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Field Efficacy of Mandipropamid for the Control of Potato Late Blight

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SUMMARY

The efficacy of mandipropamid (Revus 250 SC) in controlling *Phytophthora infestans* in potato was evaluated in field trials. The efficacies of Revus 250 SC in comparison with standard fungicides Quadris (azoxystrobin) were tested in several localities in Serbia (Kasarske Livade, Valjevska Kamenica and Opovo) in 2007 and 2008. Both of the tested fungicides exhibited high efficacy in controlling potato late blight. The differencies in the efficacy of Revus 250 SC (96.3- 99.2%) and Quadris (94.1-95.5%) were insignificant. Our experiments showed that the investigated fungicide was highly effective against *P. infestans* even under high disease pressure.

Keywords: Field trials; Potato late blight; Mandipropamid; Efficacy

INTRODUCTION

Potato late blight caused by *Phytophthora infestans* (Mont.) de Bary is the most important foliar and tuber disease of potato, both in field and under storage conditions (Fry and Goodwin, 1997). The incidence of a more aggressive strain of *P. infestans*, resistance of this pathogen to metalaxyl and the potential loss of some currently affective protective fungicides, contributed to the complexity of the issue (Kirk et al., 2000). The continuous search for new anti-oomycetic compounds, driven by resistance problems and the need for environmentally safe pesticides, suggested recently that mandipropamid may resolve the issue (Lamberth et al., 2006).

Mandipropamid is a new fungicide effective against foliar oomycete pathogens but it does not control *Pythium* spp. (Huggenberger et al., 2005; Cohen et al., 2007). Together with dimethomorph, flumorph, iprovalicarb and benthiavalicarb, it was classified into one group of carbixylic acid amide (CAA) fungicides, mainly because filed isolates of *Plasmopara viticola*, showed cross-resistance to all the members of the group (FRAC, 2005; Cohen et al., 2007; Gisi et al., 2007). The mode of action of CAA fungicides is not known. Biochemical studies with the mandelamide compound SX 623509 in mycelium of *P. infestans* suggested alternations in phospholipid biosynthesis, with inhibition of phosphatidylcholine (lecithin) biosynthesis as the main target (Griffiths at al., 2003; Cohen et al., 2007). The suggested inhibited enzyme was phosphocholinetransferase, the last enzyme in the Kennedy pathway (Griffiths at al., 2003; Cohen et al., 2007).

Mandipropamid is highly effective in preventing spore germination. It is also an inhibitor of mycelial growth and sporulation (Huggenberger et al., 2005). Being rapidly adsorbed to the wax layer of the plant surface, mandipropamid provides a rainfast and long-lasting barrier to fungal diseases (Lamberth et al., 2008). Mandipropamid has a moderate amount of translaminar and acropetal systemicity, and is most effective when used as a protectant fungicide; however, it has some degree of post-infection activity (Stein and Kirk, 2003).

The objective of this study was to evaluate the efficacy of mandipropamid against *Phytophthora infestans* in commercial potato fields in Serbia.

MATERIAL AND METHODS

Field experiments were conducted to evaluate the efficacy of mandipropamid (250 g/l, Revus 250 SC, Syngenta AG) against potato late blight. Azoxystrobin (250 g/l, Quadris, Syngenta AG) served as the standard treatment. Application rates are listed in Tables 2 and 3. All the trials were carried out in 2007 and 2008 in the following localities: Kasarske Livade (Šabac)(GPS: N 44 44 337; E 19 39 638), Valjevska Kamenica (GPS: N 44 19 638; E 19 41 542), and Opovo (GPS: N 45 02 092; E 20 27 290). The tests were laid down as randomized plots (25 m^2, 5.0 X 5.0 m), replicated 4 times with 90-100 plants/plot. Seed potato tubers (variety Desiree) were used in all the trials and sown into the soil between mid-April and early May.

