Summary MSc thesis Christian Andres

1. Problem statement

Yams (*Dioscorea* spp.) are tropical tuber crops with high food and market values, contributing significantly to food security in West Africa. The traditional method of cultivation is without fertilizers as the first crop after clearing land from natural vegetation (e.g. forests) because of their high requirements in terms of soil fertility. However, due to increased population pressure on arable land, forests have become rare, fallow periods shorter, and long term fallowing more difficult in West Africa. Consequently, declining soil fertility is one of the major constraints to yam productivity and yam yields are thus far below the estimated potential. These problems call for the development of more integrated and sustainable yam production systems.

2. Objectives

The aim of our study was to investigate the effects of fertilization with poultry manure (PM) on nutrient dynamics, nutrient use efficiencies and yield of *Dioscorea rotundata*, and to compare fertilization with PM to mineral fertilization and to a mixed PM/mineral fertilization.

3. Material and Methods

An experiment with *D. rotundata* cv. TDr 89/02461 was set up on a low fertility savanna soil in central Côte d'Ivoire in 2010. There were seven treatments: Unfertilized control, mineral fertilization with different levels of nitrogen (N) application (0/60/120 kg N ha^{-1}), fertilization with PM (7.5/15 t PM ha^{-1}, corresponding to 60/120 kg N ha^{-1}), and a mixed PM/mineral fertilization (7.5 t PM ha^{-1} & 60 kg N ha^{-1}). The trial was implemented in a complete randomized block design with four replications. Soil sampling and destructive sampling of plants were done at four time points, corresponding to physiological stages of the crop: At tuber initiation (70 days after planting (DAP)), at maximum growth of aboveground organs (112 DAP), at maximum tuber growth rate (146 DAP) and at tuber harvest (182 DAP). PM was analyzed for total Ca, Mg, N, P and K. Standard physicochemical properties of the soil were analyzed before and after cropping (texture, pH, P_{avail}, C_{org}, N_{tot}, exchangeable bases (Ca, Mg, K), and CEC). During the cropping period, concentrations of mineral N (NH_4^+, NO_3^-) and exchangeable bases in the soil were monitored, and total Ca, Mg, N and K were measured in plant organs (leaves, stems, tubers). A second MSc study (Laura Spring, ETH Zurich) measured dry matter production (aboveground, tubers, roots), Leaf Area Index, SPAD, root length and root diameters.

4. Results

Overall, results showed that effects of fertilization with PM and mineral fertilizer on nutrient dynamics and nutrient use efficiencies were very alike. Interestingly, even though PM supplied nutrients in a ratio considered suboptimal (less K/more P than needed), and at an inadequate time point (before planting, e.g. not coinciding with the crops demand in terms of nutrient uptake), fertilization with PM led to a physiological advance compared to plants fertilized with mineral fertilizers, and finally also to highest yields. The two pure PM treatments achieved about the same yield, even though one treatment received twice as much PM (and thus N). Therefore, the hypothesis that the N nutrition controls the yield formation in *D. rotundata* could not be confirmed, and results indicated that, besides the provision of nutrients, PM must have had additional beneficial effects on the crops' development. The fact that the average yield in pure PM treatments (12.3 t fresh tubers ha^{-1}) was 73% higher than in the unfertilized control (7.1 t fresh tubers ha^{-1}) underlined the potential of PM (result statistically significant, $p<0.05$). On the other hand, mineral fertilizers prolonged leave growth, and finally favored shoot over tuber growth. Another exciting result was the observed significantly greater root growth in the PM treatments (MSc study Laura Spring, result statistically significant, $p<0.05$), which may have been due to the patchy nutrient supply by fertilization with PM, and the provision of organic matter to the soil. In general, our results underline the importance of soil organic matter for sustaining yam productivity, and may contribute to the development of more integrated and sustainable yam production systems. PM could serve as a cheap and effective alternative to costly mineral fertilizers for the commercial production of yam on comparable soils, and may thus also have an important economic implication for yam producers.

5. Outlook

To increase local farmers' adoption of novel technologies which may proliferate from yam research, more on-farm trials need to be carried out in the future. These should also investigate socio-economic constraints for adoption (e.g. sanitary aspects). However, to obtain more globally valid results for extrapolation and eventual implementation schemes on large scale, the eco-physiology of the crop and its reaction to the environment still need to be better understood. Therefore, future on-station experiments are encouraged likewise.