PPO – SPECIAL REPORT NO 17 – 2015, 77-84

Strategies for the control of early blight (*Alternaria solani* & *A. alternata*) in Denmark

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SUMMARY
Field trials were performed in order to test the effect on early blight (*Alternaria solani* & *A. alternata*) of two sprayings compared with four and six sprayings at full and reduced dosages. Due to the dry July 2014 development in attack was not seen until the end of August with severe development in September. However, the attack was still sufficient to evaluate the different spray strategies. Since the development in attack came relatively late it was the strategies with sprayings late in the season that gave the best results for example in spray strategies with 4-6 sprayings which also had a high impact on yield. In average of two trials 2014 there was a tuber yield increase of 10%-19% after the different sprayings. In 11 trials 2010-2014 there was a tuber yield increase of 6.8% on average of the various treatments.

KEYWORDS
Potato early blight, *Alternaria solani, A. alternata,* control strategies, 2-6 sprayings, reduced and full dosages

INTRODUCTION

In recent years there have been many discussions on how the control of early blight should be targeted. Often the strategies have been supplementing the control of late blight (*Phytophthora infestans*) at the beginning of the season but now more focus is on extending the period during which the plants are protected to ensure a high yield potential. Field trials have been performed during the years (Bødker, 2014; Nielsen, 2013 and Nielsen 2014) and trial results from 2014 will be presented in this paper.

MATERIAL AND METHODS

Field trials with control of early blight were carried out in cooperation between Aarhus University and SEGES (Danish Advisory Service) at three locations (Flakkebjerg, Sunds and Billund). The potatoes were planted at the end of April 2014 and emerged at the end of May. The Alternaria trials were artificially inoculated at Flakkebjerg and Billund on 27th June with autoclaved barley

seeds inoculated with *A. solani* and *A. alternata* placed in the furrow between the plants. Each plot was scored as a whole for % disease severity (percentage coverage of all green leaves; EPPO guideline PP 1/2 (4), 2012).

DEVELOPMENT OF EARLY BLIGHT (*ALTERNARI SOLANI* & *A. ALTERNATA*)

Attacks of early blight are seen every year in the Danish potato fields, especially in the starch varieties with a long season. In many locations the first very small symptoms are seen from mid-July with disease development in August.

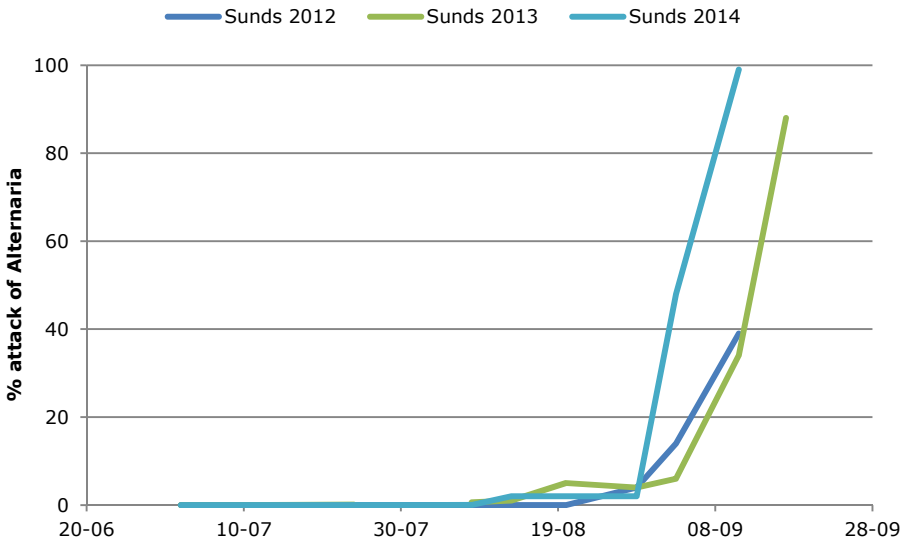

Figure 1. *Development of early blight (Alternaria solani & A. alternata) in untreated plots at Sunds (West Jutland) 2012-2014. Natural infestations. Variety Kuras*

Normally the epidemic development takes place in late August when severe attacks can be seen if the potato plants are not sprayed. Figure 1 shows the development of early blight in untreated field plots at Sunds in the western part of Denmark during the last three years in a typical potato growing area under natural infestations. The development in attack of early blight was almost similar in 2012-2014.

