

Revus Top

A new product for the control of *P. infestans* and *Alternaria* in potatoes in Europe

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SUMMARY

Revus Top is a new fungicide developed by Syngenta Crop Protection for the control of *Phytophthora infestans* and *Alternaria spp.* in potatoes. The compound contains mandipropamid and difenoconazol from which the last one is a new active ingredient for the control of *Alternaria* in potatoes in the North of Europe. Efficacy trials against late and early blight were carried out in Austria, Belgium, the Netherlands, Czech Republic, Denmark, Germany, France, Sweden, United Kingdom and Switzerland between 2008 and 2010. The results show that Revus Top is very effective to control both diseases in a rate of 0.6 liter per hectare when compared to current standard compounds. The compound is safe for crop yield, quality and propagation material.

KEYWORDS

Phytophthora infestans, *Alternaria spp.*, potatoes.

INTRODUCTION

Targets of the product

Late blight (*Phytophthora infestans*) is one of the world's most devastating crop diseases. The disease can rapidly cause severe foliar damage, leading to very significant loss of tuber production. Additionally infection of the tubers at any time – either in the field or in subsequent storage – will lead directly to the loss of edible yield.

The “early blight of potato”, caused by two fungi of the genus *Alternaria*, can occur in susceptible varieties even before the “late blight of potato”, which is caused by *Phytophthora infestans*. Massive infestation becomes visible generally in late summer in depending on weather during the vegetation period. Damage caused by *Alternaria spp.* occur predominantly in dry and warm crop areas or in years with dry and warm weather during spring and early summer because of the higher temperature demands and the lower dependence on moisture of the pest organism. Damage occurs in form of

reduced yield as a result of reduced assimilation surface and early ripening of the crop. Connected to a reduced assimilation surface and early ripening is a reduced starch content resulting in total yield losses of up to 30%.

It is important to notice that any protection measure against Early Blight has to be combined with protection against Late Blight as in Europe Late Blight is the dominant, always occurring disease.

Composition of Revus Top

Revus Top is a suspension concentrate (SC) containing 250 grams per liter (g/l) mandipropamid and 250 grams per liter (g/l) difenoconazole for use on potatoes. Registered rate will be 0.6 liter per hectare (l/ha) with a maximum of three applications per season.

Mandipropamid is a highly effective fungicide against most foliar Oomycete pathogens. It belongs to the chemical class of the mandelamide fungicides and is the first compound of this class for commercial use. Mandipropamid has a high affinity to wax layers of plant surfaces. After the spray liquid reaches plant surfaces, the major part of the active ingredient is absorbed into the wax layer and is fully resistant to wash-off by rain as soon as the spray deposit has dried. A small amount of active ingredient penetrates into the plant tissue. Due to its high intrinsic activity, the amount taken up into the plant tissue is sufficient to stop mycelia growth inside the plant and to protect the opposite leaf surface by translaminar movement. These properties of mandipropamid ensure consistently excellent, long lasting disease control.

Mandipropamid is highly active against spore germination. It also inhibits mycelia growth and sporulation. Mandipropamid is best used as preventive spray against the target diseases but also provides curative activity during the incubation period.

The biochemical mode of action of mandipropamid and all other CAA fungicides has just recently been discovered and is the inhibition of cellulose biosynthesis. No direct effects of mandelamide on other metabolic processes such as respiration or synthesis of cell walls, proteins, sterols or amino acids were observed.

Mandipropamid has been registered against Late Blight (*Phytophthora infestans*) on potatoes as REVUS since 2006 in almost all EU countries. The formulation contains 250 g mandipropamid per liter and is applied at 0.6 l/ha which will deliver 150 g mandipropamid per hectare.

Difenoconazole is a translaminar fungicide with long-lasting preventative and curative broad-spectrum-control, including leaf spot diseases, powdery mildews, rusts and scab of annual and perennial crops. It is active against plant pathogens from the Deuteromycetes, Basidiomycetes and Ascomycetes.

Difenoconazole is from the triazole class of chemistry and its mode of action is similar to other triazoles. Its main biochemical mode of action is the inhibition of the sterol biosynthetic pathway of fungi, which stops the development of fungi by interfering with the biosynthesis of sterols in cell membranes.

Taken up by the plant, difenoconazole acts on the fungal pathogen during penetration and haustoria formation. It stops the development of fungi by interfering with the biosynthesis of sterols in cell membranes. Interference with sterol biosynthesis leads to disruption of membrane function, leakage of cytoplasmic contents and hyphal death.

