

# Mancozeb: Its Value to the EU Potato Industry

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**Abstract:** Mancozeb is a multi-site fungicide used to control late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*) in potatoes, and is currently due for re-approval as part of the EU Sustainable Use Directive—Authorisation of Plant Protection Products Regulation (EC) No 1107/2009. In order to understand its value to the EU potato industry, a stakeholder survey was conducted to understand the implications for *P. infestans* control and the impact on EU potato production if mancozeb was not available. In total, 319 growers and advisers were surveyed in 8 countries: France, Germany, Ireland, Netherlands, Greece, Italy, Spain and the UK, to determine how they use mancozeb, potential alternative control strategies and the implications of withdrawal. This study demonstrates that mancozeb is a widely used and cost-effective multisite active ingredient, which is a highly valued means of control for *P. infestans*. Based on the survey results, a loss of mancozeb would lead to a reduction in gross margin for potato producers in these countries of €87 million to €507 million depending on the level of *P. infestans* pressure. The combined impact of high cost of production and increased risks is likely to lead to reductions in the availability of EU potatoes and increased costs to consumers. In addition, an assessment was completed to determine the impact of mancozeb withdrawal on fungicide resistance development to single-site acting fungicides, finding that the loss of a multi-site active ingredient like mancozeb would severely compromise fungicide resistance management.

**Key words:** Mancozeb, potato blight, *Phytophthora infestans*, potato, resistance management.

## 1. Introduction

Mancozeb is used to control late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*) in potatoes. It is a key component of anti-resistance strategies due to its multisite activity [1], so less prone to resistance development than fungicides with a single mode of action. *P. infestans* is the major foliar disease affecting potatoes in the EU, with a typical European potato crop receiving 8-12 fungicide applications per season. Here, mancozeb is often used in co-formulations or tank mixtures due to its multisite activity. In the UK, mancozeb was the second most commonly applied foliar fungicide on potato crops after cymoxanil in 2014, with over 90% of the UK crop area treated with at least one dose and almost 40% receiving more than four doses [2].

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1107/2009. In 2014 stakeholders were surveyed on the implications for EU potato production if mancozeb was not available. Likewise, an assessment was completed to determine the impact of mancozeb loss on the development of resistance in other fungicide mode of action groups used to control late *P. infestans*.

## 2. Description

ADAS has developed a methodology [3] for assessing the value of active substances to the agriculture industry, which has been adapted to assess mancozeb. Farm gross margins (for each individual country, based on published data (UK [4], Germany [5], Ireland [6]) and expert insight (France, Netherlands, Greece, Italy, Spain) were scaled up to industry level, linking the impacts—identified through stakeholder interviews—to the proportion of the crop currently treated with mancozeb. And 51% of the European potato area (1.68 million ha [7]) is covered by countries in this assessment.

And 319 grower and adviser (stakeholder)

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interviews or questionnaires were conducted in France, Germany, Ireland, Netherlands, UK, Greece, Italy and Spain (during 2014 and 2015) to understand mancozeb use and possible alternative control strategies, as well as the potential impact on variety choice, yield and cost of production. This information was aggregated and used to identify average yield impacts and cost of production increases for each country, in the short term, if mancozeb was not available—for both low and high disease pressure situations.

Trait-based risk assessment was used to identify longer term impacts of mancozeb loss, given its value in fungicide resistance management strategies [8]. To do this, the first detection of resistance (FDR) following introduction was calculated for the key fungicide groups currently available to control potato *P. infestans*.

### 3. Results and Discussion

Almost 64% of stakeholders were growers (representing 1% to 2% of each national potato area), whilst 36% were professional advisors (covering 5% to 10% of each national potato area). Over 89% of stakeholders used mancozeb, either alone, in tank mixtures or in co-formulations. Usage level in individual countries was relatively consistent with 70% to 100% of the crop area receiving at least one (often more) mancozeb application per season. The exception was Italy where usage was lower due to Integrated Pest Management (IPM) requirements. National usage statistics were not widely accessible in all countries, although UK mancozeb usage is reported at 80% of crop area based on the Pesticide Usage Surveys [9].

In low disease pressure years, most stakeholders predicted limited yield impact from mancozeb withdrawal in the short term, as alternative actives provide good control. In Germany and Ireland, a 3% to 4% average production reduction, even in a low pressure year was identified (Table 1). Overall, it was

estimated that in the absence of mancozeb, assuming a low pressure year, there would be a 1% to 2% reduction in potato production (425,000 to 529,000 tonnes).

In a high pressure year, the majority of producers—except in France—expected to see a production reduction ranging from 3% to 18%, although certain German advisers predicted up to 31% losses in extreme cases. This variation could be down to the virulence of *P. infestans* in each country, differences are in early *P. infestans* prevalence and perception of what a “high” pressure year is.

