

Field Efficacy of Fluopicolide and Fosetyl-Al Fungicide Combination (Profler®) for Control of *Plasmopara viticola* (Berk. & Curt.) Berl. & Toni. in Grapevine

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SUMMARY

The efficacy of new fungicide mixtures in controlling *Plasmopara viticola* in grapevine was evaluated in field trials. The efficacies of Profler (fluopicolide + fosetyl-Al) and the standard fungicide Mikal Flash (fosetyl-Al + folpet) were tested at Radmilovac and Slankamenački Vinogradi in 2006 and 2007. Both tested fungicides exhibited high efficacy in controlling grape downy mildew. There were no significant differences in the efficacies of Profler (96.1-99.7%) and Mikal Flash (94.9-99.2%). Our experiments showed that the investigated fungicide mixture fluopicolide + fosetyl-Al is highly effective against *P. viticola*, even when it is applied at long intervals and under high disease pressure.

Keywords: Grape downy mildew; Fungicide mixtures; Fluopicolide + fosetyl-Al; Efficacy

INTRODUCTION

Plasmopara viticola (Berk. & Curt.) Berl. & Toni., the causal agent of grapevine downy mildew, is a highly destructive pathogen on cultivated grapevine worldwide, especially during or after the blooming period, and may result in poor fruit set and poor fruit quality (Hewitt and Pearson, 1988). In vineyards located in western and central regions of Serbia, such as Mt. Fruška Gora and Vinča, as many as 8-10 applications of fungicides are required to control grape downy mil-

dew when seasonal conditions are conducive to epidemic development of the disease.

The primary component of all commercial management programs for this disease is the use of organic and inorganic fungicides (Wong and Wilcox, 2001). Among the fungicides recently made available for downy mildew control is fluopicolide, a new crop protection chemical. Fluopicolide belongs to a new chemical group of fungicides (acylpicolide) (Leroux, 2002; Anonymous, 2007b) and is highly effective on a broad spectrum of oomycetes such as *Phytophthora infestans*, *Plasmopara*

viticola and various *Phytophthora* species (Toquin et al., 2006). This compound does not show a cross resistance with other commercial oomycete fungicides and controls fungi resistant to phenylamides, strobilurins and dimethomorphs. This suggests that fluopicolide has a new mode of action. Furthermore, fluopicolide is effective in several stages of fungal life cycle several minutes after application: during the release and motility of zoospores, germination of cysts, as well as mycelium growth and sporulation (Toquin et al., 2006).

Immunolocalization studies have shown that a cytoskeleton-associated protein called spectrin-like protein, poorly characterized in fungi, is clearly delocalized after fluopicolide treatment (Toquin et al., 2006). Both in plants and fungi, spectrin-like proteins are believed to form a bridge between cytoskeleton and plasma membrane, and so may play a role during tip extension and in the polarity of hyphae elongation (Toquin et al., 2006). Fluopicolide-induced delocalization of these proteins represents a new mode of action, different to that of competitor fungicides, making it especially fit as a potential mixture partners (Toquin et al., 2006).

Profiler[®] is a new product developed by Bayer CropScience, which combines fluopicolide with fosetyl-Al, a well known systemic fungicide. The mode of action of fosetyl-Al is twofold: by reinforcing the plant's defensive reactions the compound slows down significantly the progression of the pathogen. Secondly, when applied as a preventive treatment, the compound has a direct effect on the fungus by inhibiting sporangia germination on the leaf surface and penetration of the pathogen into the plant. It also limits mycelial development and sporulation (post-infection treatments) (Gouot, 2006).

The objective of this study was to evaluate the efficacy of this new mixture of fluopicolide and fosetyl-Al fungicides against grapevine downy mildew in commercial vineyards in Serbia in 2006 and 2007.

MATERIAL AND METHODS

Location

Four tests were conducted in commercial vineyards (cv. Hamburg and Rhein Riesling) at Radmilovac (Vinča) and Slankamenački Vinogradi in 2006 and 2007. The tests were arranged in a randomized complete block design with four replications, according to EPP0 methods (EPP0, 1997a). Individual treatment-block size was 25 m².

Fungicides

The fungicide combinations fluopicolide + fosetyl-Al (40,4 g/kg + 666,7 g/kg WG, Profiler[®] Bayer CropScience) and fosetyl-Al + folpet (500 g/kg + 250 g/kg, WG, Mikal Flash[®], Bayer CropScience) were tested in this study.

