2nd Mediterranean Biochar Symposium
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Agronomic effects of the addition of biochar from different feedstocks to a typical Mediterranean agricultural soil in relation to the application rate

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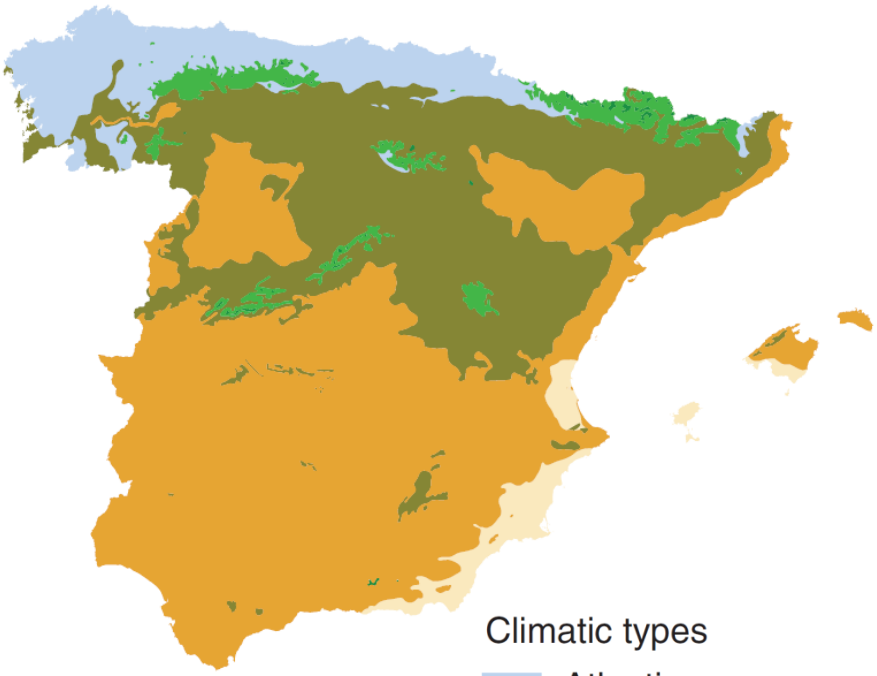
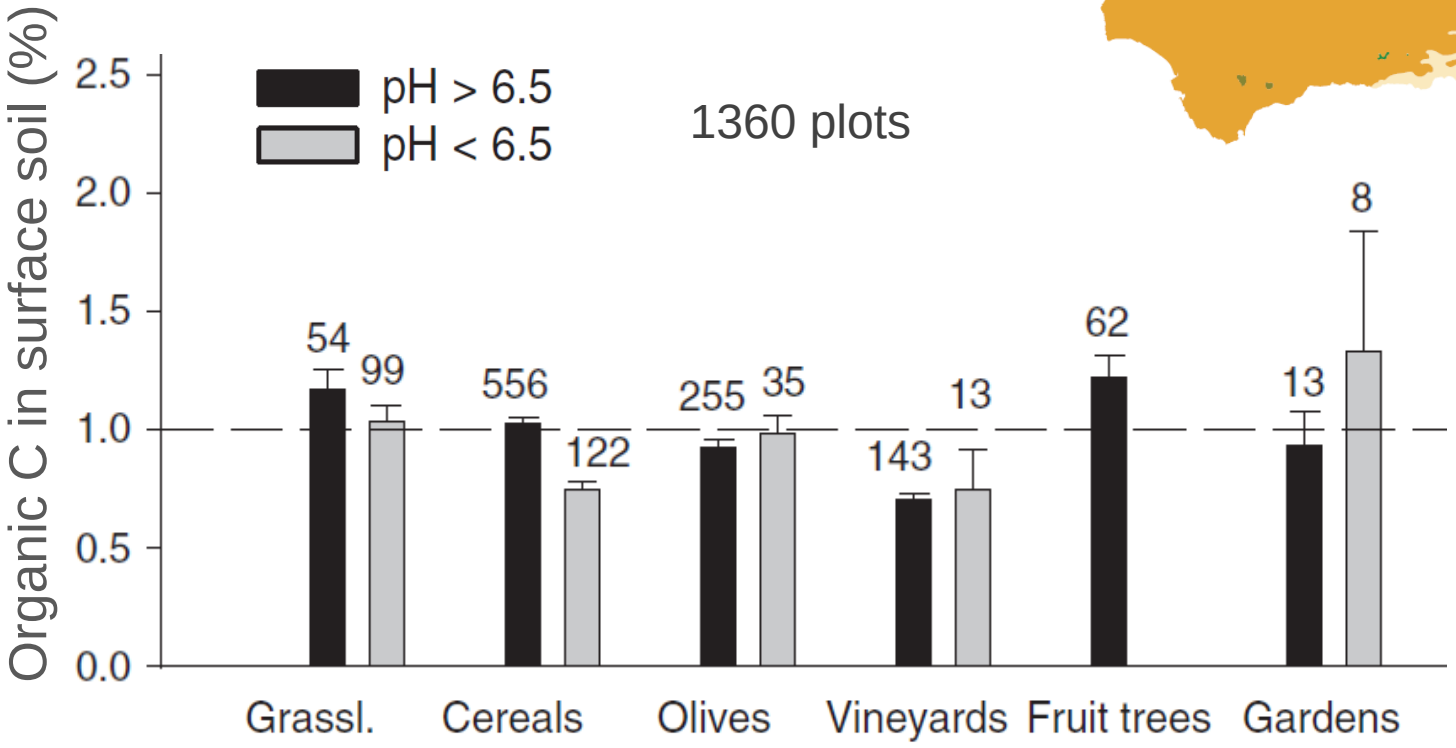
eBRN

