

Crop rotations for grain production

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Keywords: crop rotation, field experiment, green manure, cereals, manure, catch crop, cover crop, nitrate leaching

Introduction

There is an increasing demand for organically grown cereal grains in Denmark, which is expected to cause a change in the typical organic farm structure away from dairy farming and towards arable farming. Such a change may reduce the stability of the farming systems, because of decreasing soil fertility and problems with weed control. There have only been a limited number of studies under temperate conditions in Europe and North America, where different crop rotations have been compared under organic farming or similar production conditions.

Material and methods

Three factors are included in a field experiment in a factorial design (Olesen *et al.*, 2000). A: fraction of grass/clover and pulses in the rotation (crop rotation), B: catch crop (without or with undersown catch crops of ryegrass and clover species for reduction of nitrate leaching), and C: manure (without or with animal manure applied as slurry at a rate corresponding to 40% of the crop demand). All fields in all rotations are represented each year. All straw and grass/clover production is returned. The experiment was started in 1997. The experiment is conducted at four locations, representing different soil types and climate regions in Denmark. Grain yield is measured at harvest. Leaching of nitrogen is measured throughout the year using porous ceramic cups.

Results and discussion

Table 1. Grain yield of spring barley in one of the rotations (t ha⁻¹ with 85% DM).

Location	Year	Without catch crop		With catch crop	
		No man.	Manure	No man.	Manure
Jyndevad (sand)	1997	3.1	3.8		
	1998	1.4	1.7	1.7	2.3
	1999	1.3	2.4	2.2	4.0
Foulum (sandy loam)	1997	3.6	4.6		
	1998	4.7	5.6	4.5	6.3
	1999	1.9	3.7	3.6	4.3
Flakkebjerg (loamy sand)	1997	2.2	4.2		
	1998	2.9	3.3	2.6	3.4
	1999	1.5	3.3	2.5	4.3

Table 2. Nitrate leaching (kg N ha⁻¹ yr⁻¹) for one of the rotations without catch crops and with manure application. Mean of two years.

Crop	Jyndevad sand	Foulum loamy sand	Flakkebjerg sandy loam
Spring barley	81	26	11
Grass/clover	141	71	33
Winter wheat	108	60	12
Pea/barley	121	38	22

Grain yield of spring barley has decreased over the time course of the experiment in plots without manure or catch crops (Table 1). The highest and most stable yields were obtained in the systems where a mixture of ryegrass and clover were undersown in pea/barley and grown as a catch crop prior to the spring barley crop. The yield decline in the unmanured system occurred faster on the sandy soil. This was primarily caused by a much higher rate of nitrate leaching on the sandy soil (Table 2). There were large differences in nitrate leaching between the different sites. These differences were determined by differences in rooting depth, soil water storage capacity and rainfall. The largest nitrate leaching occurred after grass/clover, which was ploughed in autumn, and the least occurred after spring barley.

References

Olesen, J.E., Askegaard, M. and Rasmussen, I.A. (2000). Design of an organic farming crop rotation. *Acta Agriculturae Scandinavica, Section B, Soil and Plant Science* (in press).