Organic Knowledge Update

Greenhouse vegetables

November 2010

Organic greenhouse horticulture in the Netherlands

Total area, consumption, organisation and knowledge development

The total area occupied in the Netherlands by organic horticulture under glass is growing steadily. Several growers convert to this form of horticulture every year and some existing organic growers are expanding their businesses. However, increasing imports from Spain and other south European countries, together with rising costs, reduce the opportunities for economic development within this sector. The market share for organic products in the Netherlands is still limited at about 2.3% of the total. Because of this, large quantities of Dutch organic greenhouse products are exported. The vulnerability of cultivation systems as a result of intensive soil-use is another issue that demands specific knowledge. Entrepreneurs and researchers work together closely to ensure cultivation success. Bioconnect helps the sector to realise its ambitions and to plan suitable research projects.

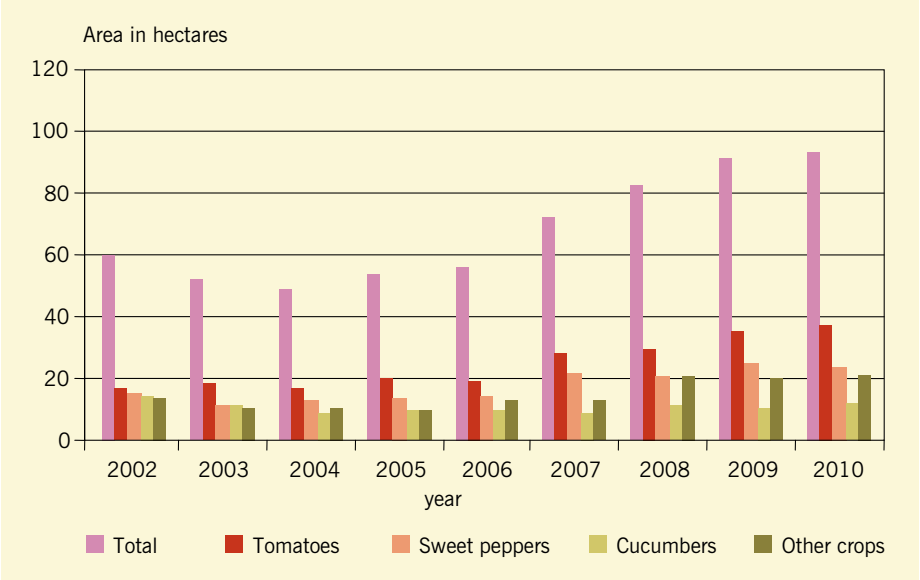

Figure 1. Area for organic greenhouse production

Area under cultivation

Some 100 hectares are currently used for cultivating organic greenhouse vegetables in the Netherlands. Over 75% (74 ha) of this area is dedicated to tomatoes, sweet peppers and cucumbers, as well as aubergines. Most of these vegetables are exported. In recent years, the consumption of organic products has increased further, with two new organic growers starting up every year. In 2010, there were 28 specialised greenhouse vegetable (tomatoes, etc) growers, as well as 10 growers with a wider range of crops. In addition to direct sales in the locality of the growers, these products end up in the usual distribution channels for organic foods.

Aspirations

By 2020 organic greenhouse production and trade is a healthy sector, that uses natural processes and means to create products that are sustainable, distinctive, healthy and tasty. A consistent group of consumers buys these products based on their trust of both production methods and quality. These consumers are willing to pay sustainable prices.

The Product Working Group 'Organic Greenhouse vegetables' (PWG) is dedicated to:

- Realising an energy neutral chain in 2020 through energy conservation, the use of renewable fuels and carbon compensation. Much research on energy reduction is currently being carried out for the greenhouse sector.
- Increasing the resilience of the greenhouse cropping system. More knowledge on soil organisms and their interactions can increase resistance to diseases. Of equal importance are less vulnerable rootstocks and the use of effective biological pest and disease controls.
- Compliance with the European Water Framework Directive by 2019.