IRNAS CSIC

Mediterranean Temperate Climate in Spain

- Low OC (< 1.5%)
- Appropriate to apply biochar

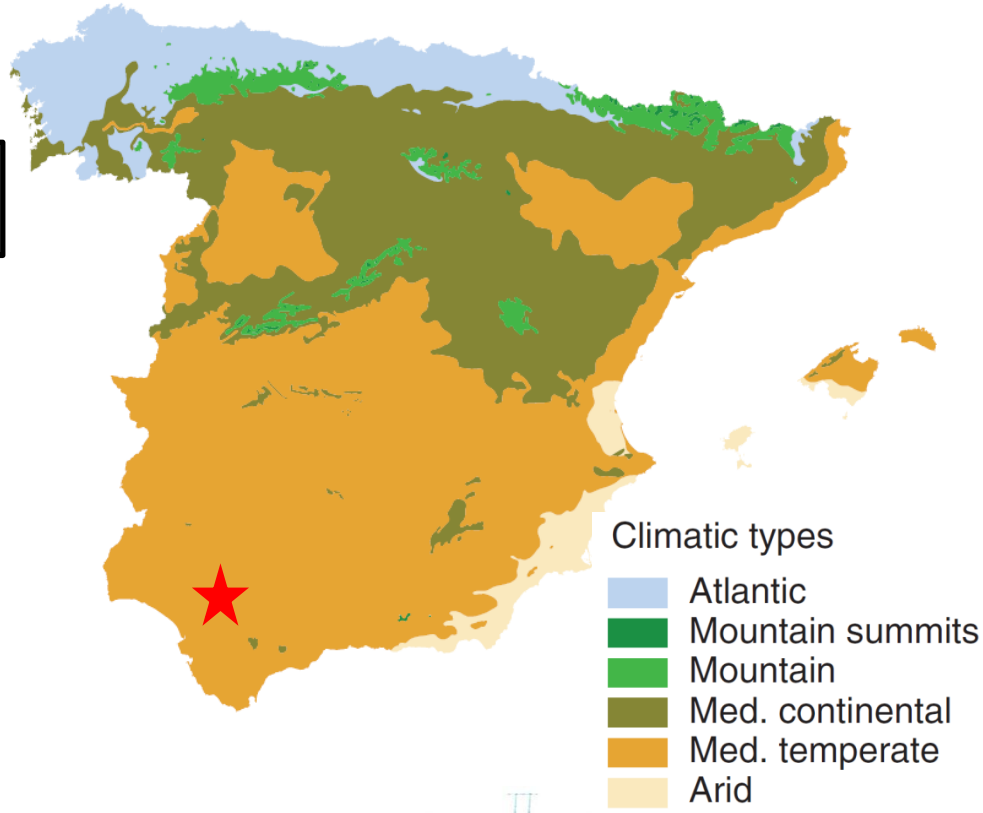




(J. Romanyà & P. Rovira, 2011)

SOIL UNDER STUDY

South of Spain.
Guadalquivir river valley (Seville)



Soil type (FAO, 1988)	Cambisol
pH	8.6
TC content (g kg^{-1})	20
TOC (g kg^{-1})	6
TIC (g kg^{-1})	14

Objectives

- Effect of biochar addition on a typical calcareous agricultural Mediterranean soil?
- Which is the most efficient application rate?
- Which is the most efficient biochar?

