Root dynamics and soil-enzyme activities in field bean/barley intercrops

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Intercropping for Sustainable Agriculture

Current know-how

- increased crop yields through **COMPLEMENTARITY** between the partner crops;
- higher **yield stability** (resilience towards climate change);
- **lower need of fertilizer** inputs
- **reduced pest susceptibility**;
- improved **soil health**.

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Complementarity

The major mechanisms contributing to, are:

Resource partitioning (niche partitioning):

- benefits derive from a more complete utilization of available resources
- when partner species differ in phenology, vegetative architecture and rooting depth,

Facilitation, occurs when one partner crop:

- improves the environmental conditions to another partner
- provides a limiting resource

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Complementarity

in legume/cereal intercrops

Different **root architecture** and **rooting depth**

- Grass roots are more superficial than legume roots

Different **N source**

- Biological N fixation of legumes reduces the competition for mineral N
- Legume increase the labile N pool in soil

DOES THIS REALLY WORK?

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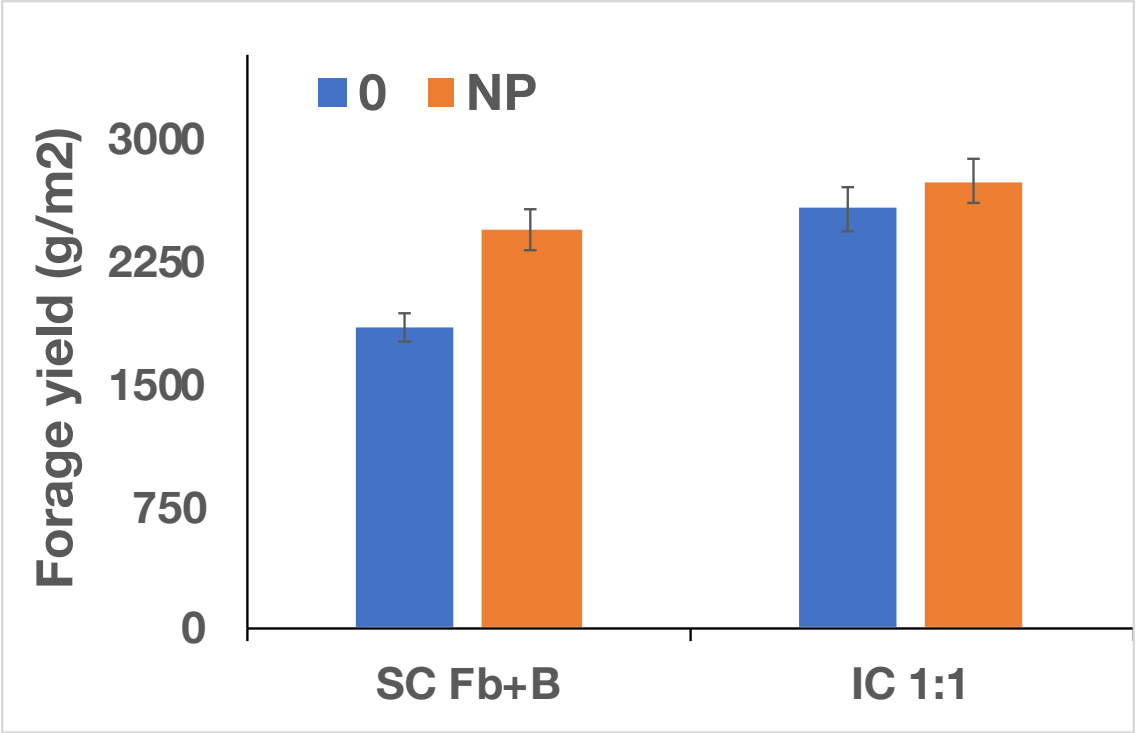
Forage yield

in legume/cereal intercrops

- Was higher in IC than SC;
- Fertilizer input increased yield of SC, but not IC;
- The proportion of field bean decreased from 50% to 40%, with NP input in both SC and IC.

WHAT HAPPENS AT THE ROOT LEVEL?