Applications were made using a knapsack sprayer (Solo 425, Germany) to simulate practical applications by farmers (water volume: 600 liter/ha). Initiation of application was generally adjusted to local practice in Serbia, starting from BBCH (Biologische Bundesanstalt, Bundessortenamt and Chemical Industry) 55-65 (pre- to full-flowering) until BBCH 70-75 (beginning of maturity) (Meier, 1997). Five foliar sprays were applied in all the trials at approxymately 6-12-day intervals in preventive programmes. Application details are listed in Table 1.

Disease incidence was evaluated approximately two weeks after the last fungicide application. In every assessment, 20 plants in the central part of each plot were evaluated. Disease percentage on plants was rated on a scale of 0 (no disease) to 5 (more than 50% infested) according to EPPO guideline PP 1/2(3) (EPPO, 1997a). Disease severity was evaluated using Townsend-Heuberger's formula (Puntner, 1981):

Disease severity = Σ(scale x number of plants) x100 / 5x20

The data were analysed by one-way completely randomized ANOVA and means were compared according to Duncan's test (EPPO, 1997b; EPPO, 1997c).

Table 1. Application details for evaluation of fungicides against potato late blight

Year	Locality	Date of evaluation	Application interval (days)	Number of applications	Date of application
2007	Kasarske Livade	July 2	7-11	4	May 21, 29 June 8, 19
2007	Valjevska Kamenica	July 17	10-12	3	June 13, 25 July 5
2008	Valjevska Kamenica	July 21	7-11	5	June 3, 10, 16, 27 July 8
2008	Opovo	July 24	6-10	4	June 11, 17, 26 July 7

RESULTS

In 2007, disease pressure in the trials was significant with 13.4-31.3% infected potato plants per plot in the untreated control. All the treatments were effective against the potato late blight pathogen and reduced disease severity significantly in all the experiments, compared with the untreated plots. Among the tested fungicides, the higher concentration of Revus 250 SC showed the highest efficacy in all trials (97.1 and 99.0%) (Table 2). There was no significant difference between the efficacies of Revus 250 SC at both concentrations (96.3-93.8%) and standard fungicide Quadris (94.1 and 95.2%) (Table 2).

Table 2. *P. infestans* - Disease intensity on potato leaves and fungicide efficacy (locality: Kasarske Livade and Valjevska Kamenica, 2007)

Treatment	Rate (l/ha)	Kasarske Livade			Valjevska Kamenica		
		Disease severity (%)*	Sd[1]	Efficacy (%)	Disease severity (%) *	Sd[1]	Efficacy (%)
Revus 250 SC	0.6	0.1 a	0.1	99.0	0.9 a	0.6	97.1
Revus 250 SC	0.5	0.3 a	0.3	97.6	1.2 a	0.6	96.3
Quadris	0.75	0.7 a	0.2	95.2	1.8 a	0.4	94.1
Untreated Kontrola	–	13.4 b	2.3	–	31.3 b	3.0	–
LSD		1.9			2.6		

*Mean values in columns followed by different letters are significantly ($p<0.05$) different according to Duncan's test
[1] Standard deviation

Table 3 summarizes the data on disease intensity on potato leaves and fungicide efficacy in the localities Valjevska Kamenica and Opovo in 2008. Like in 2007 higher concentration of Revus 250 SC showed the highest efficacy in all the trials (97.1 and 99.2%) (Table 3). There was no significant difference between the efficacies of the tested fungicide Revus 250 SC (96.5-99.5%) and Quadris (94.6 and 95.5%) (Table 3).

