SEVENTH FRAMEWORK PROGRAMME

Project no.: KBBE.2011.1.2-06; Collaborative project

Project acronym: CO-FREE

Project title:

Strategies to replace copper-based products as plant protection products in low input and organic farming systems

Grant agreement number: 289497

Coordination by: JKI, Darmstadt, Germany

Start date of project: 01.01.2012 Duration: 54 months

Reporting period: 01.01.2015 – 30.06.2016

Publishable Summary

Project description

The CO-FREE project aimed to develop innovative methods, tools and concepts for the replacement of copper in European organic and low input fruit, grapevine, potato, and tomato production systems by (i) providing alternative compounds, (ii) 'smart' application tools and (iii) by integrating these tools into traditional and novel copper-free crop production systems. CO-FREE aimed to identify strategies to develop (v) 'smart' breeding goals by the development of crop ideotypes and (vi) foster consumer acceptance of novel disease-resistant cultivars by consumers and retailers. The innovations and production systems were (iv) evaluated in a multi-criteria assessment with respect to agronomic, ecological and economic performance. In the course of the project, farmers, advisors, the plant protection industry, policy makers and researchers as well as stakeholders of the European organic and low input sector (food supply chain, retailers, producer associations) were closely involved to ensure rapid development, dissemination and adoption of the copper replacement/reduction strategies as soon as they became available.

Objectives

The objectives of CO-FREE were to develop plant protection products (PPPs) of microbial origin and plant origin including optimization of field application, characterization of the mode of action, identification of the spectrum of activity, development of a suitable formulation and optimization of the production **(objective 1)**. The developed PPPs were to be combined with disease control strategies in organic and low input/IPM farming systems to achieve the maximum disease control (**objective 2)**. The novel tools and techniques were applied to different productions systems (apple, grapevine, tomato, potato). This was addressed in **objectives 3-5**. **Objective 6** focused on eco-toxicological studies of the newly developed products. Evaluation of the economic impact of novel PPPs and strategies resulting from objectives 1 to 5 and development of a strategy to improve wholesaler and consumer acceptance of novel cultivars was the content of **objective 7. Objective 8** addressed the dissemination of new knowledge and novel practices to representatives, farmers, advisors, retailers, policy makers and researcher. The objectives are reflected in different work packages (**WP**).

Work performed and results

WP1 addressed the co-ordination of scientific activities. Five project meetings took place from 2012-2015. The CO-FREE website was updated continuously.

In **WP2** and **WP3** CO-FREE test products (CTPs) from microbial or plant origins were further developed to optimize efficacy and timing of application. Work also focused on identification of active molecules and elucidation of modes of action, formulation, up-scaling of production and reduction of costs.

In **WP4** a database compiling information of CTPs and established copper alternatives was finalized. DSS for grape (downy mildew and pilot model for black rot) and potato (late blight) have been optimized or developed from scratch. They are available to farmers on www.rimpro.eu (grape) and www.isip.de (potato). Investigations demonstrated that most of the tested CTPs were generally suited for use instead of copper in resistance management strategies against *Phytophthora infestans*. Trials on the optimization of use of existing application equipment for alternative compounds were carried out.

In **WPs 5-7** CTPs were tested in the field with final focus on possible copper reduction strategies in apple, grape, tomato and potato, by e.g. combinations of CTPs or combinations of CTPs with low doses of copper, use of tolerant varieties and DSS. Trials were conducted in IT, CH, FR, DE, GR, PL.

In **WP5**, a restricted range of CTPs was available in sufficient quantities to be evaluated in high yield orchards in IT and FR. Results indicated some biocontrol agents with promising properties. Advanced self-regulating cultivation techniques (agro-forestry and Very Low Input Systems (VLIPS)) have been explored in grapevine **(WP6)** and/or apple **(WP5)**, both of which showed potential for promotion of biodiversity and reduction of copper use. However, these experimental production systems are not yet ready for implementation at scale. In CO-FREE, a partial proof of concept was provided in selected model systems and current limits were identified.

Trials were conducted in grapevine (**WP6**) in IT, GR and FR. Several CTPs used in low copper strategies showed significant reduction of downy mildew comparable to full dose copper treatment.

