

Infito[®]: Protection against different *Phytophthora infestans* isolates of the A2 & A1 mating type

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SUMMARY

Infito[®] is a liquid coformulation of fluopicolide and propamocarb-HCl, a well-established potato fungicide with strong translaminar and curative properties, and has been specifically developed for effective and long-lasting control of potato late blight. In this study, we investigated the efficacy of Infito[®] and three other fungicides against recent field isolates with different MLGs of *Phytophthora infestans* under greenhouse conditions. The results in this study indicate no shift in sensitivity to Infito[®] in either A1 or A2 multilocus genotypes from European potato fields. Infito[®] demonstrated its reliable high efficacy on both A2 genotypes tested, 33_A2 MLG (A2_Green 33) and 13_A2 MLG (A2_Blue 13).

KEYWORDS

Infito[®], *Phytophthora infestans*, potato late blight, increased aggressiveness, A1 & A2 mating type, multilocus genotypes

INTRODUCTION

Potato late blight, caused by the oomycete pathogen *Phytophthora infestans* is considered to be the economically most important potato disease globally (Kroon *et al.*, 2011). *P. infestans* has migrated from Central or South America to Europe in the 1840's and spread rapidly throughout Europe in the next decades (Yoshida *et al.*, 2013). The population of *P. infestans* remained stable until beginning of the 1980's due to asexual reproduction of the solely appearing A1 mating type. With the arrival of the new A2 mating type in Europe in 1976, sexual reproduction and gene recombination between the two mating types allowed new populations to develop. These population changes have resulted in significant adjustments in the epidemiology of the pathogen especially in recent years, such as shorter life-cycles, reduced latent periods and earlier primary infections (also at lower temperatures) leading to increased aggressiveness and more severe damage to the potato crop (Lees *et al.*, 2008).

The pathogens genetic diversity can be monitored using different genetic markers. The simple sequence repeats (SSRs) recently have been proved effective for defining multilocus genotypes (MLGs) (Lees *et al.*, 2006). The most recent examples of aggressive new genotypes in Europe

are 13_A2 MLG, that first emerged in 2004 and rapidly displaced other genotypes (Cooke *et al.*, 2012), and 33_A2 MLG, first emerging in 2009 in The Netherlands.

In conditions of higher and more severe disease pressure, farmers need effective and reliable fungicides to assure a good protection against potato late blight without increasing the overall number of applications. Fluopicolide is a novel fungicide of the new chemical class, acyl picolides, developed by Bayer CropScience. It exhibits a high level of efficacy against a wide range of oomycete diseases. Fluopicolide has a novel biochemical mode of action and does not show cross resistance with other chemical families, including phenylamides (metalaxyl-M, mefenoxam). It combines strong translaminar properties and contact activity, with long-lasting disease control at low dose rates.

Infito[®] is a liquid coformulation of fluopicolide and propamocarb-HCl, a well-established potato fungicide with systemic and curative properties. The suspension concentrate (SC) contains 62.5 + 625 g a.i./liter of the respective active ingredients and has been specifically developed for effective and long-lasting control of potato late blight. Combining the two different modes of action with complementary fungicidal properties, Infito[®] is also a tool for a solid anti-resistance management. Infito[®] is rated in the EuroBlight fungicide table for leaf and tuber blight protection and is established in the European market as a key product against late blight.

In the present study, we investigated the efficacy of Infito[®] and several other fungicides against different multilocus genotypes of *P. infestans* (A1 and A2 mating types, field isolates from different European countries from 2008 and 2012) on four-week old potato plants under greenhouse conditions.

MATERIALS AND METHODS

Fungicide preparation: Four commercially formulated fungicides commonly used on potatoes or tomatoes were evaluated in this study: Infito[®] (active ingredients: fluopicolide and propamocarb-HCl), Shirlan[®] (active ingredient: fluazinam), Revus[®] (active ingredient: mandipropamid) and Ranman Top[®] (active ingredient: cyazofamid). We evaluated commercial formulations of the fungicides rather than the active ingredient alone to more realistically represent compounds that are used by growers in the field. The concentrations tested were according to the label recommendations. Fungicide solutions were prepared in sterile deionized water.

