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Cover crop root system and nutrient accumulation

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Cover crops

Crops planted between two cash crops. Unlike cash crops, cover crops are mostly grown for their positive effects on soil fertility or other agro-systemic services

Objective

Characterize and understand the nutrient uptake capacity of a wide range of cover crop species

Materials and methods

Characterization of 20 cover crop species in a field experiment in non limiting conditions : leaf characteristics (before flowering), shoot biomass and root characteristics (end of the growing period).

Species :

Brassicaceae
- b1 *Sinapis alba*
- b2 *Brassica juncea*
- b3 *Brassica rapa campestris*
- b4 *Raphanus sativus longipinnatus*
- b5 *Raphanus sativus oleiformis*

Fabaceae
- f1 *Vicia faba*
- f2 *Lens culinaris*
- f3 *Pisum sativum*
- f4 *Trifolium alexandrinum*
- f5 *Vicia sativa*

Poaceae
- p1 *Avena strigosa*
- p2 *Setaria italica*
- p3 *Sorghum sudanense*

Asteraceae
- a1 *Helianthus annuus*
- a2 *Guizotia abyssinica*

Other families
- o1 *Phacelia tanacetifolia*
- o2 *Fagopyrum esculentum*
- o3 *Linum usitatissimum*
- o4 *Cannabis sativa*
- o5 *Salvia hispanica*

Cover crops root systems

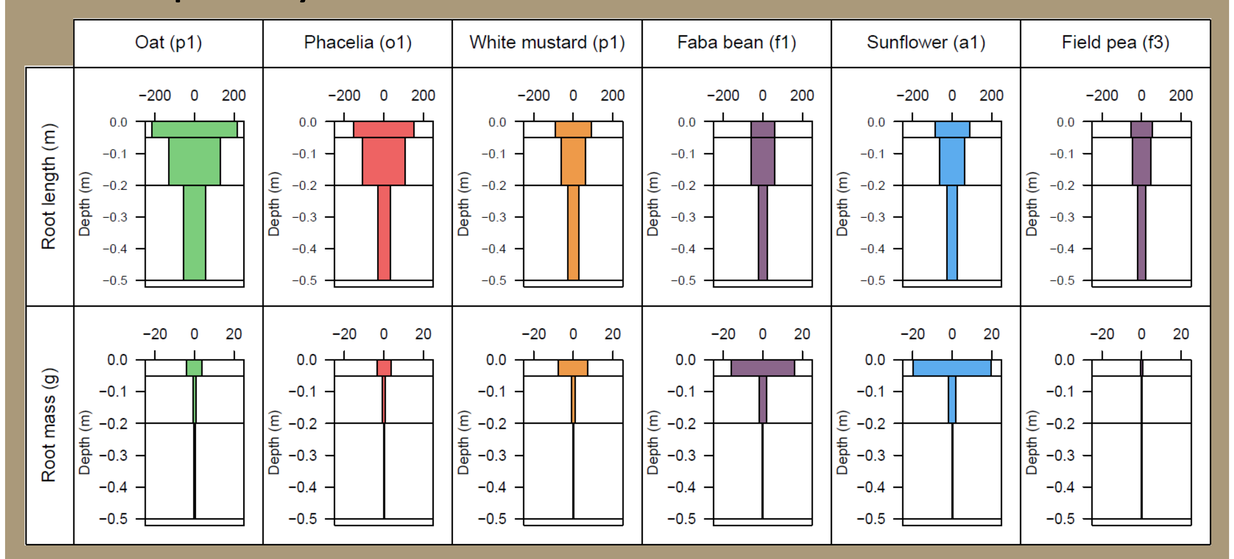


Fig. 1: Total root length (m) and root mass (g) in the 0-5, 5-20 and 20-50 cm layers of six representative species. The surface of each rectangle is proportional to the value of the respective root trait

Two contrasting root systems were observed (Fig. 1) :
- High root length (phacelia)
- Big taproot with high root mass (sunflower)