Applications

Treatments were carried out using a motorized knapsack sprayer (Solo Port 423, Germany) by thoroughly wetting the grapevine plants (water volume: 1000 liter/ha). Application was generally adjusted to standard local practice, starting from BBCH (Biologische Bundesanstalt, Bundesdienstleistung und Chemical Industry) 53-55 (beginning of bloom) until BBCH 69-71 (beginning of grape setting). Application details are listed in Table 1.

Evaluation

In each assessment, 100 leaves per plot were evaluated. The percentage of disease development on the leaves was rated on a following scale: 0-0% (no disease), 1-5% (5% of leaf surface infected), 2-10% (10% of leaf surface infected), 3-20% (20% of leaf surface infected), 4-30% (30% of leaf surface infected), 5-40% (50% of leaf surface infected), 6-60% (60% of leaf surface infected), 7-70% (70% of leaf surface infected), 8-80% (80% of leaf surface infected), 9-90% (90% of leaf surface infected) and 10-100% (100% of leaf surface infected). The efficacy of the compounds tested for grape downy mildew control was expressed in terms of disease severity using the Towsend-Heuberger's formula (Swiader et al., 2002):

$$ID = \frac{\sum(nv)100}{NV}$$

where: n = degree of infection according to the 10-grade scale, v = number of leaves per category, V = total number of leaves screened, N = highest degree of infection. The efficacy was evaluated using Abbott's formula (Abbott, 1925). Data were analysed separately for each trial using ANOVA and the means were separated by Duncan's multiple range test (EPP0, 1997b, 1997c).

RESULTS

In 2006 and 2007, conditions for development of grape downy mildew varied considerably in the experimental locations from favourable conditions for *P. vit-*

Table 1. Application details for evaluation of fungicides against grape downy mildew
Tabela 1. Uslovi primene za ocenu fungicida protiv plamenjače vinove loze

Year Godina	Locality Lokalitet	Date of evaluation Vreme ocene	Application interval (days) Intervali primene (dani)	Number of applications Broj tretmana	Date of application Vreme primene
2006 ^{a)}	Radmilovac	July 16	7-13	7	May 23, 31 June 13, 26, July 9, 19, August 01
2006 ^{a)}	Slankamenački Vinogradi	June 28	8-10	4	May 22, 31 June 9, 19
2007 ^{b)}	Radmilovac	July 31	7-13	7	May 9, 18, 25 June 4, 15, 29 July 12
2007 ^{b)}	Slankamenački Vinogradi	July 13	7-9	6	May 21, 29 June 7, 14, 25 July 3

a) Beginning of flowering: May 23; b) Beginning of flowering: May 16
a) Početak cvetanja: 23. maj; b) Početak cvetanja: 16. maj

icola in 2006 (locality Slankamenački Vinogradi) to dry and hot weather in 2007 (locality Radmilovac), especially at the end of the spring-early summer period. The disease therefore occurred quite early in the season 2006. In both localities in 2007, downy mildew did not spread before the end of August. The efficacy of tested fungicides in controlling grape downy mildew in trials conducted in these two locations in 2006 and 2007 has been summarized in Tables 2 and 3.

Table 2 summarizes the data on disease severity on grapevine and fungicide efficacy in the localities Radmilovac and Slankamenački Vinogradi (Figures 1 and 2) in 2006. The results show that there was no significant difference in the efficacies of the tested fungicides Profiler (96.1-98.7%) and Mikal Flash (94.9% and 95.4%).



Figure 1. Treatment – fluopicolide + fosetyl-Al (3.0 kg/ha) (locality: Slankamenački Vinogradi, 2006)
Slika 1. Varijanta – fluopikolid + foseetil-Al (3,0 kg/ha) (lokalitet: Slankamenački Vinogradi, 2006)

Table 2. *P. viticola* - Disease severity on grapevine leaves and fungicide efficacy (locality: Radmilovac and Slankamenački Vinogradi, 2006)**Tabela 2.** *P. viticola* - Intenzitet zaraze na lišću vinove loze i efikasnost preparata (lokalitet: Radmilovac i Slankamenački Vinogradi, 2006. godine)

Treatment Varijanta	Rate Količina (kg/ha)	Radmilovac		Slankamenački Vinogradi	
		Disease severity Intenzitet oboljenja (%)*	Efficacy Efikasnost (%)	Disease severity Intenzitet oboljenja (%)*	Efficacy Efikasnost (%)
Profiler	2.25	0.4 a	96.1	1.0 a	97.0
Profiler	3.0	0.1 a	98.7	0.6 a	98.2
Mikal Flash	3.0	0.5 a	95.4	1.6 a	94.9
Untreated Kontrola	-	10.5 b	-	32.10 b	-