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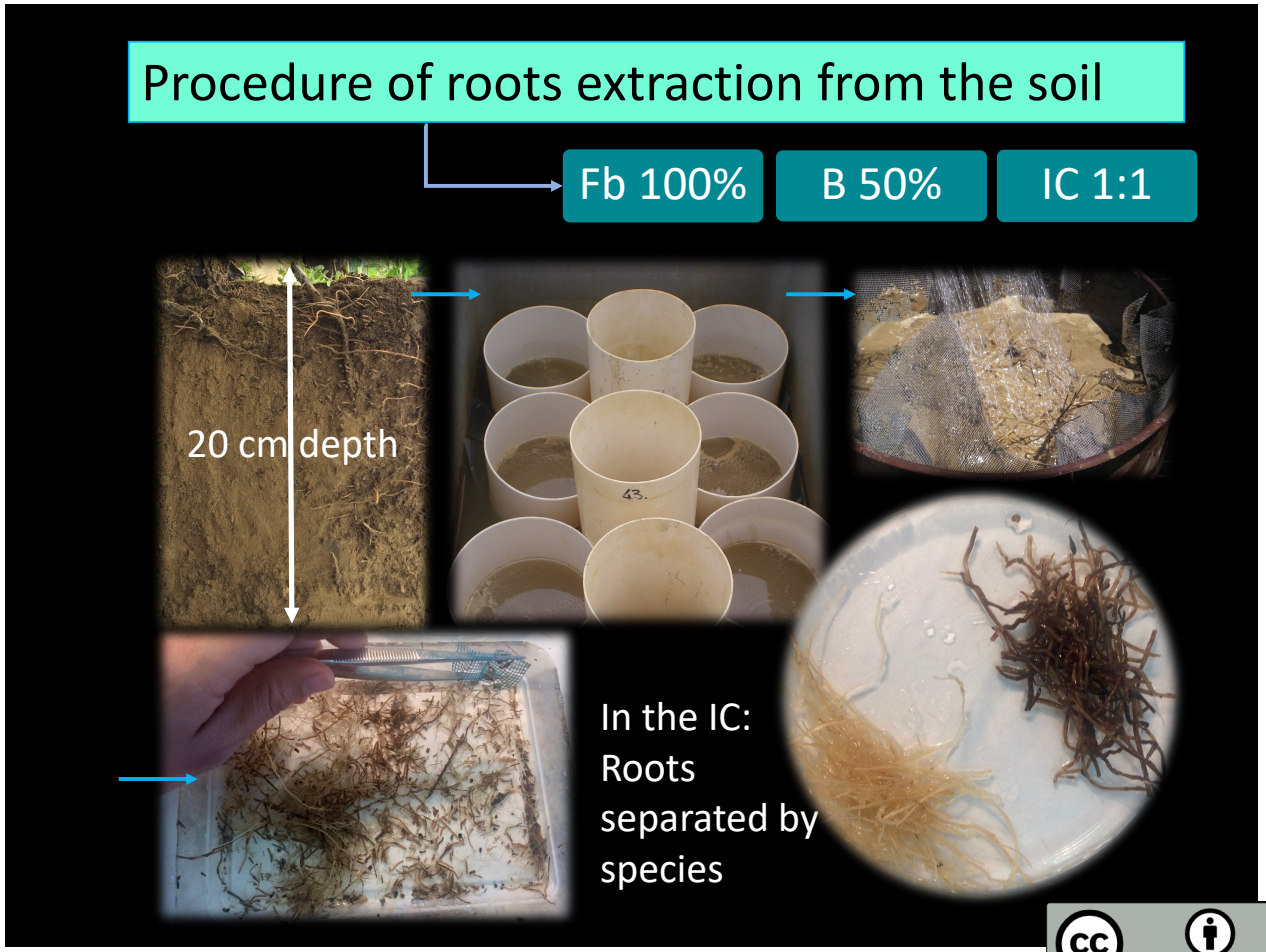
Soil cores collected from field bean and barley sole crops and intercrops

Determinations:

- Root density in soil
- Morphological traits (length, diameter, surface, volume) by means of WinRhizo
- Nodule number
- Specific Root Length
- Soil enzyme activity



