The impact of nitrogen in red clover and lucerne swards on the subsequent spring wheat

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Implications

The red clover and lucerne swards and their accumulated nitrogen (N) in residues can be useful tool in organic arable systems. Spring wheat grain yield was affected by red clover/ryegrass and lucerne/ryegrass swards and was significantly higher than that after ryegrass sward, except for lucerne/ryegrass sward after cover crop barley for whole crop. Protein content in wheat was sufficient for the grain to be used for food production. These results indicate that red clover and lucerne can contribute to the intensification of spring wheat growing in organic farming, not only by increasing yields, but also by improving quality.

Background and objectives

Nowadays, there are many negative effects on the environment, including pollution by pesticides, emission of greenhouse gases, soil degradation, and loss of biodiversity. The performed meta-analysis of European research concluded that organic farming in Europe has generally lower environmental impacts, but due to lower yields and the requirement to build the fertility of land, not always per product unit (Tuomisto et al., 2012). In practise, organic farmers and producers use national standards or regulations for organic farming; however, to choose the right technologies or their elements adapted to local conditions is not so easy. They need to keep agriculture profitable and make it sustainable for the future. In organic or low input farming systems, legumes are very important as N suppliers for cereals. Legumes also are essential because introduction of ley/arable rotations could be an effective tool for a significant further reduction of use of expensive mineral N-input and improvement of subsequent grain quality (Eriksen et al., 2006; Nemeikšienė et al., 2010) and even soil fertility (Nykänen et al., 2008). The study was aimed to assess the impact of legumes on the subsequent spring wheat in a crop rotation.

Key results and discussion

The total dry matter (DM) yield differed significantly among forage swards (Table). In a wetter year 2005 (based on the multiyear average of rainfall), especially in the first half of the growing season, red clover/ryegrass swards accumulated higher DM yields than those of lucerne. Lucerne sward herbage production depended on the sowing method and cover crop. Significantly higher yields of lucerne were produced without a cover crop. In the drier years, lucerne and ryegrass swards were significantly more productive than those of red clover and ryegrass (Sarunaite et al., 2006).
Several research studies have shown that the choice of forage legume strongly affects the N input to agricultural production (Kayser *et al*., 2010; Rasmussen *et al*., 2012). In our experiment there was no significant difference in the amount of N incorporated with red clover/ryegrass and lucerne/ryegrass swards but significantly less N was incorporated with ryegrass sward (Table). Spring wheat did not provide high grain yield and responded to dry growing season in 2006. For any given treatment, spring wheat yields were lower than that in previous experiment (Sarunaite et al., 2006). Grain yield was higher after red clover/ryegrass swards, while in previous experiment after lucerne/ryegrass swards. This fluctuations of swards effects could have been resulting by different accumulation of N in the soil and also weather conditions. N removal with spring wheat yield almost in all the cases was significantly higher after red clover/ryegrass and lucerne/ryegrass swards than that after ryegrass sward. N removal after red clover/ryegrass swards slightly varies and soil characteristics might be responsible for

this. The spring wheat grain protein was highest when wheat succeeded red clover/ryegrass and lucerne/ryegrass swards.

Table. Dry matter (DM) yield of swards in first year of use, incorporated N amount and spring wheat yield, kg ha^{-1}

Swards+cover crop	DM yield of swards	N in incorpo-rated plant residues	N in spring wheat	Protein in grain, g kg^{-1}	Spring wheat grain yield
	2005			2006	
R. clover/ryegrass	10334	106	63.1	131	2274
R. clover/ryegrass +Bgr	9530	127	84.0	145	2342
R. clover/ryegrass +Bwc	10887	115	69.3	142	2121
R. clover/ryegrass +Pwc	10388	119	74.0	145	2128
Lucerne/ryegrass	9803	133	78.1	146	2183
Lucerne/ryegrass +Bwc	7848	105	72.8	148	1866
Lucerne/ryegrass +Pwc	8810	121	73.9	147	2022
Ryegrass	4207	42	64.9	136	1776
LSD_{05}	771.0	48.1	7.46	-	185.4

N o t e. *Bgr -barley for grain, Bwc -barley for whole crop, Pwc -peas for whole crop.*

How work was carried out?

Field experiments were conducted on a loamy *Endocalcari-Epihypogleyic Cambisol* in Dotnuva, Lithuania (55°24'N, 23°50 E). In 2004, red clover (*Trifolium repens* L.) and lucerne (*Madicago sativa* L.) were sown in mixtures with perennial ryegrass (Lolium perenne L.) without a cover crop or with semi-leafless peas (*Pisum sativum* L.) and spring barley (*Hordeum vulgare* L.) as a cover crop and ryegrass was sown as a monocrop in a randomized trial design with four replicates. In 2005, DM yield of swards was determined and in the autumn the swards were ploughed-in. In the spring of 2006, spring wheat (*Triticum aestivum* L.) was sown for grain. The inorganic N in herbage yields of swards and spring wheat grain was estimated by Kjeldahl and grain protein content was calculated by multiplying N by 5.7. The experimental data were statistically processed using ANOVA.

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