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NegFry – DSS for the chemical control of potato late blight – results of validation trails in Tartu

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Abstract. Potato late blight, caused by the oomycete fungus *Phytophthora infestans* (Mont.) de Bary is the most destructive disease affecting the potato worldwide. For controlling the disease, most manuals recommend that growers apply fungicides at regular intervals of 8–10 days from the time of row closing until the end of the growing season. The NegFry model was used for timing the chemical control of potato late blight. The NegFry model is based on two existing models, the 'negative prognosis', for forecasting the risk of primary attacks, and a model for timing subsequent fungicide applications during the season. The main objective of NegFry is to get high yield and quality with minimum use of fungicides.

Present work underscores that NegFry has given a positive result by timing the first spraying for anticipation of the infection and by optimizing the number of treatments for late blight control.

Key words: *Phytophthora infestans*, decision support system, yield

INTRODUCTION

The late blight fungus usually strikes under humid, cool conditions just before harvest and can destroy the foliage in 24 hours. It causes mottled, dark lesions on leaves and stems, which produce a white, velvety growth that kills the plant and can cause rotting in potatoes in storage. The annual losses for agriculture globally are still very high: 14 million tons, representing a value of more than €3 billion (http://europa.eu.int/). Annual losses in Estonia have not yet been estimated.. As a result of the continuously changing economic conditions in Estonia, the potato growing area has also changed. As compared to 1980, the acreage of potatoes in Estonia decreased by about 35,000 hectares and amounted to 13,600 hectares in 2004. The reduction of crop size, however, did not affect considerably the intensity of late blight control. In West-Europe farmers anticipate that disease control requires regular application of fungicides at high rates and short intervals throughout the growing season. For the Baltic countries there is not a present need for reduction of the use of pesticides. On the contrary, in most cases, there is a need to increase the number of treatments (Høstgaard et al., 2003).

The first part of NegFry is based on the negative prognosis (Ullrich & Schrödter, 1966), which calculates the epidemic free period for *Phytophthora infestans* and then recommends the first spray at the end of this period. The second part of the model is based on a method developed by Fry et al. (1983) and calculates subsequent spraying intervals based on blight units. The blight units are calculated using the length of any humid spell, the air temperature during the humid spell and the susceptibility of the cultivar to late blight. The NegFry model requires, to determine the calculations, air temperature, relative humidity, rainfall, cultivar susceptibility and crop emergence date (Hansen et al., 1995). DSS NegFry validation trials had been implemented in Baltic countries since 1999 (Koppel et al., 2003). The objective of this project was to establish whether fungicide application according to a decision support system could be used to reduce fungicide applications in a potato late blight control program without loss of disease control.

MATERIALS AND METHODS

Field experiments utilizing the NegFry system in potato protection were conducted at IAES at Tartu in the years 2003–2004.

Treatments

Five different treatment regimes of potato late blight control were used: 1) untreated control; 2) routine fungicide application at 10-day intervals starting at row closing; 3) fungicide applications as dictated by the blight warnings and the NegFry decision support system; 4) modified NegFry – sprayings which were started with half a dose and were continued with full dose after infection of untreated control regime; 5) Blight Management: treatment according to the suggestions of program NegFry with other systemic fungicide. Ridomil Gold MZ 68 [mefenoxam] was used only in Blight Management treatment; in other treatment regimes it was replaced with contact fungicide Shirlan 500 SC [fluazinam]. The following fungicide doses were used: Shirlan 500 SC – 0.4 l ha^{-1}, half a dose 0.2 l ha^{-1}, Ridomil Gold MZ 68 – 2.5 kg ha^{-1}. The spray volume was equivalent to 300 l ha^{-1}.

Weather data recording

Hardi Metpole, an in-crop weather station, was used to record humidity, temperature, rainfall, radiation, wind speed, soil temperature and soil moisture. The data was recorded every 12 minutes. The reading was transmitted by radio signal to a receiver and transferred to a computer where it was stored for final analysis using the NegFry decision support software (Hansen et al., 1995).

Field experiments

Trials were conducted on a trial field of IAES using certified seed of the maincrop potato variety ‘Anti’ and early variety ‘Vineta’. Of these potato varieties, ‘Vineta’ is susceptible to late blight; ‘Anti’ is moderately resistant.. The design was a randomised complete block with 3 replications per treatment. Each plot was made up of 4 drills 11 m long. The total plot size was 38 m^2, from which 19 m^2 were harvested across the centre 2 drills. The harvesting of experimental plots took place in September using a two-row elevator digger.

