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Genotypic Diversity and Plasticity of Root System Architecture in response to Nitrogen Availability in Winter Oilseed Rape (Brassica napus)

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In the new emerging agricultural context, a drastic reduction in fertilizer usage is required. A promising way to preserve high yields while reducing fertilizer inputs is to improve nutrient use efficiency, especially for winter oilseed rape (WOSR), known to have high nitrogen requirements. To reach this aim, one key lever relies on the optimization of the root system architecture (RSA). This needs a further investigation of the plasticity of the RSA in response to nitrogen availability and genotype diversity, on which very few information is available. The aim of our study was to characterize the RSA of several WOSR genotypes and their plasticity in response to nitrogen availability, by using the ArchiSimple (model parameters Pagès et al, 2014, Ecol Modell) as screening traits.

Ten accessions of Brassica napus were cultivated in a greenhouse located in Avignon, France. Plants were grown in long tubes of 10cm diameter and 1m length under two contrasted levels of nitrogen availability. After plant excavation, roots were separated from shoots, cleaned and scanned at high resolution. Six ArchiSimple parameters relative to root diameter, elongation rate and branching characteristics were measured, using the ImageJ software. In addition, nine allocations traits were estimated to fill up the characterization of plant belowground and aboveground phenotypes. Plasticity of each trait to nitrogen availability was estimated.

Excepted inter-branch distance, which showed high levels of plasticity, architecture traits were less plastic than allocation traits. N-limited plants were the most efficient in nitrogen uptake. They were characterized by a decrease of lateral roots density and primary root diameter and by an increase of the dominance between the primary root and the lateral roots. Besides, correlations have highlighted that genotypes with high uptake efficiency displayed (i) low number of lateral roots, (ii) thin primary roots and (iii) a high variation of lateral root diameter.

This work indicates that ArchiSimple provides a relevant framework to investigate root system architecture and its plasticity. While traits of RSA are mostly stable, inter-branch distance appears to be a key trait in the adaptation of the RSA to nitrogen availability.