Using Copper in Organic Viticulture: Doing it best with less?

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Abstract

For many years, applications of copper fungicides have been used to control downy mildew on grapes. Nowadays, its intensive use is under consideration due to ecotoxicological aspects, especially in organic viticulture. As a result, this project made allowance for consumer perception about organic viticulture and is seeking suitable alternatives. The project includes an association of six research facilities, four organic wineries, several consultant agencies for organic viticulture as well as SME (small and medium-sized enterprise) partners, which are working together in four work packages. The aim of this work is to obtain an array of products that provide sufficient control of Plasmopara viticola with the lowest possible input of copper. As a longterm intention, copper-containing products should be totally replaced by other effective agents. Progress to-date suggests that some non-copper products and several copper-based products using less than 3 kg/(ha·a) have potential to effectively control the disease with less ecological residue.

Introduction

Downy mildew on grapevines caused by *Plasmopara viticola* (Berk. & Curt.) Berl. & de Toni is one of the most important pathogens in viticulture worldwide. Generally, the control of this pathogen is achieved with fungicides or copper salt applications (Gisi, 2002). However, copper fungicides are under consideration for their harmful effects on the natural environment. In response, the Council Regulation (EEC) 2092/91 Annex II limits the use of copper compounds to 6 kg/(ha·a) from 2006 onwards. Moreover, German associations for organic farming concerted to limit the use of copper products to 3 kg/(ha·a). The cluster-project work is investigating a schedule for organic viticulture based on minimum use of copper products. It began in April 2004 and the research continues in 2007. The following aspects are included: greenhouse experiments, field trials in organically managed vineyards and on-farm tests in four organically managed wineries. Micro-vinification trials and assessment studies on side effects on beneficial organisms, phytotoxicity and *Botrytis cinerea* are part of this project. Additionally, studies including analyses of resistance genes are conducted to attain knowledge about the mode of action of selected test-agents. This paper gives an overview of the current data selected in all four aspects of this work. With respect to organic viticulture, alternatives for copper applications as well as new copper-containing products are being screened for their efficiency to obtain sufficient

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regulation of *P. viticola* with less than 3 kg/(ha·a) copper with regard to environmental purposes.

Materials and methods

The cluster-project consists of four work packages: Screening under greenhouse conditions on potted vines (work package 1) and field experiments in organically managed test vineyards (work package 2) – the latter include micro-vinification trials. In work package 3, studies on four organically managed wineries are being conducted. SME and consultant partners will assure a close link between research and wineries (work package 4). By a screening process under greenhouse conditions on potted vines (work package 1), test agents should be selected for further trials in work package 2. Four potted vines (*Vitis vinifera* cvs. 'Riesling' or 'Mueller-Thurgau'; BBCH 16-18) were used for each treatment. Vines sprayed with plant protection products (Folpan 80 WDG (a.i. Folpet) and Cuprozin Flüssig (a.i. copper hydroxide)) and with distilled water alone, served as controls. Greenhouse trials were accomplished with new copper formulations (reduced copper concentration), a plant resistance improver, plant extracts, plant oils and finely ground stones. Disease assessments were made on six leaves per potted vine whereas disease severity (defined as % infection per leaf area) of the lower leaf surface was also recorded. In organically managed test vineyards (work package 2) located at six different research facilities in Germany, the selected test agents of work package 1 were evaluated. The control plots of the greenhouse experiments and the field tests were comparable: (i) untreated control, (ii) Folpan 80 WDG and (iii) Cuprozin Flüssig. In addition, sulphur applications were used to prevent powdery mildew infestation. A randomised block design with four replicates was chosen for the experiments. The sprays were applied with an air-assisted application gear (Schachtner Company, Germany). The spraying interval covered about ten days. Disease incidence (in %) and disease severity (in %) both of the lower leaves surfaces and of the berries per bunch, respectively, were recorded. Additionally, micro vinification, analyses of musts and wines and, finally, a sensory evaluation by a professional test panel of the Geisenheim Research Center were conducted. Moreover, possible side effects on beneficial organisms (e.g. *Typhlodromus pyri*) were assessed and an additional rating of *B. cinerea* was included. Work package 3 combined the results of work packages 1 and 2 and examined the applicability of different treatments under practical conditions on four German organically managed wineries (pilot sites). Furthermore, knowledge gained from this work was presented to wine growers by seminars and by publications in magazines regarding more practical aspects of viticulture (work package 4). These work packages were coordinated by Dr. Uwe Hofmann (**ECO-Consult,** Geisenheim, Germany).

Results

Greenhouse experiments (work package 1)

Based on their performance in these experiments, formulations of the substance categories “new copper formulations with reduced copper amount”, “plant extracts”, “plant oils”, “finely ground stones” and “algae extracts” were selected for further experiments in the test vineyards of the research facilities. It was possible to select about 20 substances with potential against downy mildew for the field tests in the years from 2004 to 2006.