BIOCHAR SAMPLES

	BC 1	BC 2	BC 3	BC 4
FEEDSTOCK	Mixed wood	Paper sludge & wheat husk	Sewage sludge	Vineyard wood (> 1 year old)
PYROLISIS CONDITIONS	20 – 620˚C	20 – 500 ˚C	20 – 600˚C	unknown

INCUBATION STUDY

EXPERIMENTAL DESIGN

- 150 g soil + 40 seeds (*Lolium perenne*)
- Soil with biochar (n=4):

  10, 20, 40 t ha^{-1}
- Control (without biochar) n = 6

EXPERIMENTAL CONDITION

- Incubation time: 79 days
- Temperature: 25°C
- Irrigation: 760 mm yr^{-1}
- Light: 14 h day^{-1}

INCUBATION STUDY

MEASURED PARAMETERS

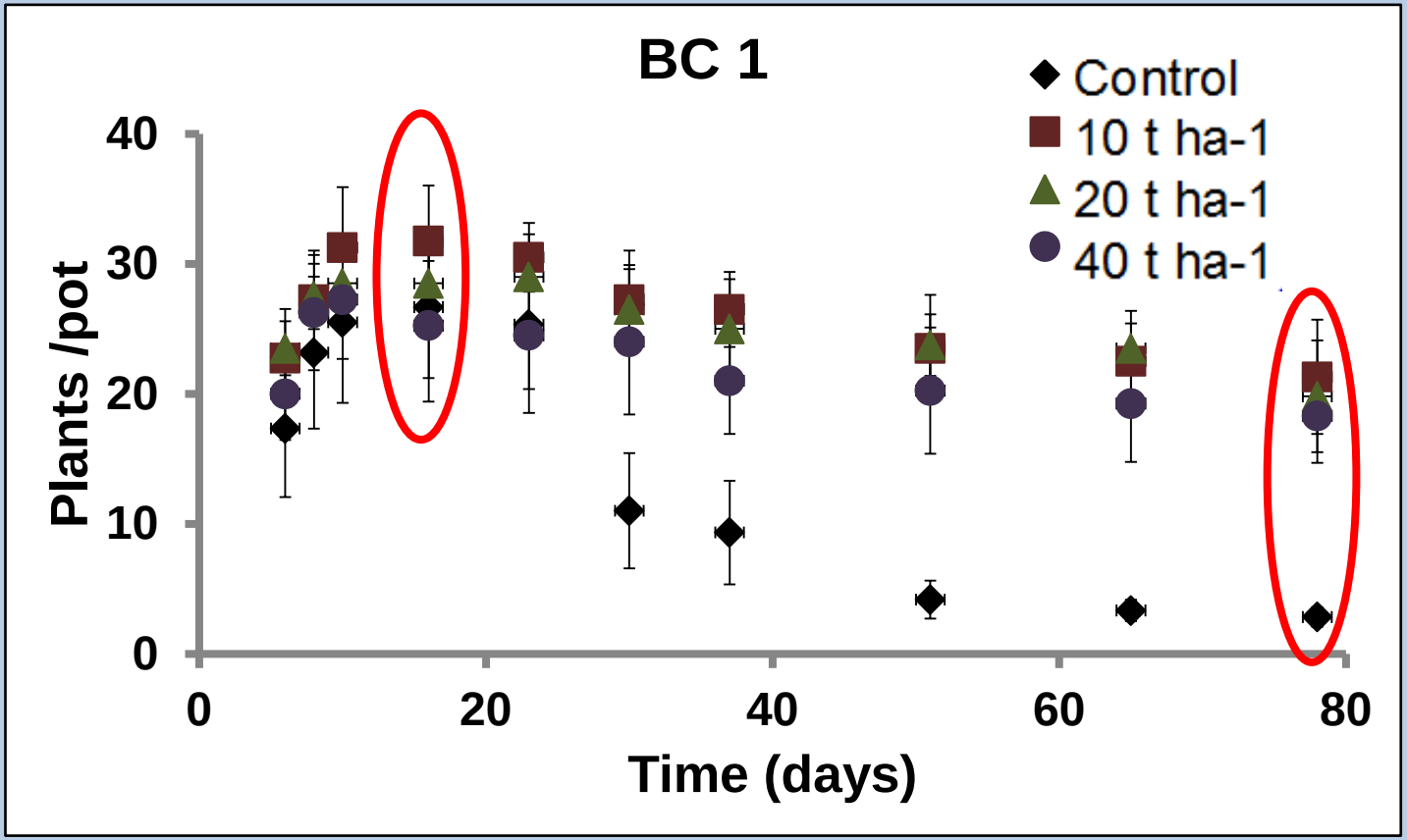
- GERMINATION AND SURVIVAL

Number of living plants
(every week)

