

## **Infinito: protection of new growth from infection with *Phytophthora infestans***

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### **SUMMARY**

This paper presents the results from field / laboratory combined tests carried out in France and in the Netherlands in 2009 in order to improve methodology and to benchmark the efficacy of INFINITO (fluopicolide + propamocarb-HCl) and other fungicides in protecting potato new growth against *Phytophthora infestans*. The same methodology as described in literature was implemented: fungicides were applied in the field then leaves or shoots were sampled and transferred to the laboratory for inoculation at different intervals after treatment. New growth development and leaf expansion were rapid in France (more than 5 new leaves formed within 12 days) and slower in the Netherlands (3-4 new leaves).

On expanding and newly formed leaves, the experiments showed that Infinito gave similar new growth protection to other new growth reference products; when growth rates correspond to typical European northern countries situations with 3- 4 new leaves developed within 10- 12 days.

### **KEYWORDS:**

*Phytophthora infestans*, potato late blight, new growth protection, expanding leaves, newly formed leaves, Infinito, fluopicolide and propamocarb HCl

### **INTRODUCTION**

In the cultivation of potatoes, the protection of new growth against potato late blight caused by *Phytophthora infestans* during the period of fast vegetative development is one of the most important challenges for potato growers. During the growing season when the new growth of the foliage is rapid: typically 3-4 new leaves develop within 10-12 days in North Europe. Sometimes, depending on local climatic conditions, more than 5 new leaves may develop, and parts of the foliage may not be protected against the disease.

Since 2004, methodologies have been discussed and developed to evaluate the performance of fungicides for the protection of new growth (PPO-special report N° 10, Jersey 2004, 157-160). As a

result, the EU Fungicide sub-group agreed to new definitions and experiments combined together field applications, laboratory inoculation and disease assessments. New growth is defined as “growth and development of leaves present at the time of the last fungicide application and or newly formed leaflets and leaves that were not present (PPO-special report N° 11, Tallinn, 2005, 95-100). In addition, the following descriptions (used in the literature by several independent institutes and companies) have been used in this paper:

- Expanding leaves correspond to leaves present at the time of application without having reached their full size
- Newly formed leaves / completely new leaves are leaves which were not present at the time of application having developed later.
- Cut shoot: one stem separated from the plant, with several leaves.
- Cut leaf: one leaf separated from its stem, with its leaflets.
- Detached leaflet: leaflet separated from its leaf.
- Top (plant top): upper part of the one plant which consists in the terminal bud + one or several unfolded leaves.

The aim of the studies described in this paper was to evaluate the performances of Infinito for the protection of new growth of potatoes against late blight, in comparison with other commercial late blight fungicides in respect to new growth protection. In addition, some variations in the protocols mixing field and bioassay in the lab were tested.

## MATERIALS AND METHODS

Two series of experiments were conducted in 2009. In France, two potato crops were planted at different dates to provide 2 different growth rates. In the Netherlands, trials were conducted at PPO with 2 consecutive fungicide applications in the field at BBCH 31-32. Assessments were done both in field and in laboratory to validate the relevance of the lab test.

### *Field trials*

In France, 2 potato crops were planted with the variety “Bintje” at Bayer CropScience’s research farm at Villefranche-sur-Saône (Rhône). One fungicide application was made with a conventional sprayer at a volume of 300 L water /ha. For each experimental treatment, one single large plot was sprayed. Sampling of leaves and shoots was carried out when the growth rate was 3-4 new leaves within 12 days, and also when more than 5 new leaves developed within 10 days. Selected shoots were tagged with coloured rings just before fungicide application to identify the “new growth” which consisted of the top plant and three expanding leaves (fig.1 and 2). Bioassays were done on detached shoots and leaves.

In the Netherlands, the field trial was carried out at PPO in Lelystad on the variety “Bintje” with 4 replicates (4 rows of 10 metres). Cover sprays of Dithane Neotech were applied prior to specific fungicide applications. Two consecutive sprays of test fungicides were done within 7 day interval according to good agricultural practices at 250 L water /ha. One artificial inoculation was performed in the field the day before the second application. To increase the success of the infection in the trial, artificial irrigation was provided by sprinklers (fig.3).

The fungicides used in the experiments and their dose rates are shown in Table 1.

