Minimisation strategies for copper pesticides in organic potato cultivation

STEFAN KÜHNE[1]

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Abstract

It can be stated that, now and in future, any successful copper minimisation strategy must be based on the implementation of all preventive measures, the further reduction of copper application rates, and the development of alternative pesticides. First results of the EU CO-FREE project (Innovative strategies for copper-free low input and organic farming systems: www.co-free.eu) have shown, that the high safety effect of copper-based products is difficult to achieve using alternative products. This paper describes short-, medium- and long-term measures for the implementation of copper minimisation strategies in organic potato production.

Introduction

Current application of copper pesticides in German potato production:

Late blight (Phytophthora infestans (Mont.) De Bary) regularly causes high yield and quality losses in organic potato cultivation. More than 70% of German organic potato producers have blight-related yield losses ranging from 15 to 20 %, depending on the growing region (Kühne et al 2013). Currently, copper-based pesticides are the only effective agents for direct control of the disease. Since the 1980s, organic farming associations in Germany have limited copper use to 3 kg per ha per year. Farmers in the Demeter Association may not use any copper in potato cultivation and thus have higher yield losses. Copper pesticides are not used routinely, but only when there is a risk of late blight infection and when yield and quality losses are expected. In the middle of the year, farmers do not use more than 1.5 to 2 kg copper per ha per year. In some regions and during dry years, copper treatments are often omitted entirely. In the early stages of infection or during high disease pressure, however, the maximum rate of 3 kg/ha/year is generally applied.

Material and methods

Two new copper-free pesticides against late blight in potatoes (variety Ditta) were tested at the Federal Research Centre for Cultivated Plants in Dahnsdorf, Germany (Brandenburg state) . The products, COFREE-1 (of microbiological origin) and COFREE-2 (of plant origin), were preventively applied six times at intervals of 7 to 10 days. The start of treatment was 04 June 2012 (Table 1). Potatoes treated with the two products were compared with untreated controls (UC) and with potatoes treated with copper hydroxide (300g Cu/l) using a randomised, single-factor block design with four replicates and a plot size of 6x34 m per treatment. The test site was certified for organic farming according to EU guidelines (control no.: D-BB-043-4143 A; soil type: sandy loess sL, mean annual precipitation: 526 mm). The Öko-SIMPHYT forecast model was used for treatment timing.

Results

The time course of late blight infestation in experimental plots treated with the different products is shown in Figure 1. It is clear that copper application delayed the time when 60% of the leaf area was destroyed by leaf blight by about 6 days (black bar). In this stage of tuber development, yields of about 0.9 t per hectare and day can be made (Möller 2002). The surplus was statistically significant ($P < 0.1$) and was 6 tons/ha higher than in untreated controls (UC) (Figure 2).

The new copper-free products do not yet achieve satisfactory yield stability. They delayed infestation of 60% of leaf area for only about two days and achieved yield increases of up to 4 t/ha, but this was not statistically significant.

[1]Federal Research Centre for Cultivated Plants, Germany, www.jki.bund.de, eMail: stefan.kuehne@jki.bund.de

Table 1: Regimen for application of copper-based (copper hydroxide (Cuprozin fl) = 300g Cu/l) and copper-free pesticides. UC – untreated controls, COFREE-1 (of microbiological origin), COFREE-2, (of plant origin)

Date of treatment	Variant 1 UC	Variant 2	Variant 3	Variant 4
04 JUNE 2012	-	COFREE-1	COFREE-2	-
15 JUNE 2012	-	COFREE-1	COFREE-2	-
27 JUNE 2012	-	COFREE-1	COFREE-2	copper hydroxid, 2,5 l/ha = 750 g Cu/ha
05 JULY 2012	-	COFREE-1	COFREE-2	copper hydroxid, 2,5 l/ha = 750 g Cu/ha
12 JULY 2012	-	COFREE-1	COFREE-2	-
20 JULY 2012	-	COFREE-1	COFREE-2	copper hydroxid, 2,5 l/ha = 750 g Cu/ha
				Total = 2250 g Cu/ha

Discussion

First results of the field experiments performed in the framework of EU COFREE project have shown that the high safety effect of copper-based pesticides is difficult to achieve using copper-free alternatives (COFREE-1 and COFREE-2). Some of the most important and effective measures to prevent yield losses due to late blight are pre-sprouting seed potatoes, choosing a resistant variety, and ensuring a good supply of nutrients. With pre-sprouting, the start of yield formation can be earlier than about 10 days, late blight infection is delayed to a later time, and the potential yield losses are reduced. Table 2 shows the most important short-, medium-and long-term measures to reduce copper pesticides in potato production. This approach is based on the "Strategy document on copper as pesticides with special consideration of organic farming" (Palm et al. 2010), which is available on the JKI website (http://kupfer.jki.bund.de). The main points of this document are summarized in Table 2.

