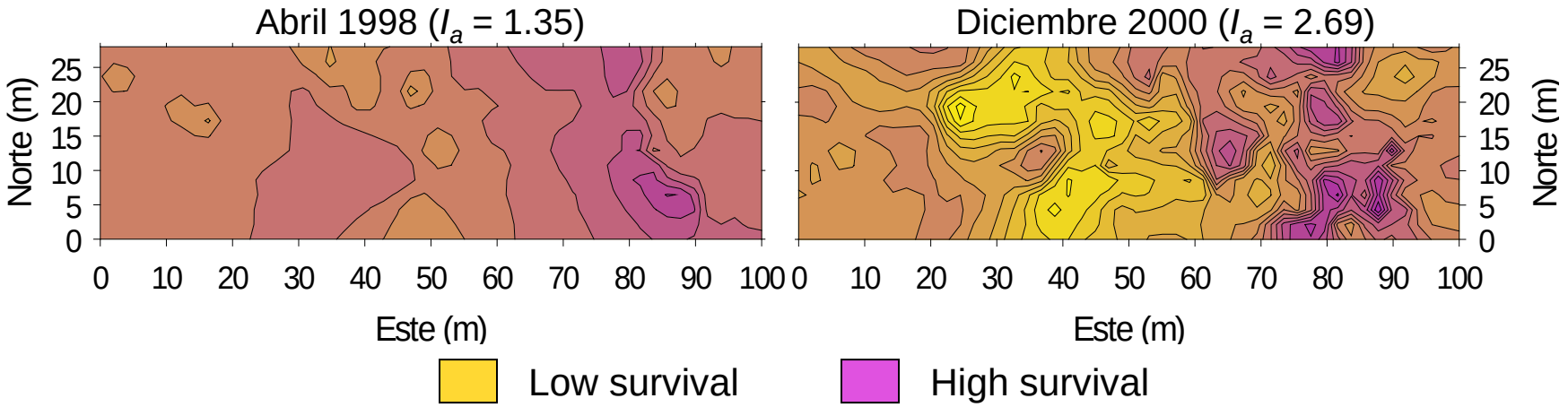
Padilla & Pugnaire (2007). *Functional Ecology* 21: 489–495

