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Sulphate catch cropping performances of rapeseed and mustard species

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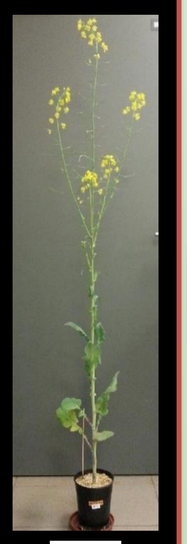
Context & Objectives

For more than 50 years, atmospheric deposition and soil reserves become insufficient to meet the sulphur (S) requirement of plants. Therefore, S fertilization often becomes the general rule to sustain crop growth with unfortunately concomitant risks of sulphate leaching losses which may eventually lead to a reduction in soil fertility, more particularly in low input farming systems. In order to control S cycle in soils, mustard and rapeseed intercrops are often used as S catch plants during the fall period. Indeed, mineralization of the buried intercrops allows S restitution and availability for the next crops while minimizing sulphate leaching losses in the fall. Meanwhile, modern rapeseed cultivars (which contain about half as much S as mustards cv [1]) are less employed than mustards for this purpose, because of an intensive breeding (00 cv.) leading to a low S-organic content in their vegetative and reproductive parts.

The performances of Brassicaceae as S catch crops are evaluated by measuring the **distribution** (between organs) and the **partitioning** of S (mineral *vs* organic) in rapeseed and mustard.

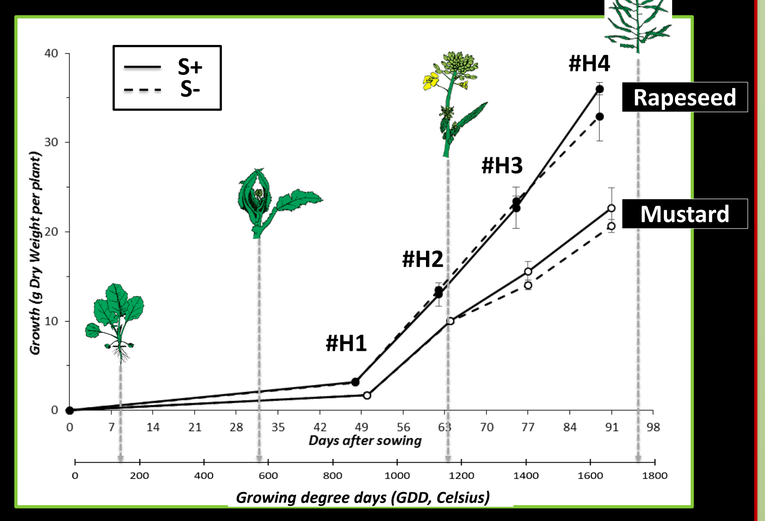
Plant material

Rapeseed (*B. napus* L. annual forage cv Liforum ; DSV, Germany) and brown mustard (*B. juncea* L. cv ISCI99 ; ISCI, Italy) were sown and grown in a greenhouse under controlled conditions on a Hoagland nutrient solution well supplied (S+) or limited (S-) with sulphate. Roots, leaves, stems and reproductive parts were regularly harvested (referenced as #H1, #H2, #H3 and #H4), sampled and stored (vaccum dried or frozen -18° C depending on further analyses)



#H3

Growth



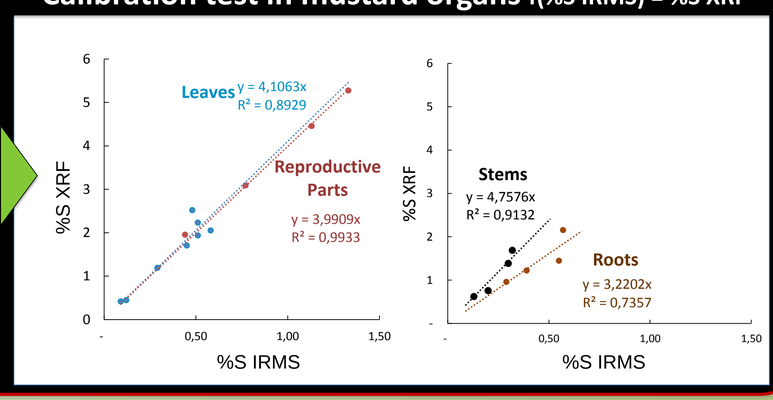
Rapeseed is stronger than mustard, but growth seems not to be affected by S nutrition under our conditions, whatever the crop.