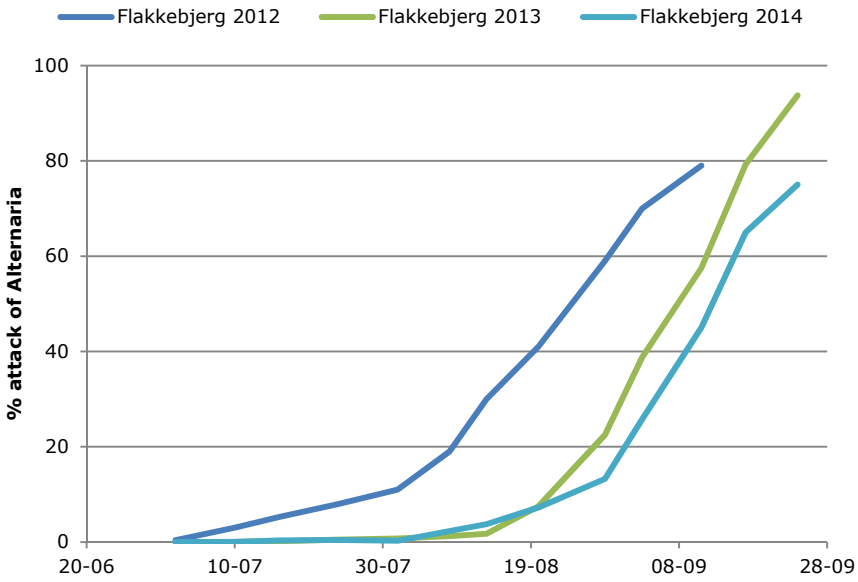

Figure 2. *Development of early blight (Alternaria solani & A. alternata) in untreated plots at Flakkebjerg 2012-2013. Artificial inoculation by inoculated barley seeds at the end of June. Variety Kuras*

At Research Station Flakkebjerg (100 km south-west of Copenhagen) the field plots are artificially inoculated and here the attacks of early blight are seen earlier in July (Fig. 2). The inoculation (as described under Materials and Methods) takes place at the end of June, and the first symptoms can be seen 7-10 days later.

The development in early blight at Flakkebjerg in 2014 was similar to the development in 2013 when the weather conditions in July also were dry but later than the development in 2012 (Fig. 2). Figure 3 shows the development in early blight at the three different locations.

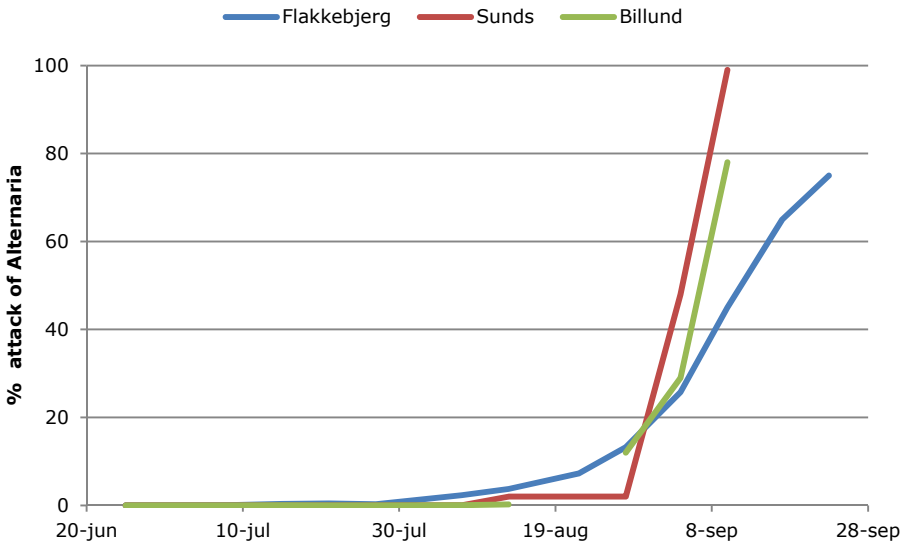

Figure 3. *Development of early blight (Alternaria solani & A. alternata) 2014 in untreated plots at Flakkebjerg, Sunds (West Jutland) and Billund (Central-Mid Jutland). Artificial inoculation at Flakkebjerg and Billund. Natural infestations at Sunds. Variety Kuras*

RESULTS

Field trials were performed in order to test the effect of two sprayings compared with four and six sprayings at full and reduced dosages. The start of the sprayings was at the very first symptoms at the beginning of July but early start before symptoms were observed was also tested. The trial set-up can be seen in Table 1.

Table 1. *Trial plan for testing different control strategies against early blight (Alternaria solani & A. alternata). Variety Kuras, 2014. Actual dates for the sprayings are indicated for the trial at Flakkebjerg. Set-up and the weekly spraying were almost the same in the trials at Billund and Sunds*

	17-jun	25-jun	01-jul	08-jul	15-jul	22-jul	29-jul	05-aug	14-aug	21-aug	28-aug	03-sep	09-sep
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Untreated*												
2			0,5 A		0,5 A								
3			0,3 A		0,3 A								
4			0,25 S		0,25 S		0,25 S						
5			0,25 S		0,25 S		0,25 S		0,25 S				
6			0,15S		0,15S		0,15S		0,15S				
7	Tridex	Tridex	0,15S		0,15S		0,15S		0,15S				
8			0,6 RT		0,6 RT		0,5 A		0,5 A				
9	0,6 RT		0,6 RT		0,5 A		0,5 A						
10			0,15S		0,15S		0,3 A		0,3 A				
11			0,15S		0,15S		0,3 A		0,3 A		0,15S		0,15S
12			0,075S		0,075S		0,15A		0,15A		0,075S		0,075S
13				0,15S		0,15S		0,3 A		0,3 A			

Tridex (2.0 kg/ha), RT: Revus Top (0.6 l/ha). 0.5A, 0.3A and 0.15A: Amistar 0.5 l/ha, 0.3 l/ha and 0.15 l/ha. 0.25S, 0.15S and 0.075S: Signum WG 0.25 kg/ha, 0.15 kg/ha and 0.075 kg/ha. All plots cover sprayed with Revus (0.6 l/ha) or Ranman Top (0.5 l/ha) at weekly intervals. Artificial inoculation at the end of June at Flakkebjerg and Billund, see Materials and Methods for details.

