QLIF subproject 3:

Crop production systems

Photo: ICROFS

Strategies to improve quality and safety and reduce cost of production in organic and low-input crop production systems

Organic crop production seeks to produce high quality foods while reducing the inputs in order to promote environmental quality and conserve resources. This necessitates optimal production systems in terms of soil fertility and plant health. Studies in QLIF subproject 3 have shown that soils may gain an improved potential to release N from added amendments through adaptation of management practices. Likewise, long-term management strategies may influence suppressiveness of soils to economically important diseases. Application of manures and other organic soil fertility inputs do not pose any additional safety risk in ready-to-eat vegetables, such as head lettuce, if good farming practice is applied. Even under experimental worst-case conditions, pathogen transfer from soil treated with farmyard manure to vegetables was not substantial.

Pest and disease control was studied both at seed and field levels, and it was shown, e.g., that ß-amino-butyric acid was efficient in controlling downy mildew in lettuce under field conditions. Finally, for organic wheat production systems, an integrated assessment indicated that yields and protein contents can be increased by improved cultivar choice and fertility management regimes promoting biological N fixation in the soil.

Strategies to improve quality and safety and reduce cost of production in organic and low-input crop production systems

Organic farming seeks to attain high quality food production and ecological balance through the design of farming systems, establishment of habitats and maintenance of diversity. Inputs should be reduced in order to maintain and improve environmental quality and conserve resources. Technological bottlenecks in organic production systems potentially affect quality and safety in organic foods, the environment, as well as costs of production. These bottlenecks include insufficient and/or untimely availability of nutrients and occurrence of pests and diseases. The aim of the QLIF subproject 3 was to (i) improve the understanding of the functionality of inherent soil fertility as a base for crop productivity and health, (ii) to develop improved agronomic strategies, and (iii) to demonstrate the impact of improved management strategies in annual (tomato, lettuce, wheat) and perennial (apple) pilot production systems.

Photo: University of Bonn

Improving soil fertility by management

Soil management such as soil tillage, crop rotation, and organic amendments has an obvious impact on soil fertility as properties such as erosion stability, nutrient availability, or water-holding capacity are strongly affected. We examined the impact of site, long-term management, and short-term fertility input strategies on soil physical, chemical and biological parameters. Long-term management with organic-matter-based inputs (e.g., farmyard manure) had a profound impact on soil fertility. In the short term, however, the input of organic matter based manures did not alter the soil biological parameters significantly, suggesting that the maintenance of high soil fertility levels needs consequent management over decades. For instance, the soils that had been managed biodynamically consistently released more N from the added amendments than the other treatments. This suggests that through adaptation of management practices, soils can be developed with an improved potential to release N from added amendments.

Suppressiveness of soils to diseases

Soil properties affect the occurrence and severity of soil-borne diseases and diseases on foliar parts of the plant. We studied the impact of site, long-term management, and short-term fertility input strategies on the suppressiveness of soils to soil-borne as well as foliar diseases under controlled conditions. We found pronounced differences between the soil types under examination. Furthermore, site-specific suppressiveness can be modulated by long-term soil management, and, to a lesser extent, by short-term fertility inputs. However, site-specific factors that cannot be influenced by agronomic practices were found to have a greater impact than cultivation-specific effects within the same site. Nevertheless, short-term, but in particular long-term management strategies have been shown to have the potential to influence suppressiveness of soils to economically important diseases.

Food safety and organic manure

As consumption of raw ready-to-eat vegetables becomes increasingly popular, public concern about the microbiological safety of vegetable is increasing. Recently, concerns have been raised that intensive use of manures might lead to increased risk of food contamination by entero-pathogenic microorganisms. Unprocessed cattle manure may be a source of faecal bacteria that might be transmitted to crops that grow near the soil surface. However, composting of manures was shown to be an efficient way to reduce pathogen loads. The aim of these studies was to assess the effect of different fertiliser types on the transfer risk of enteric bacteria in head lettuce. Different treatments

of manure application were investigated and the effect of post-harvest handling (e.g. washing) was determined. No *Salmonella enteritidis* was detected in the samples. *E. coli* was isolated in low numbers independent of the fertiliser type. The numbers of aerobic bacteria and the levels of Enterobacteriaceae and coliform bacteria tended to be lower after application of mineral fertiliser, but were generally at a low level. Thus, the studies provide no evidence that organic soil fertilisers pose any additional safety risk, even if worst-case scenarios were studied. Also field experiments with different strategies of physical weed control did not confirm the hypothesis of a substantial pathogen transfer from soil treated with farmyard manure. Based on these trials, the application of manures in good farming practice could not be linked to any food safety risk.

