Plant protection in organic apple production

A summary of research conducted under the German Federal Programme for Organic Agriculture and other forms of Sustainable Agriculture

BÖLN

Bundesprogramm Ökologischer Landbau
und andere Formen nachhaltiger
Landwirtschaft

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INTERVAL

Summary of research results of the German Federal Programme for Organic Farming (BÖLN), 2001-2011

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1. Soil fertility – https://www.orgprints.org/21868
2. Plant protection in organic arable and horticultural production - http://orgprints.org/21869
3. **Plant protection in organic apple production - http://orgprints.org/21875**
4. Nutrition of monogastrics - http://orgprints.org/21874
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6. Food quality and processing - http://orgprints.org/21871
7. Knowledge transfer - http://orgprints.org/21870
8. Regional marketing - http://orgprints.org/21873

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1. Introduction

The German Federal Programme for Organic Agriculture (BÖLN) was founded in 2001, with the goal of improving the conditions for organic farming and food industry in Germany, and to achieve the conditions for a balanced growth of supply and demand. The programme is funded by the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), and implemented and coordinated by the Federal Agency for Agriculture and Food (BLE) in Bonn. Since 2008, the programme is part of the German National Action Plan (2005-2014).

Since the beginning of 2011, the second evaluation of the programme (project ID 09OE027) is carried out by the international contractor group Organic Research Evaluations; consisting of the partners InterVal GmbH in Berlin, The Organic Research Centre, Elm Farm, United Kingdom and the University for Sustainable Development in Eberswalde, Germany.

The focus is on the programme of the BMELV to support research projects in organic farming, where more than 650 projects have been funded since 2002. The evaluation is in particular to clarify the extent to which research results helped to strengthen organic agriculture in Germany and expand its market share. The evaluation results, which are expected to be publically available in early 2013, shall also benefit a future optimisation of research funding.

The summaries of research results in eight focus topics (soil fertility, plant protection in arable and horticultural production, plant protection in apple production, nutrition of monogastrics, animal health of ruminants, food quality and processing, regional marketing and knowledge transfer) from the whole period of the programme since 2002. All projects can be identified with the individual project ID number, shown in brackets in the title; and following the link below, further information can be found on the German BÖLN website. Where available, links to the final-reports of individual projects on the Organic Eprints website are added. Further results of running projects of the BÖLN research programme are regularly published at www.bundesprogramm-oekolandbau.de.

2. Summary

In this focus area, research projects were carried out on two main subjects: apple scab (*Venturia inaequalis*) and codling moth (*Cydia pomonella*). Scab control projects started in 2002, projects on codling moth control in 2006, and research on both topics has intensified since 2010. From the beginning, the search for alternative materials for scab control was prioritised, since the use of copper as a treatment for scab is going to be restricted in the future, and the efficiency of materials approved for treating organic apples has often been too low in the past to prevent significant yield losses. Alternative materials were tested and compared, including materials from *Inula viscosa*, *Quillaja saponaria* bark, citrus species and *Saponaria officinalis*. These plant-derived products were able to significantly reduce ascospore potential of scab in greenhouse experiments. The combination of *Quillaja saponin* and sulphur reduced scab very strongly. The combination of citrus extract with GREEMAX and BIOPLUSS as adhesives had a similar effect as a quantity of 400g Cu/ha (applied as copper oxychloride) in field trials. Targeted treatments with lime sulphur during the time of sporulation were found to represent a good and safe alternative. *Gloeosporium* infestation was significantly reduced by additional MycoSin treatments before harvest. Furthermore, autumn foliage removal with leaf blowers, and the promotion of earthworm activity was tested to reduce fungal inoculum. The aim of these studies was to identify ecologically compatible substances that lead to a reduction of scab infestation. Based on the initial results of the past years, on-going projects are investigating new alternative methods, application techniques and other solutions for the reduction of copper use in organic apple production.