Fungal culture: Wild type isolates of *P. infestans* were obtained from infected leaf samples collected from commercial fields from 2008 to 2012 in Belgium, France, Germany, Poland and The Netherlands. The multilocus genotypes (MLGs) of the isolates were characterized by Dr. David E.L. Cooke using multiplex simple sequence repeat genotyping (Li *et al.*, 2013). In this study, three different *P. infestans* isolates were analyzed: A reference isolate from Germany (2008), a 33_A2 MLG isolate from The Netherlands (2012) and a 13_A2 MLG isolate from Germany (2012).

Whole-plant assay: For fungicide application, four to five-week-old greenhouse grown potato plants (cv Arkula) were sprayed to runoff with an automated spraying cabinet. 24 hours after application the plants were inoculated by spraying them with a sporangial suspension of 10.000 sporangia per ml of the appropriate *P. infestans* isolate. Inoculated plants were kept in a climatic chamber with 95% relative humidity and 20°C with a 16 hour photoperiod for 7 days. There were three replications for each multilocus genotype. Data regarding the proportion of leaf and plant blighted were visually estimated to calculate percent disease index (%DI).

RESULTS AND DISCUSSION

In this study, the protective efficacy of four different commercially available fungicides was compared against different European field isolates of *Phytophthora infestans* from 2012 under greenhouse conditions. All four tested fungicides were able to control disease development of the *P. infestans* reference isolate from 2008 on four-week old potato plants under the chosen conditions (figure 3). Mean control levels ranged from 76% for Shirlan[®] to 93% for Infinito[®] and 98% for Revus[®].



Figure 1. Efficacy of three selected fungicides used at the recommended dose rates against a *Phytophthora infestans* field isolate 13_A2 MLG under greenhouse conditions (**A:** Infinito[®] applied at 1,6 l/ha, **B:** Shirlan[®] applied at 0,4 l/ha, **C:** Revus[®] applied at 0,6 l/ha). Evaluation was done 7 days after inoculation

Against the two recent MLG isolates 13_A2 and 33_A2 from 2012 however, a clear difference in the efficacy of the four tested fungicides was observed (figure 3). MLG 13_A2 isolates are ranked amongst the most aggressive *P. infestans* isolates, showing among the shortest latent periods and the largest lesions on different potato cultivars (Cooke *et al.*, 2012). This highly aggressive genotype 13_A2 has been spreading in Western Europe from 2004 onwards. In 2006-2007 it was dominating in the Netherlands, France, United Kingdom, Switzerland, Germany and Belgium (Gisi *et al.*, 2011). Infinito[®] showed an excellent preventative efficacy against leaf infections of MLG 13_A2 (figure 1) while Shirlan[®], Revus[®] and Ranman Top[®] failed to limit the leaf infection of this isolate (figure 2). The mean efficacy levels against leaf infections of MLG 13_A2 were 75% for Infinito[®], 13% for Revus[®], 3% for Ranman Top[®] and 0% for Shirlan[®] (figure 3).

33_A2 MLG is a recent genotype that is detected in the Netherlands from 2009 onwards. 33_A2 MLG is an aggressive isolate able to replace other aggressive A1 and A2 isolates of *P. infestans* and dominates the *P. infestans* population in fluazinam treated fields (Schepers & Kessel, 2011). In the greenhouse experiments presented in this study Infinito[®] and Ranman Top[®] were able to suppress disease development of this MLG on potato leaves. The infested foliage area was 3% in the plants treated with Ranman Top[®] and 5% in the ones treated with Infinito[®] while it reached 63% in the Shirlan[®] treated plants (figure 2). In the potato plants treated with Revus[®] the infested leaf area was 27%. The efficacy of the four tested fungicides against 33_A2 MLG ranged from 97% for Ranman Top[®] and 95% for Infinito[®], to 73% for Revus[®] and 37% for Shirlan[®] (figure 3).

