University of Agriculture in Krakow, Cracow, Poland

THE APPLICATION OF SOME BIOTECHNICAL PREPARATIONS IN POTATO PROTECTION AGAINST *PHYTOPHTHORA INFESTANS*[1]

H. Kurzawińska and S. Mazur

Abstract

In 2009–2010 the effect of multiple plant spraying with biotechnical preparations (Biochikol 020 PC – chitosan-based agent, Grevit 200 SL – extract of grapefruit, Prev-AM 060 SL – orange oil) on protection against *Phytophthora infestans* of both potato canopy and tubers (cultivar 'Vineta N') was investigated. Acrobat MZ 69 WG (9% dimethomorph + 60% mancozeb) was used as a standard agent.

In the first year the examined preparations decreased the degree of canopy infection and the percentage of tubers infected by *P. infestans*. In the next year, only Acrobat MZ 69 WG significantly inhibited the development of late blight on potato canopy. The percentage of tubers infected by *P. infestans* resulting from potatoes treated with the tested agents was significantly lower than that of the control. In both years tuber yield from the protected plots was higher than that of unprotected ones.

Key words: potato, *Phytophthora infestans,* potato protection, natural agents

Introduction

Phytophthora infestans belongs to the most severe pathogens of potato and its crops are being increasingly damaged in recent years (Kurzawińska and Mazur 2009). In epidemic years it might lead to complete losses of the potato crops. Due to destruction of potato stems, the crops rapidly decrease, the growth is inhibited and their tubers become infected.

[1]This work was supported by grant No. 1486/B/PO1/2009/37 from the Polish Ministry of Science and Higher Education.

Phytopathologia 63: 31–37

ISSN 2081-1756

Application of fungicides is the most common treatment used in plant protection, including potato, against diseases. The fears of excessive environmental chemicalization and associated increasing popularity of biological husbandry cause that possibilities of replacing synthetic pesticides with those of natural origin attract more and more attention. Such natural agents include, for example, preparations containing grapefruit extracts and chitosan and its derivatives. The extracts from grapefruit seeds and flesh are of specific fungicidal and bactericidal activity. In addition to its direct effect on numerous pathogens, they strengthen the immune system of the treated plant, thus are recommended for prophylactic treatment (Orlikowski et al. 2002, Wolski and Ludwiczuk 2002). Among many antifungal compounds being present in grapefruit extracts predominate aliphatic aldehydes, monoterpenes (limonen) and nootkatone, which may have a synergistic effect on inhibiting the growth and development of phytopathogens (Orlikowski et al. 2002). Chitosan and its polymers are capable to act as elicitors inducing chitinase activity in various plant tissues. Its effect on the plant manifests itself, among other effects, as the immune reactions. In some cases application of chitosan does not reduce population of the pathogen itself, but might result in decreased disease development and harmfulness (Bell et al. 1998, Kurzawińska 2007, 2008, Nawrocki and Mazur 2007).

The aim of the work was to evaluate the effect of multiple plant spraying with biotechnical preparations (Biochikol 020 PC – chitosan-based agent, Grevit 200 SL – extract of grapefruit, Prev-AM 060 SL – orange oil) on protection against *Phytophthora infestans* of both potato stems and tubers of the cultivar 'Vineta N'. Acrobat MZ 69 WG (9% dimethomorph + 60% mancozeb) was used as a standard agent.

Materials and methods

The field experiment was conducted at the Plant Protection Experimental Station in Kraków Mydlniki in 2009–2010, on proper brown soil. The experiment was carried out on the cultivar 'Vineta N', which is highly susceptible to leaf blight and quite susceptible to tuber blight (Chotkowski et al. 1999). Both husbandry and fertilisation were done in accordance with good agricultural practice. Before establishing the experiment an analysis of percentage infestation of seed-tubers by *P. infestans* (100 tubers with four replications) was carried out. The experiment was started in the third decade of April (at 67.5 cm spacing) by employing the randomly chosen block method, independently with four replications of the following combinations: 1 – control – plants unprotected during vegetation period, 2 – plants sprayed with 2.0% Biochikol 020 PC biotechnical preparation (B.A.S. chitosan 20 g/l), 3 – plants sprayed with 0.2% Grevit 200 SL preparation (B.A.S. grapefruit extract 200 g/l), 4 – plants sprayed with 0.4% Prev-AM 060 SL preparation (B.A.S. orange oil 60 g/l), 5 – plants protected with Acrobat MZ 69 WG fungicide (B.A.S. 9% dimethomorph + 60% mancozeb) at the dose of 2.5 kg/ha. The treatments were carried out with a knapsack spraying machine by using 1000 l of liquid per 1 ha. The first treatment