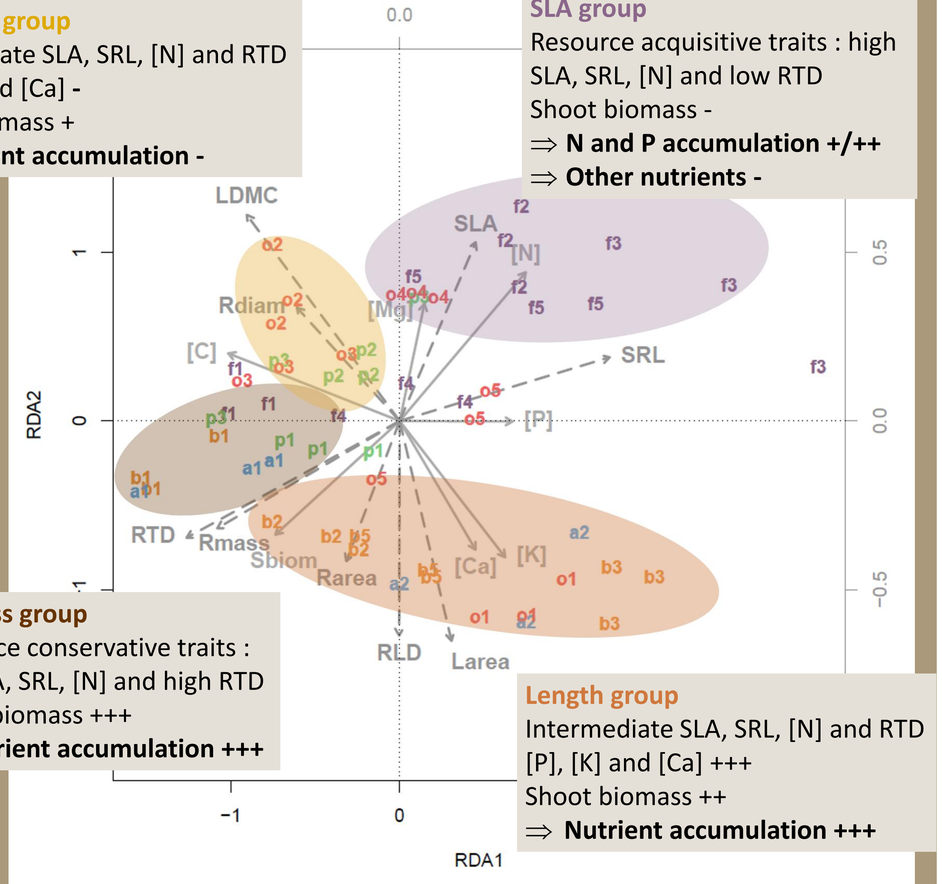
High amounts of nutrients were accumulated in less than 3 months (Fig. 2) :
- **More than 160 kg ha^{-1} of N** accumulated by common vetch (f5), berseem clover (f4) and faba bean (f1)
- As much N and high P and K uptake observed for **sunflower (a1 - high shoot biomass)** and for **phacelia (o1 - high nutrient concentration)**

Variable accumulations according to species

Relationships between plants traits and nutrient uptake

Diameter group
Intermediate SLA, SRL, [N] and RTD
[P], [K] and [Ca] -
Shoot biomass +
⇒ **Nutrient accumulation -**

SLA group
Resource acquisitive traits : high SLA, SRL, [N] and low RTD
Shoot biomass -
⇒ **N and P accumulation +/++**
⇒ **Other nutrients -**



Biomass group
Resource conservative traits :
low SLA, SRL, [N] and high RTD
Shoot biomass +++
⇒ **Nutrient accumulation +++**

Length group
Intermediate SLA, SRL, [N] and RTD
[P], [K] and [Ca] +++
Shoot biomass ++
⇒ **Nutrient accumulation +++**

Fig. 3: Redundancy analysis between leaf and root traits (explanatory variables), and shoot biomass and nutrient concentrations (response variables) of 19 cover crop species. Larea: leaf area, SLA: specific leaf area, LDMC: leaf dry matter content, Rmass: root dry mass, Rdiam: root average diameter, RTD: root tissue density, SRL: specific root length, Sbiom: shoot biomass

Nitrogen, phosphorus and potassium accumulation

Fig. 2: N, P and K concentration (g kg^{-1}) as a function of shoot biomass (t ha^{-1}) of the different cover crop species. The dashed lines correspond to the mean values of all the species. The grey lines represent isolines of the correspondent nutrient uptake in the shoots (kg ha^{-1})

On the basis of leaf and root characteristics and patterns of nutrient accumulation, **four nutrient acquisition strategies were delineated** (Fig. 3)
In non-limiting conditions, two strategies enabled high accumulation of all the nutrients (biomass, length)

Conclusions

High amounts of nutrients recycled by cover crops
Choice of species according to nutrient availability :

- **Satisfactory or rich conditions :**
  - **High root and shoot biomass** (Sunflower)
  - **High nutrient concentration and root length density** (Phacelia)
- **Poor conditions :**
  - **Biological N fixation (**Fabaceae)
  - **High specific root length** (Turnip rape)

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