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Towards a knowledge-based approach for an integrated control of *Alternaria* spp. in potatoes

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SUMMARY

Field trials in different seasons and multiple locations were performed in order to establish the timing for the first treatment against early blight (*Alternaria solani*) that proved to be effective and necessary for a good control of the disease. The results of the trials were used to fit a simulation model for a better prediction of disease pressure and to obtain an improved advice for a better timing of applications, and especially the first application. Besides weather parameters, the disease model also takes crop stage and physiological resistance of the crop into account. As both seasons 2017 and 2018 were markedly hot and dry, an attempt was made to account for increased susceptibility of the potato crop caused by drought stress. However, even if there was increased susceptibility of the crop caused by drought stress, the pathogen failed to profit from this due to a lack of sufficient leaf wetness periods. In both years, a clear distinction could be made between treatments that were performed too early – all with no or very low levels of disease - and treatments that were performed too late – with disease levels approaching that of the untreated control – and a critical date for the first necessary application could be established. The disease model was able to simulate the observations in the field.

KEYWORDS

Potato early blight, *Alternaria solani*, control strategies, disease model, simulation models, physiological resistance, senescence

INTRODUCTION

As in many other potato areas around the world, the potato early blight disease (*A. solani*) is viewed as a growing concern for potato growers in Flanders, Belgium. Factors such as more favourable weather conditions or stricter fertilisation guidelines with lower nitrogen dosage could be contributing to this increase. However, the shift in available late blight fungicides towards more oomycete-specific fungicides, without an effect on early blight, plays an important role. As specific early blight fungicides are made available for the control of the disease, potato growers are facing the question: "How and when should I use these fungicides to achieve an optimal, cost-efficient crop protection?"

MATERIALS AND METHODS

Field trials were carried out in cooperation between PCA (Kruishoutem), Inagro (Rumbeke-Beitem) and University of Ghent (UGent) at three locations. Results were consistent for the three locations. Trials from the location in Kruishoutem (B) in 2017 and Elsegem (B) in 2018 will be discussed in this paper. No artificial inoculation was done in the trials, although it has to be mentioned that in both years in an adjacent trial (<25 m), autoclaved barley seeds inoculated with *A. solani* were applied between the rows in the month of June. In both years, the ware potatoes cv. Fontane were planted at the end of April and emerged towards the end of May. All plots were left untreated with regard to early blight until the last week of July. From then on, treatments were started for an increasing number of variants, each one with a start date one week later than the previous one. Once started, a good disease control against early blight was maintained with weekly applications of a mixture of Shirlan + Tanos, alternated with Narita (a.i. difenoconazole). Besides an untreated control, one other variant was sprayed weekly with mancozeb (Dithane WG 2 kg/ha), beginning at the time of the first specific treatment against early blight.

Table 1. *Trial setup and protocol for 2017 and 2018*

	Applications							
Start date	**t1**	**t2**	**t3**	**t4**	**t5**	**t6**	**t7**	**t8**
t1	T+S	N	T+S	N	T+S	N	T+S	N
t2	-	T+S	N	T+S	N	T+S	N	T+S
t3	-	-	T+S	N	T+S	N	T+S	N
t4	-	-	-	T+S	N	T+S	N	T+S
t5	-	-	-	-	T+S	N	T+S	N
t6	-	-	-	-	-	T+S	N	T+S
t7	-	-	-	-	-	-	T+S	N
t8	-	-	-	-	-	-	-	T+S
UTC	-	-	-	-	-	-	-	-
mancozeb7d	mcz	mcz	mcz	mcz	mcz	mcz	mcz	mcz

T+S Tanos + Shirlan
N Narita
mcz Dithane WG

The same setup and design – a randomized complete block design with 4 replicates – was used in 2017 and 2018. Disease assessments were performed weekly, and severity was expressed as percentage diseased leaf area for the two central rows of each plot.

Since 2013, a weather based disease model derived from the FAST model (Madden *et al.*, 1978) has been used to simulate the development of early blight and to predict the date for a first application. Age-dependent susceptibility of the potato crop has been added to the calculations in the model, in function of the degree of crop senescence.