Pest and disease control at seed level

Although a range of diseases are controlled efficiently by agronomic methods (e.g., crop rotation), certain pests and diseases can cause major problems in organic and low-input systems. The prerequisite for successful crop production is the use of disease-free planting material. Seed treatment is one of the options to remove pathogenic bacteria and fungi. In QLIF, the studies focused on the development of strategies to obtain disease-free tomato and wheat seeds. Good control of *Didymella lycopersici* was achieved in seed treatments, whereas control of *Fusarium* resulted only in slight reductions of damping-off. The bacterial disease *Clavibacter* was well controlled by acidified nitrite solutions, but also by a wide variety of compost extracts. Another option, which is currently evaluated on wheat, is to avoid seed contamination by *Fusarium* during seed production. Preliminary results show that cultivars differ in sensitivity to seedling blight, and that cultivars with stronger early growth rates appear to be less sensitive to seedling blight.

Efficient control of mildew in lettuce

Air-borne foliar diseases such as *Bremia lactucae* in lettuce or *Phytophthora infestans* in tomato may cause high losses in organic vegetable production systems. An alternative procedure to protect plants against disease is to activate their own defence mechanisms by specific biotic or abiotic elicitors. A major finding of this study was that ß-amino-butyric acid was efficient in controlling downy mildew in lettuce under field conditions, reducing the disease by 50-90 percent.

Photo: Organic Denmark

Pest control through beneficial insects

At field level, the need for intervention with pesticides can be reduced by promoting build-up of populations of beneficial insects. This approach has been explored in brassica crops in the UK. It was demonstrated that companion plants may decrease the number of cabbage root fly eggs and field margin companion plants may lead to increased predator populations not only in mid-European but also in more humid UK climates.

Integration of crop production strategies

One of the major aims of the QLIF subproject 3 was to integrate novel preventative crop protection techniques into improved crop production systems. For instance, yield and protein content of wheat produced under organic standards was repeatedly shown to be between 20 and 40 percent lower than levels achieved in conventional farming systems. This is thought to be at least partially due to lower N-supply to the crop later in the growing season and poor adaptation of the currently used wheat cultivars to organic production conditions. Our results indicate that two of the main problems relating to the sustainability of the current organic wheat production methods (lower yields and protein contents) can be addressed by changes in fertility management practices and cultivars choice. Strategies include (i) the promotion of legumes by *Rhizobium* inoculation of clover seeds prior to the wheat crop, (ii) and the choice of adapted wheat cultivars. Results showed that cultivar choice had the greatest effect on yields, but that fertility management practices also significantly affected wheat yields and protein quality for some of the cultivars. This clearly indicates that yields in organic wheat production can be significantly increased by improved cultivar choice and fertility management regimes.

QLIF subproject 3: Development of strategies to improve food quality and safety and production efficiency in organic and low-input crop production systems

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Selected publications

Kasselaki AM, Malathrakis NE, Goumas DE, et al. (2008). Effect of alternative treatments on seed-borne *Didymella lycopersici* in tomato. Journal of Applied Microbiology 105 (1), 36-41

Tamm L, Koepke U, Cohen Y, and Leifert, C (2007) Development of strategies to improve quality and safety and reduce cost of production in organic and 'low input' crop production systems. In: *Improving Sustainability in Organic and Low Input Food Production Systems* (Niggli U, Leifert C, Alföldi T, Lück L and Willer H, eds). Proceedings of the 3rd International QLIF Congress, March 20-23, 2007, Hohenheim, Germany, pp 151-157. www.orgprints.org/10626.

About QLIF

The Integrated Project QualityLowInputFood aims to improve quality, ensure safety and reduce costs along the organic and low-input food supply chains through research, dissemination and training activities. The project focuses on increasing value to both consumers and producers using a fork-to-farm approach. The project is funded by the European Union and runs from March 2004 to March 2009. The research involves thirty-one research institutions, companies and universities throughout Europe and beyond.

QLIF comprises seven subprojects on:

1) Consumer expectations and attitudes
2) Effects of production methods
3) Crop production systems
4) Livestock production systems
5) Processing strategies
6) Transport, trading and retailing
7) Horizontal activities

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Information on partners and subprojects is found at the project website **www.qlif.org**. The website also holds the library for project newsletters and serves as entry to Organic Eprints, where more than 100 publications from the QLIF project are available: http://orgprints.org/view/projects/eu_qlif.html

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