Difenoconazole is currently registered and used in European countries for repeated applications at dose rates between 100 and 200 g ai/ha, depending on the country.

The active ingredient difenoconazol is new for *Alternaria* control in potatoes in North of Europe.

The combination of mandipropamid and difenoconazole in Revus Top will provide long residual foliar control against both important potato pathogens Late Blight (*Phytophthora infestans*) and Early Blight (*Alternaria spp.*).

EFFICACY RESULTS

Laboratory and glasshouse tests

Mandipropamid is highly active against *Phytophthora infestans* in potatoes and tomatoes, *Plasmopara viticola* in grapes and against *Pseudoperonospora cubensis* in cucurbits in greenhouse tests in whole plant assays. In Figure 1 results are shown from a comparison of mandipropamid with key competitive compounds against *Phytophthora infestans*. Applications made 1 day before (preventively) artificial inoculation. 5 days after inoculation (6 days after spraying) mandipropamid gives around 90 % control. These results show that mandipropamid provides clearly better preventive disease control than the reference standards cymoxanil or dimethomorph, when used at the same application rates. For field use the recommendations for cymoxanil is 100-150 g ai/ha and for dimethomorph 150-200 g ai/ha.

At equal application rates mandipropamid is also clearly more effective than the preventive standard mancozeb. For field use mancozeb is recommended at 1000-2000 g ai/ha.

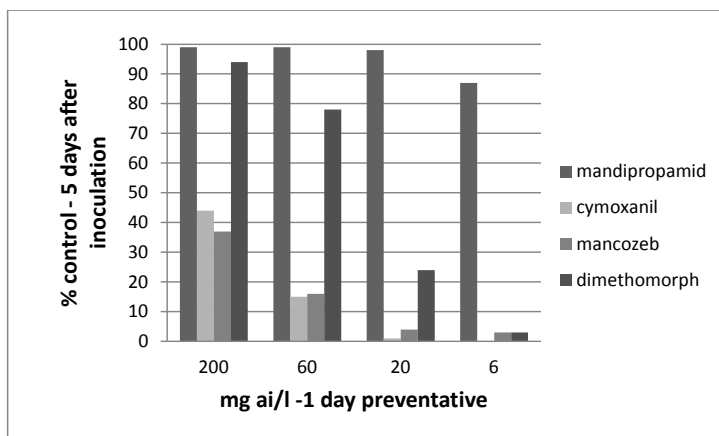


Figure 1. Comparison efficacy of several active ingredients against *Phytophthora infestans*

Difenoconazole is highly active against *Alternaria solani* in potatoes and tomatoes. Typical results from greenhouse screening tests with different difenoconazole rates against *Alternaria solani* in potatoes are summarized in Figures 2 and 3.

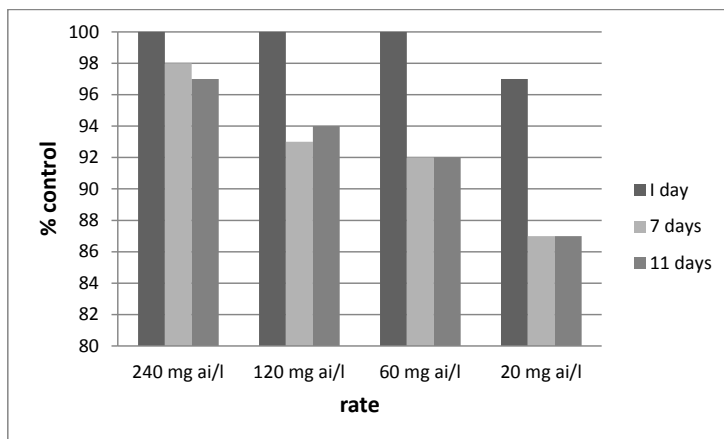


Figure 2. Difenconazol efficacy against *Alternaria solani*. Preventative spraying 1, 7 and 14 days before inoculation. Assessment 6 days after inoculation.

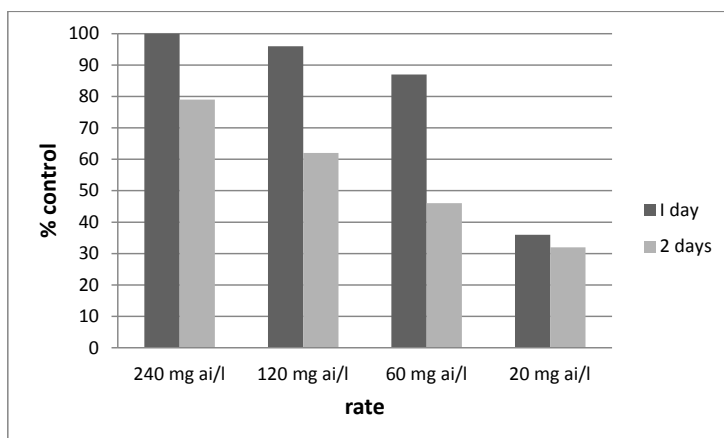


Figure 3. Difenconazol efficacy against *Alternaria solani*. Curative spraying 1 and 2 days after inoculation. Assessment 6 days after inoculation.