RESULTS AND DISCUSSION

Growing season 2017

The first lesions of early blight in the trial were found on August 21th, with start of epidemic development from August 28th onwards in the untreated control. Disease severity reached 37,5% in the untreated control on September 11th. All treatments with a start date on or before August 21 had a very low disease rating at the end of the season (<0.03%). Starting with an early blight fungicide on August 28th led to a disease level of just below 1%. A weekly application of mancozeb from July 25 onwards gave sufficient protection, leading to a very low disease level (0.03%) at the end of the season.

Based on these observations, August 28th seems to be a turning point or deadline for a protection against early blight. Best result from a preventive application was obtained with a spraying performed on August 21th. Adding earlier treatments did not contribute to the level of protection at the end of the season: no difference in effectiveness was observed between the start date of August 21th and earlier treatments, i.e. adding one, two, three or four (starting July 25th) previous treatments.

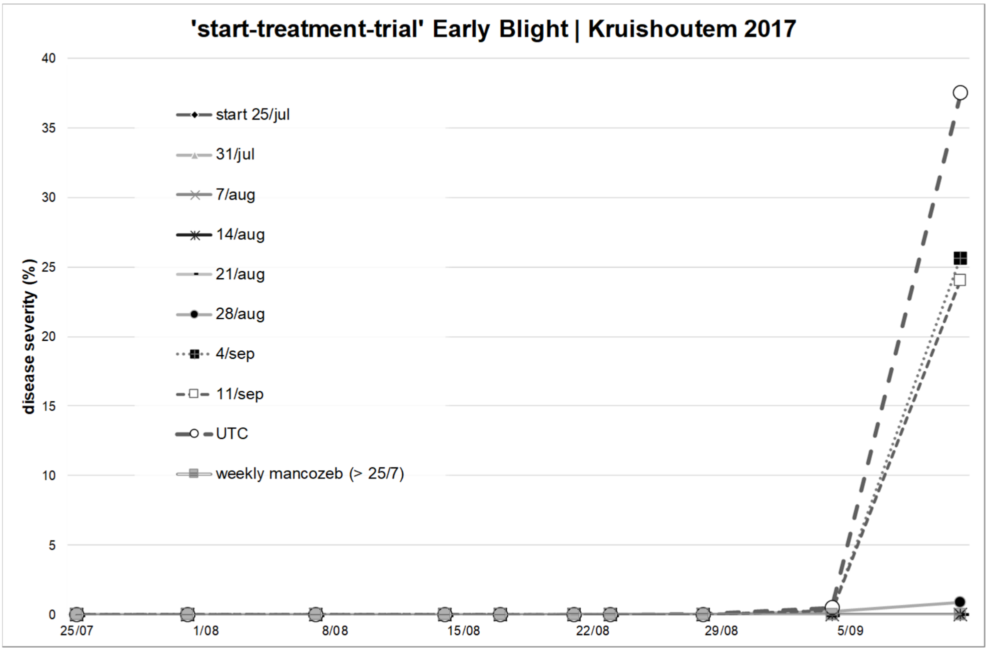

Figure 1. *Development of early blight disease severity (%) in 2017, for different dates of first treatment*

Simulation model

According to the disease model, a first application against early blight in 2017 was advised on August 23th – five days ahead of the critical date of August 28th, but a few days after the first observations of early blight lesions in the trial.

As the growing conditions in 2017 were hot and especially dry, it was obvious that the potato crop was suffering from drought and the associated stress. It could also be assumed that this factor led to an increase of crop susceptibility for the disease. On the other hand, the very dry weather conditions, and more specifically the lack of dew periods during the night, were by no means conducive to development of the disease. This was reflected in the many observations in the field, where attacks of early blight remained absent.

In order to assess the supposed increased susceptibility of the potato crop, an additional factor for stress was added to the disease model. The size of this factor was chosen in order to fit the model with the observations in the field trials. With an increase of susceptibility with 30%, the model predicted a first application date of August 17th.

Growing season 2018

The first lesions of early blight in the trial were found on August 16th, with start of epidemic development from August 29th onwards in the untreated control. Disease severity reached 12,5% in the untreated control on September 27th. All treatments with a start date on or before August 16th had a very low disease rating at the end of the season (<0.1%). Starting with an early blight fungicide on August 23th led to a somewhat higher disease level of 1.8%. A weekly application of mancozeb from July 26 onwards gave sufficient protection, leading to a very low disease level (0.03%) at the end of the season.