was done just after the first alternariose symptoms occurred on potato leaves. Further sprayings were done every 10-14 days, depending on weather conditions (seven treatments in each vegetation season). The canopy infestation by *P. infestans* was estimated according to a scale of 1 to 9, where 1 indicates the lowest, and 9 – the highest infestation (Metodyka... 1985). Analyses were made continuously on the same 25 plants from each plot. In final record sheet the average degree of stem infection was calculated for each combination according to the above scale. The potato yield was assessed at harvesting. The total yield from individual plots was weighed and the average yield was calculated for each combination. The occurrence of tuber infected by *P. infestans* was assessed directly after digging out (September) by determining percentage of infected tubers in a randomly chosen sample – 100 tubers taken from each plot (400 from each combination). The results were examined statistically by using variance analysis. The significance of differences between the means was evaluated by Duncan's multiple range test ($p = 0.05$).

Results

A relatively small infestation by *P. infestans* (1.8%) was found (Table 1).

Table 1

Percentage of seed-tubers infected by *Phytophthora infestans*

2009	2010	Mean
1.6	1.8	1.7

Vegetation seasons in Kraków Mydlniki had different weather conditions, which resulted in differences in the date of potato blight symptoms occurrence and disease intensity. According to the data from the Kraków Balice meteorological station, in 2009 the rainfall totals were as follows: May – 124, June – 215, July – 147, August – 70 mm, while the mean monthly temperatures were 13.2°C, 15.6°C, 19.3°C and 18.3°C, respectively. In 2010 the total precipitation was as follows: May – 302, June – 52, July – 112, August – 138 mm, while the mean monthly temperatures were 12.7°C, 17.8°C, 21.6°C and 19.4°C, accordingly (Table 2). In 2009 the potato blight occurred on June 19, while in 2010 the first blight symptoms were recorded earlier, on June 9. In the 2009 and 2010 seasons meteorological conditions were propitious to the development of the disease in the Cracow area (Table 2).

The results of the two-year field experiment indicate that during the first year (2009) the infestation of potato canopy by *P. infestans* was significantly lower in combinations protected with all preparations. In the second year the canopy infestation was significantly lower only in the combination protected with the fungicide Acrobat MZ 69 WG (Table 3). Both in the first and second year a strong tendency to inhibit the development of *P. infestans* on the potato top sprayed with this preparation was observed.

Table 2

Average air temperatures and rainfall sums during the vegetation period in 2009–2010

Year	Month	Average air temperatures (°C)				Rainfall sums (mm)			
		for decade			monthly	for decade			monthly
		I	II	III		I	II	III	
2009	May	12.9	13.1	13.6	13.2	0.2	58.4	65.3	123.9
	June	13.7	15.3	17.9	15.6	31.0	62.6	121.6	215.2
	July	19.4	19.2	19.4	19.3	61.5	45.3	40.3	147.1
	August	19.3	18.4	17.3	18.3	1.3	12.3	56.6	59.8
	September	15.8	14.1	13.5	14.5	22.6	16.5	3.0	42.1
2010	May	12.7	10.9	14.5	12.7	79.4	188.0	35.0	302.4
	June	18.6	17.9	16.9	17.8	1.6	28.0	22.0	51.6
	July	19.8	23.6	21.3	21.6	8.6	31.6	72.2	112.4
	August	19.9	19.6	18.6	19.4	27.8	38.0	72.4	138.2
	September	11.7	13.4	12.1	12.4	49.6	0.4	1.2	51.2

Table 3

Influence of preparations tested on the infestation of potato stems by *Phytophthora infestans*

Combination	Mean degree of infestation in the 1–9 scale	
	2009	2010
Control	9.0 d	8.9 b
Biochikol 020 PC – 2.0%	7.8 bc	8.8 b
Grevit 200 SL – 0.2%	7.6 b	8.6 b
Prev-AM 060 SL – 0.4%	8.0 c	8.6 b
Acrobat MZ 69 WG – 2.5 kg/ha	6.9 a	4.0 a

Means in columns followed by the same letter are not significantly different at p = 0.05 according to Duncan's multiple range test.

The tuber crop from protected fields was higher than that of the control plots (Fig. 1). The highest yield was reached in combination where the plants were sprayed with the standard agent Acrobat MZ 69 WG and was 22 t/ha and 32 t/ha in 2009 and 2010, respectively. All the preparations used in both years had significant effect (compared to the control) on increase of the total yield (Fig. 1).