Table 1. Overview of results and side-effects obtained in 2004, 2005 and 2006. ++ = very good efficacy; + = good efficacy, (+) = minor efficacy ,– = no efficacy and 0 = no disease pressure, n.e.= not examined.

year	products	biological effect downy mildew			side effect on					
		green house	field test	pilot site	*T. pyri*	*Botrytis cinerea*	must	wine	sensory panel	phyto-tox.
2004	control_copperhydroxide	n.e.	+	n.e.	+/-	n.e.	-	-	-	-
	standard organic schedule	n.e.	+	n.e.	+	n.e.	-	-	-	-
	copperoxychloride-1	n.e.	(+)	n.e.	+	n.e.	-	-	-	-
	finely ground stones-1	n.e.	+	+	+/-	n.e.	-	-	-	-
	phoshonate-1 *until BBCH6 8*	n.e.	++	+	+	n.e.	-	-	-	-
	phoshonate-3 *BBCH 68*	n.e.	+	n.e.	+/-	n.e.	-	-	-	-
2005	control_copperhydroxide	++	+	n.e.	+/-	+/-	-	-	-	-
	standard organic schedule	++	+	n.e.	+	-	-	-	-	-
	copperoxychloride-2	++	+	+	+	(+/-)	-	-	-	+
	finely ground stones-1 new	++	+	+	-	-	-	-	-	-
	phoshonate-1 *until BBCH 6 8*	++	++	n.e.	-	+/-	-	-	-	-
	phoshonate-3 *BBCH 68*	++	++	n.e.	-	-	-	-	-	-
	finely ground stones-2	+++	++	n.e.	-	-	-	-	-	-
	copperoxychloride-3	++	+	n.e.	-	-	-	-	-	-
	algae extract	++	--	n.e.	-	-	-	-	-	-
	algae extract + copperhydroxide	++	-	+	+/-	-	-	-	-	-
2006	control_copperhydroxide	++	+	n.e.	+/-	-	-	Data are not on hand		-
	standard organic schedule	++	0	n.e.	-	-	-			-
	copperoxychloride-2 new	++	+/-	+	+/-	-	-			-
	copperhydroxide new	++	+/-	n.e.	-	-	-			-
	finely ground stones-1 first application BBCH 13	++	+	n.e.	n.e.	-	-			-
	phoshonate-1 until BBCH 68	++	+	n.e.	-	-	-			-
	phoshonate-3 BBCH 68	++	0	n.e.	+	-	-			-
	finely ground stones-2 first application BBCH 13	++	+	n.e.	+	-	-			-
	algae extract first application BBCH 13	++	(+/-)	n.e.	-	-	-			-
	algae extract first application BBCH 13 + copperhydroxide	++	(+/-)	+	+	-	-			-
	plant extract first application BBCH 13 + copperhydroxide	++	+	n.e.	+/-		-			-
	plant extract first application BBCH 13 +finely ground stones-1	++	+	+	n.e.	-	-			-

Field trials 2004 - 2006 (work package 2)

The years 2004 and 2006 were characterized by a low natural infestation level of *P. viticola* in the wine growing district Rheingau, Germany. Therefore, the organically managed plot in Geisenheim could not be evaluated in 2004 and 2006. In 2005, an early primary infection (7th May; growth stage: BBCH 13/14) and a high infestation

level of *P. viticola* occurred. In addition, secondary infection cyles started on the 21th May, 2005. However, the application intervals were started on the 25th May 2005. With the benefit of hind-sight, the start of the applications was indeed too late. Therefore, inflorescences were attacked by *P. viticola* severely. Regarding all conducted studies including side effect assessments in 2004 and 2005 (table 1), the tested products have had no impact on wine quality. Only the tested copperoxychloride-2 had an effect on the predator mite and had caused phytotoxicity on leaves and berries. A new formulation was tested in 2006 and had shown no phytotoxicity.

Discussion

In the year 2005 the efficacy of phosphonates, finely ground stones as well as new copper formulations were as successful as the reference treatments Folpan 80 WDG and “organic standard” (standard organic treatment schedule including a mixture of copper fungicide, sulphur and finely ground stones), respectively. Considering the low amount of the total copper of less than 2 kg/(ha*a) and the delayed start of the applications, the gained results are satisfactory. Unfortunately, under high infestion levels, the new copper products achieved insufficient efficacy (unpublished data). However, the results of the investigations of the years 2004, 2005 and 2006 gained from the Research Center Geisenheim and in the vineyards of the five partner institutes indicated that plant extracts in combination with copper, finely ground stones and new copper formulations could serve as plant resistance improvers and plant protection products, respectively, to manage medium size attacks of *P. viticola*. As a result, it was possible to select several potentially useful products and application strategies for the growing period 2007.

Conclusions

Preliminary greenhouse and field studies have indicated that it might be possible to use less than 3 kg/(ha*a) copper in an effective spray program against grapevine downy mildew. Products with potential for use in this program to handle medium infection pressure from *P. viticola* include a new copper product, an improved formulation of finely ground stones, and a mixture of a plant extract with copper compounds. Up to now, it has not been possible to control high infection pressure from *P. viticola* without copper applications.

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