Agro-TCR

Establishement of an agro-forestry instrumented site in Champenoux, France: to optimize productivity and sustainability of intensive cropping systems through symbiotic nitrogen fixation

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Context — Intensive tree plantations aiming at producing biomass for energy purposes, such as short rotation coppice (SRC) plantations, are an important asset to reach 20% of energy consumption from renewable resources, objective set by the European Union for 2020. The combination of species capable of fixing nitrogen from the atmosphere with species of economic interest may be a way to overcome many of the disadvantages posed by SRC plantations such as soil depletion in nutrients. Actually, biological nitrogen fixation reduces the financial and environmental cost of chemical fertilizers. The nitrogen-fixing species can be woody (black locust, alder) or grasses (alfalfa, clover, pea).

Objectives — The objective of the project is the establishment of an instrumented plantation associating nitrogen-fixing species (alder, alfalfa) to species of economic interest (poplar, cereals) on an agricultural plot of the experimental farm of La Bouzule located in Amance in Lorraine.

Approach — The plantation is composed (1) of "forest" plots (poplar and alder monocultures, mixture poplar / alder), (2) agricultural plots (cereals and alfalfa monocultures), and (3) agroforestry plots (poplar / alfalfa mixture, alder / cereals mixture) in order to assess the fertilizer effect of nitrogen-fixing species on non-fixers. The experiment has started in April 2014.

Key results —

- The extension of the project in 2016 allowed replanting a significant number of trees that have not survived in 2015. About 200 poplar trees and 200 alder trees (about 5.5% of total) were planted again in April 2016 from one-year-old rooted saplings. For poplar, this way to proceed favoured the tree survival as compared to the cuttings planted in 2015. It was necessary to irrigate the poplar trees in August 2016. As during the first two years, weed control on tree lines has represented a huge work during spring and early summer.
- The instrumentation of the trial was completed with the installation of a 10 m mast carrying an anemometer, a pyranometer, and a PAR sensor. A rain gauge was also installed and two additional moisture / temperature soil profiles (4 depths) were set in agroforest plots of block 1 in addition to the 8 profiles already present in the forest plots since 2014 or 2015.
- Height growth monitoring of a selection of trees of both species, within the three treatments (forest monocultures, forest mixture, and agroforestry) and the three blocks was conducted during the 2016 growing season (360 trees). Some differences are already visible, trees in the agroforestry treatments showing a slower growth in height. Trees in the third block, located on a very shallow and stony soil, are also less developed in height than in both others blocks. Globally, tree heights are very heterogeneous probably because of soil plot spatial variability. The tallest poplar trees reach almost 6 m.
- Since 2014, the trial is used for student training: a dozen of Master 1 projects have been realized on the plantation; Master 1 students contribute to annual inventories in the framework of practical works included in the Master FAGE training; the plantation is also shown as a demonstration tool to ENSAIA students; etc.

Main conclusions including key points of discussion — Four years after the implementation of the trial, no facilitation effect is yet detectable. On the other hand, in agroforestry plots, the trees are very constrained by competition with herbaceous species at the root level. The trial is part of the SOERE F-ORE-T network since 2016.

The trial is likely to become a very nice tool for multidisciplinary projects aiming at comparing agroforest and forest mixtures to monocultures, as well as a demonstration object for farmers and for students.

Future perspectives — The plantation will be equipped in 2018 to measure soil emissions of CH_4 and N_2O in the seven forest, crop and agroforest treatments in order to compare the emissions in mixtures and in monocultures. In the same way, radiometers will be installed in order to estimate reemitted solar radiations in the agroforest plot as compared to monoculture.

Valorisation —

Oral presentations

Marron, N., B. Amiaud, D. Epron, E. Dallé, A. Laflotte, S. Piutti. 2016. Optimization of productivity and sustainability of intensive cropping systems through symbiotic nitrogen fixation in agroforestry plantations.

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