Goal conflicts in long-term cropping system trials – the example of carrots

P. Modig[1], Marie-Louise Albertsson Juhlin[1], A. Gunnarsson[1] and C. Gissén[2].

[1]Rural Economy and Agricultural Society, Kristianstad (Hushållningssällskapet Kristianstad), Box 9082, SE-291 09 Kristianstad, Sweden (per.modig@hush.se), [2]Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Alnarp, Sweden

Implications

Agricultural research on multiple cropping systems in parallel increases the potential for knowledge transfer between organic and conventional systems. This project aims to develop cropping systems towards greater sustainability through work in long-term trials that have a unique opportunity to contribute to a holistic research perspective. Data on the fourth crop rotation (2007-2012) are now being compiled. This paper presents preliminary results from cultivation of carrots as an example to demonstrate goal conflicts in organic and conventional systems between good nutrient management and good economy on one hand and nematode control and intensive cropping systems (good short-term economy) on the other. Good productivity and sustainable production levels are major overall goals in the project. The conclusion is that more research on nematode susceptibility and propagating at different crops and varieties is very important.

Background and objectives

The issue of different cropping systems has occupied agronomists for many decades and during the 1980s it reached a wider audience. A major research drive was therefore initiated in 1987 and three long-term cropping trials were set up. One of these trials (Önnestad) is still running, but the objectives have changed, with the main aim now being not system comparisons, but system improvement according to the unique conditions. However, there may be goal conflicts between the key figures used to push development forward and evaluate the farming systems: good economy, fossil energy efficiency, nematode control in vegetable crop rotations, integrated pest management (IPM) in conventional systems, improved yields in organic cropping systems, etc.

Key results and discussion

The data presented in this paper are preliminary results for the fourth crop rotation (2007-2012). Taking carrots as an example, the results reveal that goal conflicts are strongly present in cropping system research – just as they are in practice.

Average yield of carrots for the whole rotation (before sorting) was 113 ton/ha in the conventional treatment A. Organic cropping in treatments C and E produced 84 and 78% of the conventional yield (Fig. 1.). In the previous (third) crop rotation, the crop was sugar beet and the yield in organic C and E was 95 and 85%, respectively, of that in A (Gissén and Larsson 2008). In C, sugarbeet was grown after ley to reduce nitrogen (N) losses (Gissén and Larsson 2008), which are otherwise high after clover-grass ley (Gunnarsson 2001). In the fourth crop rotation, carrots were grown in A, C and E after beetroot, ley and red clover resp. The mineral N content in the topsoil (0-60 cm) in late autumn (=risk of N losses) was high after carrots grown after ley or clover: 44, 143 and 64 kg NO_3+NH_4-N/ha in A, C and E, respectively, compared with the mean for these treatments (46, 53 and 48 kg NO_3+NH_4-N/ha respectively). These high values were surprising, since the carrot growing season is long, carrots are known to have a deep root system, they were assumed to empty the soil of mineral-N and the fertilisation rate was moderate.

To reduce the risk of N losses black fallow has been excluded, which means a potential risk of increasing the nematode *Meloidogyne hapla* in the cropping systems. Analyses in spring 2012 showed that levels of *M. hapla* were high or very high, on average for the

crop rotation 270, 100 and 709 nematodes/250 g soil for treatments A, C and E, respectively. The highest levels were found in the plots where carrots were grown (95, 450 and 4000 for A, C and E, respectively). When *M. hapla* infect carrots, they restrict growth and the roots become deformed (Potter and Olthof 1993). On analysing the carrots after harvest, it was clear that *M. hapla* had caused damage to the marketable crop (Fig. 2).

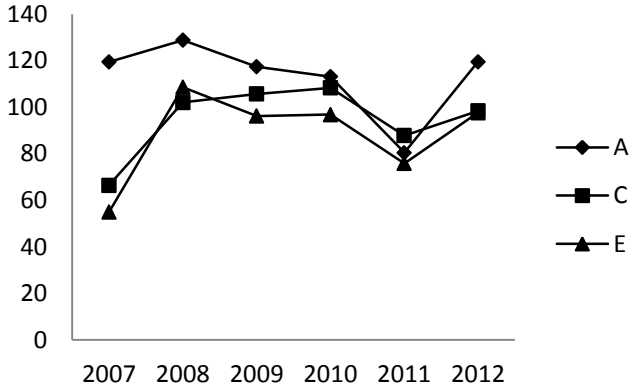

Fig. 1. Carrot yield before sorting (ton/ha).

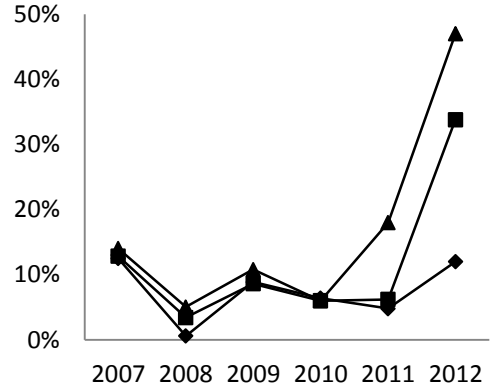

Fig. 2. Proportion of deformed carrots.

In 2013 a new crop rotation will start. The challenge will be to deal with the nematode problems without compromising good nutrient management and good crop economy.

How work was carried out

The Önnestad field trial consists of five 6-year cropping systems. Every crop is grown every year, i.e. there are 30 plots, each 12*15 m. The soil has the following particle distribution: 7% clay, 27% silt and 66% sand and the organic matter content is 6%. Despite the light soil texture, water supply is good, presumably through capillary transport from below. Irrigation is used in vegetable crops. The experiment has two conventional and three organic 6-year crop rotations, all with vegetable production (carrots in A, C and E):

A Conventional cropping without animals.
B Conventional cropping with ley and manure (with animals).
C Organic cropping with ley for biogas production and digestate.
D Organic cropping with ley and manure (with animals).
E Organic cropping without animals

To achieve good productivity levels, the crop rotation is quite intensive:
A: Carrot – leek – potato – rye – red clover – beetroot
C: Carrot – barley – leek – oats – ley – ley
E: Carrot – green manure – leek – barley – rye – red clover.

For detailed methods, see report on the third crop rotation (Gissén and Larsson 2008).

References

Gissén C and Larsson I 2008. Environmentally friendly and sustainable cropping systems 1987-2005. Rapport 2008:1. SLU.

Gunnarsson A 2001. Utlakningsrisker i olika odlingsformer 1995-1998. SLU, Meddelande fån Södra Jordbruksförsöksdistriktet, nr 52.

Potter J W and Olthof T H A 1993. Nematode pests of vegetable crops. In: Plant Parasitic Nematodes in Temperate Agriculture (eds. Evans K, Trudgill D L and Webster J M), pp 171-207. CAB International, Wallingford, England.

The results from all study years are available in databases at www.odlingssystem.se.