



Research article

Effect of catch crops on N dynamics and following crops in organic farming

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Abstract – Green manure catch crops promote the sustainability of agricultural systems by reducing soil erodibility and by nutrient uptake and transfer to the following main crops. This effect efficiently reduces the risk of nitrate leaching. Biological nitrogen fixation by legume catch crops is an additional benefit, mainly in organic farming. Such crops may, however, reduce nitrogen uptake from the soil and increase nitrate leaching. Additionally, under drought conditions, their extra water consumption may outweigh the beneficial effects. To determine the best catch crop management in stockless organic farming under dry, Pannonian site conditions in eastern Austria, four treatments were compared in 2002 and 2004: (1) legumes: field pea, common vetch and chickling vetch, (2) non-legumes: phacelia, oil radish and turnip, (3) a legume and non-legume mixture (all mentioned components), and (4) a bare fallow control. Our results show that catch crop biomass and N yield, biological N fixation, and crop N uptake from the soil were about 4 times higher under moderately dry conditions in 2002 than under drought conditions in summer and autumn 2004. In 2002, the legume/non-legume mixture had the highest biomass and N yield and the highest biological N fixation. Both the legume/non-legume mixture and the non-legumes were more efficient than legumes in N uptake from the soil (+32 kg N ha⁻¹); and in reducing both soil inorganic N contents by –45 kg N ha⁻¹ and nitrate concentrations in soil solution by –20 mg N L⁻¹. These findings show that the legume/non-legume mixture combined the positive effects of non-legumes and legumes. In 2004, catch crop effects did not differ except for their above-mentioned effect on inorganic N contents. The only pre-crop effect was that of legumes compared with non-legumes on spring barley grain dry matter of +0.6 Mg DM ha⁻¹ and grain N yield of +17 kg N ha⁻¹ in 2005. The water consumption of catch crops never adversely affected the following crops.

green manure / biological nitrogen fixation / nitrogen conservation / drought / legume catch crop

1. INTRODUCTION

Catch crops have a wide range of positive effects in cropping systems, in conventional as well as in organic farming (Renius et al., 1992; Kolbe et al., 2004). Using catch crops as fodder is an obvious economic advantage. Green manure catch crops have important ecological functions such as reducing soil erosion by covering the soil, improving soil fertility by an input of organic matter with their roots, and by increasing soil water-holding capacity (Joyce et al., 2002). They can reduce losses of N and other nutrients remaining in the soil after harvest of the main crop and transfer them to the succeeding crops, thus increasing their N supply (Stute and Posner, 1995). In a long-term experiment by Hösch and Dersch (2003) in Eastern Austria, with 900 mm mean annual precipitation, catch crops including legumes and non-legumes reduced the average yearly nitrate leaching compared with the same rotation without catch crops from 48 kg N ha⁻¹ to 18 kg N ha⁻¹.

Askegaard et al. (2005) determined catch crops as the most efficient means to reduce nitrate leaching in an experiment at three Danish sites with soil texture ranging from sandy loam to coarse sand. If green manure catch crops are incorporated into the soil in late autumn or in spring, nutrients in their biomass become available to the following main crop. In organic farming, especially in stockless farming, where no flexible fertility inputs are available, this may contribute considerably to plant nutrition.

Another benefit of leguminous catch crops is their ability to biologically fix nitrogen. Although legumes exploit available nitrogen (N) in the soil before intensifying biological nitrogen fixation, leguminous catch crops no doubt leave more soil inorganic N (N_{in}) than non-leguminous catch crops (Reents and Möller, 2000; Thorup-Kristensen, 2006a).

In dry regions, like in the Pannonian region of Eastern Austria, the water use by the catch crops may outweigh their beneficial effects because it may limit the yield of the succeeding main crop. This calls for considering the additional water use by catch crops – compared with bare soil.

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