Contributions from the IMPAC³ Project

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P11 – S2

Agronomic performance of white clover genotypes in sole and mix cropping with ryegrass and chicory

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White clover (*Trifolium repens* L.) is recognized as the most important forage legume in the temperate zones of the world. The cultivation of clover in mixture with ryegrass (*Lolium perenne*) is a common practice because there are a number of potential advantages of mixtures as compared to monocultures. The inclusion of a forb as a third component may provide further production advantages, in the present investigation the hypothesis was tested that the performance of mixtures is dependent on growth characteristics of white clover that vary among different clover genotypes. Eight novel genotypes of whit clover were grown on two sites either as monoculture or as binary mixtures with ryegrass and or chicory or as multi species mixtures with ryegrass and chicory. Herbage was harvested two times in the sowing year and four times in the first main production year. The mixtures produced high-accumulated total dry matter yields than the clover monocultures. The multi species mixture was not better performing than the binary mixtures. For the accumulated yield no significant effect of the factor clover genotype and the interaction clover genotype x cultivation was found. However, if single harvest were considered, clover genotype showed significant effects. A detailed analysis of the growth characteristics of the white clover genotypes is on the way and is intended to enable the identification of clover traits that are relevant for the mixture performance.

17:00-17:10 Oral – S5

The re-innovation of Mixed Cropping – who cares? – Trial Willingness among German farmers

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Mixed cropping (MC), the growing of two or more coexisting crops in one field, specifically the mix of cereal and grain legumes, can contribute to a more sustainable agricultural land use. Despite a variety of ecological benefits and promising grain productivity, applications are scarce among German farmers (ca. 0.007 % of land use). R&D and agriculture machineries evolve around monocultures. Many stakeholders believe substantial technical barriers to hinder the industrialization of MC. In consideration of MC's potential we analyze farmer's trial willingness to identify a profile of "early adopters" within the farming sector. The subsequent telephone interviews were quoted in respect to a representative geographical distribution of farmers within Germany. A proportional odds model regressed the hypothesized drivers upon the gradual change to carry out MC-trials. Preliminary results point to a significant role of land ownership and prior adoption of legumes. The latter implies a strong dependence of MC's implementation on legume adoption pattern. The perception of technical barriers and the perception of MC's usefulness are also major drivers. Research and visionary agribusinesses will need to identify the implementation costs of the technical barriers and quantify monetary advantages of the MC-approach before a communicational strategy for MC can and should be developed, otherwise diffusion will remain marginal.

P59 – S7

Biomass production in an improved sustainable mixed short-rotation woody cropping of *Populus hybrids* and *Robinia pseudoacacia*

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The rising demand on bionenergy leads to a necessity for optimization of biomass production. Hardwood short-rotation coppice crops are used as a source for carbon-neutral energy. Mixed cropping is seen as an improvement towards higher ecological complexity. Intercropping - the cultivation of different crops on the same land at the same time- may lower the dependence on additional input by recovering the internal regulation of a natural ecosystem and enhancing the crop systems stability.

Due to their rapid high woody biomass production the fast-growing *Populus* hybrids are particularly used as elements for bioenergy production in monocropping systems. *Robinia pseudoacacia* L. is a lesser known species for energy plantations, but has the promising ability to fix nitrogen.

This study aims to throw light on a potential facilitation and complementarity between the N-demanding species poplar (*Populus* spp.) and the N-fixing legume species black locust (*Robinia pseudoacacia*) on biomass increment. Along with tree measurements, the crown structure and leaf-area-index will be analyzed as indication for tree interaction. The poplar hybrids that benefit most from this type of crop mixture will be identified.

P109 – S13

Diverse winter faba beans in mixed crop stand with wheat

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Mixed crop stands can show higher yields when compared with pure stands. Such yield increments are assumed to result from complementarity effects between crops. In particular, it is argued that mixed crop stands of legumes and non-legumes have the potential to the promote sustainability and resilience of our food and feed production. One such example is the mixed cropping of winter faba bean (*Vicia faba* L.) and winter wheat (*Triticum aestivum* L.). A detailed description and thorough understanding of mixing effects would allow plant production systems to better exploit this phenomenon, for instance via breeding. Will such yield increments be found in these mixed stands? If they are, how can this information be used to guide plant breeding efficiently? To address such questions, mixed stands of N=8 winter faba bean lines a nd N=3 winter wheat cultivars were compared with their corresponding pure stands within the framework of IMPAC³ (a German research project based at the University of Goettingen). In 2015, field experiments at two locations near Goettingen were implemented. Mixtures and pure stands were conducted in a row intercropping design over 360 plots (10.5 m² each). Yield parameters were observed in detail. Preliminary results show significant yield surplus of mixed crop stands over pure stands. Moreover, there is a significant variation of this mixing effect caused by the different faba bean lines.

11:30-11:45 ORAL – S14

Legume-based mixed cropping systems may have higher water use efficiency than mono crop systems

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Improving sustainability and productivity of agricultural systems is a major concern facing global change. The increasing probability of seasonal droughts and freshwater scarcity emphasizes the importance of crop traits such as water use efficiency (WUE). In this context, multi-species crop stands with legumes are less dependent on external inputs and may have higher resource use efficiency.

Our study aimed to evaluate two different agro-ecosystems: cropland and grassland, cultivated as mono or mixed cropping with legumes (faba bean and white clover). Canopy WUE in each treatment was determined via transparent chambers connected to a gas exchange system (GFS-3000, Heinz Waltz GmbH, Germany). Additionally, a Quadrocopter (Raptor, EagleLive Systems GmbH, Germany) equipped with a spectral camera (ADC Micro, Tetracam Inc., California) was used to measure normalized difference vegetation indices (NDVI).

The gas exchange data clearly showed that in cropland both net-photosynthesis and WUE were highest in mixed cropping (faba bean + wheat) in summer 2015, while during a temporal drought period the evapotranspiration was lowest. In pure white clover stands, net-photosynthesis was considerably higher than both in ryegrass and their mixed stands. NDVI values were almost similar when comparing pure legume stands and their mixed cropping, which was significantly higher than pure wheat or grassland stands. Both methods suggested that mixed cropping systems improved productivity and WUE.

15:20-15:30 Oral – S16

Quantitative analysis of the root distribution in a faba bean-wheat intercropping system by Fourier transform infrared (FTIR) spectroscopy

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Intercrops often demonstrate higher yields compared to their sole crops due to complementary resource use e.g. in light or nutrients. Another reason for this effect could be a differing rooting system of both intercropping partners and therefore a shift in rooting patterns resulting in root mass overyielding. To study these species-specific rooting patterns, roots have to be identified to species level. In this study, Fourier transform infrared (FTIR) attenuated total reflection (ATR) spectroscopy was successfully used to discriminate specie specific root proportions in a faba bean-wheat intercropping system. Eight winter faba bean lines (*Vicia faba* L.) and one winter wheat cultivar (*Triticum aestivum* L.) grown in in a field trial of pure stands and mixtures were investigated in regard to their differences in root distribution down to 60 cm soil depth (4 repl.). FTIR spectroscopy was used to analyze absorption spectra of dried and ground roots. Roots of pure stands were used to prepare artificial samples of faba bean and wheat root mixtures to calibrate and validate a FTIR model which predicted the species proportion in root mixtures. Root absorption spectra showed species specific peak distributions. Faba bean and wheat root spectra were clearly separated by the cluster analysis. Preliminary results indicate a root partitioning of both species and a tendency of higher root biomass in mixtures than in sole stands (overyielding).