HIGHER ARIDITY – HIGHER VARIABILITY



Machado et al. (2011). *J. Arid Environ.* 75: 1244-1253

HIGH SPATIAL VARIIABILITY IN SEEDLING PERFORMANCE

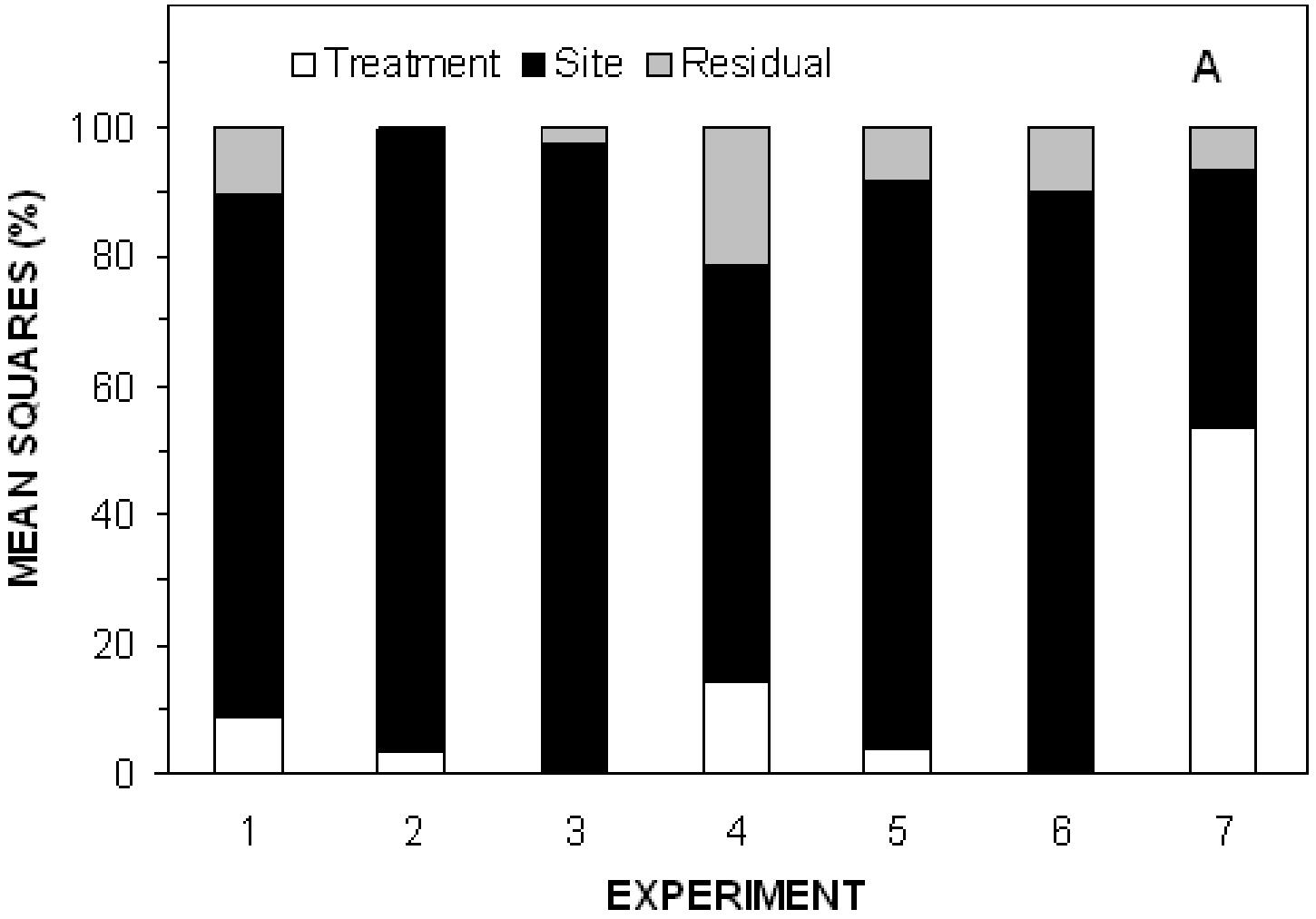


	Sampling Date								
	Apr 1998	June 1998	Sept 1998	Nov 1998	Apr 1999	Nov 1999	Apr 2000	Sept 2000	Dec 2000
Bare soil	−0.33	−0.34	−0.35	−0.32	−0.32	−0.36	−0.31	−0.34	−0.37
Hole depth		0.27		0.12	0.12	0.14			

[a] *Fraction of variation a + b*

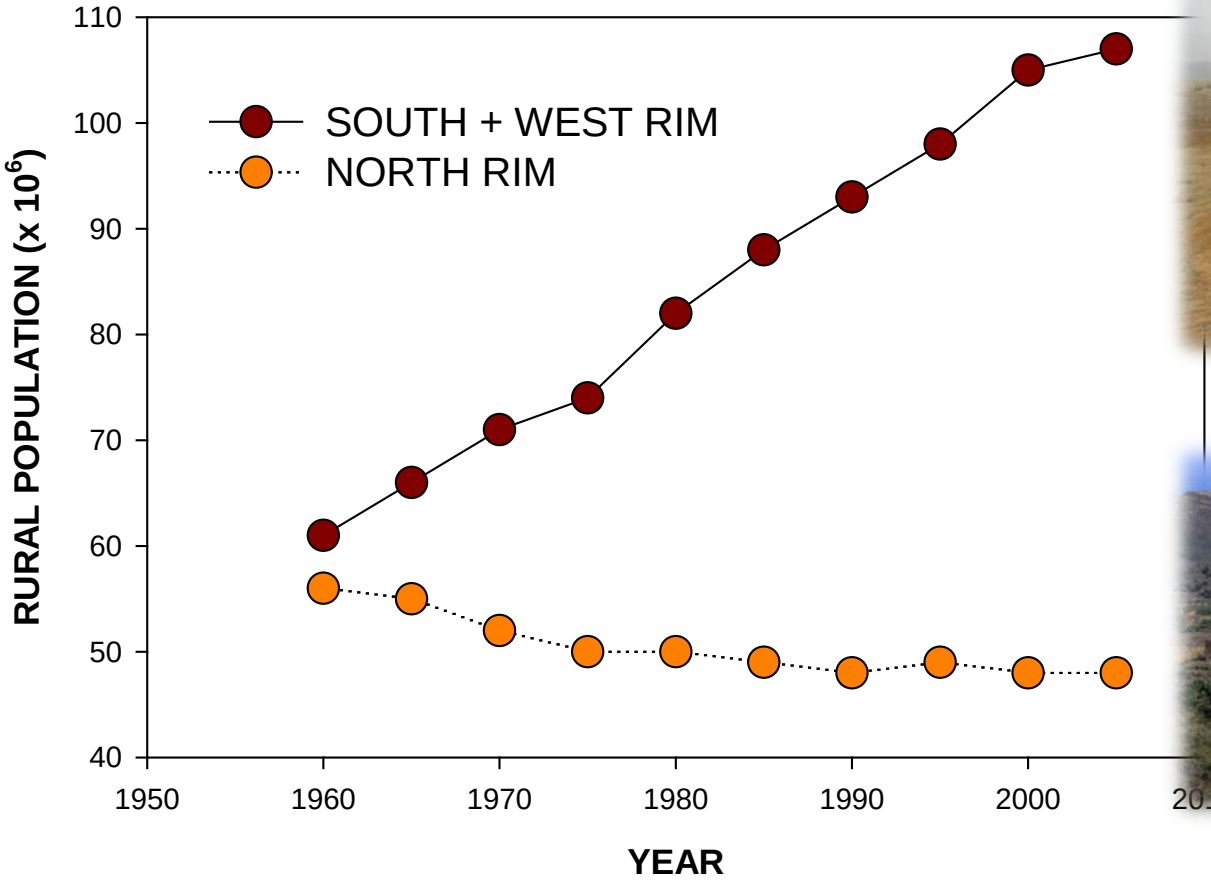
Maestre et al. (2003). *Ecosystems* 6: 630-643

UNKNOWN DRIVERS OF SEEDLING PERFORMANCE



Cortina et al. (2011). *J. Arid. Environ*. 75: 1377-1384

SOCIO-ECONOMIC LIMITATIONS OF SEEDLING PRODUCTION



(FAOSTAT, 2010)

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THANKS FOR YOUR ATTENTION!!

Alejandro Valdecantos

David Fuentes

Jorge Monerris

Maria R. da Silva

Roman Trubat

José Huesca

Karen Disante

TARGET SEEDLING FOR DRYLANDS

>350 mm

1. Large, balanced, well fertilized seedlings, with high growth potential above and belowground.

< 350 mm

1. Control aboveground biomass
   → restrict nutrient inputs if necessary

2. Promote belowground biomass and rooting depth
   → containers +20 cm depth if possible

3. Ensure that nutrient status is good
   → fertilization immediately pre-planting