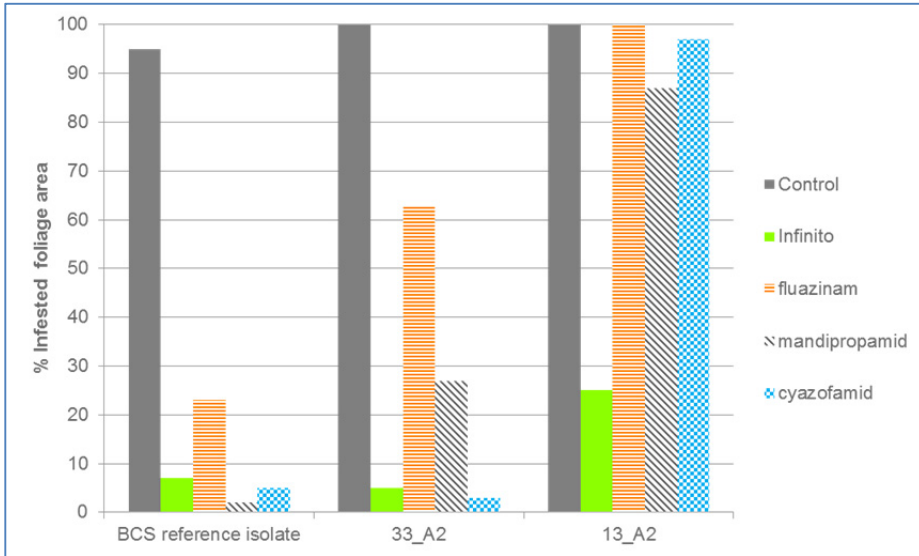


Figure 2. Mean intensity of infestation measured 7 days after inoculation of potato plants with 3 different isolates of *Phytophthora infestans*

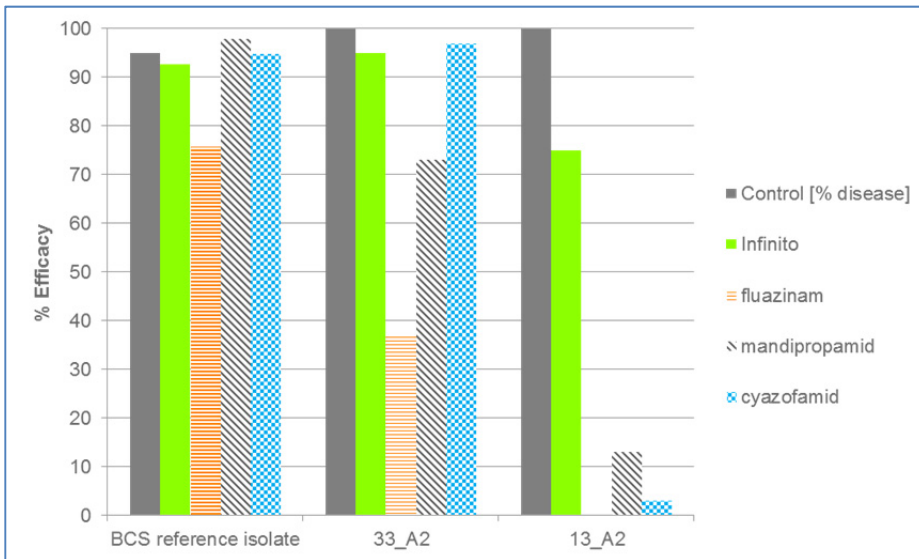


Figure 3. Mean efficacy of 4 different fungicides, measured 7 days after inoculation of potato plants with 3 different isolates of *Phytophthora infestans*

CONCLUSIONS

BCS conducts annual sensitivity monitoring programs to evaluate shifts in the European population of *Phytophthora infestans* against fungicides with different modes of action. As a result of this annual monitoring from 2008 to 2012 a change of importance of different isolates & genotypes of *Phytophthora infestans* in the main potato growing areas has been shown. The research work presented indicates no shift in sensitivity to Infinito® in either A1 or A2 multilocus genotypes from European potato fields. These genotypes can be found in increasing percentage in infected potato fields with some challenges in control with introduced standard products. Nevertheless Infinito® proved to have a continuously high efficacy on both A2 genotypes tested, 33_A2 (A2_Green 33) and 13_A2 (A2_Blue 13). In the European market Infinito®, is a leading fungicide with top performance against *Phytophthora infestans*. BCS recommends the use of Infinito® in spray programs in alternation with other fungicides.

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