In recent years, codling moth populations have appeared that showed low susceptibility to the commonly used codling moth granulovirus (CpGV) preparations, and thus cannot be properly controlled with this treatment. Following research that clarified and described the unusual inheritance of virus resistance in codling moth, new CpGV isolates were developed that are able to break this resistance. Commercial farms with CpGV resistance or suspected resistance are recommended to use the new, resistance-breaking virus isolates. In on-going experiments, other methods of codling moth control are being tested, such as the use of nematodes and *Trichogramma* wasps. Investigation of the individuals resistant to new and other potential isolates of CpGV as well as a risk assessment regarding resistance development are prioritised in the current projects.

3. The individual projects

Alternative substances for apple scab control and copper replacement (02OE109) 01-05-2002 to 31-12-2003 http://orgprints.org/4743/

Alternative methods for the control of apple scab (*Venturia inaequalis*) should not only achieve the same efficiency as copper, but should ideally be even better than copper. Such an effect could be achieved by a combination of different strategies for apple scab control. There are innovative ways to promote the decomposition of leaves to reduce scab inoculum, as well as novel plant extracts, which were tested as potential inhibitors of sporulation. Promising active ingredients from plant extracts were tested for direct control of the pathogen. The approach of the project was to use microbiological culture media and natural enzymes to promote natural microbes so as to achieve an additional enzymatic decomposition of the leaves. With regard to leaf decomposition and especially in terms of ascospore potential, significant effects were recorded for the tested media. 19 media caused a significant reduction (up to 93%) in the ascospore potential. In greenhouse trials on direct scab control, extracts from *Inula viscosa*, *Quillaja saponaria* bark, citrus species and *Saponaria officinalis* showed significant effects. Combinations of *Quillaja saponin* and sulphur reduced the scab infestation very strongly. The combination of citrus extract with GREEMAX and BIOPLUSS as adhesives had a similar effect as a quantity of 400g Cu/ha (applied as copper oxychloride) in field trials.

Sprinkler technology for scab prophylaxis (03OE501) 01-12-2004 to 31-12-2005

Apple scab (*Venturia inaequalis*) is the most important disease in apple production. Scab infection requires leaf wetness at favourable temperatures for about 8 hours. Therefore, organic apple growers are often forced to treat apples prophylactically during the primary scab season. This requires many treatments that are unnecessary in hindsight. An automated sprayer was optimised in this project to substantially shorten the time needed for the application of a plant protection product (down to a few minutes per treatment unit) so that the treatments can be carried out guided not (only) by the weather forecast but by the actual weather conditions. Timely application alone can reduce expenditure on pesticides by over 50% while increasing the efficiency of the pesticide. The aim was therefore to optimise the spraying technique by describing and evaluating technical parameters such as drift data and droplet spectra. This included: (1) setting up the test facility, installation of a sprinkler system, (2) optimising the application technique, (3) studies on spray drift, droplet distribution and assessment of the possible risks, (4) calculation of the amount of active ingredient, (5) comparison of the current technique and the sprinkler technology, (6) economic and biological evaluation of both methods, (7) evaluation of the new technology in a workshop with the following parties: BBA (Section Application Technology), LWK Hanover (Plant Protection Service), Federal Office of Consumer Protection and Food Safety (BVL), University of Hannover (Institute of Vegetable and Fruit growing), GS BÖL and BMVEL.

Development of apple scab inoculum in apple variety mixtures (06OE194) 15-03-2007 to 31-12-2009 http://orgprints.org/16698/

The establishment of mixed-culture systems in apple (growing different varieties in the same orchard) was used with the aim of reducing pest and disease pressure. The project investigated to what extent mixed-culture systems affect the abundance of major pests such as apple mites, apple saw fly (*Hoplocampa testudinea*), and infestation with canker (*Nectria galligena*). In addition, the impact on the development of apple scab inoculum (*Venturia inaequalis*) was studied. The results were compiled based on a comparison of a mixed culture containing four genetically unrelated apple varieties with a pure culture of planting the same varieties. Planted varieties were 'Holsteiner Cox', 'Elstar', 'Fuji' and the scab-resistant variety 'Topaz'. Any potential economic disadvantages of the mixed culture were recorded and assessed based on the performance parameters at harvest, the effort needed for cultural activities, yield and navigability of the system. Probably due to the young age of the pilot orchard no effects of the mixed-culture planting were observed on the pest and disease infestation.

