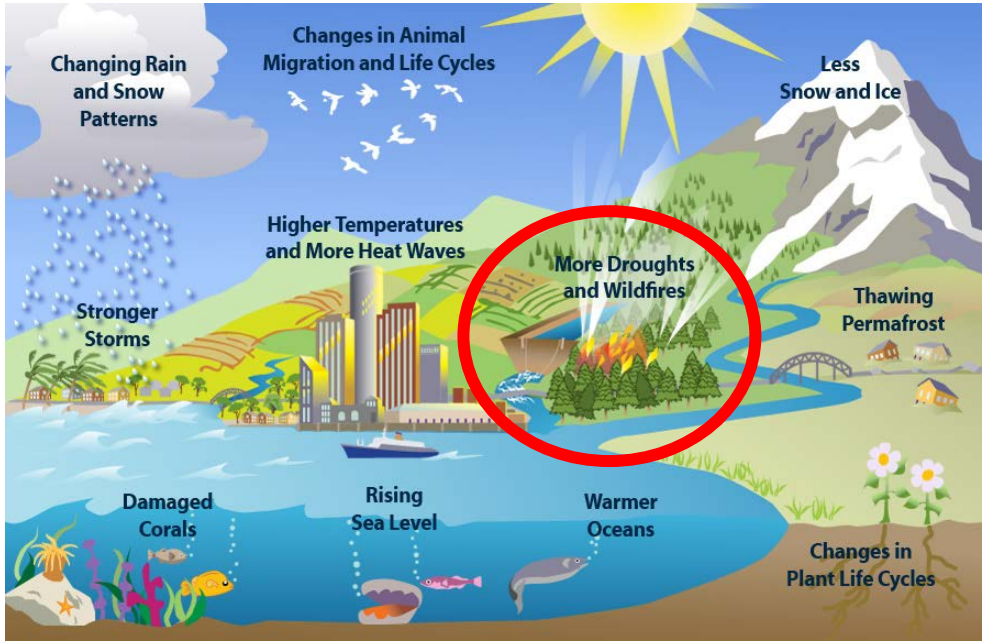
Drought changes the structure and elemental composition of very fine roots in seedlings of 10 woody species. Implications for a drier climate