Current research projects

- Energy efficient organic greenhouse production
- Rootstocks for organic vegetables
- Improving water management to reduce emissions
- Soil resilience, crop rotation and antagonistic crops
- Biological soil disinfection and Verticillium and nematodes
- Controlling downy mildew in cucumber and mildew in leafy vegetables
- Biological control of aphids in sweet pepper

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Market

The market share of organic foods in the Netherlands grew slightly in 2009 to 2.3%. Sales of organic fruit and vegetables remained stable at around 4%. Dutch consumers are buying more organic products in the supermarkets – 44% of the total market share in 2009. The health food markets followed with a 40% share. In the Netherlands, the per capita spending on organic foods is €31.50, just above the European average of €29. Dutch glasshouse growers depend on exports, which are estimated to be around 70%. The most important customers are Germany, UK, Italy, Austria, Scandinavia, Switzerland and the USA.

The ambitions of the Product Working Group Organic Greenhouse Vegetables

The Product Working Group consists mainly of greenhouse growers, but representatives from the trade also have their say about research plans. The PWG has a knowledge manager, who takes care of the agenda for the Product Working Group. Energy, soil and water are high on the Working Group's agenda: "We would like to take the lead in matters of energy consumption and the use of alternative energy sources, in order to become climate-neutral by 2020. This means: no longer being dependent on fossil fuels and introducing as many energy-saving measures as possible. The related research questions are generally in line with the demands of the entire greenhouse horticulture sector. Research into energy for organic greenhouse horticulture has therefore been included in the energy research programme".

For greenhouse growers, it is important to ensure cultivation success, as intensive cultivation under glass is rather vulnerable. "This is why we are looking for new cultivation systems and control methods in order to avoid crop failures and to ensure sufficient production and yield. There is a great deal of interest in the soil and in functional soil organisms, as well as in measures that increase disease resistance and limit damage to crops. Above ground, pest infestations also play a role and the control of plant aphids is a particularly important research topic for us".

Because the soil is so important for organic greenhouse horticulture, leaching of minerals into the groundwater or surface waters is also a focus of attention. Within the next 10 years, the Product Working Group wishes to see total compliance with the Water Framework Directive. This will mean reducing nitrogen and phosphate leaching to about zero.

Energy – towards climate neutrality

A number of projects are being carried out in the field of energy conservation. Organic greenhouse growers are taking part in projects that can supply them with useful information. New ideas for greenhouses involve the storage and re-use of solar energy. Organic grower Bijo has invested in a closed glasshouse concept which makes lettuce cultivation completely independent of fossil fuels.

In addition to these new concepts, other measures are necessary to reduce the consumption of fossil fuels. Organic growers are faced with specific problems in a closed greenhouse however, such as climate control and removal of undesirable gases. In the research greenhouses belonging to Wageningen UR Greenhouse Horticulture in Bleiswijk, researchers experiment with systems in which external air is heated and subsequently allowed to flow into the greenhouse under the crops. This ensures the relative humidity does not increase too much and that the crops remain dry. With the aid of special fans such as Aircobreeze, the greenhouse air is refreshed and moved around to prevent the relative humidity becoming too high and to prevent condensation on the crop The crop remains dry and the CO_2-content can be kept on the right level for a optimal production.

Contact: Marcel Raaphorst
marcel.raaphorst@wur.nl

Soil: resistance through prevention and control

The Dutch interpretation of the EU rules is that organic cultivation under glass should take place in the soil. The Dutch certification organisation Skal does not certify cultivation in natural substrates. The demand to recognize substrate cultivation as organic is nevertheless increasing and has led to intensive discussions with the government and with various organisations at home and abroad. Many years of intensive cultivation of greenhouse vegetables in the same soil causes production to drop off and soil infections and infestations to increase. An increasing occurrence of root-knot nematodes and/or soil fungi such as *Verticillium* means the problem needs to be tackled now. The greenhouse growers require considerable skills to manage these problems, as prevention and control need to complement each other.

External air is warmed up, ensuring low relative humidity and drier crops

According to research coordinator Rob Meijer, at Wageningen UR Greenhouse Horticulture, soil-associated cultivation systems need to be altered. "In the short term, steaming the ground can have an effect, but it undermines natural resistance. Many growers have therefore stopped steaming and are looking, together with researchers, for more suitable measures. The soil is a complex system, and we know relatively little about it, so we are carrying out a long-term research projects in which the results from fundamental research will be tested in practice. The bio-rotation greenhouse project looks at the effect of alternative rotation systems; it could lead to suitable preventive measures. In addition, we are investigating greenhouse soil vitality measures that will make the soil more resistant to infections and infestations. Two companies are now cultivating greenhouse vegetables in strips in such a way that 50% of the ground is cultivated and the available space is utilised in the best possible way".