The results in Figures 2 and 3 show that difenoconazole provides a very good control of *Alternaria solani* by both preventative and curative action.

However, difenoconazole does not only provide activity against *A. solani* but also on the other *Alternaria* causing species *A. alternata*. Comparing the efficacy of difenoconazole on the two *Alternaria* species appearing on potatoes, *A. solani* and *A. alternata*, it has to be stated that the intrinsic activity against *A. solani* is somewhat higher than against *A. alternata* (Figure 4).

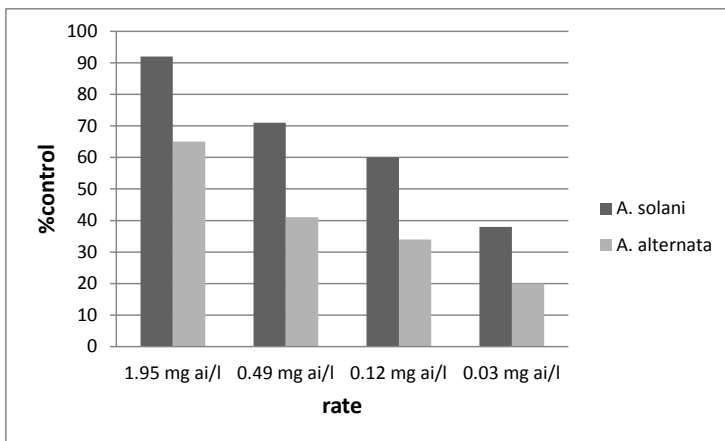


Figure 4. Difenconazole efficacy against *Alternaria solani* and *A. alternata*. (Petri dish tests)

Field tests

Phytophthora infestans

To investigate the efficacy of Revus Top in field potatoes against Late blight (*Phytophthora infestans*) 21 efficacy trials were carried out. These trials were carried out between 2008 and 2010 in Belgium, Czech Republic, Denmark, Germany, France, Ireland, The Netherlands, Sweden, Switzerland, and the United Kingdom. The objective was to confirm the performance of Revus Top at 0.6 l/ha (150 g mandipropamid +150 g difenoconazole /ha) in season long applications.

In all trials Revus Top at 0.6 l/ha was compared with the commercial reference product Revus at 0.6 l/ha. In average Revus Top showed an excellent control of Late Blight relative to the untreated (eff. = 87 %) and was in all cases equal or statistically superior (two cases) to the reference product Revus (average eff. = 84 %).

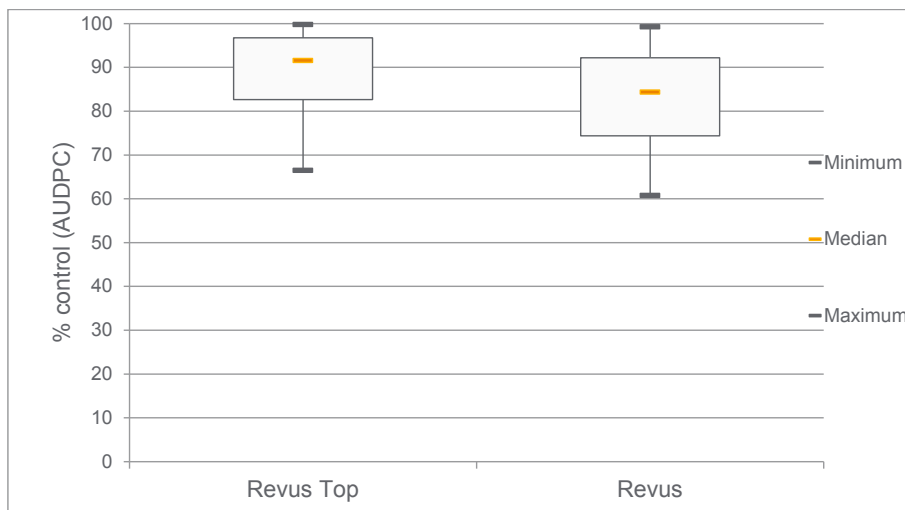


Figure 5. Efficacy of Revus Top and Revus against Late Blight (Box-Whisker, n = 21)

Revus is in the Euroblight ranking systems (updated January 2012) evaluated over the last couple of years as the strongest compound currently registered on the European market for the control of *Phytophthora infestans*. Revus Top is equal to better than Revus showing the strong performance of the formulations on this disease.