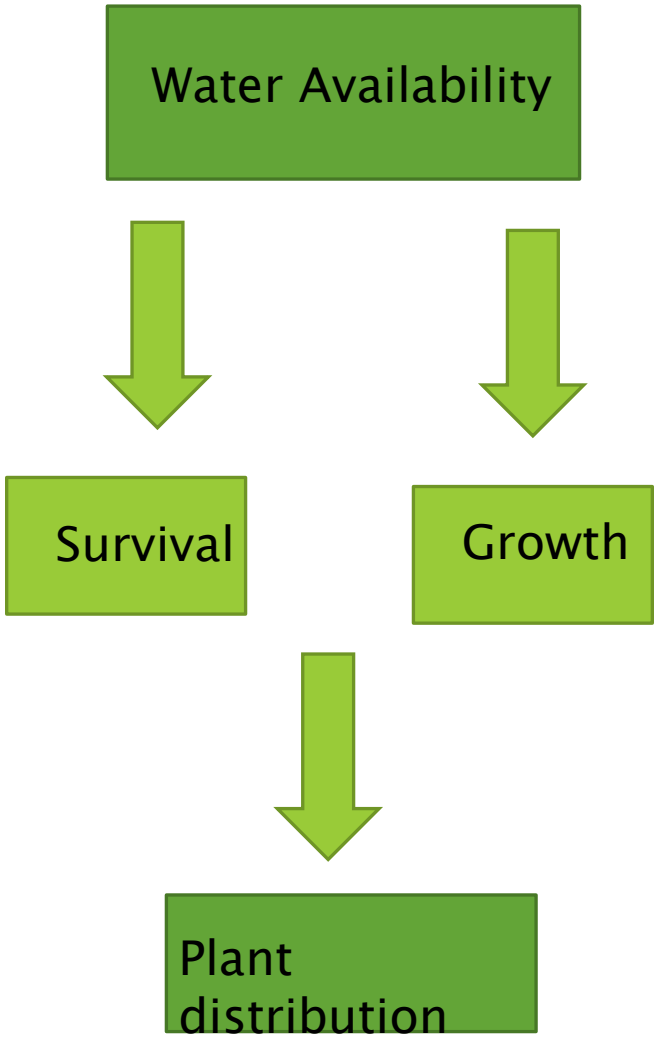
INTRODUCTION: BACKGROUND

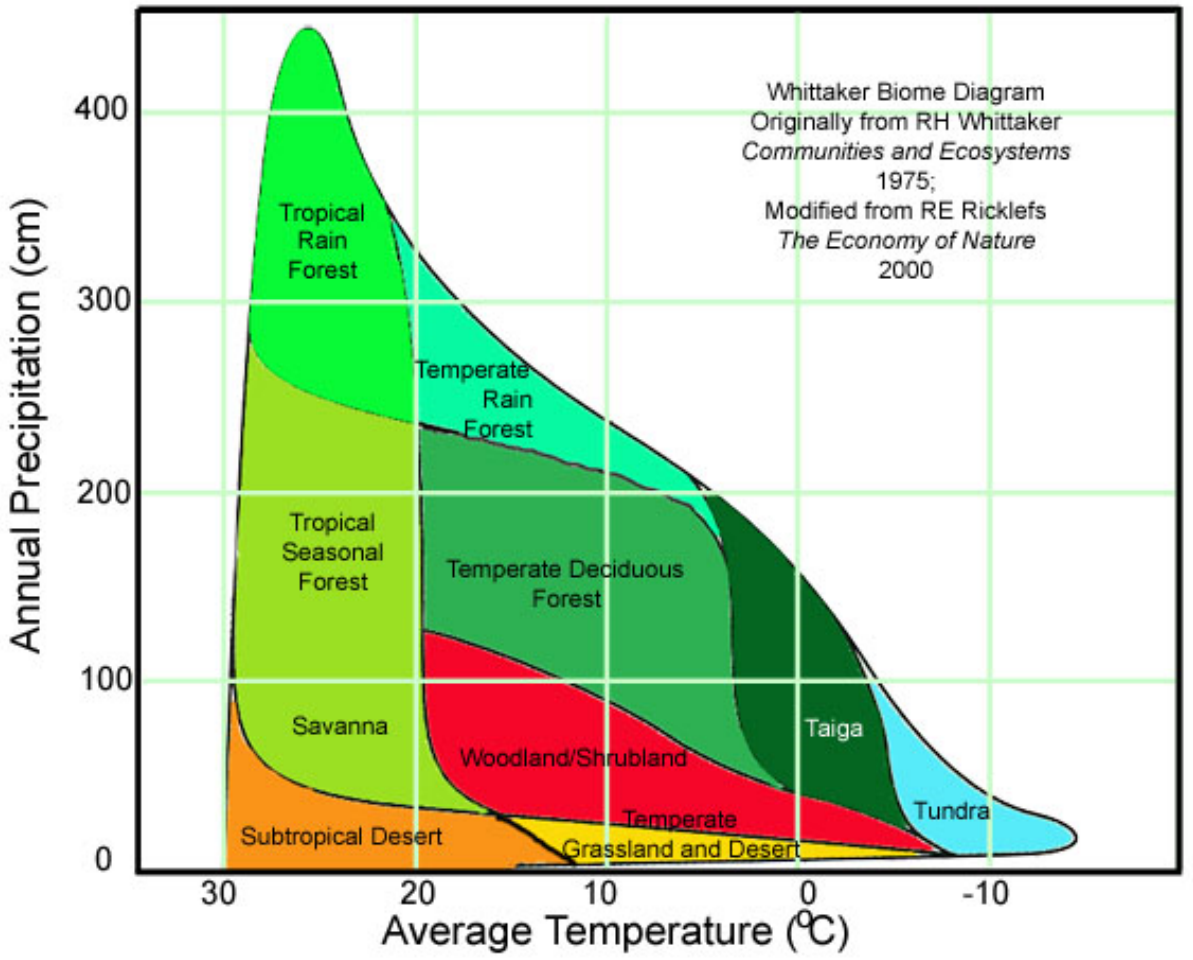


Manuel Olmo, Barbra Lopez-Igesias, Rafael Villar

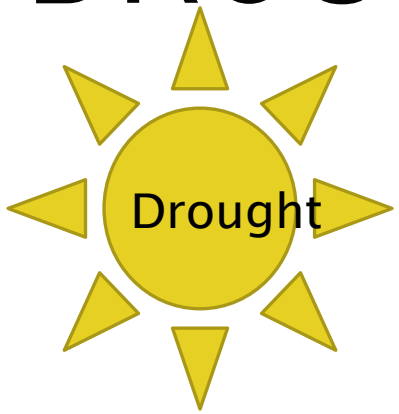
Plant and Soil (2014)

INTRODUCTION: DROUGHT





INTRODUCTION: EFFECTS OF DROUGHT



Decrease in shoot biomass

Increase in root biomass

Increase in root biomass(Allocation)