Production is estimated to fall by 7% to 8% (2.5 to 3.0 million tonnes), if all countries were simultaneously affected by high *P. infestans* pressure. This assumes crop areas remain the same, despite increased production risk, so in reality the decline may be greater.

Importantly, mancozeb alternatives were widely cited as more expensive, increasing production costs for growers if mancozeb is not used. Alongside a reduction in yield, this means that gross margins will be negatively affected by its loss. Nationally, mancozeb withdrawal could cost between €0.6 (Italy) to €247 million (Germany), depending on *P. infestans* pressure, crop area and level of use. Therefore, gross margins for the eight countries are predicted to decline by between €87 million and €507 million (Table 1).

#### 3.1 Resistance Management

Predicted FDR time can be used to demonstrate the risk of resistance development to *P. infestans* for active substances considered to be medium to high risk and to support retention of products that contribute to resistance management strategies. All the “predicted” FDR times given are from the year when the mode of action group was first introduced. The predicted time to FDR for phenylamides was 6.9 years using the model, and resistance or reduced sensitivity to *P. infestans* was reported for phenylamides four years after introduction in Switzerland [10]. Mancozeb

**Table 1** Impact of the loss of mancozeb on potato production in eight European countries and scaled up to EU8 level, as well as reduction in industry gross margin, based on grower and adviser views.

Country	Baseline potato production thousands tonnes	% Reduction in national production				Reduction in industry gross margin (€M)				
		Low <i>P. infestans</i> pressure		High <i>P. infestans</i> pressure		Baseline industry gross margin	Low (grower)	High (grower)	Low (adviser)	High (adviser)
		Grower	Adviser	Grower	Adviser					
France	6,888	-0	-0	-0	-7	790	-4	-12	-11	-88
Germany	10,656	-4	-4	-17	-17	639	-62	-238	-62	-247
Ireland	346	-4	-3	-18	-3	39	-5	-14	-3	-3
Netherlands	6,353	-0	-0	-3	-3	613	-3	-44	-3	-39
UK	5,398	-0	-0	-4	-4	840	-4	-56	-4	-56
Greece	665	-1	-1	-13	-13	89	-6	-37	-6	-37
Italy	2,789	-0	-0	-1	-1	246	-1	-4	-1	-4
Spain	2,162	-0	-0	-5	-5	241	-3	-31	-4	-34
Total (8 countries)	35,256	-1	-2	-7	-8	3,498	-87	-435	-93	-507

**Table 2** Predicted time to first detection of resistance for the major single site active fungicide groups used to control late *P. infestans* in Europe (based on the trait based risk assessment in Grimmer et al., 2014).

Group name	Active substances	Predicted FDR as average for group (years)	Year introduced	Resistance reported ( <i>P. infestans</i> )
Cyanoacetamide-oxime	cymoxanil	6.8	1976	No
PA fungicides phenylamides	metalaxyl-M, benalaxyl	5.9	1977	Yes
QI fungicides	cyazofamid, amisulbrom	3.5	2001 2007	No
QoI fungicides	famoxadone, fenamidone	4.1	1996 1998	No
Benzamides (pyridinylmethyl-benzamides)	fluopicolide	5.5	2006	No
Benzamides (toluamides)	zoxamide	6.1	2001 1988	No
CAA-fungicides carboxylic acid amides	dimethomorph, benthiavali carb-isopropyl, mandipropamid	4.2	2003 2005	No (laboratory mutants have been produced [11])
QoSI fungicides	ametoctradin	7.8	2011	No

use has been widespread for disease control since then and a key component of anti-resistance strategies. The risk assessment suggests that the FDR time, for single-site acting fungicide active ingredients, is between 3 and 8 years. However, no resistance to these groups has been reported so far, which is surprising given that this active has been in commercial use for several decades (Table 2).

#### 4. Conclusion

As the interviews show, mancozeb is a widely used and comparatively cost-effective control option. Although the impact of withdrawal will differ by

country, it would have far reaching consequences across Europe as an additional cost for producers who have to use more expensive alternatives, with a fall in yield meaning a gross margin reduction of between €87 million (low pressure—grower estimate) and €507 million (high pressure—adviser estimate) across the EU8 countries.

Although in the short-term—especially in low pressure years—the effect on yield is likely to be minor, if resistance to alternative active substances occurs, the effect on yield would become much more significant.

New alternative active substances could be

developed, along with new *P. infestans*-resistant varieties. However, given that this could take more than 10 years, if mancozeb was withdrawn from the market in the next few years there would be insufficient time to develop and test new varieties or active substances.

Therefore, a loss of mancozeb will make future control of *P. infestans* more costly and challenging. Likewise, the risk of resistance development to single site active substances is increased, and time to resistance development is likely to be shorter. Widespread failures in control could occur in the future, due to resistance development, with yield losses from untreated *P. infestans* ranging from 10%-50% depending on infection severity and timing [12]. Although the cost to consumers was not directly calculated, an increase in cost of production and reduction in availability of supply are expected to lead to increased consumer costs.

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