Bio-rotation greenhouse

Crop rotation is a well-established strategy to prevent the occurrence of soil-associated infections and infestations. However, the inclusion of resistant hosts within crop rotation in greenhouse horticulture is complicated by the high level of specialisation. Growers and researchers are therefore looking for intelligent alternatives. Biodynamic grower Marc Baijens has already used a cultivation system in which cucumbers are rotated with *Tagetes* (African marigolds). The inclusion of fallow with *Tagetes* means that the soil is used less intensively. This helps to suppress plant parasitic nematodes. The Verbeek brothers have a similar solution: a Köver system in which foil is placed vertically between rows, extending down into the soil. Instead of using two rows, the plants are cultivated in double density in one single row. This means one of the cultivation strips remains unused, creating the opportunity to leave it fallow or plant suppressive crops there. Another company has started experimenting with a combination of sweet peppers (2009) – tomato (2010) and fallow. The combination with green manures has stopped because of negative effects on the yields and an increased demand for labour.

Contact: Willemijn Cuijpers
w.cuijpers@louisbolk.nl
André van der Wurff
andre.vanderwurff@wur.nl

Soil vitality greenhouse

Outbreaks of soil-borne plant diseases in horticulture are generally determined by three factors. The presence and density of pathogen propagules, the resistance of the host plants and the characteristics of the soil. The presence of pathogen propagules does not always result in crop damage. This is described by the phenomenon of disease suppression in soils. Suppressive soils are an underutilized resource for the control of soil-borne pathogens, but considerable progress is being made. By increasing or maintaining the levels of organic matter in the soil for instance, soil organisms are stimulated which helps resistance to infections in general. Higher biological activity does not automatically imply that the resistance to infections is good however; specific antagonistic microorganisms are needed. Several fungi can suppress the development of plant-pathogenic fungi such as *Fusarium*, *Botrytis* and *Pythium*. The Soil Vitality Greenhouse project involves identifying soil properties related to disease suppression in soils. In a large experiment in 2010, soil samples originating from fourteen companies showed a large degree of variation in the suppression of root-knot nematodes, *verticillium* wilt and *pythium* damping-off. At the moment, follow-up experiments are executed to investigate whether suppression levels can be artificially increased. The ultimate aim is to unravel the underlying mechanisms and investigate whether suppression levels can be increased and used in an integrated soil management system.

Compost provides organic matter and stimulates soil life

Contact: André van der Wurff
andre.vanderwurff@wur.nl and
Willemijn Cuijpers
w.cuijpers@louisbolk.nl

Rootstocks for greenhouse vegetables

Rootstocks are used both in soil and substrate cultivation systems. These strongly rooting stocks may be less resistant to fungi, thus increasing production in grafted varieties. Sensitivity to nematodes, especially to *Meloidogyne incognita* but also *Verticillium*, plays an important role in an organic grower's choice of rootstock. Little is known about the sensitivity of rootstocks, which is why they have been tested for sensitivity and the degree to which nematodes multiply after infection. These tests are carried out in buckets in order to regulate the concentration of infection. Several new rootstocks with high tolerance have been found for cucumbers and these are being tested for production and product quality in practice.

Rotation with *Tagetes* suppresses the nematode population

Contact: Jan Janse, *jan.janse@wur.nl*

Antagonistic crops

Antagonistic crops reduce the numbers of injurious organisms in soil. Some plants attract nematodes, ultimately killing them, thus causing the population to decrease. Capturing nematodes by inter planting with 'capture plants' is another possibility. The capture plants are subsequently removed from the greenhouse together with the crop. Results of laboratory tests show that *Tagetes*' roots especially, are responsible for the antagonistic effect. Also members of the Asteraceae family and plants that produce biofumigants, such as Brassicaceae and Crotolariaceae, have antagonistic properties.