Methods

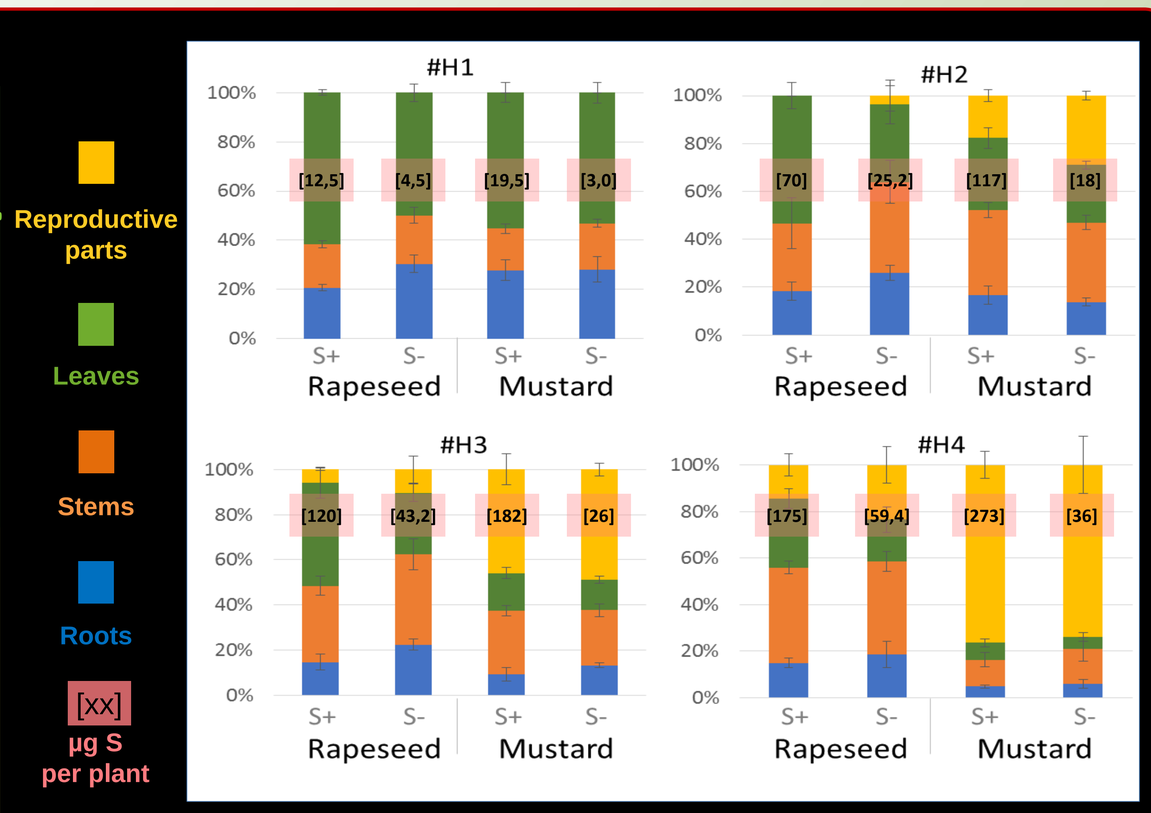
X-Ray fluorescence (XRF) Titan (Bruker) is a portable spectrometer used to determine the elemental composition of various materials (from Mg to U, through S).
It is a non-destructive analytical technique which determine the elemental composition of any sample by measuring the fluorescence emitted when the sample is excited by a primary X-ray source.

To compare the relative elemental concentration between the organs, the XRF data are carefully corrected with a **calibration test**. In this example, the % of S determined by a isotopic ratio mass spectrometer (IRMS) is correlated with the value of %S measured by XRF Titan. The equation relying % S from IRMS and XRF is applied directly in the instrumental software.

