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

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Coordination by: JKI, Darmstadt, Germany

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The CO-FREE project aims 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. Copper-free production systems will be achieved by (i) providing alternative compounds, (ii) 'smart' application tools and (iii) by integrating these tools into traditional and novel copper-free crop production systems. The copper-free apple, grapevine, potato and tomato production systems will be (iv) evaluated in a multi-criteria assessment with respect to agronomic, ecologic and economic performance. CO-FREE will also develop strategies to develop (v) 'smart' breeding goals by development of crop ideotypes and (vi) foster consumer acceptance of novel disease-resistant cultivars by consumers and retailers. By involving farmers, advisors, plant protection industry, policy makers and researchers as well as the stakeholders of the European organic and low input sector (food supply chain, retailers, producers associations), CO-FREE will ensure a rapid development, dissemination and adoption of the copper replacement strategies.

Objectives

The objectives of CO-FREE are 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 will 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 will be applied to different productions systems (apple, grapevine, tomato, potato). This is addressed in **objectives 3-5**. **Objective 6** focuses 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 is the content of **objective 7. Objective 8** addresses the dissemination of new knowledge and novel practices to representatives, farmers, advisors, retailers, policy makers and researcher. Objectives are reflected in different work packages (**WP**).

Work performed and results

WP1 addresses the co-ordination of scientific activities. The consortium met four times in 2012 -2014 to plan further steps and activities. The CO-FREE homepage was successfully established.
In **WP2** and **WP3** CO-FREE test products (CTPs) from microbial origin and plant origin 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 with information of novel and established copper alternatives was built up. The DSS for downy mildew control on grapevine was validated based on a large set of data provided by partners for *Vitis vinifera* varieties and further adapted to conditions in partially resistant interspecific cultivars. Excellent progress was made in the development of a DSS for potato, demonstrating the potential for substantial reduction of copper or alternative product use.
In WPs 5-7 CTPs developed in CO-FREE are tested in the field. Trials were conducted in IT, CH, DE, GR, and partially in FR due to legal restrictions (ADE permits).
In **WP5**, a limited range of CTPs was available yet at sufficient quantities to be evaluated in IT and FR high yield orchards. Those CTPs showed only limited efficacy, except for a biocontrol agent with promising properties.
The climate in 2012 demonstrated the limits of preventive strategies tested in CH in 'very low input' and 'no PPP input' production systems when a first major outbreak of virulent *V inaequalis* populations was observed. Control strategies were subsequently adapted. The overall strategy to contain further spread and to eradicate the virulent *V. inaequalis* population proved to be very successful in 2013 (and 2014) whereas the emerging disease *M. coronaria* has further spread.
In agroforestry systems evaluated in UK apple yields were satisfactory and incidence of apple scab was less than half as compared to intensive organic production. When scaled up to 100% land cover, the agroforestry apple yields compared well with standard figures. The preliminary data suggest that an agroforestry approach per se is not successful at reducing scab levels, while varietal diversity may be more important.
In trials conducted in grapevine (**WP6**) in IT and FR highlighted the limits of the pilot CTPs in their current form if used as stand-alone treatments. However, some CTPs had a satisfactory efficacy under low disease pressure. In France in 2013 and 2014 a high pressure of grapevine downy mildew was observed which limited the efficacy of the tested CTPs. One CTP reduced bunch infection significantly in GR 2013. In 2014, significant differences of leaf infection were observed between the control, „low copper" and a CTP. Results from trials in CH in 2014 under high disease pressure suggest that in robust grapevine varieties (PIWI), copper-free plant protection strategies may be feasible and provide adequate protection against downy and powdery mildew.
In potato field trials with *P. infestans* (**WP7**) conducted in DE and PL, the application of new CTPs increased yield of cv. `Ditta´ significantly by up to 4 t / ha (35%). In field trials conducted in France, CTPs tested so far provided little if any protection against potato late blight. Key traits concerning

potato ideotype design for organic production showed resistance to *P. infestans* as being of major importance. CTPs and low copper strategies evaluated on tomato in GR and FR showed only limited efficacy yet, emphasizing the destructiveness of *P. infestans* in disease conducive conditions.

In **WP8**, laboratory toxicity tests of four CTPs were conducted on 8 arthropod indicator species. The toxicity of five CTPs has been assessed on non-target aquatic indicator organisms. The ecologic impact assessment was conducted in the field trials under WPs 5-7 according to the common handbook for ecological impact assessments.
In **WP9**, a common protocol to describe production system parameters and cost/benefit analyses based on standard quantitative approaches was developed. The market introduction of new potato cultivars was conducted in 2013 and 2014 and presented to the public.
Dissemination (**WP10)** took place via the CO-FREE homepage and 2 issues of the newsletter.
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 Sanco, EGTOP, IFOAM EU, and on expert discussions. An exclusive training seminar for CO-FREE partners on registration issues took place in 2014.
There were changes in the consortium due to termination of participation of two partners and inclusion of a new partner (**WP11**).

The expected final results and their potential impact and use

The overall aim of the CO-FREE Project is to develop copper free organic and low input production systems while maintaining yield and quality of crops and reducing negative environmental impacts. During the first 36 months good progress was made. It was shown that by using CTPs in combination with different cultivars (e.g. potato), different production systems, DSS and in strategies, disease development and yield could be positively influenced. Due to unfavourable weather conditions several field trials were not easy to evaluate. Formulations of the CTPs and strategies will be further optimized addressing these obstacles.
In the end promising novel CTPs engineered under WPs 2 and 3 together with an optimized application strategy will be 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 will be 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 will be provided as a key component by CO-FREE through horizontal activities organised 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 will strongly contribute to the market introduction of up to 10 novel products of plant or microbial origin, will develop/refine smart tools for apple, grapevine, potato and tomato disease control, and will explore advanced apple and grapevine production systems with reduced dependency on pesticide inputs and will contribute to open the market for disease-tolerant cultivars. This will have wide socioeconomic impact on the use of copper.
To follow the CO-FREE project, see http://www.co-free.eu/.