Strip intercropping strategy for biomass to energy production while on the same time maintaining soil fertility

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In contrast to energy technologies like solar and wind, energy in the form of biomass can be stored and bioenergy produced when needed using a wide range of technologies. However, a substantial rise in the use of biomass for energy is expected, which means additional pressure on farmland sustainability. Organic agriculture (OA) is facing a big challenge producing bioenergy from local resources and on the same time maintaining soil fertility. There is a clear goal to reduce reliance on fossil fuels and thereby decrease greenhouse gas emissions, but the question is how to reach it? In a four year ICROFS (www.icrofs.org) project titled "BioConcens" (www.bioconcens.elr.dk/uk/) one objective is to design and test a strip intercropping concept.

Strip intercropping (IC) is based upon general IC principles focusing on the management of plant interactions to maximize productivity and resource utilizations (Willey, 1979). The crops are not necessarily sown and harvested at the same time, but the crops co-occur for a significant period of their growth. IC is a practice with crops grown in strips wide enough that each can be managed independently, yet narrow enough that the strip components can interact. This kind of cropping strategies was common in developed countries before the 'fossilisation' of agriculture (Matson et al., 1997) contributing to yield stability and soil fertility, lowering nutrient losses and reducing weeds, diseases and pests (Hauggaard-Nielsen et al. 2007).

The field experiments were designed to deal with cropping diversity in time and in space. A diversified perennial grass-clover strip (feed, energy (biogas and bioethanol) and soil fertility building) and a strip consisting of either i) winter rye + winter vetch intercropping or ii) maize was established (food, feed and energy (biogas and bioethanol)). Winter rye was sown before maize to capture growth resources during autumn and early spring. The annual strip was initiated in September by winter rye (+ vetch) and finalized in august 2 years later with harvest of triticale (see table below). The strips were 5 meters wide with all mechanical operations conducted using traditional farm machinery.

Table 1. Strip intercropping concepts comparing two annual cropping systems

Time (mth)	1	2	3	4	5	6	7	8	9	10	11	12
Diversity in space									Winter rye + vetch			
	Winter rye + vetch								Triticale			
	Triticale											
Diversity in time									Winter rye			
	Winter rye				Maize						Triticale	
	Triticale											

Picture 1. Maize and grass-clover strip interactions show strong grass-clover competitive ability with 10-20% increased total dry matter production when grown in close proximity to maize (0-25 cm) as compared to >150 cm away. Total maize yield (silage) was increased from around 450 g dry matter per m^2 adjacent to the grass-clover strip up to 1000 g DM per m^2 when grown > 150 cm away ©hnie@risoe.dtu.dk

The grass-clover strip seems to be particularly competitive in the early growth stages reducing the annual crop yields significantly. Soil water content was reduced in the annual crops close to the grass-clover strip (0-25 cm), possibly due to efficient water use by the growing grass-clover reducing the annual seed emergence. Thus, when analyzing the final yields such initial growing conditions shaping the competitive ability of the annual strip needs to be taking into account. It is likely that changes in management practice could improve the annual growth. Another controlling parameter could be soil nitrogen, because increased clover proportion was found in the grass-clover strips grown adjacent to winter rye whereas an increased grass proportion was found when grown adjacent to vetch.

The first total crop biomass production during the two years will be presented together with initial conclusion on the interspecific competitive interactions between strips. Is it possible at this stage to identify advantages and possible drawbacks? And is the inclusion of a perennial grass-clover strip sufficient to enhance soil fertility, extract nutrients form deeper soil layers, fix N_2 and compensate for the effect of annual crops on soil fertility?

References

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