ESA2018

XV^e European Society for Agronomy Congress

August 27-31, 2018 - Geneva, Switzerland

www.esa-congress-2018.ch

ABSTRACT BOOK

INNOVATIVE CROPPING AND FARMING SYSTEMS FOR HIGH QUALITY FOOD PRODUCTION SYSTEMS

CICG, GENEVA SWITZERLAND
27 - 31 AUGUST 2018

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PoS2-27

Diversified Agrosystem and Long Term Evolution: Should we Have to Open the Soil Black Box in Conception ?

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Abstract: Crop diversification is necessary for agroecological transition. Crop diversification can be managed at various time and spatial scales. As a consequence to crop diversification, some ecosystem components will be impacted, and in particular soil functioning. The objective of this study is to estimate the impact of intercropping on soil quality and related consequences to ecosystem services. To foresee the long term consequences, we have conceptualized the long term relationships between soils sub systems and plants. STICS model has been chosen to simulate a succession of intercrops in comparison with the rotation of same crops during (i) 10 years for one soil type and (ii) 6 years for 42 soil types for a same oceanic climate located in Brittany (France). Intercrops are pea and barley followed by a mustard during winter, same crops are also simulated in rotation. Intercropping maintains the stock of soil organic matter compared to crop rotation (-3%) but increased denitrification. When considering nitrate lixiviation, the environmental performance of crop rotation is lower compared to intercrops. Such results pointed out the balance of ecosystem services/ disservices between pedoclimatic situations. Among pedoclimatic situations, we have identified some very contrasted results providing evidences of a local adaptation of crop systems by modelling. These results can be used to guide further development of crop models for designing agricultural systems.

Keywords: Evaluation, Ecosystem Services, Rotation, Association, Biogeochemical Cycles

PoS2-28

Productivity and Pre-Crop Effects of Various Legume Species in Agricultural Conditions in Three French Regions

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Abstract: Legumes offer a wide array of services to be promoted in production systems and supply chains: production of protein-rich raw materials with interesting nutritional properties for both food and feed; beneficial preceding crop effects through the restitution of biologically fixed N and the time/space diversification of cropping systems. However the high variability of performances hinders anticipating and exploiting such services through adapted cropping system management. Today, stakeholders are lacking local references for diverse legume species and insertion modes (sole crops, intercrops for cash crops as well as cover crops). Hence approaches to insert more legumes in territories need to be assisted by identifying 1) the actor's expectations, 2) services obtained by farmers in real farm context, 3) the main variability factors and levers to optimally exploit services, and by sharing results with actors. In 3 french territories (Pays de la Loire-PDL, Burgundy-B and Midi-Pyrénées-MP) observatories have been set up in partnership with cooperatives. Several species and insertion modes selected by local actors have been studied: spring/winter lupin as sole crop or intercropped with triticale (PDL); alfalfa and spring pea (B), soybean, and lentil as sole crop or intercropped with wheat (MP). A 2-year followup of the legume crop and the next crop has been performed in 2015-16 and was repeated on other plots in 2016-17. The variability of productivity (grain and protein yield) and grain protein content was high but differed according to species. Moreover there is a high variability in the yields and N acquisition of the following crops in relation to the performances of the legume and its N acquisition and allocation (N2 fixation, nitrogen harvest index, nitrogen in residues). The conditions and levers required to achieve both high yield productivity of legumes and high N preceding effect are discussed.

Keywords: Lupin, Pea, Soybean, Lentil, Alfalfa, Intercropping

PoS2-29

Combination of Spatial and Temporal Diversification in European Cropping Systems

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Abstract: There is a lack of results on the advantages and limitations of combining different crop diversification strategies both in time and space, which makes it difficult for famers and advisers to find relevant information for the transition towards more diversified cropping systems. A network of ten field experiments (diverIMPACTS project) was built across seven European countries, covering a range of pedo-climatic conditions and different farming systems: arable and vegetable systems under both conventional and organic management. Each field experiment tests one or several diversified cropping systems, which combine three diversification strategies with low input practices. These diversified cropping systems are compared to reference systems, which are less diversified and more dependent on external inputs. The three strategies of crop diversification are rotation, multiple cropping (growing different crop species on the same land within one growing season) and intercropping (growing different species in proximity on the same field). A diversified system includes, for example, the addition of cover crops or cash crops, such as legumes, for their expected ecosystem services, or crops for new markets (e.g hemp, lentil), the use of multiple cropping to increase productivity per year (e.g. winter barley with soybean) and intercropping (e.g. barley/pea,wheat/ faba bean, oat/lupin) to increase productivity per unit of area and reduce external inputs. Expected impacts include: higher arable land productivity, diversification and increased farmer revenues through access to new markets and reduced economic risk, lower environmental impact through reduced use of pesticides, chemical fertilisers, energy and water, and improved delivery of ecosystem services, including biodiversity. The diversified cropping systems will be assessed using standardized measurements across the network and multi-criteria assessment tools. Decisions regarding the design and management of the diversified cropping systems will be recorded to support other diversification initiatives. The year 2018 is the first year of the network. This paper presents the original approach, the strategies designed in the network, and the assumptions concerning the interests to combine temporal and spatial diversification in order to improve the delivery of multiple services. This network will be a source of inspiration for other initiatives of crop diversification in Europe. The ultimate goal is

to guide farmers in their transition towards more diversified cropping systems and to promote innovations by various actors at different scales (e.g. innovations regarding machinery for sowing or harvesting new sole or mixed crops, value-chains through the consolidation of new markets, new process of transformation, or adaptation of value-chains to intercropping).