**Figures 1 & 2:** *Field overview at the time of treatment and close-up of a tagged potato shoot (BCS farm location near Lyon, France)*



**Figure 3:** *overview of the trial design in Netherlands at the development stage of the crop on the day of the first application*

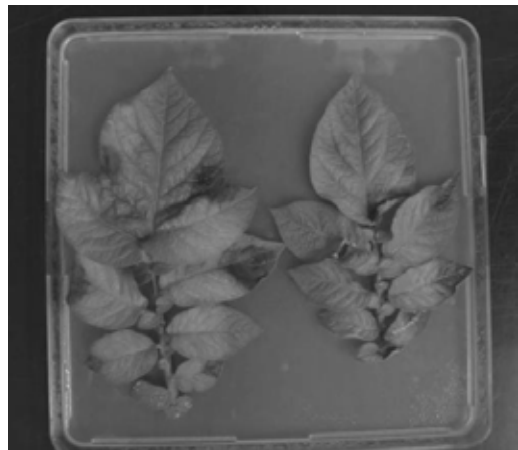
**Table 1:** Dose rates of commercial fungicides applied in field trials in France and Netherlands

Mode of action (distribution on/ in plant)	Fungicide ( dose rate)	Active ingredient (dose rate)
Contact	Shirlan (0.4 L/ha)	fluazinam (200 g a.i./ha)
	Dithane neotech (2.0 kg/ha)	mancozeb (1500 g a.i. /ha)
	Ranman (0.2 L/ha + 0.15 L/ha adj.)	cyazofamid (80 g a.i. /ha)
Translaminar + Contact	Revus (0.6 L/ha)	mandipropamid (150 g a.i. /ha)
	Valbon (2.0 kg/ha)	benthiavalicarb + mancozeb ( 25 + 1400 g a.i. /ha)
Translaminar + Systemic	Infinito (1.2 L/ha)	fluopicolide + propamocarb HCl ( 75 + 750 g a.i /ha)
	Infinito (1.6 L/ha)	fluopicolide+ propamocarb HCl ( 100 + 1000 g a.i /ha)

**Bioassays:**

In the French trials, 20 shoots and leaves from 20 different potato plants were collected and transferred to the laboratory 0 to 12 days after the fungicide applications and subsequently artificially infected with a suspension of *P. infestans* sporangia calibrated at 40 000 sporangia per ml. After inoculation, cut shoots were incubated in a climatic chamber at 16°C and fog humidity. Cut shoots were placed in bottles containing a nutrition solution of Murashige and Skoog to prevent wilting (fig.4). Detached leaves were incubated on agar amended with kinetine 1% survival medium in Petri dishes (fig.5). Disease assessment was performed 5 days after inoculation on either detached leaves of expanding leaves in Petri dishes, or on entire plants including three expanding leaves and plant top.

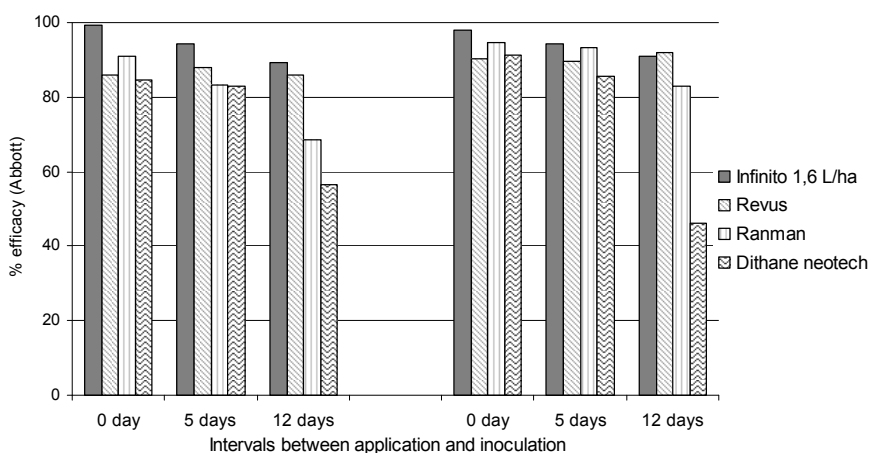
In the Dutch test, the leaves were picked from the preventively sprayed plot 6 days after the first spraying, but 12 hours before artificial inoculation. The uppermost 3-4 leaf layers of ten plants were sampled and inoculated in the laboratory. The inoculated leaves were placed in a climatic room at 15°C and 98% Relative Humidity. Disease symptoms were assessed one week after inoculation.

**Figure 4:** Cut shoot next to inoculation and incubation in climatic chamber at 16°C**Figure 5:** Detached leaf test in Petri dishes

## RESULTS

### *Bayer CropScience trials, France 2009*

In the trials a comparison of bioassay testing methods showed that protection of new growth on cut shoots was comparable to detached leaves (fig.6). However, efficacy results on whole cut shoots provided more reliable information than on the detached leaflets. In addition, this method was less time consuming. Therefore it is suggested that the whole cut shoot method is adopted for further testing of new growth protection.