Contact: André van der Wurff
andre.vanderwurff@wur.nl

Biological soil disinfection

Control of soil-borne diseases and pests with biological control agents by steaming the soil, by biological soil disinfection or with grass has proven insufficient. New organic substances are tested to replace grass. These substances are to be brought into the soil and covered for some weeks with plastic. They seem to work. A protocol is now being developed to apply the method and to monitor the effect in the period after application.

Contact: Daniël Ludeking
daniel.ludeking@wur.nl

Water – prevent leaching

The European Nitrates Directive sets out requirements for soil-based greenhouse horticulture. Standards of use apply at this moment but ultimately the goal is to achieve zero emission. To find out exactly how much mineral matter disappears into the ground water, six lysimeters have been buried in the ground in three greenhouses in order to capture the outflow of water plus minerals. These data are coupled to the watering system. This can then be adjusted if necessary. In the first year there was very little leaching of water, so mineral loss was limited. In 2011 special attention will be given to prevent or to solve increase of sodium, chloride and sulphate levels in the topsoil. For better mineral management, the content of these elements in organic fertilizers are also measured.

Contact: Wim Voogt, *wim.voogt@wur.nl*

Biological control of aphids

Aphids are a constant threat to organically grown sweet peppers and aubergines. Although a large range of natural enemies is available, some crops still fail each year because biological control has only been partly successful. Strategies for aphid control vary widely among organic growers and it is still unknown which 'team' of natural enemies is best for fighting aphids. When releasing natural enemies for aphid control, it is important to consider the possible interactions with other pest species and natural enemies that may be present. Within the natural enemy communities that are created for multiple pest control, direct and indirect interactions occur that can enhance or disrupt biological control. These interactions include: predators eating other predators, behavioural changes, plant responses and competition. We recently proved, for example, that predatory mites strongly disrupt the biological control of aphids by the aphid predatory midge *Aphidoletes aphidimyza*, because of hyperpredation by the mites on the *Aphildoletes eggs*. Current research is focusing on selecting and evaluating generalist predators that are suitable for the control of both aphids and thrips and compatible with specialist aphid predators. We conclude that an integral view of the entire greenhouse-ecosystem is required when identifying the best combination of natural enemies for aphid control.

Predatory mite *Amblyseius swirskii* introduced to fight thrips disturbs biological control of aphids

Contact: Gerben Messelink
gerben.messelink@wur.nl

Diseases in leaf crops

Botrytis and downy mildew are difficult to control in leaf crops and cucumbers. There are now several methods on the market claiming to be effective against these pathogenic fungi. This year the effects of *Trichoderma* (Trianum) and *Coniothyrium minitans* (Contans) will be tested. In these trials, the effect of UV light on these fungi will also be noted. Also the effect of ventilation to control the air humidity is being studied.

Contact: Jantineke Hofland-Zijlstra
jantineke.hofland-zijlstra@wur.nl

Growers' network and exchange of bioknowledge

Since 2006, a company network has been organising seminars and special meetings on organic greenhouse horticulture, thus allowing knowledge and experience to come together. In the study groups, the entrepreneurs in particular can exchange knowledge and experiences. The theme of each special meeting is introduced by experts and illustrated by means of demonstrations. Of the 38 growers, 32 are actively involved in this company network.

Contact: Leen Janmaat
l.janmaat@louisbolk.nl

Bioconnect aims to further develop and strengthen the Dutch organic sector by initiating and implementing research projects. Within Bioconnect organic entrepreneurs (from farmers to shop-keepers) work together with research institutes, colleges and universities and consultancy organisations. This leads to demand-driven research that is unique to the Netherlands.

Bioconnect
The innovation network of organic agricultural chains

The Ministry of Economic Affairs, Agriculture and Innovation sponsors these research projects.

Ministry of Economic Affairs, Agriculture and Innovation

Wageningen UR (University & Research centre) and the Louis Bolk Institute together carry out these research projects. About 140 projects dedicated to organic agriculture are currently under way.

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Colophon

Contact: Rob Meijer
E-mail: rob.meijer@wur.nl
Telephone: +31 317 485 632
www.biokennis.nl

Editing / Design / Production
Wageningen UR, Communication Services
E-mail: info@biokennis.nl
Telephone: +31 317 486 370