Final report PROLEGSO (PIEF-GA- 2009-254533)

Project period: 01 January 2011 – 31 July 2014

1. FINAL PUBLISHABLE SUMMARY REPORT

Personal development

Objectives

My objective was to aquire new methodological knowledge, expand my theoretical knowledge and to further development my leadership qualities and my academic career.

Main results

- I successfully completed several courses on the molecular identification and quantification of nematodes and mycorrhizal fungi, and on the use of new statistical software.
- I also developed my leadership and teaching capabilities through courses, and especially through the practice of supervision of Bsc, Msc and PhD students (3 internal and 4 external PhDs) as well as of a technical assistant.
- I established fruitful collaborations, as illustrated by the published papers, and initiated new projects nationally (within and outside Wageningen UR) and internationally. I look forward to develop these further with the newly awarded grants.
- My visibility within the research community has strongly increased during the time of the fellowship and I was invited to several committees to evaluate grant proposals and PhD theses within and outside The Netherlands. I was also invited to several editorial boards of international well regarded scientific journals and I joined the board of Journal of Ecology and Ecosystems.
- My leadership qualities are well recognised within the university and I was chosen as new chair of the Wageningen Young Academy http://www.wageningenur.nl/en/Expertise-Services/Collaboration-and-partnerships/WYA/WYA-Mission-Statement.htm
- During my Marie Skłodowska-Curie fellowship I was able to make the major transition as a scientist to be promoted from post-doctoral fellow to Assistant Professor in 2011 to Associate Professor in 2014 at Wageningen University (tenured).

Conclusions

I have made very significant developments in my knowledge, skills and scientific career moving from a postdoc to Associate Professor and the fellowship has been very instrumental in enabling me to achieve this goal. I have also been successful in obtaining new grants to pursuit my scientific and societal goals.

Scientific developments

Introduction

In natural and agricultural systems legume species can greatly stimulate plant biomass production and nutrient concentrations of non-legume species, such as grasses, when growing in species mixtures. This facilitative effect of legumes is due to their ability to fix nitrogen from the air through symbiosis with root inhabiting rhizobia. This extra nitrogen input becomes available to neighboring plant species via root exudation and root decomposition of legumes.

The question however remains whether legume species can also benefit of growing with non-legume species. If legumes also benefit from non-legumes in a mutual beneficial way a stable co-existence and sustainable benefits for productivity and plant quality can be achieved by making better use of diversity and reducing the need for and use of mineral fertilisers thereby putting less pressure on the environment.

Objective: The overall scientific objective of the proposal was to investigate whether and how legume species can benefit of growing with non-legume species.

Hypotheses: I tested three hypotheses corresponding to three main ways via which legume species could benefit of growing with non-legume species: 1) via increased nutrient resource use complementarity, 2) via reduced pathogen or herbivore pressure, 3) via increased benefits of root mutualists such as mycorrhizal fungi and rhizobia.

Approach: I explored each of the three potential mechanisms by means of empirical experiments: I 1) quantified potential overyielding of mixtures of clover in pairwise combinations and related clover benefits to divergence in the uptake of different plant nutrients (**WP1**), 2) tested the sensitivity of different clover species to different species of root-feeding nematodes and investigated the potential dilution of these nematode species in a field experiment with legume monocultures and mixtures of legumes and non-legumes (**WP2**), 3) studied the legacy effects of non-legume and legume species via shifts in soil microbial communities on subsequent clover growth and the diversity and community composition of mycorrhizal fungi and rhizobia using cutting edge molecular techniques (**WP3**).

Main results: the main findings from the experimental work demonstration that

- not only non-legumes can profit from legume species, legume species can also profit from growing with non-legume species and in this soil organisms seem to play an important role (De Deyn *et al.* 2012 PlosOne)

- clover performs better with plant species that acquire less P and K, which turn out to be the slower growing species rather than those with a low tissue concentration of P and K.
- the level of sensitivity toward root-feeding nematodes in terms of biomass reductions is different between birdsfoot trefoil (Lotus corniculatus) and red and white clover (*Trifolium pratense* and *T. repens*). Of the root-feeding nematodes tested *Meloidogyne hapla* results in strongest plant growth reduction in part due to its fast population build-up. This nematode species was however not the most abundant in our field experiment, while the root-feeding nematode species *Paratylenchus sp.* was most abundant. The density of root-feeding nematodes was not reduced in plant species mixtures.
- different grassland plant species create biotic legacies with differential impacts on the growth of red and white clover. Non-mycorrhizal plant species and grass species generally leave a less good biotic legacy than legumes and mycorrhizal forbs. Highest clover biomass in response to biotic legacies is associated with an average richness of mycorrhizal fungi (about 9 OTUs) but of specific composition.

Conclusions:

Legume species can benefit from growing with non-legume species but this requires specific traits of the non-legume species. These traits comprise the promotion of beneficial community compositions of mycorrhizal fungi and having a relative low uptake of P and K by not growing much faster than the legumes.

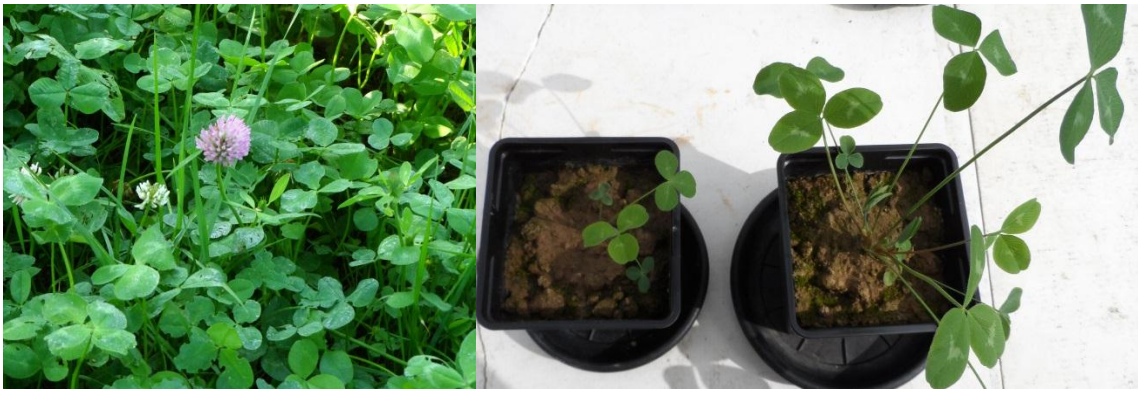

Image: *Grass-clover mixture in the field (left picture) are difficult to maintain. Negative legacies of grass species via less beneficial soil communities (right picture) could be part of the reason.*