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01e. Characterization and evaluation of rice genetic diversity, including 'omics'

PHENOMICS AND GWAS FOR RICE EARLY VIGOR RELATED TRAITS: RELEVANCE OF NON STRUCTURAL CARBOHYDRATES AND PLANT GROWTH MODEL PARAMETERS RELATED TO CARBON SOURCE-SINK RELATIONS

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Purpose:
Until now no GWAS targeted early vigor (the capacity of the seedling to grow rapidly and colonize efficiently space and resources, commonly characterized by (shoot) biomass Accumulation) in particular for rice. Nevertheless, early vigor is crucial for rice plant adaptation to dense stands as practiced for direct seeding or to cropping systems favoring high weed pressure.
Recently, phenomics studies highlighted that the genetic diversity observed in terms of rice early vigor was explained by the way the plant allocates Non Structural Carbohydrates (NSC: hexoses, sucrose, starch) to structural growth (sink activity).It was also demonstrated that, by formalizing in a simplified way within a plant growth model (Ecomeristem) the Carbon (C) source-to-sink relations underlying plant early morphogenesis and its phenotypic plasticity, it was possible to capture the genetic diversity of processes underlying such a complex trait, based on genotypic model parameters.

Approach and methods used:
In the present study, we tackle the hypothesis that both NSC related traits and genotypic model parameters controlling C source - sink relations are relevant traits to be considered for GWAS. Accordingly GWAS was performed using both these types of traits and compared to GWAS performed on corresponding variables directly measured on the plant (eg. shoot dry weight, tillering, leaf size). 16 664 markers (9727 DArTs and 6717 SNPs, with 46% of the markers positioned in genic regions) were used based on GBS

Key results:
GWAS pointed out that NSC (in particular starch and the soluble sugar / starch concentration ratio) and model parameters controlling plant development, growth potential and its regulation by C availability, could detect markers that were not detected (or to a lower level) by related measured variables. Some markers co-localized with genes involved in cell differentiation at early developmental stages.

Synthesis and Applications:
This study demonstrated that metabolic traits and ecophysiological model parameters are relevant to dissect the genetic bases of early vigor. Results are discussed with respect to the opportunities and limits metabolomics and complex trait modelling can play in the context of genetic studies and the opportunities for marker assisted breeding.