Reduction of copper use in apple scab control (06OE324) 01-03-2008 to 31-03-2011 http://orgprints.org/19277/

The aim of the project was to optimise the existing process to achieve effective apple scab control with minimal use of copper. The regionally specific climatic conditions of the four different field trials had an effect on the intensity of the scab levels. Also, there were undesirable side effects of some treatments on the appearance of the fruit. In greenhouse experiments, early protective applications of sulphur preparations, plant extract P1 and PHYTOCARE in the germination stage of *Venturia inaequalis* showed the best effects. In curative application for up to 48 hours after inoculation carbonates were the most effective. The combination of the two substances can effectively cover the entire time range both before and after scab infection in the greenhouse. In field trials, the analysis of all test results of the 3 years and all trial sites revealed that it is possible to reduce the copper application rate is applied per hectare per year by optimising copper application and substitution ofg copper. A good and safe alternative proved to be

targeted treatments with lime sulphur into the sporulation phase. This presents the greatest potential for savings of copper applications. *Gloeosporium* infestation in stored apples was significantly reduced by MycoSin treatments before harvest. In the cultivar 'Braeburn' the dipping method achieved the best efficiency of 88.3% in significantly combating this disease.

Software tool for targeted group advice on copper treatments (10OE050) 01-12-2010 to 31-05-2012

Currently, there are no instruments available that reflect the impact of certain measures (e.g., the use of copper) on the environment and allow for comparison among farms. Also a representation is needed of different optimisation strategies and their impact on the overall process (first as a model, later in real terms). Against this background the BÖL Project 06OE100 (“Network to develop the concepts of organic farming fruit production") worked on the further development of pest and disease management in organic orchards, with a specific focus on sustainability assessment. After intensive discussions with various international experts, advisers and practitioners as well as the consideration of similar models in other European countries, indicators were chosen that are both meaningful and measurable on farm. The next step is to implement these indicators in an existing quality management system so as to provide a decision support tool that allows the data acquisition for the indicators by interested farms, while ensuring later analysis by advisers for the development of individual farm strategies. The aim of this joint project, consisting of projects 10OE024, 10OE048, 10OE049 and 10OE050, is a software tool for the comprehensive collection and presentation of strategies for prophylactic and sustainable minimisation of the risks of copper use. A further aim is the optimisation of the alignment to the principles of organic farming in organic fruit production by adapting the web-based documentation and quality management system Nutriweb (field record for collecting the necessary data and analysis tool for the representation). The project will develop the system Synops to correctly represent the characteristics of copper as plant protection product.

Reduction of scab inoculum to minimise copper use in organic apple production (09OE044) 15-10-2010 to 31-12-2013

This collaborative project focuses on the overwintering period of the apple scab pathogen. The project studies targeted phytosanitary measures, such as removing fallen leaves as source of inoculum by leaf blowers or mechanically chopping up the leaves to promote decomposition and thus create more favourable conditions for scab control in the following season. The investigations of this project are carried out in pilot orchards with scab-susceptible varieties and are the same at all locations. The basis of the plant protection strategies is the experience gained under the on-going project 06OE324 "Reduction of copper use in apple scab control ". Scab assessments on the trees of the plots are conducted at the end of the ascospore phase and in the further course of the season and at harvest; in addition, the ascospore inoculum is regularly determined in the trial orchards.