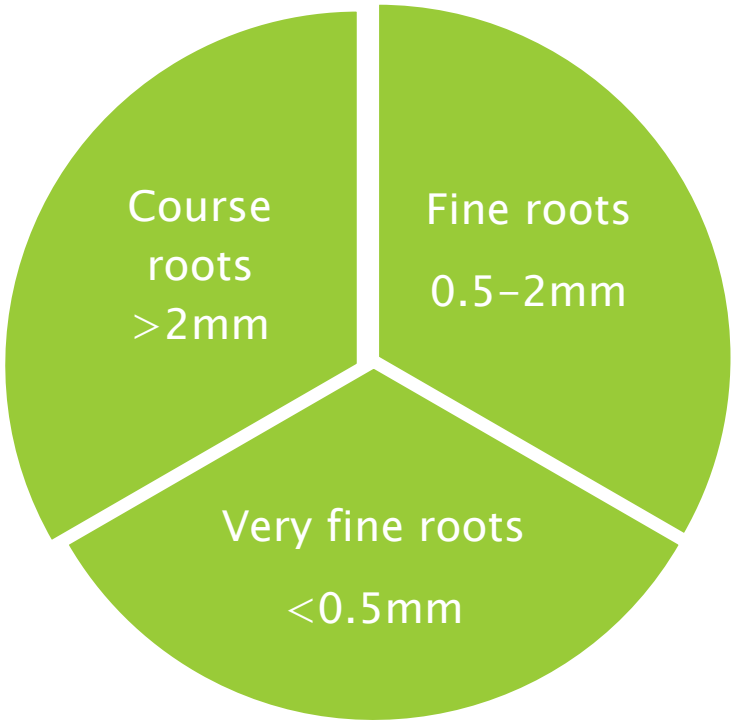
Minimize water transpiration
Increase the efficiency of soil exploration
and water acquisition

Higher probability of survival

Vertical Root distribution

Deep roots and the ability of extracting water

INTRODUCTION: ROOT FUNCTIONS ACCORDING TO SIZE



Course roots (>2mm): Anchoring the plant to the soil and for carbohydrate reserves

Fine roots (0.5-2mm): Involved in water and nutrient transportation

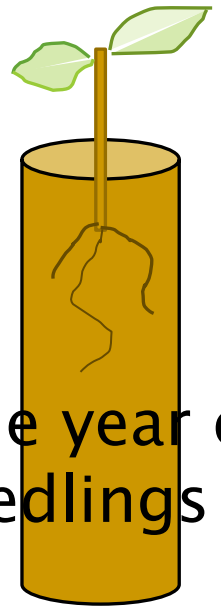
Very fine roots (<0.5mm): Plays and important role in exploration of the soil for water and nutrient absorption. Can reflect exposure to stress that may not appear in shoots, and respond to induced stresses more intensively and rapidly than any other type of root.

INTRODUCTION: QUESTIONS AND HYPOTHESIS

An important mechanism in acclimatization of plants to environmental change is phenotypic plasticity

1. How are biomass allocation ,vertical root distribution and root diameter with depth affected by drought? → Under drought plants will increase root biomass with an increment in proportions of very fine and fine roots in deep soil.
2. What are the effects of drought on key root traits? → Under droughts plants would show higher SRL and higher C concentration but lower N concentration
3. Can the capacity to modify root characteristics be a strategy for better enduring drought? → High root plasticity index plays and important role in species drought resistance and survival.