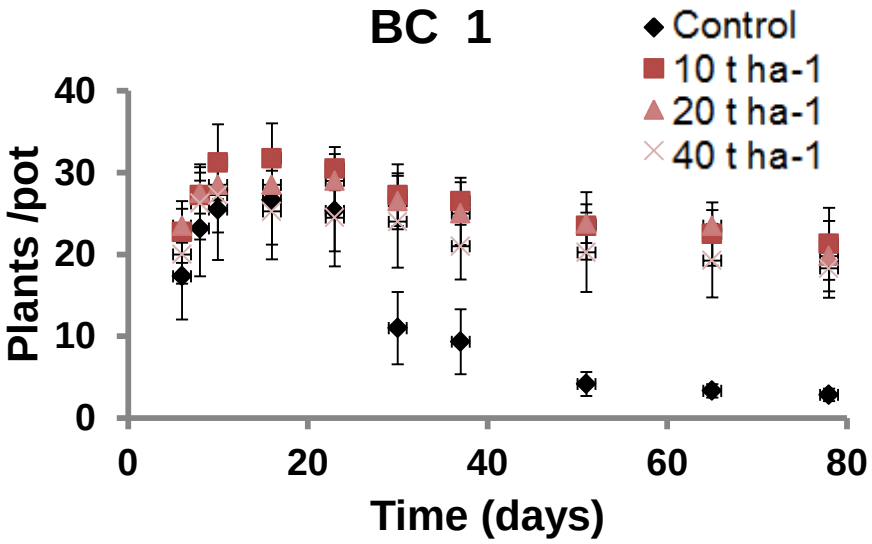
- AGRONOMIC PRODUCTIVITY

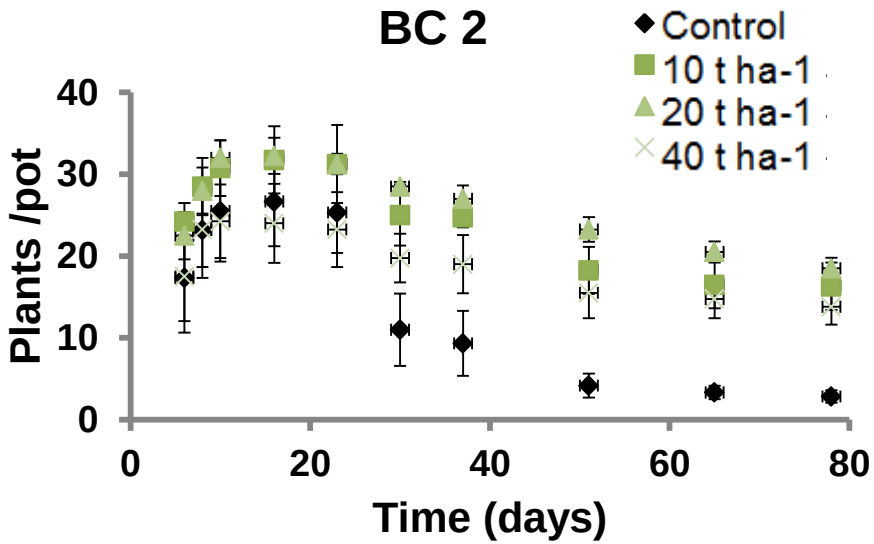
Shoots were cut, dried (48 h, 40˚C)
and weight (every other week)

