Nitrate leaching from arable crop rotations in organic farming

J. E. Olesen and M. Askegaard

Department of Agroecology, Danish Institute of Agricultural Sciences, Box 50, DK-8830 Tjele, Denmark

Introduction

The crop rotation is a crucial and integral part of organic farming systems. It must be designed to maintain and exploit soil fertility, and to minimise the impacts on environment, e.g. through nitrate leaching. Crop rotations in organic farming typically include legume crops to provide nitrogen fixation and improve soil fertility. Catch crops are also commonly used, if demands for soil tillage to control perennial weeds allow. This paper presents results on nitrate leaching from a field experiment with comparison of three different crop rotations with and without catch crops designed for organic farming.

Methods and results

A crop rotation experiment was initiated in 1997. The experiment is designed as a factorial experiment with three factors where all fields in the rotations are represented every year (Olesen et al., 2000). The experimental factors are (1) crop rotation, (2) catch crop (with and without) and (3) manure (with and without animal manure applied as slurry). Three different four-year crop rotations were compared (Table 1). These two rotations differ with respect to the use of a grass-clover green manure, which is present in rotations 1 and 2, but not in rotation 4. The grass-clover was followed by spring wheat in rotation 1 and winter wheat in rotation 2. Leaching of nitrogen was measured using porous ceramic cups in selected plots in combination with calculation of the water balance using the Evacrop model.

Results on average nitrate leaching are presented in Table 2 for three sites representing different soil types and climate regions in Denmark. Jyndevad is located in Southern Jutland on a coarse sandy soil with an average annual rainfall of 964 mm. Foulum is located in Central Jutland on a loamy sand with an annual rainfall of 704 mm. Flakkebjerg is located in Western Sealand on a sandy loam with an annual rainfall of 626 mm. Nitrate leaching declined with increasing soil clay content and with decreasing rainfall. Nitrate leaching was reduced by catch crops on the sandy soils. There were no difference in nitrate leaching between rotations 1 and 2, but nitrate leaching was considerably lower in rotation 4 without green manure crops.

Table 1. Three different four-course crop rotations with and without catch crops. The sign ':' indicates that a grass-clover ley, a clover or a ryegrass/clover catch crop is established in a crop of cereals or pulses. The sign '/' indicates a mixture of peas and spring barley or bi-cropping of winter cereals and clover.

Catch crop	Course	Rotation 1	Rotation 2	Rotation 4
Without	1	S. barley:ley	S. barley:ley	Spring oat
	2	Grass-clover	Grass-clover	Winter wheat
	3	Spring wheat	Winter wheat	Winter cereal
	4	Lupin	Peas/barley	Peas/barley
With	1	S. barley:ley	S. barley:ley	S. oat:clover
	2	Grass-clover	Grass-clover	W. wheat/clover
	3	S. wheat:Grass	W. wheat:Grass	W. cereal/clover
	4	Lupin:Grass-clover	Peas/barley:Grass-clover	Peas/barley:Grass-clover

Table 2. Effect of crop rotation and catch crop (CC) on average nitrate leaching (kg NO_3-N ha^{-1} yr^{-1}) at the three experimental sites for four years (1997 to 2001).

Site	Rotation 1		Rotation 2		Rotation 4	
	– CC	+ CC	– CC	+ CC	– CC	+ CC
Jyndevad (coarse sand)	102	68	95	63		
Foulum (loamy sand)			49	35	34	36
Flakkebjerg (sandy loam)			32	23	25	24

References

Olesen, J.E., Askegaard, M., and Rasmussen, I.A. 2000. Design of an organic farming crop rotation experiment. Acta Agriculturae Scandinavica, Section B, Soil and Plant Science 50: 13-21.