

DIV-N-FIX

Mobilizing Diversity for improving biological N Fixation in peanut

ABSTRACT

Biological nitrogen fixation (BNF) performed symbiotically by legumes plays a crucial role in agroecological approaches aiming to maximize food production while minimizing negative externalities of modern agriculture practices. This could be of high importance in the Sahelian zone, where food production is often maintained with a minimum input of synthetic fertilizer by cultivating cereals in rotation with nitrogen-fixing legumes such as peanut, the second most cultivated legume which was imported to Africa from South America. Attempts to improve nitrogen fixation in Sahelian countries have mostly focused on the development of inoculants but the nitrogen fixation trait has rarely been directly targeted in peanut breeding programs and poor knowledge is available on the genetic determinants of nitrogen fixation. Furthermore, the effect the plant genotype on the recruitment of efficient symbionts has not been examined.

The Div-N-Fix project will bring together geneticists, molecular biologists and microbiologists from France, Senegal and Argentina to identify and characterize genetic determinants controlling nitrogen fixation in peanut. Our project has two main objectives:

1) By measuring traits related to nitrogen fixation in a collection of African cultivars and landraces we aim to identify genomic regions controlling peanut nitrogen fixation with a GWAS approach. The corresponding genetic markers allow to include the nitrogen fixation trait in breeding strategies.
2) Use the powerful NGS technology to discover the identity of bacteria differentially recruited by cultivated peanut modern varieties, landraces and several wild relatives. Experiments will be performed in Senegal and in Argentina to monitor shifts in microbial communities linked to the plant genotype that occur in an area where peanut was introduced versus its endemic area.

Altogether, the results on the plant genetic determinants involved in nitrogen fixation and on rhizobial communities recruited by different genotypes will be used to further understand the determinants of peanut nitrogen fixation but also to develop strategies to improve nitrogen fixation in Senegalese fields.

Keywords : Peanut, Biological, Nitrogen, Fixation, GWAS, Diversity, Microbiome, Peanut, Arabidopsis, Senegal, Argentina

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Flagship project : no

Project leader : Sergio SVISTOONOFF

Project leader's institution : IRD

Project leader's RU : PHIM AGAP

Budget allocated : 200000 €

Total budget allocated (including co-financing) : 200000 €

Funding : Labex

GOAL

In the Div-N-Fix project, we aim to explore other possibilities that could lead to the improvement of BNF in peanut. The project contains two work packages (=GRAFIX and DIASPORA) that will explore two

different and complementary sources of diversity regarding BNF. DIASPORA will focus mainly on wild species and the evaluation of their potential to recruit efficient rhizobia and exclude cheater strains, while the second WP, GRAFIX will use a collection of African cultivars and landraces to explore variation in BNF in the cultivated compartment of peanut. Peanut was introduced in Africa in the XVIth century and its adaption to African environments is partly due to the selection operated for centuries by African farmers in low-input farming systems. By screening this collection, we expect to find alleles that are particularly suitable to improve the BNF trait in African fields.

In a third part, WP3, we want to cross and share the results of the two work packages in order to build a larger project on BNF in peanut.

To summarize, the three objectives of the Div-N-Fix project are:

- Exploiting cultivated peanut genetic diversity to generate knowledge on the molecular basis controlling peanut biological nitrogen fixation in Senegalese fields (WP1).
 - o Grow a collection 300 peanut varieties representative of African peanut diversity in a Senegalese field and collect phenotypic data related to biological nitrogen fixation.
 - o Combine genotyping data available for these 300 varieties and the collected phenotypic data to perform genome-wide association study in order to identify quantitative trait loci (QTLs) controlling the traits related to biological nitrogen fixation.
 - o Characterize the symbiotic phenotype of one QTL that shows the highest potential to increase nitrogen fixation. Accessions carrying favourable alleles at this QTL will be studied using a combination of molecular, histological and physiological approaches. The effect of this QTL on the recruitment of efficient symbionts will also be analysed.
- confirming that the plant genotype has an influence on the recruitment of specific bacterial communities and to decipher how it further influences BNF in cultivated peanut (WP2).
 - o Investigate the influence of the plant genotype on the recruitment of specific bacterial communities and evaluate the associated BNF efficiency by comparing modern commercial peanut accessions, landraces and a selected wild *Arachis* species grown in natural or agricultural soils.
 - o Decipher the influence of peanut domestication and selection on the recruitment of bacterial communities in its endemic area (Argentina) compared to West African introduction area (Senegal).
- crossing and share the results of the two work packages in order to build a larger project on BNF in peanut.

ACTION

WP1: GRAFIX – IMPLEMENTING A GWAS APPROACH TO DECIPHER THE MOLECULAR BASIS OF PEANUT BIOLOGICAL NITROGEN FIXATION IN SENEGAL

WP2: DIASPORA: FROM WILD TO CULTIVATED PEANUTS: EXPLORING THE SOIL MICROBIAL DIVERSITY TO SUSTAINABLY PROMOTE BIOLOGICAL NITROGEN FIXATION

WP3: GOVERNANCE AND SUPPORT OF A NEW HIGH-LEVEL SCIENTIFIC PROJECT ABOUT BIOLOGICAL NITROGEN FIXATION (BNF) IN PEANUT