Keywords: Rotation, Multiple Cropping, Intercropping, Cropping System

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PoS2-30

Yield Stability and Agronomic Performance of Heterogeneous Winter Wheat Populations (CCPs) Under Organic and Conventional Management

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Abstract: Alternative breeding concepts, such as evolutionary breeding of heterogeneous crop populations, have been promoted mainly for organic and low-input agriculture. In 2005, the F4 of three winter wheat composite cross populations (CCPs) based on 9 high yielding, 12 baking quality or all 20 parents from the UK arrived at University of Kassel, Germany, and have since been growing under both organic and conventional management with two parallel non-mixing populations of about 150m^2 each. Yield performance and stability were assessed for the CCPs and two pure line varieties in order to evaluate the potential of CCPs as an alternative germplasm source, particularly for organic and low-input agriculture. In addition to mean grain yield, a number of stability measures were chosen to represent both the static and dynamic concept of stability including the Finlay-Wilkinson slope bi, environmental variance EV_i testing for static stability, the genotype superiority index P_i, a yield reliability index Ii that combines both mean yield and EV_i, and Wricke's ecovalence W^2, a measure for dynamic stability.

Experimental entries and experimental year under both management systems interacted strongly, indicating high yield response plasticity to differing environments. Under organic management, CCPs were comparable to the pure line varieties for both grain yield and stability. However, under conventional management, the pure line variety yielded significantly better and tended towards better stability in comparison to the CCPs. Parental varieties had been selected for agronomic performance in low-input systems in Europe. Thus, apparently, this performance advantage carried through in the CCPs. Under both management systems, CCPs with a wider genetic base tended towards higher yields and greater stability, supporting the hypothesis that higher levels of genetic diversity provides greater buffering capacity. The CCPs from high yielding parents reacted strongest to management system, diverging between organic and conventional. Thus, genetic traits of the parental varieties were still apparent, even after 11 generations.

The significant differences in grain yield and stability parameters demonstrate the genetic variability still present in the CCPs, supporting the premise that heterogeneous crop populations have the capacity to change and adapt to their environments, and as such are an important alternative germplasm resource, particularly in light of climate change. Additionally, CCPs can be improved through the addition of new genetic material, particularly for increased suitability to agricultural systems with higher N-inputs.

Keywords: Heterogeneous Crop Population, Composite Cross Populations (Ccps), Evolutionary Breeding, Intra-Specific Diversity, Yield Stability

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PoS2-31

Studies on Agrotechnology of Cereal Mixtures including Allelopathic Aspects

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Abstract: Mixed sowings increase biodiversity of canopies and thus allow for a better use of production space. They also increase health and productivity of plants. Cereal mixtures, especially those with oats component, mitigate the effects of saturation of crop rotations with cereals, and therefore constitute a desirable crop rotation element in both integrated and organic farming.

The aim of this study was to determine the effect of different agronomic factors (date and density of sowing) on the yields of pure sowings and cereal mixtures, taking into account allelopathic aspects. The study concerned two hulled and two naked cultivars of barley and oats (4 in total) in pure and mixed sowings (50:50 proportion of species).

It was assumed that the agronomic requirements of naked oat and barley varieties differ from the requirements of the hulled forms. Our previous studies showed that the allelopathic potential of naked forms is different than of the hulled forms, which may affect the growth and development of plants in the mixtures, and thus the yield and grain quality. The verification of the hypotheses was performed based on the laboratory, pot, and field experiments with the spring cereals and cereals mixtures.

Cereal mixtures were found to have a weaker competitiveness of naked oats compared with the hulled forms. Barley (regardless of the form) prevailed in the grain yield in the mixture with naked oats, but its share was lower in the mixture with hulled oats. Mixtures including naked forms of spring barley and oats compared with the mixtures with the hulled forms of these species have a lower grain yield, a higher protein content in the grain. Changes in the spatial structure of the mixture canopy were determined by the share of the species and the date of sowing. Yielding of ears was strictly and positively correlated with the height of culms. The competitiveness of hulled oats, as compared to hulled barley, was positively affected by the deterioration of soil conditions, while negatively affected by the delayed sowing (14 days later than the optimum). Allelopathic interactions among the species of cereals grown in mixtures affected the development of seedlings, while energy and germination were not subject to significant changes. Benzoic acid, which was found in the root exudates, was the main chemical compound responsible for the phenomenon of allelopathy in mixed sowings. Our laboratory tests showed that naked forms of oats and barley had a higher allelopathic potential compared with the hulled forms. The vicinity of the studied forms of naked and hulled cereals determined their yield-forming characteristics. Hulled barley mixed with hulled oats showed a higher tiller production than in pure sowing, while naked barley tillered better in the mixture with naked oats. Allelopathic interactions should be taken into account when developing the technology of the production of oats and barley mixtures.

Keywords: Mixtures, Pure Sowings, Barley, Oat, Productivity, Allelopathy