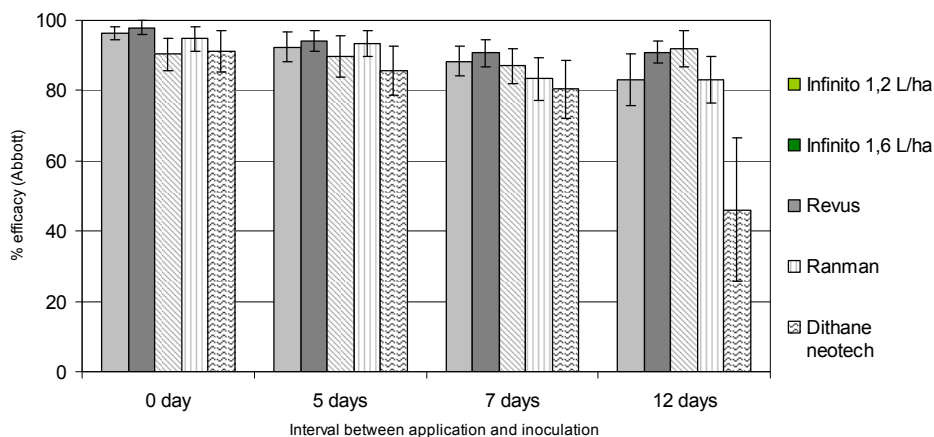


**Figure 6:** Comparison of laboratory testing methods (detached leaves compared to cut shoots) on new growth protection collected from the field 3 hours, 5 days and 12 days after treatment

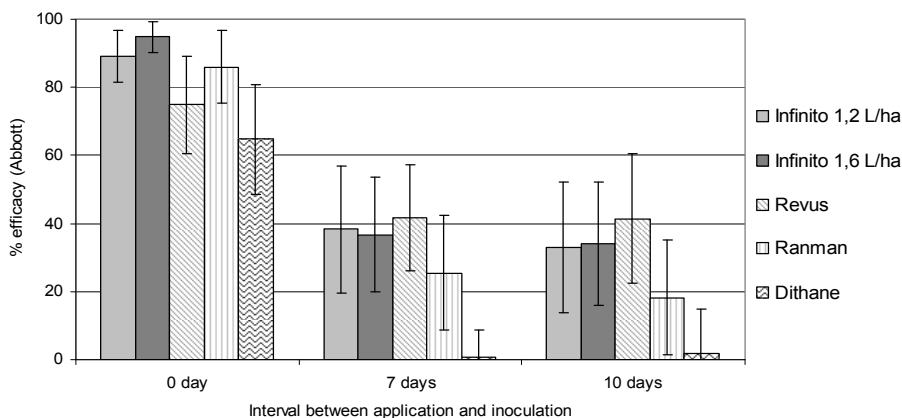
The results from the trial carried out in low growth rate conditions (3-4 new leaves within 10-12 days) and in high growth rate conditions (more than 5 new leaves within 10 days) are presented in figures 7 and 8.

Without rain-washing between treatment and sampling / inoculation all the products tested, Infinito at 1.2 and 1.6 L/ha, mandipropamid (Revus) at 150 g a.i./ha, cyazofamid (Ranman) at 80 g a.i./ha + 0.15 L/ha adjuvant were equivalent, and gave 80% protection of expanding leaves already present at the time of treatment. The efficacy of mancozeb at 1500 g a.i./ha gradually declined to 50% control, 12 days after treatment. On new growth, corresponding to very small apical leaves at the time of treatment, all the products except mancozeb provided around 80% efficacy when the interval between treatment and inoculation was 7 days.

In the second trial carried out in rapid growth conditions, 5.4 mm rainfall occurred 4 days after treatment. Mancozeb was inactive in an assessment on leaves formed and developed after treatment when sampling was carried out 7 and 10 days after application. In these conditions cyazofamid also showed only a very small effect. Infinito at both dose rates and mandipropamid averaged less than 40% efficacy.