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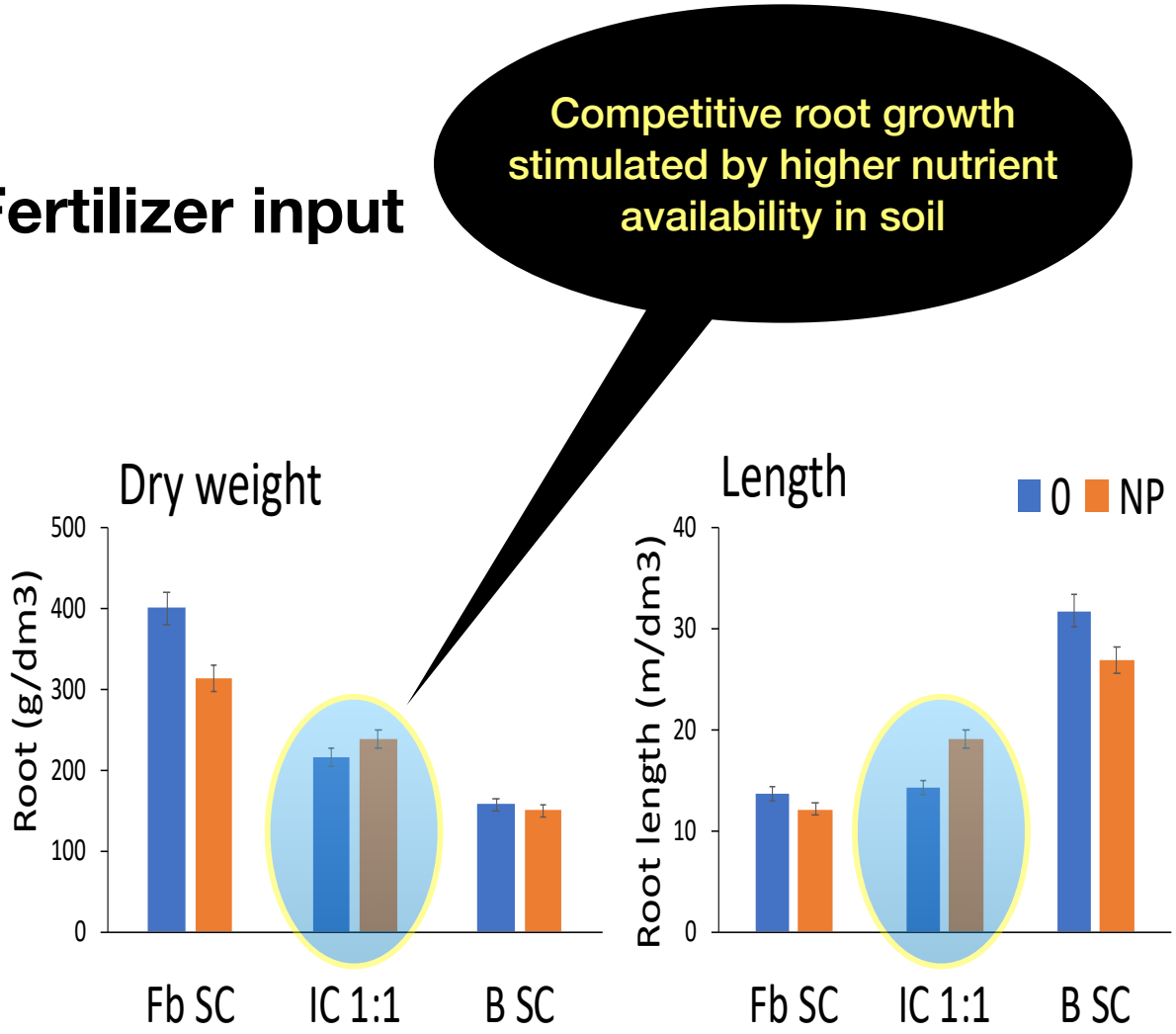
Root density

Response to Intercrop and Fertilizer input

- Root density of intercrops (IC) was intermediate than in sole crops (SC)
- Fertilizer input:
  - reduced root biomass and length in solecrops
  - increased root biomass and length in intercrops
  - increased the proportion of B roots from 30 to 38%.