MATERIALS AND METHODS



One year old seedlings

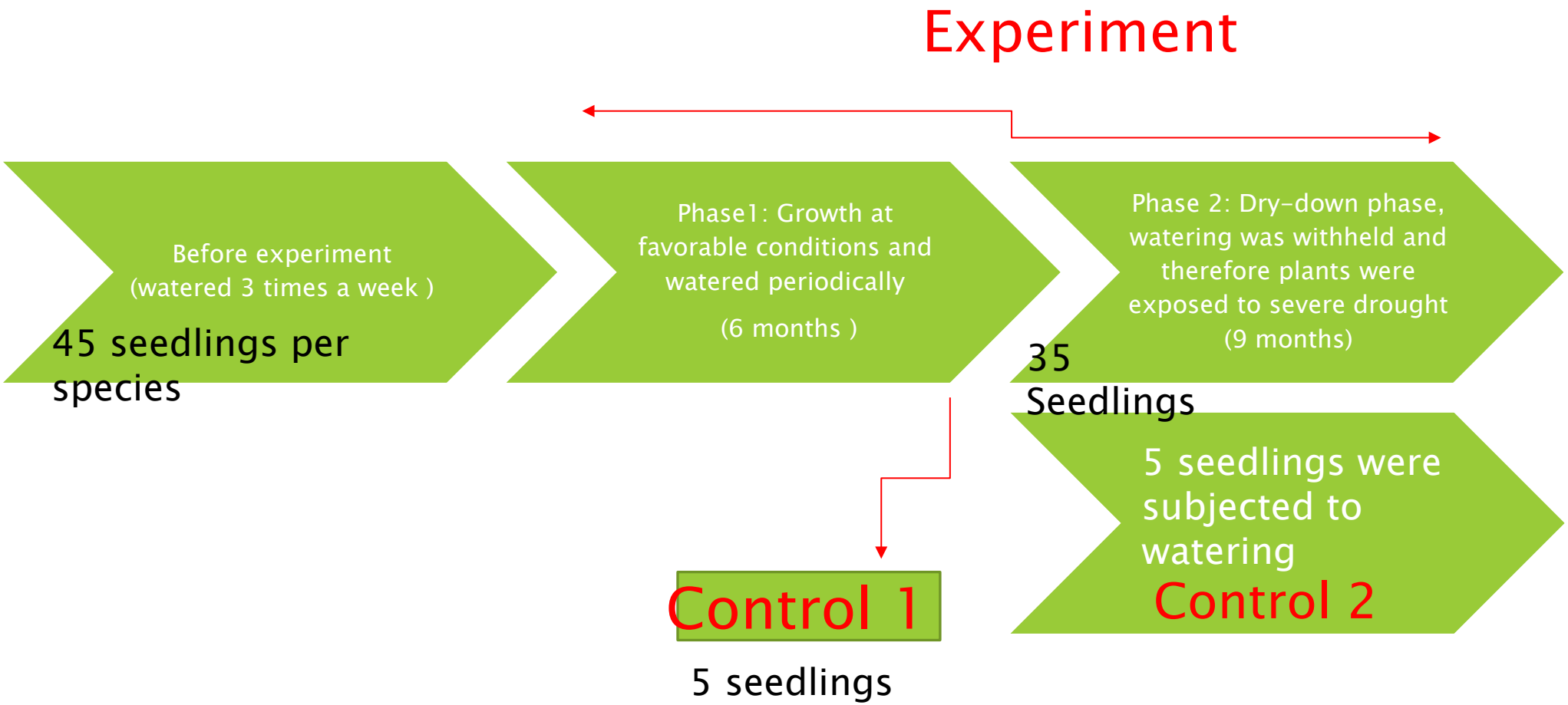
Diameter: 10.5cm

Height: 50cm (Soil height: 40cm)

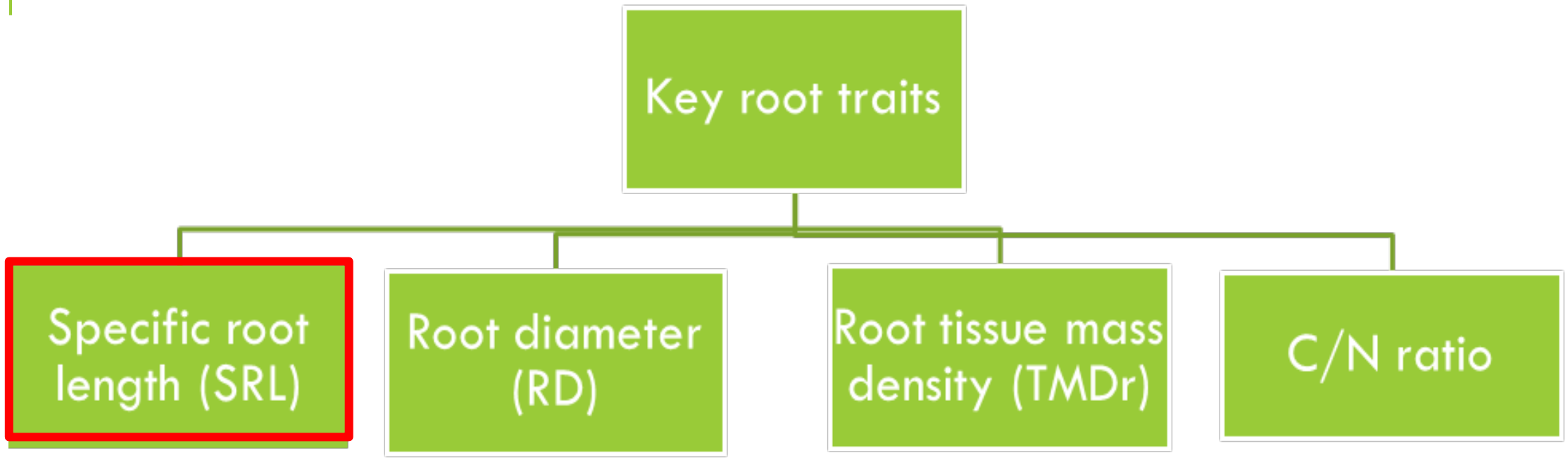
Table 1 Families and species used in the study, species code, functional group (D: deciduous; E: evergreen) and growth form. Nomenclature is from López González (2001)