RESULTS AND DISCUSSION

In 2003, using recommendations of the late blight decision support system (DSS) by NegFry, the first sprays were anticipated and applied at the proper time. On variety ‘Anti’, NegFry recommended one spraying less than modified NegFry; the routine variant had five sprayings, as with NegFry.) On variety ‘Vineta’, NegFry and modified

NegFry recommended two sprayings more than the routine variant. Subsequent spray regimes according to the suggestions of Modified NegFry reduced a single spray dose by 50%. The numbers of full dose sprays were reduced one time on ‘Vineta’ and four times on ‘Anti’ (Table 1). The reduction of doses and sprays did not decrease the tuber yield and quality. The weather conditions in 2003 were favorable for the distribution of late blight, and by NegFry recommendations the reduction of fungicide input compared to routine treatments was not obtained in all cases. Despite the weather conditions, the early variety of ‘Vineta’ yield did not remain remarkably smaller in the variant without chemical protection (Table 2). In all variants most of the tuber yield was performed before late blight infection destroyed the haulms. During the same period, observation results also showed that natural senescence occurred on protected leaves, with a little delay. The haulms of ‘Anti’ were not infected until the end of August. The crop was harvested on the 22nd of September. By that time spread-variant yields were higher. A single dose of systemic fungicide Ridomil Gold provided protection against late blight for a longer period than Shirlane, which was sufficient with three sprayings, according to suggestions of the NegFry program. As in 2003, the weather conditions in 2004 were favorable for the distribution of late blight.In spread variants the yields were higher than in the untreated variant (Table 2). The use of different late blight DSS in several European countries reduced fungicide input by 8–62% compared to routine treatments (Hansen et al., 2001). The NegFry program was successful for deciding on the timing of the first application and the choice of fungicide type (Hansen et al., 2003).

Table 1. Comparison of spray regimes in 2003 and 2004.

Variety	Spray regime	Fungicide	Single dose, l ha^{-1}, kg ha^{-1}	Number of sprays		Total l ha^{-1}, kg ha^{-1}	
Year				2003	2004	2003	2004
‘Vineta’	Routine	Shirlan	0.4	6	4	2.4	1.6
	NegFry	Shirlan	0.4	8	x	3.2	x
	Modified NegFry	Shirlan	0.2–0.4	8	4	3.0	1.0
	Blight Management	Ridomil Gold	2.5	-	4	-	10.0
‘Anti’	Routine	Shirlan	0.4	5	5	2.0	2.0
	NegFry	Shirlan	0.4	5	x	2.0	x
	Modified NegFry	Shirlan	0.2–0.4	6	6	1.6	1.8
	Blight Management	Ridomil Gold	2.5	3	4	7.5	10

Table 2. Tuber yield, t ha^{-1}.

Variant	‘Vineta’		‘Anti’	
Year	2003	2004	2003	2004
Control	44.4	38.2	44.4	44.3
Routine	48.6	50.8	49.2	69.2
NegFry	46.5	-	48.2	-
Modified NegFry	49.2	56.4	51.2	65.0
Blight Management	-	48.9	50.2	53.3
LSD_{05}	2.48	5.3	8.73	6.5

Spraying with the NegFry modified strategy has helped to reduce the amount of fungicide Shirlan (Table 1) usage remarkably on ‘Vineta’: NegFry modified 1.0 l ha^{-1} *versus* routine 1.6 l ha^{-1} (62.5%). Blight Management strategy has also helped to avoid late blight infection and reduce the number of sprayings due to its longer protection period: ‘Anti’ NegFry modified 6 times *versus* Blight Management 4 times.

CONCLUSIONS

According to NegFry, the sufficient number of applications to control late blight in Estonian weather conditions in 2003 and 2004 was 3–4 times. The first sprays were anticipated and applied at the proper time. According to the suggestions of NegFry, subsequent spray regimes reduced a single spray dose by 50%. It is possible to obtain satisfactory control against late blight and at the same time reduce the number and amounts of fungicide treatments, compared with the routine protection model. The reduction of doses and sprays did not decrease the tuber yield and quality.

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