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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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Project description

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 production 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.

Work performed and results

WP1 addresses the co-ordination of scientific activities. The consortium met twice to plan further steps and activities (**Del.1.2, Del. 1.3**). The CO-FREE homepage was successfully established (**Del.1.1**). In **WP2** and **WP3** alternative plant protection products (PPPs) from microbial origin and plant origin were further developed and their modes of action were analyzed. This work started in time and made good progress (**Del.3.3**). In **WP4** the use of the developed PPPs and management tools are optimized. Work included the establishment of a database with information of novel and established copper alternatives. The Decision Support Systems (DSS) for grapevine and potato were further adapted.

PPPs from CO-FREE were tested in the field. In apple, PPPs showed some effect on primary infection of leaves with apple scab in Northern Italy when applied as stop treatment. The climate in 2012 was extremely difficult and demonstrated the limits of preventive strategies tested in 'very low input' and 'no PPP input' production systems in Switzerland: In 2012, a first major outbreak of virulent *Venturia inaequalis* populations was observed. In the evaluation of agroforestry systems total apple yields were higher and incidence of apple scab was less than half of those in orchard apples. Solitary and bumblebee abundance was higher in the orchard, while predatory and parasitic wasps were more abundant in agroforestry. (**WP5**). In trials conducted in Italy in 2012, a high pressure of grapevine downy mildew was observed which highlighted the limits of the pilot PPPs in their current form, if used as stand-alone treatments. In France in 2013 a high pressure of grapevine downy mildew was observed which limited the efficacy of the tested PPP. In Greece, frequent treatments with CO-FREE PPPs over 5 months had no adverse effects on yield nor on quality of grapes. (**WP6**). In potato field trials conducted in Germany, the application of new

PPPs increased yield of cv, Ditta clearly but not statistically significant by up to 4 t / ha (35%). In Poland small differences in yields of both varieties with respect to treatments and cultivar were noted. In field trials conducted in France, alternative PPPs tested so far provided little if any protection against potato late blight. A questionnaire targeted to identify key traits in the different types of organic potato crops was developed and distributed. In south west France and Greece none of the pilot PPPs controlled *P. infestans* on tomato under low and high disease pressure conditions (**WP7**). Initial toxicity bioassays with the beneficial arthropod *Coccinella septempunctata* were set up in Greece. In addition the EC₅₀ values for *Selenastrum capricornum* and *Daphnia magna* will be determined for the first four available alternative compounds and gradually for the rest of the PPPs of the project. The toxicity tests on the earthworms *Eisenia foetida* (compost worm), and *E. albitus* (white potworms) according to Guidelines of OECD 207, 1984 and OECD 220, 2004 as non-target soil indicator organisms were set up. According to the handbook for ecological impact assessments on arthropods impact of novel PPPs, assessment of strategies and production systems in the field were conducted (**WP8; Del.8.9**). A common protocol was designed to describe production system parameters and cost/benefit analyses based on standard quantitative approaches. A report has been published on literature review and expert consultation to identify key-obstacles and promising strategies to introduce new sustainable food products in different supply chains (**WP9; Del.9.3, Del. 9.4**). The CO-FREE homepage was established to spread results and information concerning the project. On conferences and meetings, exchange with the different stakeholder groups took place. The frame and venue of a workshop in the second year was discussed with the ABIM steering committee. There were changes in the consortium due to termination of participation of two partners. The coordinator set up an amendment process to deal with this (**WP10**).

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 18 months a good progress was made. It was shown that by using PPPs in combination with different cultivars (e.g. potato) and different production systems, the yield could be positively influenced. Due to unfavourable weather conditions the field trials were not easy to evaluate and so the formulations of the PPPs and strategies will be further optimized addressing these obstacles.

In the end promising novel PPPs 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/>.