The strong performances of Revus Top is also experienced in a trial carried out in 2011 in the Benelux comparing Revus Top with a lot of standard compounds registered on the Dutch market, including Revus.

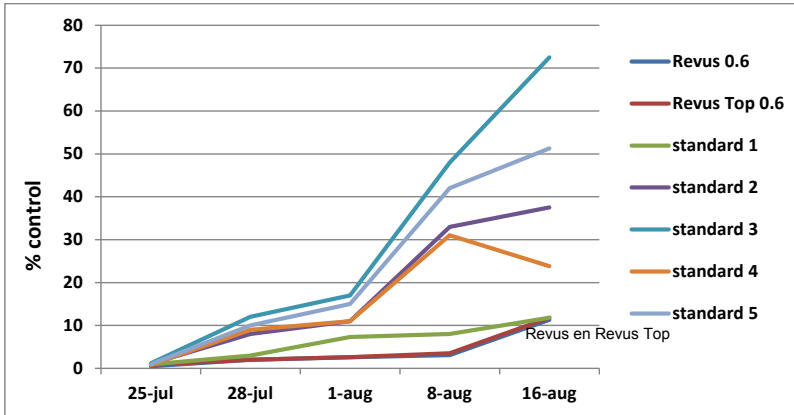


Figure 6. Trial in the Benelux in 2011 with Revus Top for the control of *P. infestans*.

***Alternaria* spp.**

13 Efficacy trials to check the efficacy of Revus Top against Early Blight (*Alternaria solani* and *A. alternata*) on potatoes are carried out between 2008 and 2010 in Austria, Germany, The Netherlands, Sweden and Switzerland. The objective was to confirm the performance of Revus Top at 0.6 l/ha (150 g mandipropamid +150 g difenoconazole /ha) in season long applications.

The results over three seasons demonstrated that the efficacy of Revus Top at the proposed label rate of 0.6 l/ha matches the efficacy of standard compounds. This rate should thus be considered to be effective against Early Blight (*Alternaria solani* and *A. alternata*) on potatoes.

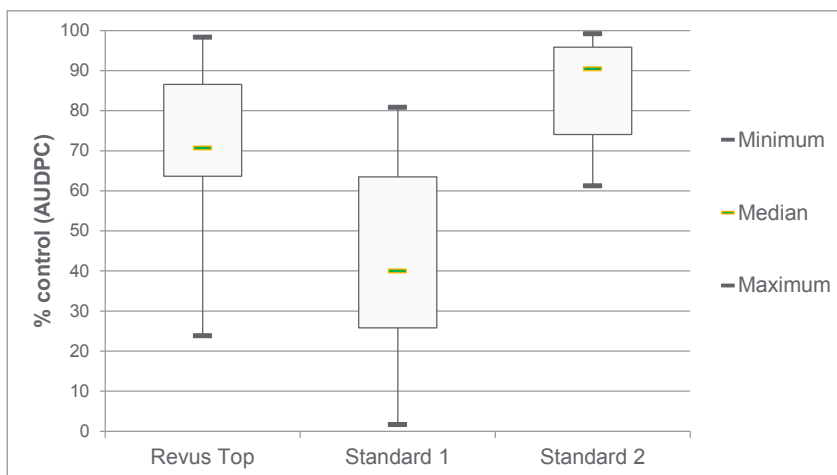


Figure 7. Comparison Revus Top with standard compounds against Early Blight (Box-Whisker, n 9)

Effects on yield and quality and other aspects

In 35 trials in 11 different countries with 19 different varieties as Amado, Bintje, Dali, Elkana, Felsina, Gala, Hermes, Kardal, Karnico, King Edward, Jumbo, Rooster and Secura no observation of phytotoxic effects were observed. No negative impact of Revus Top on yield, grading of the harvested product nor on propagation material were found.

Revus Top is not harmful to honeybees and safe to *Aphidius rhopalosiphi*, *Typhlodromus pyri*, earthworms and soil micro-organisms.

Revus Top has no restrictions on following crops nor on adjacent crops.

The maximal number of three registered applications for Revus Top are regarded as sufficient to minimize selection, no additional anti-resistance strategies are deemed necessary.

