Potato Fungicides

Technical Update – Ireland

February 2018

UPL Mancozeb Products

Mancozeb is a 'protectant contact multi-site fungicide' that is available as a 'straight' or as part of a formulated product. UPL Europe Ltd (UPL) has been involved with mancozeb for over 35 years and is today the world's largest mancozeb manufacturer. Table 1 provides information for some of the UPL mancozeb products that are marketed and approved for use on the potato crop.

Table 1. Products Containing Mancozeb Marketed by UPL Europe Ltd for Use on the Potato Crop

Product name	Actives	PCS No.	Final Use Date	Max. No. Apps	Max. Ind. Dose (ha/yr)	Max. Total Dose (ha/yr)	Harvest Interval (days)
NAUTILE DG	680 mancozeb 50 cymoxanil	04540	31.07.20	8	2.0kg	16kg	NS*
PENNCOZEB 80WP	800 mancozeb	03609	28.02.19 31.07.20	8	1.7kg	13.6kg	7
PENNCOZEB WDG	750 mancozeb	03608	31.01.19 31.07.20	8	1.7kg	13.6kg	7

* NS = Not stated

Nutrient Benefits of Mancozeb

Mancozeb is a complex of zinc and maneb containing 20% Mn (Manganese) and 2.5% Zn (Zinc) (ref. FAO Spec.), therefore it can supply useful amounts of these nutrients when applied regularly within a potato fungicide programme. Table 2 compares the amount of manganese supplied from **PENNCOZEB 80WP** and **PENNCOZEB WDG** compared to other sources of this nutrient.

Table 2. Comparison of Products Supplying Manganese

Product	Amount of Mn in 1.0 kg/litre	Amount of Zn in 1.0 kg/litre
PENNCOZEB 80WP	160g	20g
PENNCOZEB WDG	150g	18.75g
Manganese Sulphate	270g	—
Manganese 15%	150g	—

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Mode of Action of Mancozeb

Mancozeb will prevent spores from germinating and infecting the potato plant if applied prior to spore release, however, once the infection has occurred and the fungus has penetrated the leaf, it will no longer control the disease. Timing of mancozeb applications within a potato fungicide programme is important, as is the selection of partner actives.

Table 3. Mode of Action of Key Potato Fungicide Actives

Active	FRAC Code	Mode of Action	Target Code	Target Site	Group Name	Resistance Risk
dimethomorph benthiavalicarb mandipropamid	40	Cell wall biosynthesis	H5	Cellulose synthase	**c**arboxylic **a**cid **a**mides (CAA fungicides)	L to M
propamocarb	28	Lipid synthesis or transport/membrane integrity or function	F4	Cell membrane permeability, fatty acids	carbamates	L to M
oxathiapiprolin	49	Lipid synthesis or transport/membrane integrity or function	F9	Lipid homeostasis and transfer/ storage	OSBPI (Oxysterol binding protein homologue inhibitor)	M to H
zoxamide	22	Cytoskeleton and motor proteins	B3	β-tubulin assembly in mitosis	benzamides and thiazole-carboxamides	L to M
fluopicolide	43	Cytoskeleton and motor proteins	B5	Delocalisation of spectrin like proteins	benzamides	Not known
mancozeb maneb	M3	Multi-site contact	M3	Multi-site contact activity	dithiocarbamates	L
benalaxyl metalaxyl-M	4	Nucleic acids synthesis	A1	RNA polymerase I	**P**henyl**a**mides (PA fungicides)	H
boscalid	7	**Respiration**	C2	Inhibition of Complex II: succinate-dehydrogenase	SDHI	M to H
azoxystrobin pyraclostrobin famoxadone fenamidone	11	**Respiration**	C3	Inhibition of Complex III: cytochrome bc1 at Qo site	QoI-fungicides (**Q**uinone **o**utside **I**nhibitors)	H
amisulbrom cyazofamid	21	**Respiration**	C4	Inhibition of Complex III: cytochrome bc1 at Qi site	QiI-fungicides (**Q**uinone **i**nside **I**nhibitors)	M to H
fluazinam	29	**Respiration**	C5	Uncoupler of oxidative phosphorylation	Uncoupler of oxidative phosphorylation	L
ametoctradin	45	**Respiration**	C8	Complex III: cytochrome bc1 at Qo site (stigmatellin binding sub site)	QoSI fungicides (**Q**uinone **o**utside **I**nhibitor)	M to H
cymoxanil	27	Unknown	U27	Unknown	cyanoacetamide-oximes	L to M

