Efficacy testing of novel organic fungicides and elicitors: from the lab to the field

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***Abstract* – Novel organic fungicides and elicitors against downy mildew on grapevines were evaluated on grapevine seedlings in a series of indoor screening experiments under controlled conditions and, if they have shown a good efficacy indoors, in a screening vineyard under field conditions.**
From 39 products tested under controlled conditions 10 were further examined under field conditions.
All of the new products tested under field conditions showed at least partial efficacy. However, the efficacy was not good enough to protect grapevine plants sufficiently from downy mildew. For a complete replacement of copper in plant protection against downy mildew on grapevine in organic agriculture, additional new products are needed.[1]

INTRODUCTION

Plant protection against downy mildew in organic viticulture is strongly dependant on the use of copper. Due to the forseeable ban of copper in plant protection in the EU, alternative solutions are urgently needed.

The development of new plant protection products is a long and costly process. When a potential substance, plant extract or biocontrol agent is available in standardised quality, efficacy testing against various pathogens on important agricultural crops is a next step.

To increase the number of products that can be tested and to optimise the often limited amount of field work, a system of screening on seedlings and under natural conditions was established.

MATERIALS AND METHODS

Efficacy testing for fungicidal and elicitor activity was performed on grapevine seedlings (cv. Chasselas). The seedlings were treated with test substances when 3-4 leaves were fully expanded. The test substances were applied in an automatized spray cabinet (plants exposed to spray for 20s; 1,2 bar at spray nozzle). Each test substance was tested in at least 2 concentrations and compared to reference substances (i.e. copper and BABA). Subsequent to application, plants were either incubated for 5 days before challenge inoculation (elicitor screening) or inoculated 1 day after treatment (fungicide screening). The inoculation was performed by applying two individual 10 µl drops of sporangia suspension of *P. viticola* (100'000 sp/ml) per leaf (elicitor screening) or spraying of whole plants with a sporangia suspension (fungicide screening). Subsequently, plants were incubated during 24 h at 100% RH and 21°C and then grown 6 d at 60-80% RH at 20°C (light regime: 16h day/8h night). Plants were incubated for 12 h at 100% RH and darkness prior to disease assessment. The standard disease assessment included disease incidence (proportion of leaves showing symptoms) and disease severity (proportion of infected leaf surface) and/or lesion diameter.

The field experiments were carried out in the screening-vineyard of FiBL in Frick, Switzerland. The plot consists of 576 plants of the susceptible grapevine varieties 'Riesling-Sylvaner' ('Müller-Thurgau') and 'Chasselas' ('Gutedel'). Twelve different treatments were arranged in a „Randomized Block Design", with four replicates, each consisting of six plants per variety. Besides an untreated control, a copper treatment ('Kocide DF') and a systemic fungicide ('Aliette'), the test products and strategies were deployed weekly. The plants were treated with an air assisted knapsack sprayer until near run-off.

During the growing season, visual disease scoring was carried out several times by recording disease incidence (proportion of leaves with symptoms) and disease severity (proportion of diseased leaf area) of *P. viticola* on leaves and by recording disease severity (%) on grapes (Table 4). The experiments were carried out following the relevant EPPO-guidelines.

RESULTS AND DISCUSSION

Indoor screening

In general, infection levels of control treatments were stable and reproducibility of results was satisfactory, meaning that the test systems are well suited to perform primary screenings of fungicidal activity. However, results of elicitor screening tend to vary considerably between experimental sets. The reference elicitor used as a standard (BABA) showed variable effects. Several of the substances were run in two independent experimental sets in order to obtain a more precise assessment of the substances' potential. Many of the tested substances are not well formulated for application on grapevine. However, elicitors need to interact with plant tissue and therefore depend on spread on the plant's surface. The efficacy of candidate substances might therefore be considerably improved by optimum formulation.

Approximately 75% of all tested substances showed no effect on disease expression. Of the remaining 25% of test substances, some had only

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slight effects at the dosage which is recommended by the manufacturer. However, efficacy at lower dosages in indoor screenings is necessary, if any activity in the field may be expected.

Based on the results of the indoor screening trials 10 out of 39 test substances were recommended to be tested under field conditions. Priority was given to products which with proven activity and high efficacy as well as availability and formulation.

Results of field screenings 2004 and 2005:

The first symptoms of grapevine downy mildew were observed on June 14th in 2004 and on May 30th in 2005. In 2004 disease pressure was high; disease incidence reached 100% in the beginning of August in the untreated control. In 2005 disease pressure was even higher, in the untreated control, disease incidence reached 100% already in mid of July.