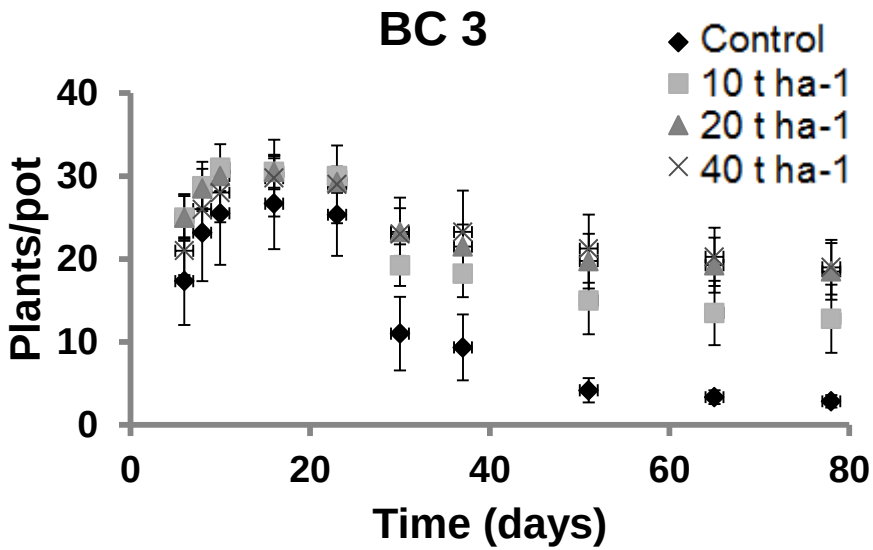
RESULTS: Germination and survival rates

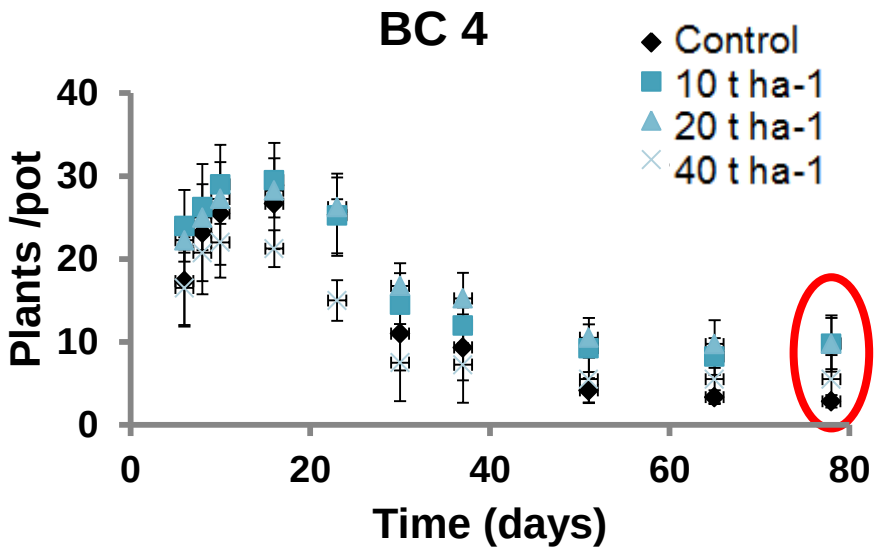


RESULTS: Germination and survival rates

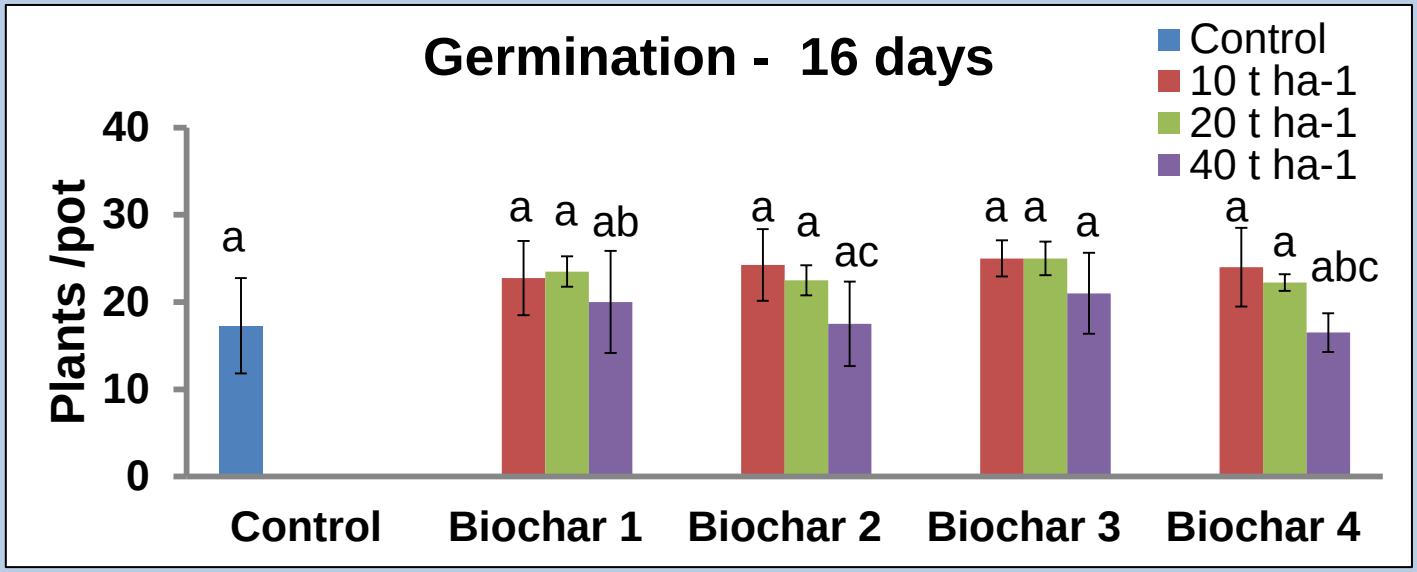






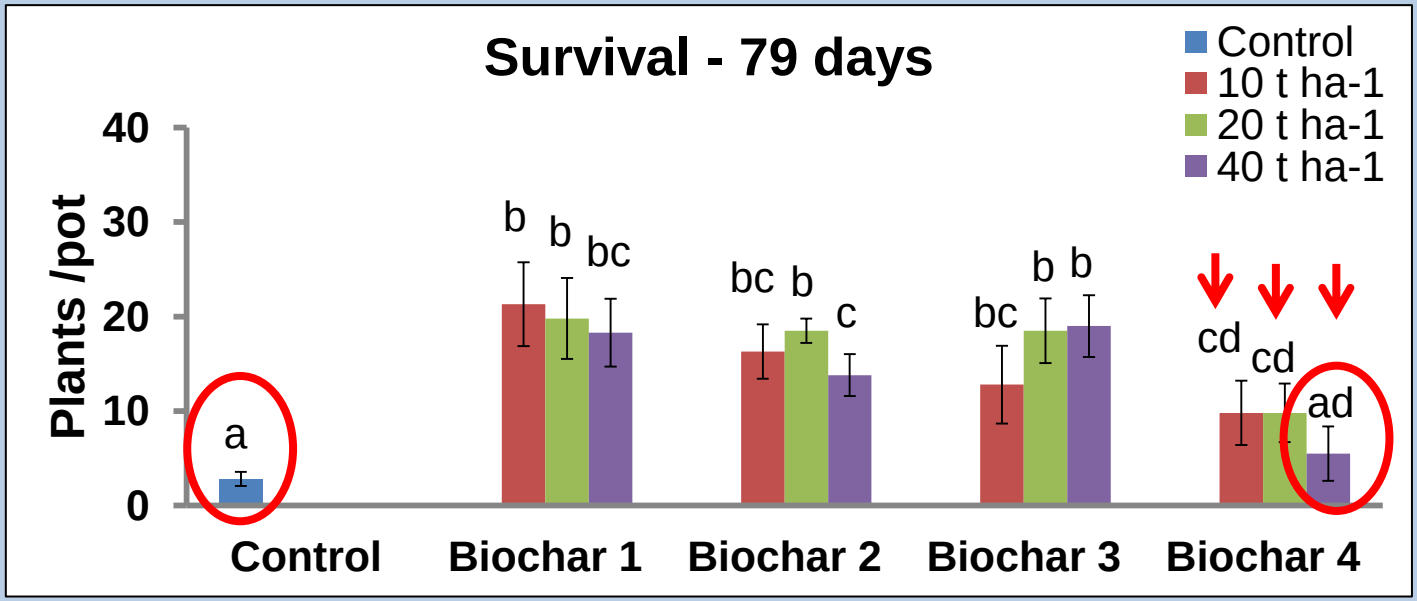


RESULTS: Germination and survival rates



- Control = amended pots

- Highest doses: Slight decrease

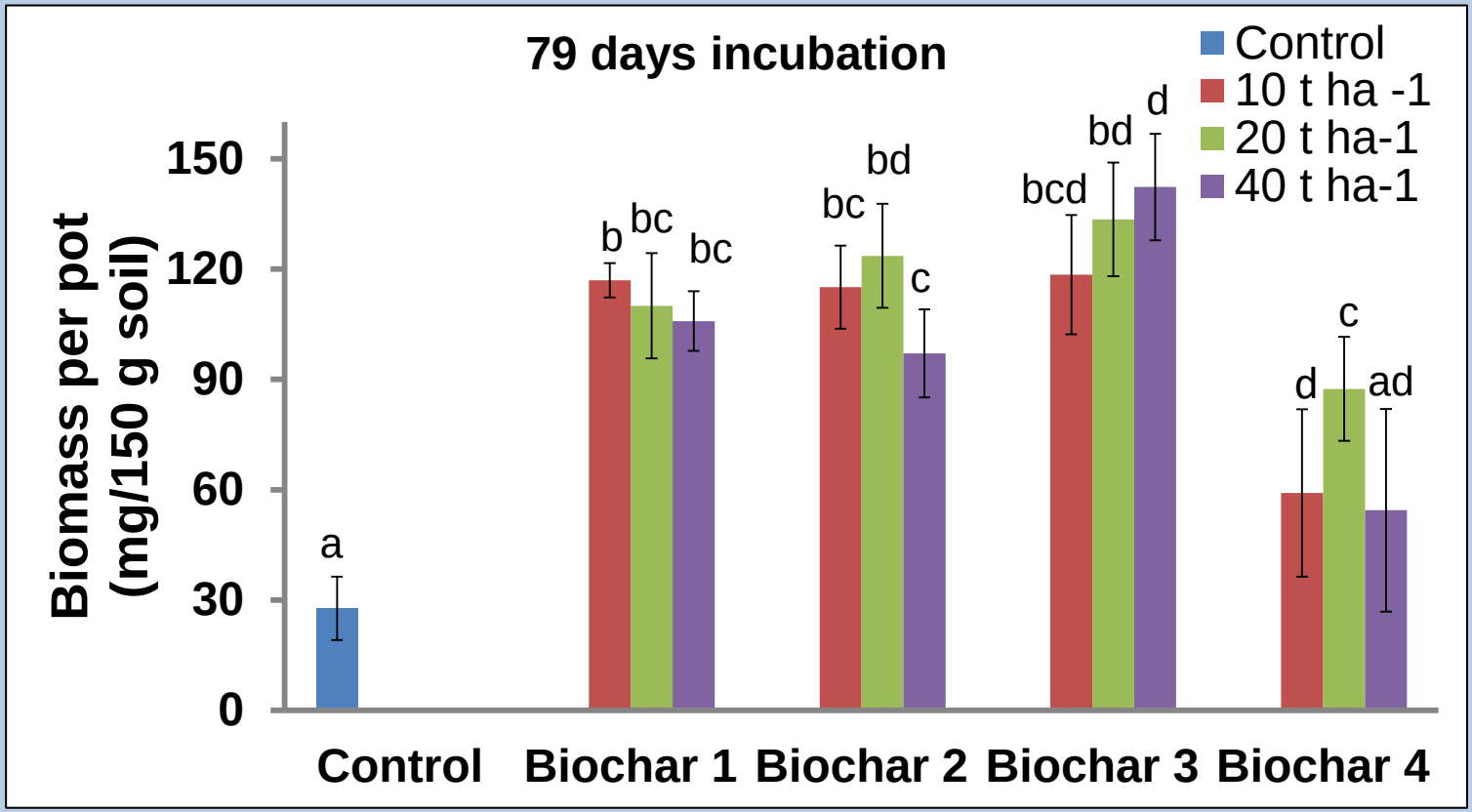


- Control ≠ amended pots

- Highest doses: Lower survival (except for BC 3)

- BC 4 shows the lowest survival rate

Results: Biomass production (cumulative)



- Biochar amendment increases yield
- BC 4 shows the lowest production

-BC 1, 2 and 4 ➔ highest yields at 10 and 20 t ha^{-1}

- BC 3 ➔ The higher the dose the higher the productivity

INCREASE OF BIOMASS PRODUCTION	
TREATMENTS	**EFFECT**
Biochar 1, 2 and 3 vs. Control	230-370%
Biochar 4 vs. Control	66-200%

Location	Plant	Treatment	Biomass yield	Reference
Australia /Alfisol	Radish	10 t ha^{-1}	- 30%	Chan et al., 2007
Australia/ Ferralsol	Spring wheat	10 t ha^{-1}	ns	Van Zwieten et al., 2010
Australia/ Alfisol	Radish	100 t ha^{-1}	130%	Chan et al., 2007
Japan /-	Sugi tree	0.5 t ha^{-1}	+224%	Kishimoto and Sugiura, 1985
Colombia/ Oxisol	Savanna veget.	26 t ha^{-1}	+378%	Major et al., 2007

(Modified fromVaccari et al., 2011)

What caused this great increase in biomass production?