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

*Srednje vrednosti u kolonama označene različitim slovima se statistički značajno razlikuju ($p < 0.05$) u skladu sa Dankanovim testom

Table 3. *P. viticola* - Disease severity on grapevine leaves and fungicide efficacy (locality: Radmilovac and Slankamenački Vinogradi, 2007)**Tabela 3.** *P. viticola* - Intenzitet zaraze na lišću vinove loze i efikasnost preparata (lokalitet: Radmilovac i Slankamenački Vinogradi, 2007. godine)

Treatment Varijanta	Rate Količina (kg/ha)	Radmilovac		Slankamenački Vinogradi	
		Disease severity Intenzitet oboljenja (%)*	Efficacy Efikasnost (%)	Disease severity Intenzitet oboljenja (%)*	Efficacy Efikasnost (%)
Profiler	2.25	0.1 a	98.8	0.4 a	97.2
Profiler	3.0	0.13 a	99.7	0.1 a	99.0
Mikal Flash	3.0	0.2 a	99.2	0.5 a	96.4
Untreated Kontrola	-	1.6 b	-	13.4 b	-

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

*Srednje vrednosti u kolonama označene različitim slovima se statistički značajno razlikuju ($p < 0.05$) u skladu sa Dankanovim testom

**Figure 1.** Control – untreated plants (locality: Slankamenački Vinogradi, 2006)**Slika 1.** Kontrola – netretirane biljke (lokalitet: Slankamenački Vinogradi, 2006)

Table 3 summarizes the data on disease severity on grapevine leaves and fungicide efficacy in the localities Radmilovac and Slankamenački Vinogradi in 2007. As in the previous year, there was no significant difference between the efficacies of the tested fungicide Profiler (97.2-99.7%) and fungicide mixture fosetyl-Al + folpet (96.4% and 99.2%).

DISCUSSION

Profiler, a WG formulation combining fluopicolide and fosetyl-Al, is a new tool for the control of grape downy mildew. Profiler combines an excellent protectant efficacy on leaves and bunches when applied at 2.25 to 3 kg/ha during the flowering period with high consistency and long residual activity allowing 14 day spray

intervals. This feature is linked to the long-lasting action of fluopicolide (Gouot, 2006). Fluopicolide, with its excellent activity against *P. viticola* zoospores and mycelium even at low treatment rates, and the systemic effect of fosetyl-Al ensure a high and consistent level of disease control. Moreover, Profiler exhibits an excellent plant safety profile.

This study shows that the fungicide mixtures tested are highly effective against *P. viticola*, even under high disease pressure, confirming and extending the data obtained in trials conducted in Italy, France, Germany, Spain and Portugal from 2001 to 2006 (Gouot, 2006). Our previous trials, carried out on several locations in Serbia in 2003, also showed that these fungicide combinations were most effective, even when applied at long intervals and under high disease pressure (Rekanović, 2003). Gout et al. (2006) suggested that spray intervals should be adjusted to local weather conditions and growers' practices.

In order to achieve a good efficacy of Profiler, FRAC recommends a maximum of three applications of fluopicolide per season and the use of all locally available tools and models to monitor and forecast disease development (Anonymous, 2007a).

Combining complimentary modes of action of two active ingredients, Profiler provides growers with a new and powerful tool to manage downy mildew control in grapes (Gouot, 2006).

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Efikasnost kombinacije fluopikolida i fosetil-Al (Profiler[®]) za suzbijanje prouzrokovala plamenjače vinove loze (*Plasmopara viticola*) u poljskim uslovima

REZIME

Ispitivana je efikasnost nove kombinacije fungicida za suzbijanje *Plasmopara viticola* na vinovoj lozi u poljskim uslovima. U 2006. i 2007. godini ispitivana je efikasnost Profiler (fluopikolid + fosetil-Al) u odnosu na standardni fungicid Mikal Flash (fosetil-Al + folpet) na lokalitetima Radmilovac i Slankamenački Vinogradi. Oba ispitivana fungicida ispoljila su visoku efikasnost u suzbijanju prouzrokovala plamenjače vinove loze. Između efikasnosti Profiler (96,1- 99,7%) i Mikal Flash (94,9- 99,2%), nije zabeležena statistički značajna razlika. Naši ogledi su pokazali da je ispitivana kombinacija fungicida fluopikolid + fosetil-Al visoko efikasna protiv *P. viticola*, čak i kada se primenjuje u dužim vremenskim intervalima kao i pri uslovima jake zaraze.

Ključne reči: Plamenjača vinove loze; kombinacije fungicida; fluopikolid + fosetil-Al; efikasnost