Species	Family	Species code	Leaf habit	Growth form
Celtis australis L.	Ulmaceae	Ca	D	Tree
Cistus ladanifer L.	Cistaceae	Cl	E	Shrub
Fraxinus angustifolia Vahl.	Oleaceae	Fa	D	Tree
Nerium oleander L.	Apocynaceae	No	E	Shrub
Olea europaea L. var. sylvestris (Mill.)	Oleaceae	Oe	E	Tree
Pistacia lentiscus L.	Anacardiaceae	Pl	E	Shrub
Pinus pinea L.	Pinaceae	Pp	E	Tree
Quercus ilex L. subsp. ballota	Fagaceae	Qi	E	Tree
Quercus suber L.	Fagaceae	Qs	E	Tree
Rhamnnus alaternus L.	Rhamnaceae	Ra	E	Shrub

MATERIALS AND METHODS



MATERIALS AND METHODS

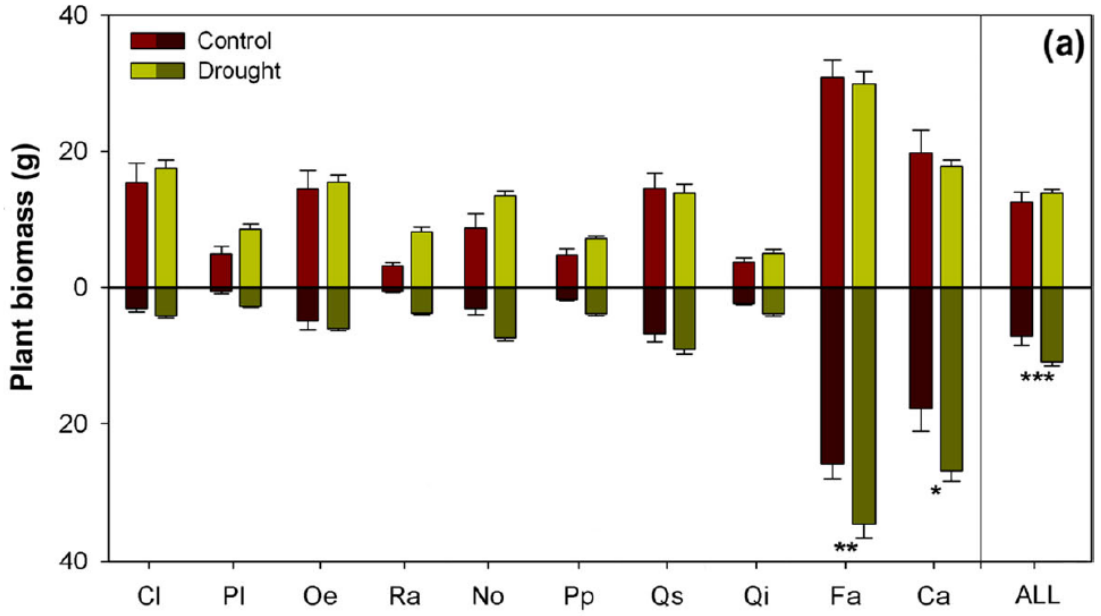


SRL=1/(TMDR x RD^2) x 4/π

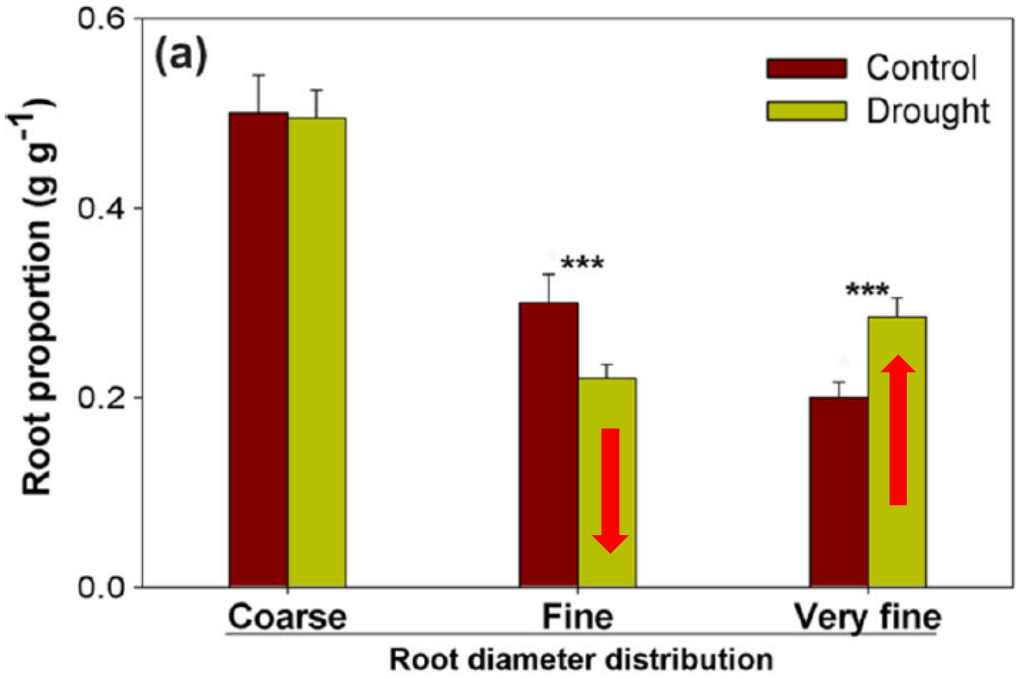
Review of other experiments to see a general effect of drought on SRL