The results from the three trials can be seen in Figure 4 in which % leaf area attacked at the beginning of September is shown.

In 2014 the strategies in which most of the fungicide input was made in the first part of the season (e.g. 2 x Amistar) had the lowest effect (Fig. 4). However, it is interesting to note that the effect of the two early sprayings lasted approximately until the first week of September (6 weeks), but could not reduce the late attacks in September. Comparing the sprayings with Signum WG there was a clearly better control, using 4 sprayings than 3 sprayings and only small differences between 4 x 0,25 kg/ha and 4 x 0.15 kg/ha. Comparing the strategies using Revus Top, it seems that the first spraying at T1 (plot 9 in Table 1) was placed too early in relation to the actual disease development. Because of the relatively late start of the epidemic at the beginning of August there was in general a good effect of 6 sprayings. 2 x Signum WG 0.15 kg/ha + 2 x Amistar 0.3 l/ha + 2 x Signum WG 0.15 l/ha (60% dose level) gave a very high control level. Reducing this input to 30% dose level had an almost similar high effect. More details can be seen in Bødker (2014) and Nielsen (2014).

The results are similar to the results from 2013 when 2-4 treatments were compared. Best effect in 2013 was achieved with four treatments with either 4 x Signum WG or 2 x Revus Top + 2 x Amistar (Nielsen, 2013).

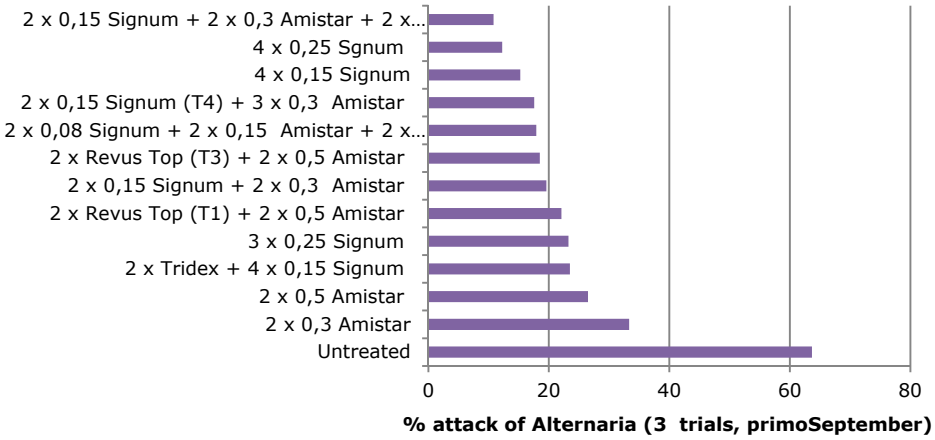

Figure 4. *Atack of early blight (Alternaria solani & A. alternata). Average of assessments at the beginning of September in 3 trials (Flakkebjerg, Sunds and Billund). The trial treatments have been arranged according to level of control. See Table 1 for details. Variety Kuras, 2014*

In average of two trials (Flakkebjerg and Sunds, the trial at Billund was not harvested) there was a tuber yield increase of 10%-19% after the various sprayings. The economy calculations in the different spray strategies showed that there was a high net yield increase relative to untreated from DKK 4,473 to DKK 7,380 Kr (15%-25% net yield increase). In 11 trials 2010 and 2012-2014 there was a tuber yield increase of 6.8% on average of the various treatments with a net yield increase of DKK 3.084-3.158 by using effective treatments (Bødker, 2014).

CONCLUSIONS

The trials with control of early blight (*Alternaria solani* & *A. alternata*) were performed in trials both with artificial inoculation and under natural infestations. Due to the dry July 2014 development in attack was not seen until the end of August with severe development in September. Although the start was relatively late in 2014 the level of attack was still sufficient to evaluate the different spray strategies. Since the development in attack came relatively late, it was the strategies with sprayings late in the season that gave the best results for example in spray strategies with 4-6 sprayings which also had a high impact on yield both in tubers and starch.

The results shows good effect of the late sprayings. What is needed now is more information on the start of the early blight treatments and the timing of the first spraying in order to optimize the length of the control period.

In average of two trials, 2014 there was a tuber yield increase of 10%-19% after the different sprayings (15%-25% net yield increase). In 11 trials 2010 and 2012-2014 there was a tuber yield increase of 6.8% on average of the various treatments with a net yield increase of DKK 3.084-3.158 by using effective treatments.

The results show that extending the control period with several sprayings had a high impact on the disease but it could also lead to an increased selection for fungicide resistance. It is crucial that anti resistance management is part of the spray strategy and includes fungicides with different modes of action.

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