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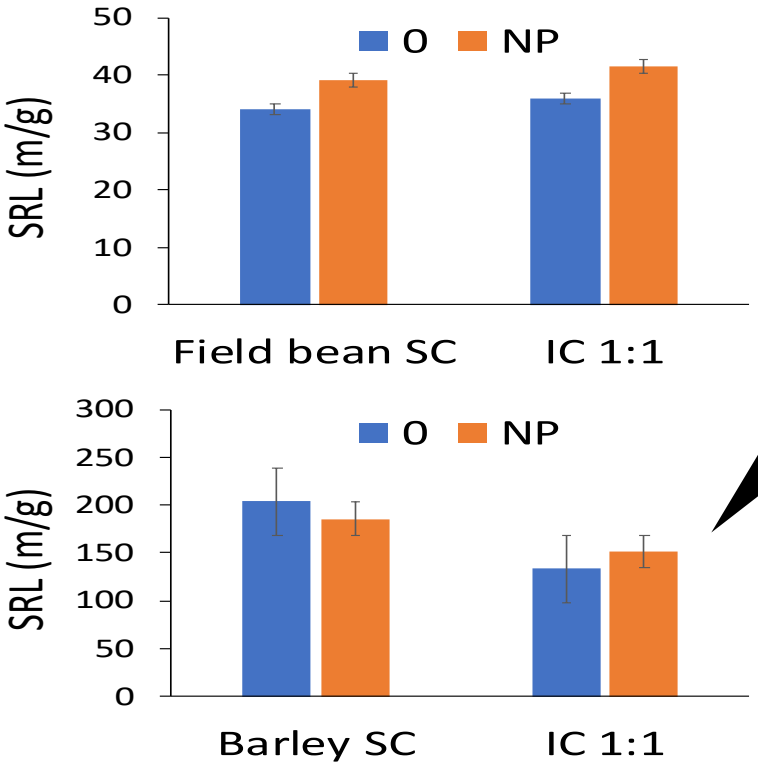
Specific Root Length

Nodule density

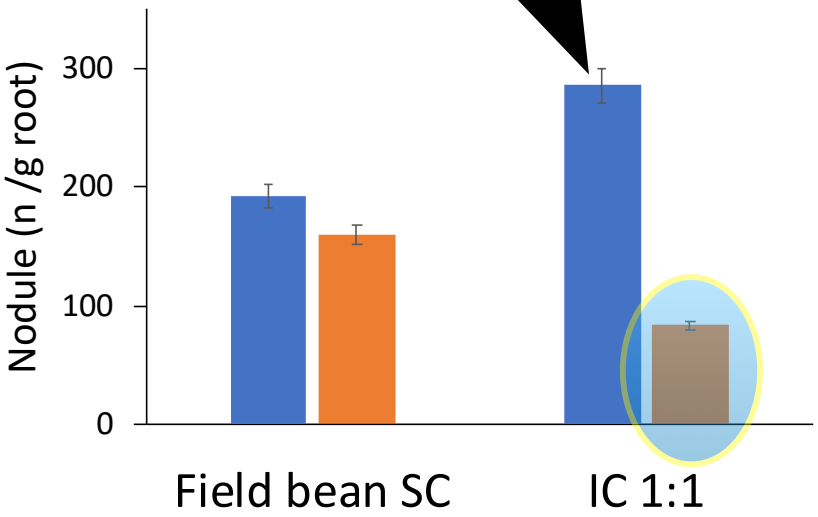
Response to Intercrop and Fertilizer input

- NP increased SRL of both species in IC



Fb and B compete for nutrient acquisition.

Intercropping stimulates nodulation only at low input



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Enzyme activity in soil

in legume/cereal intercrops

- Dehydrogenase (an intra-cellular oxidoreductase enzyme activity) was stimulated by field bean.
- All other hydrolytic enzyme activities and GMea were highest in the barley SC and lowest in the IC.

	Dehydrogenase	β-glucosidase	Phosphatase	Arylsulphatase	GMea
Crop System	µmol TPFg-1h-1	µmol p-nitrophenol g-1h-1			
Field bean SC	0.113 a	0.589 b	1.428 b	0.322 b	0.418 ab
Barley SC	0.098 b	0.713 a	1.566 a	0.340 a	0.438 a
IC 1:1	0.103 ab	0.572 b	1.373 c	0.300 c	0.394 b

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Summary of Results

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- Forage yield was IC 1:1 > Fb+B SC on equivalent land surface;
- Root density in soil was intermediate in IC between Fb and B SCs;
- NP increased root density and the SRL in the IC, but dramatically decreased nodule density;
- enzyme activity seemed to be associated with higher root length density in soil

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Preliminary Conclusions

Root dynamics and soil-enzyme activities in field bean/barley intercrops

- **Complementarity** for N source **only** in **limited N** conditions;
- **Competition** for mineral uptake was demonstrated by changes in root traits and nodule density when **mineral NP** were supplied;
- **Replacement** of spot crop failures and **Facilitation** in water and nutrient acquisition should be considered as drivers of high forage yield in intercrops.

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