RESULTS

Control=Control 1

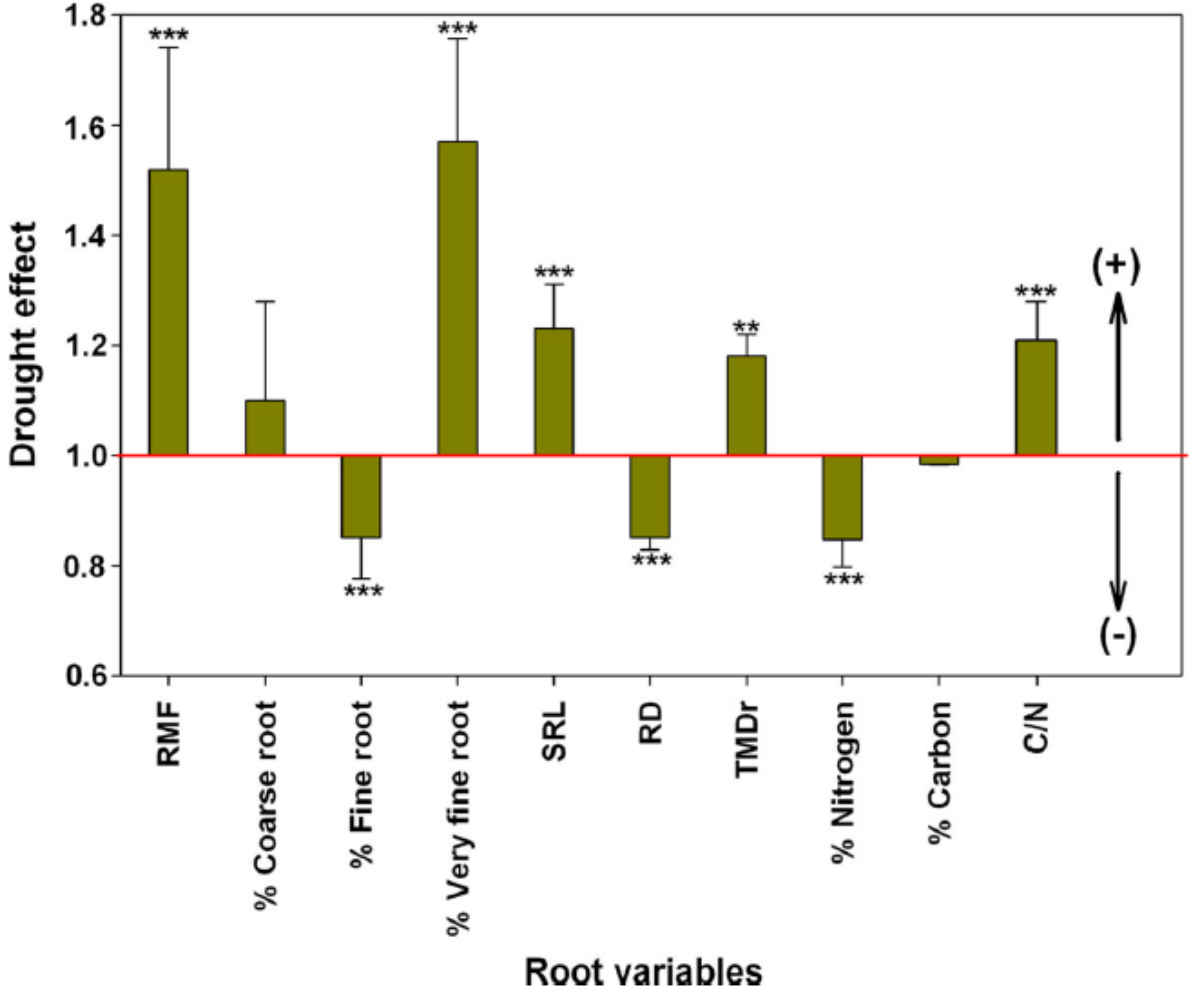


- Drought led a significant increase of root biomass
- Although decreasing LMF(leaf mass fraction), there was no effect on SMF(stem mass fraction)
- Species respond to drought in a similar way



- Drought had no effect on course roots
- Drought decrease the amount of fine roots
- Drought increased the amount of very fine roots

RESULTS

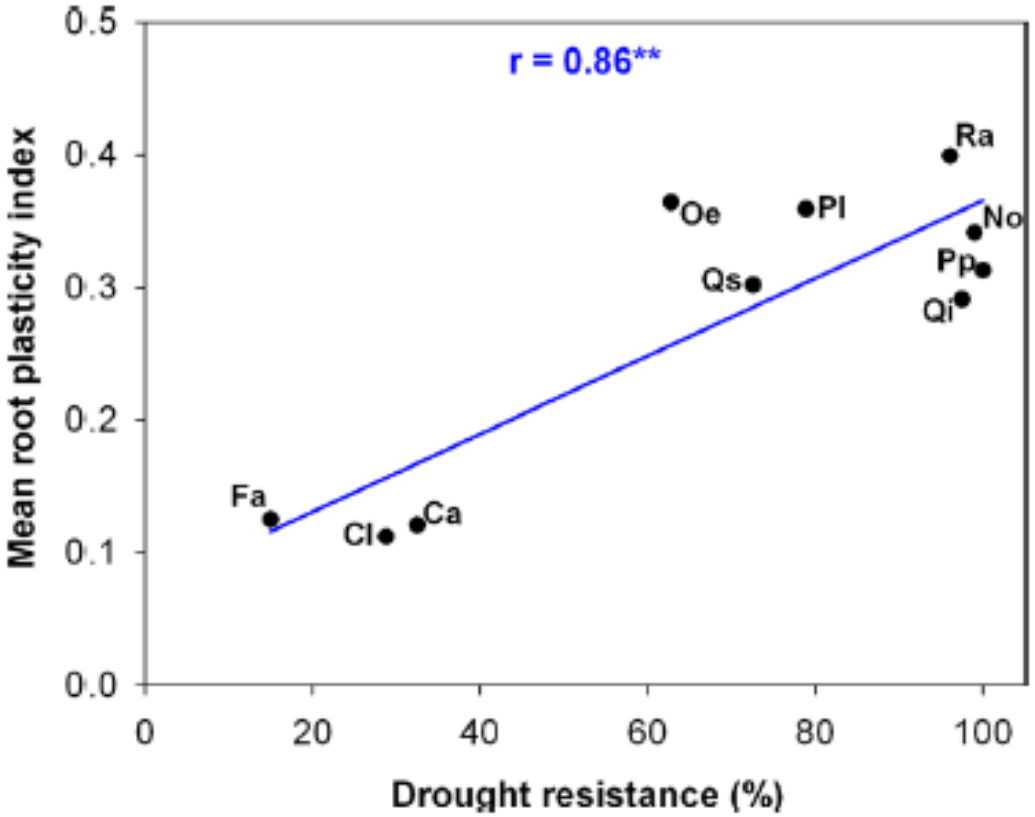


$$\text{Drought effect} = \frac{\text{Mean root train } i \text{ under drought}}{\text{Mean root train } i \text{ under control}}$$

A value of >1 means that drought increased the value of this trait and if the value is <1, it means that drought decreased the value of this trait. The drought effect indicates the effect of drought and its magnitude on the root characteristics.

$$\text{Plasticity index} = \frac{\text{maximum value} - \text{minimum value}}{\text{maximum value}}$$