* L = Low, M = Medium and H = High

Source: FRAC Code list 2017

Control of Early Blight, *Alternaria solani*, *Alternaria alternata* and *Alternaria tenuissima*

Loss of sensitivity to QoIs fungicides has been reported for *A.solani* in potato in the USA (Pasche and Gudmested 2008) and recent research in Germany has shown that *A.solani* isolates possessing the F129L mutation had reduced sensitivity to azozystrobin. The F129L mutation has been reported in Germany (2014) and the Netherlands (2013) but so far not in the UK. UPL commissioned 'Applied Plant Research Institute (Wageningen, NL)' to test the efficacy of fungicides on spore germination of *A.solani* in 2015. Results are shown in Graph 1 where the EC_{50} value for the germination rate of 15 different *A.solani* isolates are given for azoxystrobin, boscalid + pyraclostrobin and mancozeb.

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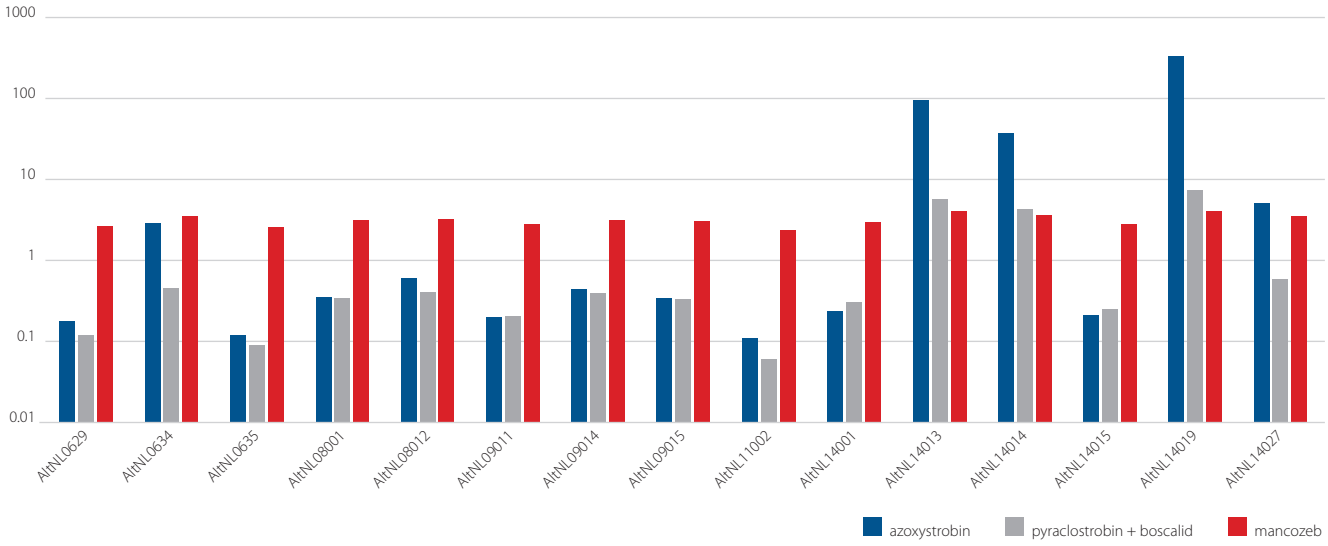
Graph 1. EC_{50} Values of Azoxystrobin, Boscalid + Pyraclostrobin and Mancozeb Showing the Germination Rate of 15 *A.solani* Isolates



Conclusions from the Wageningen Work were:

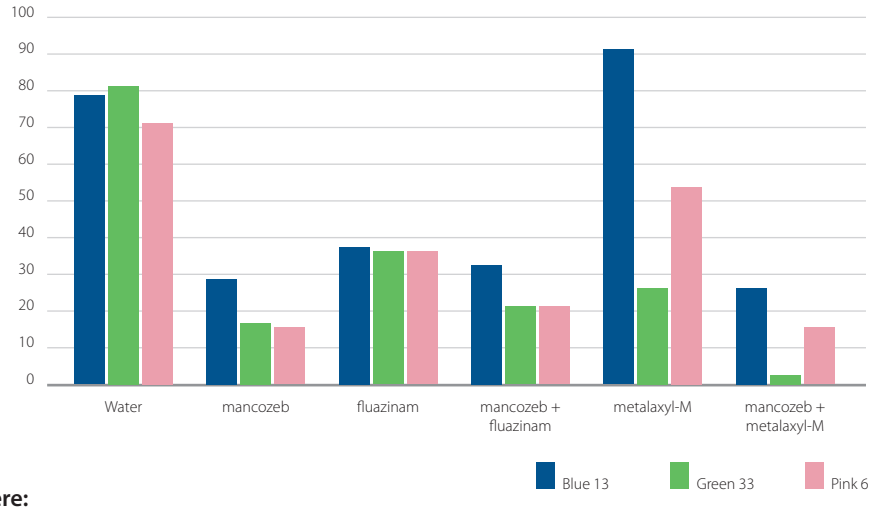
- Mancozeb was stable for all *A.solani* isolates tested, which indicated that there was no shift in sensitivity of *A.solani* to mancozeb.
- Values varied for azoxystrobin with some being very high, which indicated a reduced sensitivity to *A.solani* to this active and a shift in population.
- The values for boscalid + pyraclostrobin varied amongst the isolates tested, with some being moderately high compared to others, indicating a possible reduced sensitivity to these two actives.
- It cannot be concluded that higher values will lead to a lack of control in the field, however it could be an indication.

For further information on Alternaria in the UK potato crop there is an informative document 'Potatoes: Alternaria by Barry Florendine' which is available at www.fwi.co.uk/academy. In this article the inclusion of mancozeb was discussed with respect to alternaria control, suggesting that if mancozeb was included at rates of about 1500g per application then it may well be sufficient to keep alternaria under control. **Note:** to achieve this inclusion rate, mancozeb products as listed in Table 1 would need to be partnered with other mancozeb containing products.

Control of Late Blight, *Phytophthora infestans*

Wageningen also carried out work for UPL looking at the efficacy of fungicides to control different strains of late blight; these included the two dominant genotypes in the UK – Pink 6 and Blue 13 – as well as Green 33. Results showed that the Blue 13 isolate was more aggressive than the Pink 6 with the overall level of necrotic foliage higher in the treated potato plants inoculated with that strain. The efficacy of mancozeb to control the Blue 13 isolate was significantly better than the efficacy of fluazinam or metalaxyl-M on their own, however the combination of mancozeb + metalaxyl-M was significantly better than all other treatments (see Graph 2).

Graph 2. Percentage of Necrotic Foliage per Treatment Expressed as stAUDPC After Inoculation with 3 Different *P. infestans* Isolates.



Conclusions from the Wageningen Work were:

- Mancozeb is effective against all strains of *P.infestans* tested.
- Its efficacy is less against the Blue 13 as a consequence of high agressivity of this isolate.
- A combination of mancozeb + metalaxyl-M was beneficial.

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Mancozeb Summary

Mancozeb is a critical component of resistance management and integrated disease management programmes for early and late blight. It also provides a useful source of zinc and manganese.

UPL Cymoxanil Product

SACRON WG is a straight cymoxanil that must always be used in tank mix with a contact preventative fungicide such as PENNCOZEB WDG or PENNCOZEB 80WP. Key label information is provided in Table 4.

Table 4. Key Information for Sacron WG

Product name	Actives	PCS No.	Final Use Date	Max. No. Apps	Max. Ind. Dose (ha/yr)	Max. Total Dose (ha/yr)	Harvest Interval (days)
SACRON WG	450 cymoxanil	04541	28.02.22	8	0.22kg	1.76kg	14

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