Calibration test in mustard organs f(%S IRMS) = %S XRF

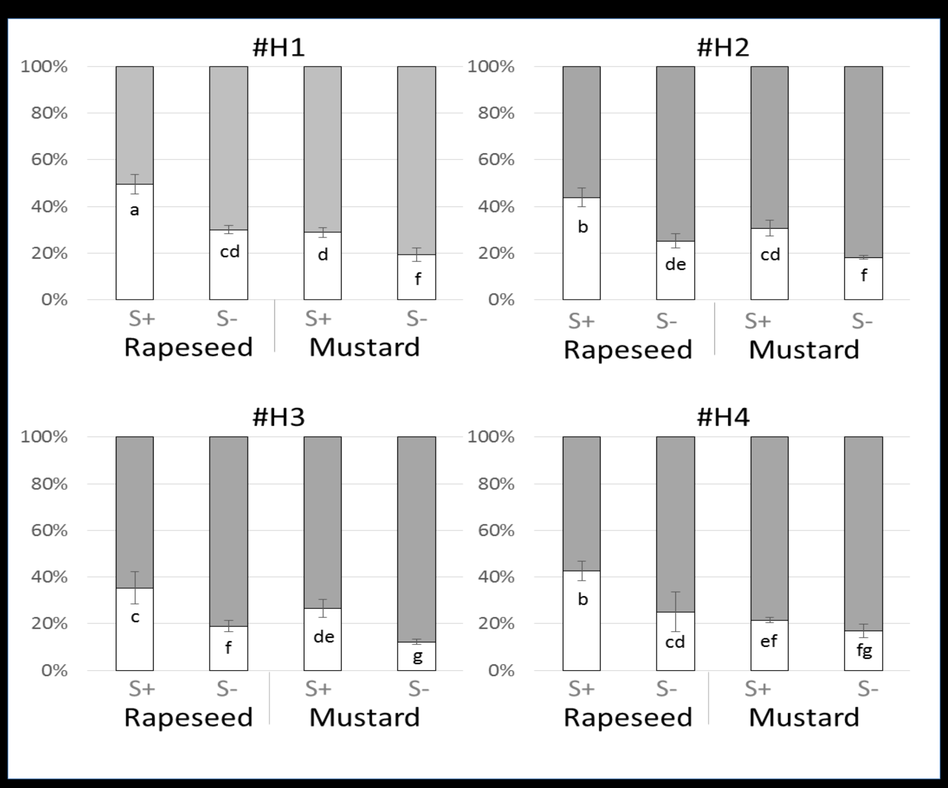


Total S distribution within the plant



The distribution of elemental S between different organs changes during plant development. At the beginning of the cycle (#H1), S is mostly stored in the leaves (~60%). The stems then co-participate in the storage. Finally, at the end of the cycle (#H4), the reproductive organs become the stronger S storage site in **mustard** (about 90% of total S stored) against only 20-30% in rapeseed. Root compartment appears to be more involved in S storage when sulphate availability is low (S-), especially in **rapeseed**.

Total S partitioning in the whole plant



(1) Organic S = [Total S – Mineral S]
(2) Mineral S = S-SO_4^{2-} (elemental S in SO_4^{2-})

At the whole plant level, S-partitioning (mineral S *vs* organic S) does not change throughout the growth period (from #H1 to #H4). For both species, plants fertilized with sulphate (S+) have a higher percentage of mineral S than plants limited with S fertilization (S-). Mineral S is higher in **rapeseed** than in **mustard**, where it accounts for up to 40-50% of total S.

Conclusions & Perspectives

At the end of the crop cycle, rapeseed preferentially accumulates S in the roots and stems while mustard gradually distributes S to the reproductive organs. Besides, rapeseed tends to accumulate more sulphate than does mustard, even under conditions of low S availability. In future studies, we will investigate the impact of growth, destruction and burial of mustard (*vs* rapeseed) intercrop on (i) further soil-S bioavailability and (ii) microbial communities involved in organic-S mineralization.

(1) Hellou S, Michel V, Le Dily F. 2014. SO_4^{2-} disponibility affects leaf S content and senescence in Canola and Mustards species. *9th International Workshop on Sulfur Metabolism in Plants*, April 14th-17th , 2014, Freiburg, D