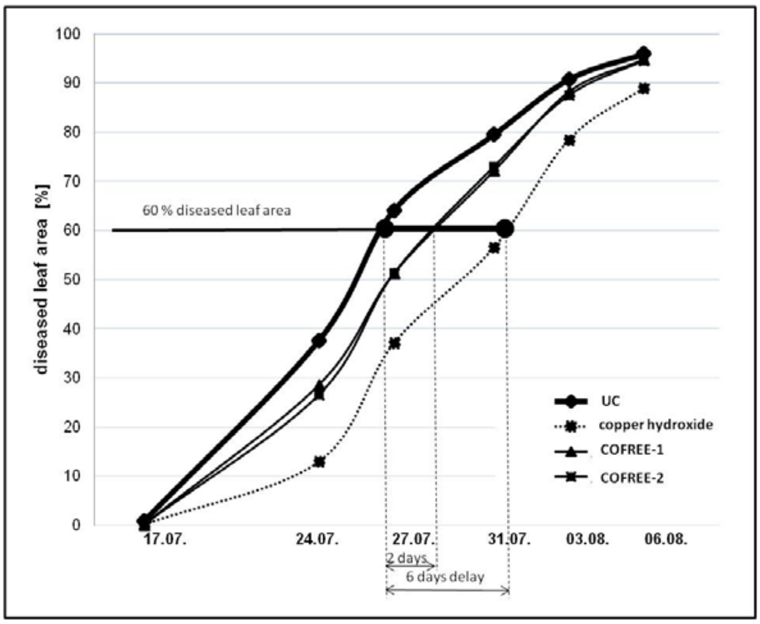

Figure 1: Time course of leaf area infected with late blight (Phytophthora infestans) in field experiments with the potato variety Ditta in 2012. UC = untreated controls, copper hydroxide 2250 g Cu/ha, COFREE-1 and COFREE-2 (copper-free agents of microbiological and plant origin)

Table 2: Copper minimisation strategy measures outlined in the "Strategy document on copper as pesticides with special consideration of organic farming" (Palm et al. 2010)

Short-term measures
Cultivation measures; Presprouting; Optimisation of the N supply; Physical separation of early and late varieties; Field design according to the main wind direction (the more vulnerable, the further downwind); Elimination of diseased plants; Variety selection; Use of eco-SIMPHYT forecast model; Optimisation of application technology; Check application of phosphonates; Use of pesticides with low copper formulations; Copper-based treatment of tubers; Strengthen plant protection consultation
Medium-term measures
Development of new plant protection products and plant strengtheners; Investigate the influence of crop rotation; Basic research on the epidemic curve; Knowledge transfer
Long-term measures
Development of new plant protection products and plant strengtheners; Breeding tolerant varieties; Knowledge transfer

A successful copper minimisation strategy must be based on the future implementation of all preventive measures, the further reduction of copper application rates, and the development of alternative pesticides. Their further use in organic farming required a listing in Appendix II on plant protection agents of the EC organic regulation.

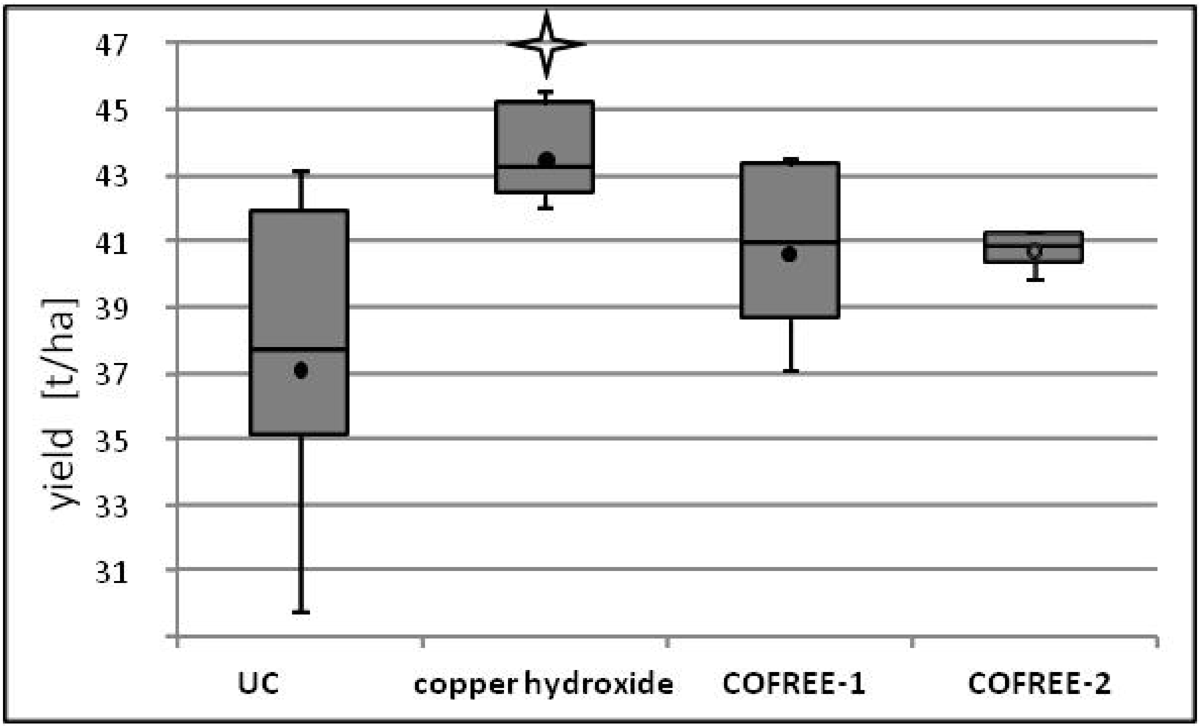

Figure 2: Yields of Ditta potatoes, in t/ha, in 2012. * Statistically significant difference to the untreated control (UC) (Simulate, P < 0.1). UC = untreated control, copper hydroxide 2250 g Cu/ha, COFREE-1 and COFREE-2 (copper-free agents of microbiological and plant origin)

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