Nutrients and weeds through 13 years of organic farming

The comparison of the cash crop and the dairy cow crop rotations showed some effects on yield, weeds and nutrients after 13 years of different management, but most of them are so far not statistically different.

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Farming systems (e.g. with or without livestock keeping) and crop rotations are the most important factors for a successful crop production in organic farming. The evaluation of long-term experiments in organic farming showed firstly a great necessity for research in the field of comparing farming systems with and without livestock keeping and secondly, the survey indicates that most of these comparisons are carried out at field trial level (Urbatzka *et al.,* 2013). However, the Trenthorster long-term monitoring, which was established at the Experimental Farm of the Thünen-Institute of Organic Farming in 2003, is applied to the comparison of farming systems at farm level to generate results which are comparable to common practice.

Materials and methods

The Experimental Farm Trenthorst is located near Lübeck (53°46'N, 10°31'E) in a temperate maritime climate (Ø annual precipitation 706 mm, Ø annual temperature 8.8°C) on loamy soils. Schaub *et al.* (2007) give a detailed description of the site conditions and study set-up. Details of the two crop rotations are given in table 1. At the cash crop farm (31 ha arable land), clover grass was mulched three times per year in the first crop rotation. In the second crop rotation red clover is cultivated for seed production. Straw is mostly incorporated into the soil. At the dairy cow farm (64 ha arable land/39 ha grassland, 90-100 milking cows with their offspring) clover grass and straw are harvested for fodder production respectively for bedding. Manure of the farm-own livestock is used for fertilisation of cereals, but nitrogen and other nutrients are transferred from grassland to the arable land via manure.

On each arable field, four or eight representative monitoring points were established, where all parameters have been measured annually since 2003. Soil samples were taken in three depths (0-30, 30-60 and 60-90 cm) before the start of the growing season, and the soil mineral nitrogen content (N_{min}) was analysed. Plant available P, K, Mg, as well as pH, C_t and N_t were determined in the soil of the 0-30 cm layer.

During three autumn-winter seepage periods (2010/2011 to 2012/2013) leachates were collected by an in-situ sampling with ceramic suction cups, which were installed in 70 cm depth to assess the leaching rate below the rooting zone. The analysis of the nitrate concentration was done by a photometric autoanalyser to calculate the NO_3-N load with help of the seepage rate that is assessed by a model from the German Meteorological Service (DWD).

Yields were determined by harvesting 1 or 2 m² by hand. After the sheaves had dried/had been dried, they were threshed by a threshing machine for calculating yields of grain and straw.

The vegetation surveys were

Table 1. Crop rotations of the cash crop farm and the dairy cow farm during the two periods in the long-term monitoring Trenthorst.

Farm type	Years	Position in crop rotation					
		1	2	3	4	5	6
Cash crop	2003-2007	Clover grass[1]	Winter wheat	Oats	Pea	Winter rape	Triticale[2]
	2008-2014	Red clover	Winter wheat	Spring barley	Pea	Winter rape	Triticale
Dairy cow	2003-2007	Clover grass	Clover grass	Winter wheat	Oats+Field bean[4]	Pea+Barley[4]	Triticale
	2008-2014	Clover grass	Clover grass	Silage maize	Winter wheat[3]	Oats+Field bean[4]	Triticale

[1] =White clover in 2005, [2] =Spelt wheat in 2003 and 2004, [3] =Summer wheat in 2011, [4] = Intercropping

carried out within a circle with an area of 100 m² according to the method of Braun-Blanquet.

The dairy cow and cash crop rotations obtained similar average yields. Yield differences are often due to weather conditions and pest infestation with aphids on grain legumes.

In the first crop rotation period the soil mineral nitrogen contents showed a rotation average which was similar between the both crop rotations. But in the course of the crop rotations differences became evident: compared to the dairy cow farm the cash crop farm showed higher N_{min} values after the first rotation year (mulched vs. cut grass clover) but lower values in the fourth and fifth year of the rotation. Since a precise nitrogen supply via manure as in the livestock farms is impossible in a self-sustaining cash crop farm, the excess of nitrogen at the beginning and the lack of it towards the end of the rotation could not be balanced.

The results of nitrate leaching during the autumn-winter seepage periods reconfirm that the leaching rate could be reduced if grass-clover stands are ploughed in spring compared to autumn. The cultivation of grain legumes showed no higher N load compared to the other crops like wheat, maize or triticale.

Soil contents of plant available K and P decreased over the years in both crop rotations. The plant available P content decreased from 90 mg kg^{-1} soil in 2003 to 77 in the cash crop and 70 mg kg^{-1} soil in the dairy cow crop rotation in 2012. Thus, they have not reached the lower limit (44 mg kg^{-1} soil) that is discussed for good agricultural practice in conventional farming (Kuchenbuch and Buczko 2011). Nevertheless a supply of nutrients is required in the future.

Variation in weed abundance was observed between plots. Neither general increase, nor general decrease in weed abundance could be identified. A more intensive view was on the abundance of *Cirsium arvense* and *Galium aparine agg.*, two problematic weed species. A comparison of the frequencies of *C. arvense* and *G. aparine agg.* between the two rotations reveals some differences. While *C. arvense* is significantly more frequent in the cash crop rotation, the higher mean frequency of *G. aparine agg.* in the dairy cow rotation cannot be statistically secured.

References

Kuchenbuch RO & Buczko U. 2011. Re-visiting potassium- and phosphate-fertiliser responses in field experiments and soil-test interpretations by means of data mining. J. Plant Nutr. Soil Sci. 174: 171-185.

Schaub D, Paulsen HM, Böhm H & Rahmann G. 2007. Der Dauerbeobachtungsversuch Trenthorst - Konzeption und Versuchsaufbau. In: Zikeli S, Claupein W (eds) Beitr. 9. Wiss-tagung Ökolog. Landbau, Bd 1, 33-36.

Urbatzka P, Cais K, Rehm A & Rippel R. 2011. Status-Quo-Analyse von Dauerversuchen: Bestimmung des Forschungsbedarfes für den ökologischen Landbau. http://orgprints.org/19317/.