**Figure 7:** Protection of expanding leaves in low potato growth rate conditions and no rainfall (field / lab cut shoots test)

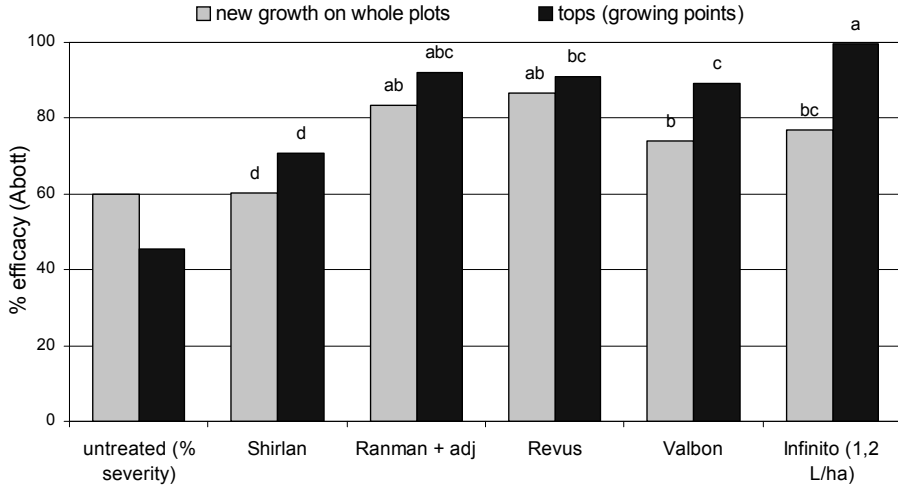


**Figure 8:** Protection of newly grown leaves in high growth rate conditions with 5.4 mm rainfall 4 days after treatment (field / lab cut shoots test)

The results from trials carried out in France demonstrated excellent protection of expanding leaves with Infinito and other fungicides except mancozeb. On newly formed leaves, all products were less effective and persistency was significantly reduced.

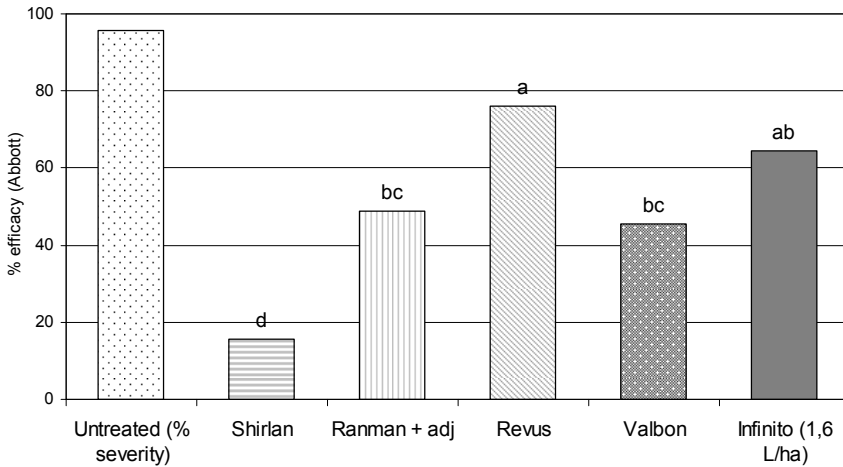
*Trials carried out by PPO in the Netherlands, 2009*

Results from field assessments, 9 days after artificial inoculation, showed the excellent efficacy of Infinito for the protection of new growth and plant tops corresponding to newly formed leaves (fig.9).



**Figure 9:** New growth protection in field trial carried out in Netherland conditions (2009). Assessment 9 days after inoculation

In the bioassay performed on expanding detached leaves collected 6 days after one preventive fungicide application, Infinito provided very good efficacy just following Revus, although differences were not significant. The protection offered by Valbon, Ranman + adjuvant and Shirlan were significantly inferior (fig.10).



**Figure 10:** New growth protection in field / bioassay tests on expanding detached leaf test carried out in the Netherlands (2009). Sampling 6 days after preventive fungicide application

## DISCUSSION-CONCLUSIONS

Consistent results were obtained with fungicides tested using different evaluation methods for new growth protection against potato late blight. Inoculations made on whole plants in the field or on cut shoots and expanding detached leaves in the laboratory demonstrated the performance of different fungicides with similar Euroblight rankings.

In practice, growth rates are often too low to make specific observations on newly formed leaves and/or expanding leaves in the field. Therefore the combined methodologies with fungicide applications in the field followed by inoculation and disease assessment in the laboratory offer valuable tools to determine the protection of new growth by different fungicides.

Infinito demonstrated good protection of new growth in comparison to the best market standards. Overall, the performance of Infinito, Revus and Ranman was at the same level, while the contact fungicides Shirlan and Dithane were clearly less effective. Although all fungicides offered only moderate protection of new growth under very fast growing conditions, Infinito outperformed contact fungicides Ranman and Dithane

Results from 2009 trials confirm previous data and support the Infinito rating (++) for new growth effectiveness in the EuroBlight fungicide comparison table (= mandipropamid and cyazofamid)

## REFERENCES

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