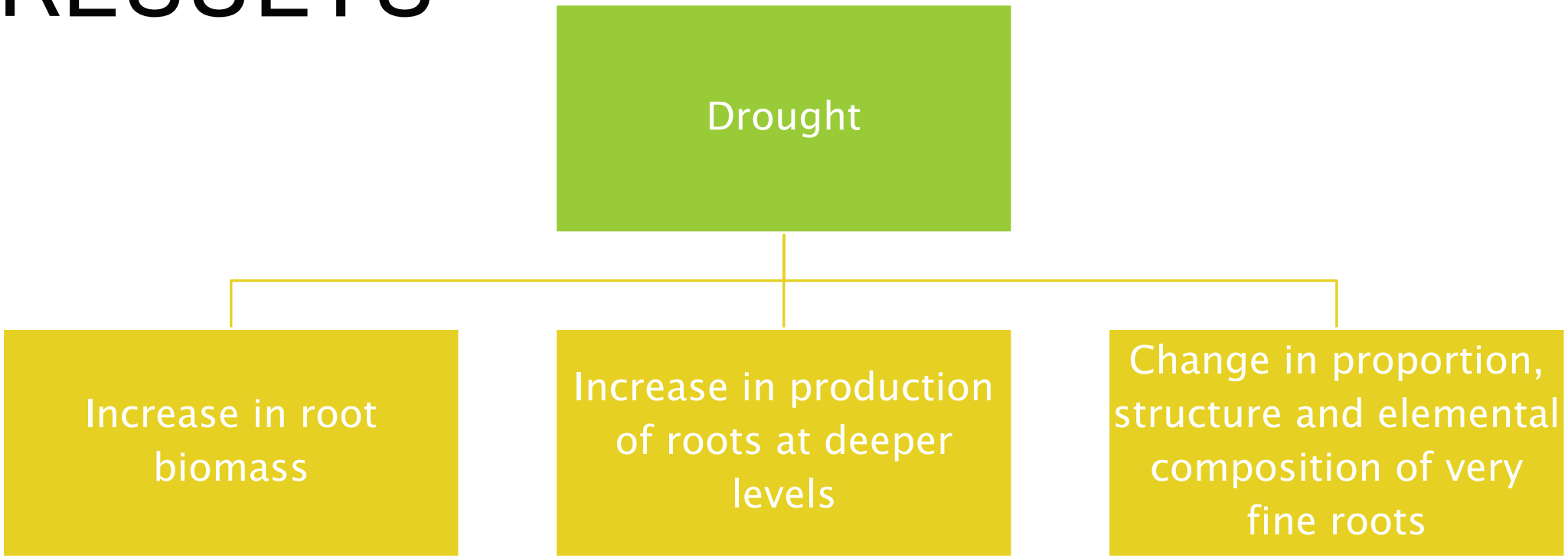
RESULTS



Drought resistance=%of individuals that were alive after 3 months of experimental drought

Drought Resistance had a positive correlation with Root plasticity index

RESULTS



There is a species difference in the amount of the response to drought stress

Thinner, higher tissue mass density, lower N concentration and high C/N ratio

DISCUSSION

How are biomass_allocation_,vertical root distribution and root diameter with depth affected by drought?

1. Plants respond to drought by modifying their biomass allocation. However the response seems to depend on the intensity of drought. (light drought=slight increase in RMF, severe drought=strong increase in RMF)
2. Distribution of root biomass changed due to drought because the water availability in upper layers of soil changed
3. The increase of very fine roots may have been due to change in root morphology(RD reduction)or to the proliferation of new fine roots in response to soil drying

DISCUSSION

What are the effects of drought on key root traits?

SRL,TMDr and C/N raito increased but RD decreased for very fine roots.

1. No clear effect of drought on SRL is found from other studies→SRL depends on both TMDr and RD and drought can affect these variables in different ways
2. Smaller RD may be due to higher resistance to embolism of roots with smaller xylem vessel diameter
3. Increase of TMDr due to drought may be caused by narrower vessels and higher lignification
4. N concentration decreased→lower N availability in soil due to restriction mycorrhizal formation
5. No change in C concentration→other studies show increase in C concentration
6. Increase in C/N ratio→lesser activity of very fine roots?

DISCUSSION

Can the capacity to modify root characteristics be a strategy for better enduring drought?

1. Drought resistance maybe be enhanced by improving the ability of the roots to extract water by changes in root traits (SRL, diameter, tissue mass density)
   →adaptive plastic adjustments
2. High mean root plasticity index was positively correlated with drought resistance
   →Species with higher plasticity may be more drought resistant and survive longer