In both years the reference treatments with copper (Cuprofix 2004, Kocide DF 2005) and with a systemic fungicide (Aliette) gave good protection of the grapevine plants against downy mildew (Fig. 1). The use of Aliette is not an official strategy, but this product is included because of its systemic mode of action. The total amount of copper used during the season 2005 was 6.8 kg per ha, which is more than the maximum of copper allowed in Switzerland.

The use of a reduced amount of copper ('Strategy Low Copper' 0.4 kg/ha and year) gave a good protection against *Plasmopara* on leaves; however protection of the grapes was not sufficient with this copper concentration. Treating the grapevine plants first with Mycosin plus Stulln Sulphur and later on with Copper (2.8 kg Cu/ha yr) protected leaves and grapes well from downy mildew of grapes.

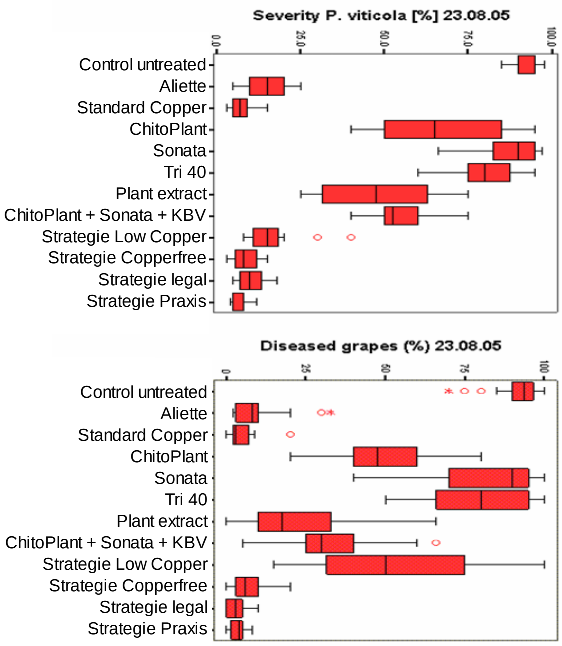

Figure 1. Effect of plant protection products strategies against Plasmopara viticola on grapevine plants cv 'Müller-Thurgau' under natural conditions. Disease severity on leaves (Figure 1A) and grapes (Figure 1B) recorded visually on August 23rd 2005. Each data box represents the values of four replicates of six plants each.

The strategic use of Myco-Sin, Stulln-Sulphur and copper („Strategy Praxis", see also the paper by Tamm et al., this volume), showed a similar efficacy against *P. viticola* during the whole season as the reference treatments. However, some phytotoxic symptoms (small black dots and small necrotic areas on the leaves) were observed. This is a known effect, caused by the switch from copper to Mycosin plus Stulln Sulphur when there was less than 15-20 mm of rain.

As copper free variants, besides the new test products, acidified clay mineral products were applied (Myco-Sin combined with Stulln-Sulphur in both years and Myco-Sin Vin in 2004). In all of these treatments in both years, efficacy against *P. viticola* was good and the grapevine plants were well protected.

In both years, phytotoxic effects on the grapevine plants and leaves were observed after the application of inducers of resistance (PEN and BABA in 2004, ChitoPlant in 2005). Compared to the untreated control, a slight decrease of disease was observed in these treatments (Fig. 1). However, the leaves and grapes were not protected enough against grapevine downy mildew for a use of these products in practice.

In 2004, a slightly reduced incidence of grapevine downy mildew compared to the untreated control was observed in the treatments Stimulase, Inulex and Agricure but the efficacy of these treatments was not sufficiently high to substantially reduce the disease. In 2005 the same was observed for the treatments Tri-40, Plant extract, Sonata and the combination of ChitoPlant, Sonata and KBV 99-01.

Conclusions and Outlook

Of the new products that have shown promising results against grapevine downy mildew on seedlings under controlled conditions, none has shown high efficacy against the disease under natural conditions. All of the products tested showed slight effects, but the protection against the disease was insufficient compared to standard treatments. The way of a product from the lab to the field is hard, only very few reach the level of field testing.

Under Swiss conditions a replacement of copper seems to be possible with clay-mineral products, however, these products have other possible disadvantages.

Within the framework of the EU-project "Replacement of copper fungicides in organic production of grapevine and apple in Europe" a new series of promising products will be tested under controlled conditions. From further indoor screening experiments done in winter 2005/6, five products were recommended for field screening in the season 2006. From all of these experiments we hope to find at least one or two products or strategies that show good protection in field screenings, so that they can be tested on a larger scale in on-farm-trials in the season 2007.

Acknowledgement

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