Based on these observations, August 23th seems to be a turning point or deadline for a protection against early blight. Best result from a preventive protection was obtained with an application performed on August 16th. Adding earlier treatments did not contribute to the level of protection at the end of the season: no difference in effectiveness was observed between the start date of August 16th and earlier treatments, i.e. adding one, two or three (starting July 26th) previous treatments.

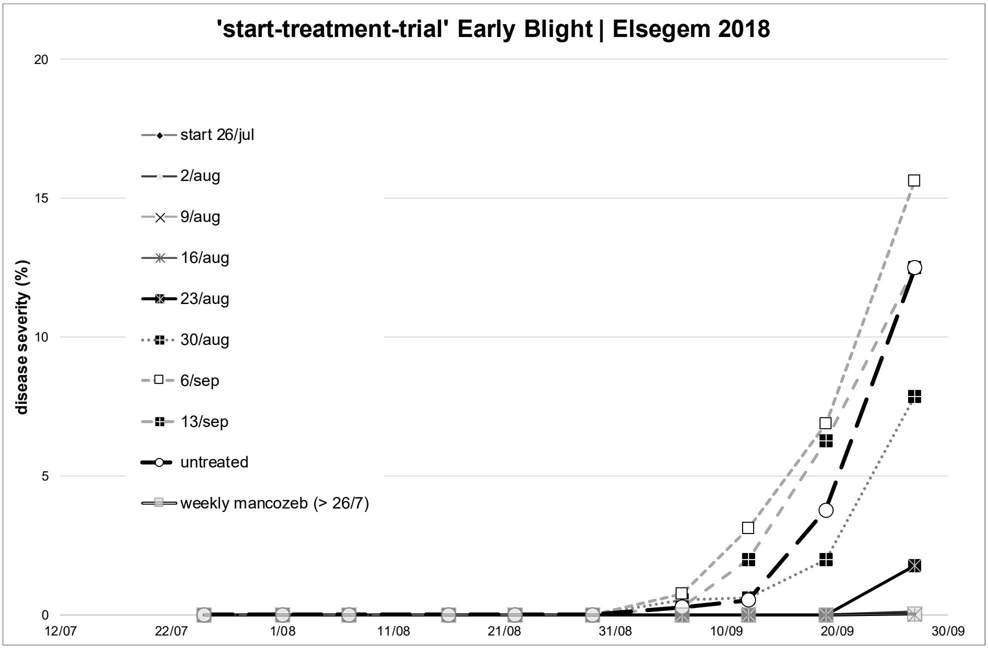

Figure 2. *Development of early blight disease severity (%) in 2018, for different dates of first treatment*

Simulation model

According to the model, a first application against early blight in 2018 was advised on August 19th – four days ahead of the critical date of August 23th, but again a few days after the first observations of early blight lesions in the trial.

As the growing conditions in 2018 were very hot and exceptionally dry, it was obvious that the potato crop was suffering from drought stress, and it could be assumed that this led to an increase of crop susceptibility for the disease. On the other hand, the very dry weather conditions, and more specifically the lack of dew periods during the night, were by no means conducive to development of the disease. This was reflected in the many observations in the field, where attacks of early blight remained absent.

In order to assess the supposed increased susceptibility of the potato crop, an additional factor for stress was added to the disease model. The size of this factor was chosen in order to fit the model with the observations in the field trials. With an increase of susceptibility with 50%, the model predicted a first application date of August 16th.

CONCLUSIONS

In the prevailing growing conditions in Flanders, early blight has to be regarded as a disease of the senescing potato crop. A certain level of senescence seems to be a condition for epidemic development of *A. solani*. Preventive applications with specific fungicides against early blight can be necessary to safeguard the potato crop against undesirable disease levels.

These trials are designed to answer the most important question in this regard: when do we have to start treating for a cost-effective and efficient protection? In both seasons, the trials managed to distinguish a clear and critical deadline for a first treatment. It also became clear that additional applications, carried out earlier, did not add to the level of protection of the crop.

The disease model, used to simulate development of the disease and more specifically calculate a critical time for first treatment, gave satisfying results in both seasons. The model uses both weather data and crop data – i.e. physiological resistance derived from crop senescence – as input. Using an additional factor for stress, which could lead to increased crop susceptibility, could improve the results of the model.

In both years, the potato crop suffered from severe drought stress. Although this could well cause an increased crop susceptibility, it was determined that the pathogen could not fully benefit from this, mostly due to the lack of dew periods, and hence leaf wetness, during the night.

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