Autumn foliage treatments to develop effective apple scab treatments (09OE037) 19-10-2010 to 31-12-2013

This collaborative project focuses on apple scab (*Venturia inaequalis*), in particular on the overwintering stage of the disease. The aim of the project is to find new substances and methods which lead to a reduction of the infection pressure in spring by reducing the sporulation that starts from the autumnal (abscised) foliage. Approaches include direct fungicidal effects on the scab fungus itself and the promotion of microbial competition against the fungus. In addition, indirect effects can be achieved by optimising the extracts for an increased attractiveness of the treated leaves for earthworms. In 2010/2011 the project investigated yeast extract, TSB (a soy-containing medium) and various plant extracts. In addition, the microbiological colonisation of the leaves will be examined after contact with the ground. Weather data from an existing weather station (soil temperature) will be used to work out optimal application times of the preparations used to promote earthworms. Finally, various plant extracts will be fractionated and separated into classes of compounds. The aim is to identify organically acceptable substances that lead to a reduction of apple scab pressure.

Reduction or substitution of copper use in apple scab control (09OE043) 01-01-2011 to 31-12-2013

One of the most effective measures against apple scab is the use of scab-resistant varieties. Currently, however, only a few varieties are available (e.g. Topaz) that meet the requirements of buyers and consumers. This project builds on the previous findings of the BÖL project 06OE324 "Reduction of copper use in apple scab control ". Further alternative substances and additives are selected with regard to potential phytotoxicity and rust symptoms in the field. Possibilities of customised application technologies are tested, and the impact on the disease symptoms in stored apples is determined. The aim is to develop an integrated scab control strategy for efficient advice to working farms. To ensure transferability of the results, the project works closely with all partners and takes into account region-specific climate conditions in the typical fruit-growing regions of Germany.

Decreased sensitivity of the codling moth to granulovirus (05OE023/1-2) 01-01-2006 to 31-12-2009

http://orgprints.org/18236/ and http://orgprints.org/18235/

Since 2003, codling moth populations have increasingly been found that show decreased susceptibility to granulovirus (CpGV) preparations (by a factor of 1,000); these populations can practically no longer be controlled with the virus. To prevent further spread of this phenomenon, targeted studies were conducted on the population genetics of codling moth in Germany. For this purpose, crossing experiments between susceptible and less sensitive codling moth populations were performed. So far, more than 40 codling moth populations in Europe have been found with CpGV resistance. In all cases these presumably belong to the same resistance type. The resistance is selected very efficiently by an unusual inheritance mechanism. New CpGV isolates can break resistance. The results lead to the following recommendations. (1) Farms without CpGV resistance - this is the overwhelming number - can continue to use conventional CpGV preparations. As soon as new CpGV isolates are registered these should be used in order to avoid selection of the known resistance. (2) Farms with CpGV resistance or suspected resistance should immediately use new resistance-breaking isolates. These have been available since 2006 as test preparations; their approval is expected. (3) Codling moth control must be placed on a broad basis.

Virulence management in the codling moth (09OE097) 15-06-2010 to 31-12-2012

The project aims to develop a viable long-term strategy for the regulation of the codling moth in organic fruit growing, in collaboration with research, advisory services and practitioners. Part of this strategy is virulence management of the codling moth granulovirus (CpGV); in addition, further control methods suitable for organic apple production are currently under development. In a first step, fundamental issues still need to be clarified regarding virulence management of CpGV. On this basis, and taking into account previous findings, building blocks will be developed for a codling moth control strategy (e.g. with nematodes, Trichogramma, and new antifungal developments). (1) Risk assessment regarding the rapid emergence and development of resistance. (2) Investigation of those insect individuals resistant to new CpGV isolates with regard to other potential isolates of CpGV. (3) Study of the effect of new CpGV isolates. Based on the results of a project initiated in 2005, this collaborative project will clarify the fundamental questions of possible virulence management, and various strategies will be developed and tested for codling moth control (e.g. nematodes, Trichogramma), and will be combined with control strategies for fungal diseases in organic apple growing