Analyses of tuber infection by *P. infestans*, done directly after harvesting, revealed a relatively high percentage of tuber infestation (5.3–21.4%) for unprotected plots. Spraying potato plants with preparations under examination decreased the percentage of tubers infected by *P. infestans*. In both years the percentage infestation of potato tubers by *P. infestans* in combinations where preparations were used was significantly lower than that of the control (Table 4).

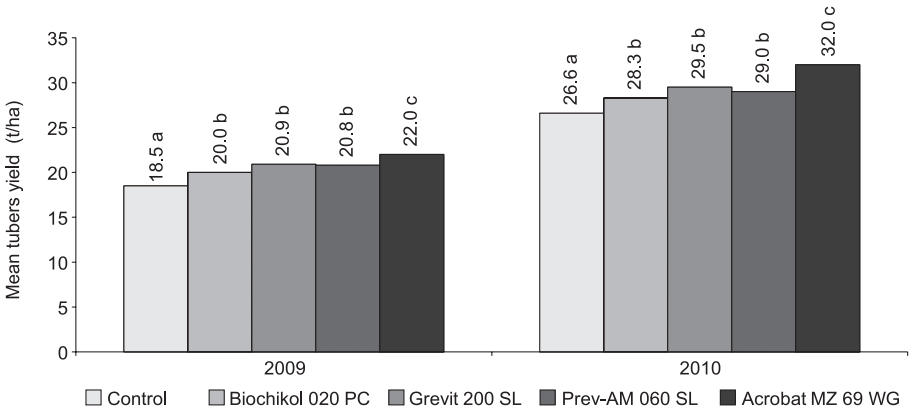

Fig. 1. The effect of preparations tested on potato yield (means followed by the same letter are not significantly different at p = 0.05 according to Duncan's multiple range test)

Table 4

Influence of preparations tested on the infestation of potato tubers by *Phytophthora infestans* (%)

Combination	Year	
	2009	2010
Control	5.3 c	21.4 e
Biochikol 020 PC – 2.0%	2.5 b	16.0 c
Grevit 200 SL – 0.2%	1.8 ab	18.4 d
Prev-AM 060 SL – 0.4%	1.8 ab	15.3 b
Acrobat MZ 69 WG – 2.5 kg/ha	1.5 a	11.2 a

Means in columns followed by the same letter are not significantly different at p = 0.05 according to Duncan's multiple range test.

Discussion

The analysis of 'Vineta N' seed-potato salubrity pointed to relatively low extent of tuber infection by *P. infestans*. The tubers of this potato cultivar are quite susceptible to infection by the pathogen (Chotkowski et al. 1999).

The occurrence and development of *P. infestans* in Kraków Mydlniki in 2009–2010 depended on weather conditions during vegetation period. Kapsa (2004) reports that potato leaf infection by *P. infestans* is stimulated primarily by heavy precipitations, high humidity and long lasting leaf wetting. In addition, observations of potato blight development in the field experiments indicate that meteorological conditions favourable to pathogen development have an effect not only on the date of occurrence of late blight first symptoms, but also on disease de-

velopment (Kapsa 2007). This was confirmed not only by the date of disease symptoms occurrence, but also by the extent of stem infection by *P. infestans* during the experiment.

In both years of experiments the tuber crops from protected plots were higher than those of the control ones. The higher yields from protected plots are connected with the destruction of potato stems by *P. infestans*. It was found that the destruction of 50-70% of leaf assimilation area blocks the crop growth completely. The earlier plant destruction occurs, the higher crop losses (Van der Plank 1963).

The percentage of potato tubers infected by *P. infestans* was relatively high in unprotected plots. However, in both years of the experiment the percentage of infected tubers in combinations where preparations were used was significantly lower than that of the control. A number of authors (Kurzawińska 2001, Kapsa 2004, Kurzawińska and Mazur 2009) report that chemical protection of potato has an important effect not only on crop, but also on its commercial value during storage.

The results of the work indicate that biotechnical preparations can be used prophylactically in potato protection against *P. infestans*. The application of such preparations enables reduction of chemical protection agents use, enhances quality of the raw material for ecological food production and improves environmental protection due to weaker impacts of these preparations and their easier biodegradation.