Table 3. *P. infestans* – Disease intensity on potato leaves and fungicide efficacy (locality: Valjevska Kamenica and Opovo, 2008)

Treatment	Rate (l/ha)	Valjevska Kamenica			Opovo		
		Disease severity (%)*	Sd[1]	Efficacy (%)	Disease severity (%) *	Sd[1]	Efficacy (%)
Revus 250 SC	0.6	0.2 a	0.1	99.0	0.1 a	0.1	99.2
Revus 250 SC	0.5	0.8 a	0.2	96.5	0.4 a	0.1	98.0
Quadris	0.75	1.3 a	0.4	94.6	0.8 a	0.3	95.5
Untreated	–	23.3 b	3.6	–	17.6 b	2.2	–
LSD		2.9			1.8		

*Mean values in columns followed by different letters are significantly ($p<0.05$) different according to Duncan's test
[1] Standard deviation

Figure 1. Control – untreated plants (Locality: Valjevska Kamenica, 2008)

Figure 2. Treatment – mandipropamid (0.6 l/ha) (Locality: Valjevska Kamenica, 2008)

DISCUSSION

This study shows that the mandipropamid is highly effective against *P. infestans*, even under high disease pressure, confirming and extending the data obtained in previous trials conducted on potato in Israel (Cohen et al., 2007). The new products showed a remarkable activity against potato late blight ensuring longer intervals of protection during periods of high epidemic risk (6-12 days).

Similar trials carried out on several locations in Serbia, also showed that mandipropamid was the most effective in potato late blight control (Stević et al., 2007; Rekanović et al., 2008).

Whilst resistance to CAAs in *P. viticola* was detected in 1994, shortly after the introduction of dimethomorph in France, no resistance has been reported in filed isolates of *P. infestans*, even though dimethomorph has been in use for more than 15 years (Cohen et al., 2007; Gisi et al., 2007). The reasaons of this are lower fitness of resistant isolates *P. infestans*, different epidemiology of this two pathogens (oospores of *P. viticola* initiate epidemics in the spring, whereas *P. infestans* does not necessarily do so), and the fact that in *P. viticola*, resistance to CAAs in filed isolates was found to be controlled by recessive genes (Gisi et al., 2007). Recessive genes for resistance would need several sexual recombinations to be fixed in the population and expressed phenotypically, which in *P. infestans* may not happen frequently enough for establishment in the field (Cohen et al., 2007).

Sensitivity to the mandipropamid in *P. infestans* was measured for isolates collected between 1989 and 2002 in Israel prior to the commercial use of this fungicide (baseline sensitivity, 44 isolates), and from mandipropamid-treated (25 isolates) and untreated fields (215 isolates) in nine European countries and Israel between 2001 and 2005. All the isolates were sensitive to mandipropamide, with EC_{50} values ranging from 0.02 to 2.98 µg/ml (Cohen et al., 2007). Although this experiment suggests that isolates resistant to CAA fungicides may not appear in field populations, suitable anti-resistance precautions should be taken, including continuous monitoring, preventive use of the products, limitation of the number of applications per season (maximum 50 % of the total number of intended applications for late blight control), and use of CAA products within a spray programme with fungicides of other chemical classes (Cohen et al., 2007; Anonymous, 2009).

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Efikasnost mandipropamida za suzbijanje prouzrokovača plamenjače krompira u poljskim uslovima

REZIME

Ispitivana je efikasnost mandipropamida (Revus 250 SC) za suzbijanje *Phytophthora infestans* u usevu krompira u poljskim uslovima. Efikasnost preparata Revus 250 SC ispitivana je na nekoliko lokaliteta u Srbiji (Kasarske Livade, Valjevska Kamenica i Opovo) tokom 2007. i 2008. godine. Kao standard poslužio je Quadris (azoksistrobin). Oba ispitivana fungicida su ispoljila visoku efikasnost u suzbijanju prouzrokovača plamenjače krompira. Između efikasnosti Revus 250 SC (96.3- 99.2%) i Quadris (94.1-95.5%) nije utvrđena statistički značajna razlika. Naši ogledi su pokazali da je ispitivani fungicid visokoefikasan u suzbijanju *P. Infestans*, čak i u uslovima jake zaraze.

Ključne reči: Ogledi u poljskim uslovima; prouzrokovač plamenjače krompira; mandipropamid; efikasnost