

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	Fabaceae	Poaceae	Other families
b1 <i>Sinapis alba</i>	f1 <i>Vicia faba</i>	p1 <i>Avena strigosa</i>	o1 <i>Phacelia tanacetifolia</i>
b2 <i>Brassica juncea</i>	f2 <i>Lens culinaris</i>	p2 <i>Setaria italica</i>	o2 <i>Fagopyrum esculentum</i>
b3 <i>Brassica rapa campestris</i>	f3 <i>Pisum sativum</i>	p3 <i>Sorghum sudanense</i>	o3 <i>Linum usitatissimum</i>
b4 <i>Raphanus sativus longipinnatus</i>	f4 <i>Trifolium alexandrinum</i>	Asteraceae	o4 <i>Cannabis sativa</i>
b5 <i>Raphanus sativus oleiformis</i>	f5 <i>Vicia sativa</i>	a1 <i>Helianthus annuus</i>	o5 <i>Salvia hispanica</i>
		a2 <i>Guizotia abyssinica</i>	



Cover crops root systems

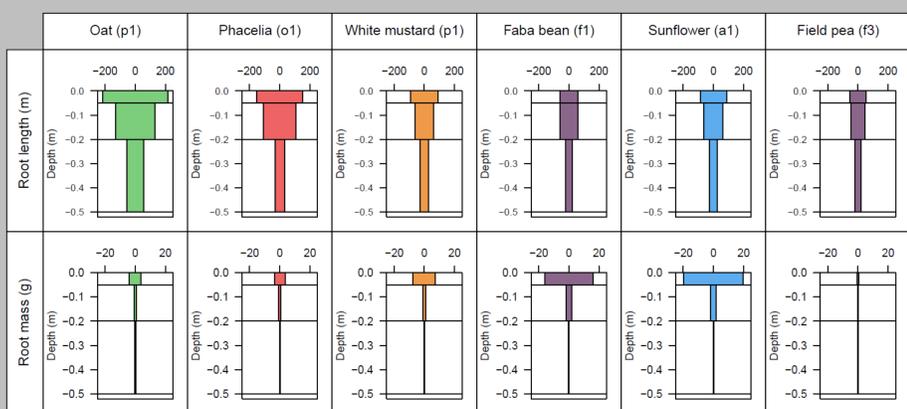


Fig. 1: Total root length (m) and root mass (g) in the 0-5, 5-20 and 20-50 cm layers of six representative species. The surface of each rectangle is proportional to the value of the respective root trait

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

Nitrogen, phosphorus and potassium accumulation

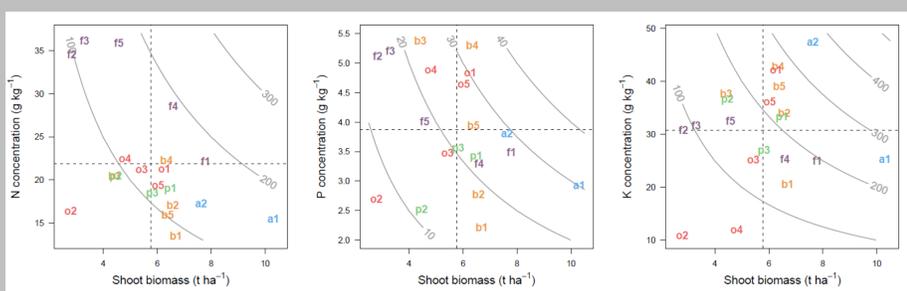


Fig. 2: N, P and K concentration (g kg⁻¹) as a function of shoot biomass (t ha⁻¹) of the different cover crop species. The dashed lines correspond to the mean values of all the species. The grey lines represent isolines of the correspondent nutrient uptake in the shoots (kg ha⁻¹)

Relationships between plants traits and nutrient uptake

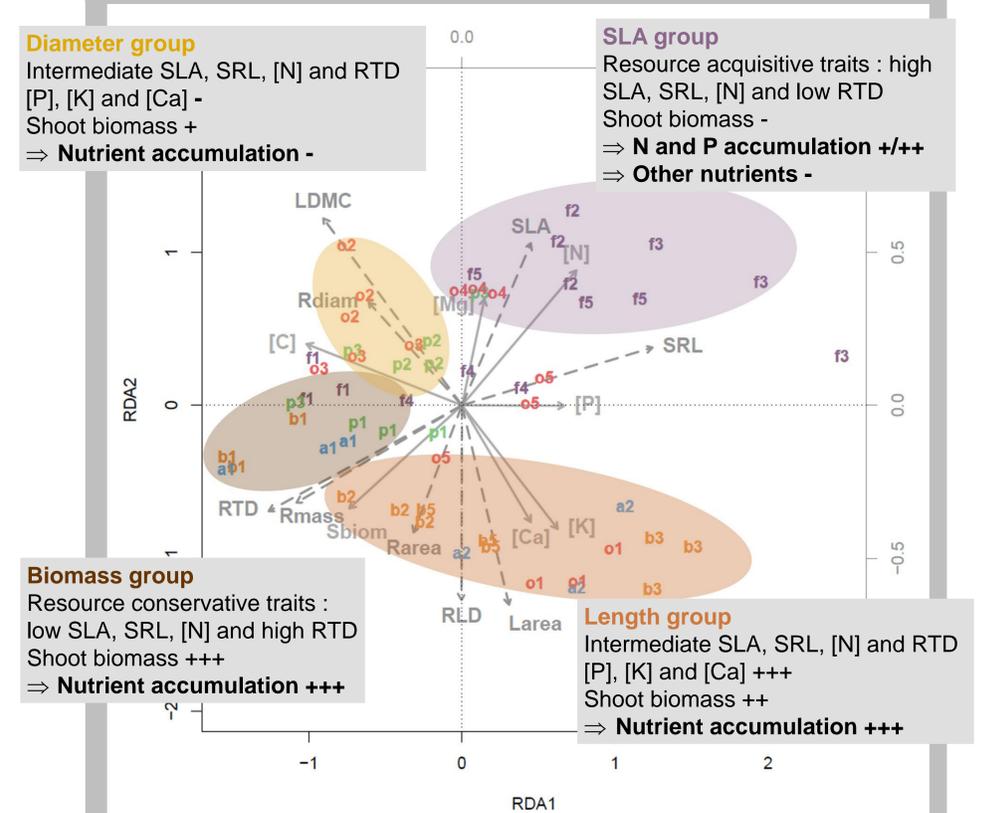


Fig. 3: Redundancy analysis between leaf and root traits (explanatory variables), and shoot biomass and nutrient concentrations (response variables) of 19 cover crop species. Larea: leaf area, SLA: specific leaf area, LDMC: leaf dry matter content, Rmass: root dry mass, Rdiam: root average diameter,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

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)