Streszczenie

ZASTOSOWANIE NIEKTÓRYCH PREPARATÓW BIOTECHNICZNYCH W OCHRONIE ZIEMNIAKA PRZED *PHYTOPHTHORA INFESTANS*

W latach 2009–2010 na terenie Stacji Doświadczalnej Katedry Ochrony Roślin Kraków Mydlniki Uniwersytetu Rolniczego w Krakowie przeprowadzono doświadczenie polowe. Badano wpływ kilkakrotnego opryskiwania roślin preparatami biotechnicznymi (Biochikol 020 PC – oparty na chitozanie, Grevit 200 SL – wyciąg z grejpfruta, Prev-AM 060 SL – olej z pomarańczy) na porażenie zarówno naci, jak i bulw ziemniaka odmiany 'Vineta N' przez *Phytophthora infestans*. Jako środek standardowy służył Acrobat MZ 69 WG (9% dimetomorfu + 60% mankozebu).

Stwierdzono, że w pierwszym roku doświadczenia badane preparaty statystycznie istotnie obniżyły stopień porażenia naci ziemniaków oraz procent porażonych przez *P. infestans* bulw, natomiast w drugim roku tylko stosowanie fungicydu Acrobat MZ 69 WG istotnie zahamowało rozwój zarazy na naci badanej odmiany. Procent porażonych przez *P. infestans* bulw pochodzących z kombinacji z zastosowaniem badanych środków był istotnie mniejszy niż w kontroli. W obu latach badań plon bulw z poletek chronionych był większy w porównaniu z plonem z poletek niechronionych.

Literature

Bell A.A., Hubbard C.J., Liu L., Davis M.R., Subbarao V.K., 1998: Effects of chitin and chitosan on the incidence and severity of *Fusarium* yellows of celery. Plant Dis. 82: 322–328.

Chotkowski J., Komorowska-Jędrych J., Rembeza J., Wróbel S., 1999: Polski katalog odmian ziemniaka. IHAR, Bonin.

Kapsa J., 2004: Zmiany stanu zagrożenia i ochrony plantacji ziemniaka przed zarazą (*Phytophthora infestans*) w Polsce na tle krajów europejskich. Prog. Plant Prot. / Post. Ochr. Rośl. 44, 1: 129–137.

Kapsa J., 2007: Effect of climatic conditions on infection pressure of *Phytophthora infestans* and harmfulness of the pathogen to potato crops. J. Plant Prot. Res. 47, 4: 357–366.

Kurzawińska H., 2001: Badania przydatności wybranych fungicydów w ochronie ziemniaka przed zarazą *Phytophthora infestans* (Mont.) de Bary. Acta Agr. Silv. Ser. Agr. 39: 95–101.

Kurzawińska H., 2007: Potential use of chitosan in the control of lettuce pathogens. Prog. Chem. Appl. Chitin Deriv. Monogr. 12: 173–178.

Kurzawińska H., 2008: Metoda biologiczna w integrowanej ochronie roślin warzywnych przed chorobami. In: Zrównoważone rolnictwo a bezpieczna żywność. Ed. E. Cieślik. Wyd. Nauk. PTTŻ, Kraków: 53–62.

Kurzawińska H., Mazur S., 2009: The evaluation of *Pythium oligandrum* and chitosan in control of *Phytophthora infestans* (Mont.) de Bary on potato plants. Folia Hortic. 21, 2: 13–23.

Metodyka obserwacji i pobierania prób w agrotechnicznych doświadczeniach z ziemniakami. 1985. Ed. S. Roztropowicz. Instytut Ziemniaka, Bonin.

Nawrocki J., Mazur S., 2007: Effectiveness of Biochikol 020 PC in the control of carrot and parsley pathogens. Prog. Chem. Appl. Chitin Deriv. Monogr. 12: 211–215.

Orlikowski L.B., Skrzypczak Cz., Wojdyła A., Jaworska-Marosz A., 2002: Wyciągi roślinne i mikroorganizmy w ochronie roślin przed chorobami. Zesz. Nauk. AR Krak. 387, Ses. Nauk. 82: 19–32.

Van der Plank J.E., 1963: Plant diseases: epidemics and control. Academic Press, New York.

Wolski T., Ludwiczuk A., 2002: Naturalne pestycydy i ich zastosowanie w ochronie roślin. Przem. Chem. 81, 6: 370–373.

Authors' address:
Prof. Dr. hab. Halina Kurzawińska, Prof. Dr. hab. Stanisław Mazur,
Department of Plant Protection, University of Agriculture in Krakow, al. 29 Listopada 54, 31-425 Kraków, Poland, e-mail: h.kurzawinska@ogr.ar.krakow.pl

Accepted for publication: 10.06.2012