- The soil contains very low amount of nutrients:
  - Biochar addition may supply nutrients
  - Biochar addition may improve the structure of the soil
- Biochar avoided leaching of nutrients during irrigation in the amended pots

Macronutrient content of the pots (end)

Total content	N Kjeldahl	P	K	S	Ca	Mg
	(%)	mg/kg	mg/kg	mg/Kg	mg/kg	mg/kg
Bulk soil	0.066	496.2	1616	127.5	31763	1966
Soil post incub	0.063	435.7	1771	126.0	32193	1987
BC 3, 10 t ha^{-1}	0.070	757.3	1591	159.1	31649	1978
BC 3, 20 t ha^{-1}	0.090	1273.1	1695	214.1	30795	2001
BC 3, 40 t ha^{-1}	0.110	2038.2	1472	277.3	29656	2009

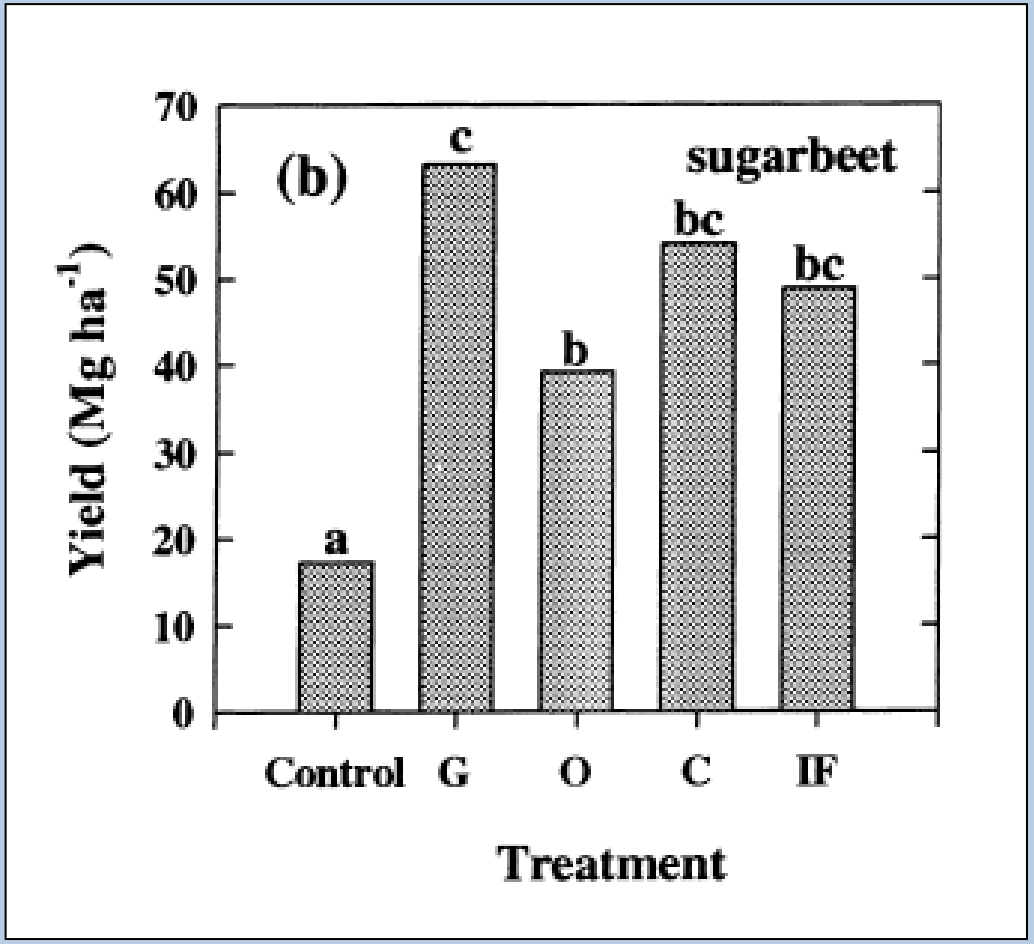
- **No leaching in control pots**
- **No differences in BC 1, 2 and 4 amended pots**
- **Higher N and P content in BC 3 amended soils**

Other amendment but same soil

ORGANIC AMENDMENT:
- **G:** 18% vinasse and 82% grape-marc
- **O:** 17% vinasse, 76% olive pressed cake, 6% leonardite
- **C:** 49% vinasse ,47% cotton gin trash, 3% leonardite
- **IF:** inorganic fertilizer

YIELD INCREASE

Up to a 250%



Madejón et. al 2001 *Agric. Ecosyst. Environ.: 84, 55–65*

CONCLUSIONS

- Biochar addition did not affect germination rates but increased significantly survival rates.

- Biomass production:

  ➔ The most appropiate biochars from an agronomic point of view:

  Biochar 1 and 2

  - Biochar 3: high content of heavy metals

  - Biochar 4: high content of PAHs

  ➔ The most suitable application rate tested:

  10 or 20 t ha^{-1}

  ➔ Doubling the amount of added biochar didn't increase significantly biomass production.

Thanks for your attention

Also thanks to:

- MINECO (Spanish Goverment)
- EBRN
- Torres winery