Potato field trials for control of late blight (**WP7**) conducted in DE and PL with strategies using different varieties and CTPs (alone, combined or with low copper dose), showed significant yield increases and disease reduction. In FR CTPs tested provided little if any protection against late blight in potato and their efficacy proved cultivar-dependent rather than disease-resistance dependent. One CTP evaluated on tomato in GR showed overall efficacy of 57%, even under extremely conducive conditions for late blight. Other CTPs tested in FR showed only limited efficacy. Key traits concerning potato ideotype design for organic production showed resistance to late blight as being of major importance.

In **WP8**, laboratory toxicity tests of a total of 10 CTPs were finalized on 8 arthropod and two soil indicator species. The toxicity assessment of 11 CTPs was conducted on two non-target aquatic organisms. Most tested compounds had no or low toxic effect on the tested indicator organisms. The ecological impact assessment was conducted in field trials under WPs 5-7 according to the common handbook for ecological impact assessments.

In WP9 the economic impact of minimization of copper use was assessed for potato, tomato, apple and grape production systems. It was concluded that besides the development of good resistant varieties with comparable yields and qualities as current varieties, major marketing efforts, along with the introduction of 'copper-free' crop products and varieties, are an essential element of a strategy to minimize the use of copper. The novel approaches for the market introduction of new potato cultivars were piloted in 2013 and 2014 and results were subsequently presented to stakeholders along the value chain and the public. In 2015, several variety demonstrations and a workshop on consumer acceptance of new varieties was organized.

Dissemination **(WP10**) took place via the CO-FREE website and issues of the Newsletter. The final CO-FREE stakeholder conference was organized during BIOFACH in Germany 2016. Intensive exchange with different stakeholder groups took place on conferences, meetings and open field days. Representatives of CO-FREE took part in activities of DG Sante, EGTOP, IFOAM EU, in EXPO 2015 and on expert discussions. An exclusive training seminar for CO-FREE partners on registration issues took place in 2014. Results were published in 18 peer reviewed articles and in more than 100 other dissemination activities (oral presentations, posters, a video, leaflets etc.). Dissemination took place also via the CO-FREE website.

There were changes in the consortium due to termination of participation of two industry partners and inclusion of a new industry partner **(WP11)**.

The expected final results and their potential impact and use

The overall aim of the CO-FREE project was to develop copper free organic and low input production systems while maintaining yield and quality of crops and reducing negative environmental impacts.

As concluded in the final CO-FREE conference, immediate phasing out of copper would at present create unbearable risks and costs (e.g. for tools or risk compensation). Thus, phasing out of copper is currently not feasible generally. However, in the four systems under investigation in CO-FREE, further reduction is achievable in most crops, and possibilities are seen highest in potato>apple>tomato>grapevine.

In CO-FREE, depending on the crop, a range of measures were developed and are ready to be implemented and used, while others need some more time. E.g. for several of the alternative compounds investigated in CO-FREE, completed registration is to be awaited earliest from 2022. Also, new varieties need time to be adopted by farmers, retailers and consumers, communication and commitment along the whole value chain being essential. Results indicated that strategies including the use of alternative compounds as one component together with DSS, robust/resistant varieties and further measures will be the way forward to further reduce/replace copper.

In the project, promising novel alternative products investigated under WPs 2 and 3 together with an optimized application strategy were developed in close collaboration between SMEs, researchers, advisors and farmers (WP4). In WPs 5-7 a range of component strategies adapted to specific crops and pedo-climatic conditions were adopted, taking into account regional and cultural differences as well as the economic realities and the local legal framework. The development of innovative generic strategies to increase/support acceptance of innovative systems by policy makers, advisors, farmers, wholesalers, consumers and the wider public were provided as a key component by CO-FREE through horizontal activities organized under WPs 8-10. With these activities, it is anticipated to decrease the overall dependency on copper use in organic and low input farming systems in EU/EFTA countries substantially. This will have a positive impact on the environment and will create a substantial growth of organic and low input farming systems in regions where organic and low input farming was limited due to high disease-related production risks. This increased demand will also strengthen the competitiveness of European biopesticides manufacturers. CO-FREE has strongly contributed to development of up to 17 novel products of plant or microbial origin, has developed/refined smart tools for apple, grapevine, potato and tomato disease control, and has explored advanced apple and grapevine production systems with reduced dependency on pesticide inputs and has contributed to open the market for disease-tolerant cultivars. This will have wide socioeconomic impact on the use of copper.

For further information on the CO-FREE project, see http://www.co-free.eu/.