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Epidemics and control of early & late blight, 2017 & 2018 in Europe

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INTRODUCTION

The EuroBlight late blight country profile was launched in 2007 to keep track of the development of early and late blight and its control in Europe in individual countries and over years. This paper reports the development and control of early and late blight in Europe, 2017 and 2018.

One important motivation for sharing data is that the single results in this way can be analysed in a pan-European context. When data are available over several years it will be possible to analyse the data over years and across countries. This is especially interesting now that all countries in Europe have to adapt to the new EU pesticide package implemented by 2014. Using the data we collect before and after 2014 might be used for impact assessment of this EU regulation. We will also use the data to stimulate to collaboration, harmonisation and coordination between institutions and different stakeholder groups.

At the workshop in York special attention was drawn to the collaboration between global networks, and colleagues from North-America, South-America, Africa and Asia were invited to present their results and to participate in discussions how collaboration on a global scale can be strengthened. The parties' ultimate aim is to gain new knowledge about populations of *Phytophthora infestans,* how these populations evolve, how local strains are spread from one continent to another and how we most effectively can control *P. infestans* on the field level. The European monitoring initiative has already given the parties a better understanding of the strains of *P. infestans* that are active in Europe. This information enables a more targeted use of fungicides and helps growers to choose potato varieties with the right levels of resistance. A

second area of concern is the increasing problems with fungicide resistance related to the control of late blight and especially early blight.
This paper reports the development and control of late and early blight in Europe, 2017 and 2018 and thereby describe the foundation for the further insight in the structure and behaviour of the European *P. infestans* (meta) and *Alternaria solani* populations.

LATE BLIGHT COUNTRY REPORTS

A questionnaire about late blight and early blight development and control was answered by the EuroBlight country editors. The detailed questions can be found in previous proceedings.
The reports per country published below are the abstracts of the country reports only slightly edited. The abstracts of the country reports are sorted according to regions in Europe. General trends and observations on disease development, fungicide use etc. are discussed in the section of summary information. Information regarding "Date when first infections were reported in more than five conventional, normally planted potato fields" for 2017 and 2018 is shown for all European countries on maps in Figure 1-2.

Estonia

2017: The first outbreaks were recorded in the beginning of July. The first fungicide applications were applied about the same time and mainly systemic fungicides were used. The first outbreaks were recorded when the risk of the development of potato late blight was estimated to be high, the rest of the growing season the risk of late blight was medium.

2018: The late blight risk in 2018 was very low throughout the potato cultivation period. The risk of late blight was higher in the beginning of July and in the beginning of August. In most regions epidemics of late blight did not occur and the crop yield was poor because of the unfavourable weather conditions. The first sprays were conducted in the middle of July, the spraying frequency was very variable according to the region.

Lithuania

2017: Application by fungicides started on the 7th of July. Fungicides were applied with 7 to 11 days intervals. In total, 5 applications were performed. The last application was performed on 11th of August. First disease symptoms were found on 13th of July, therefore first application with fungicide was already sprayed before symptoms appeared. At the beginning, disease development was slow. One week after the first symptoms appearance, disease severity was 0.42% in the untreated control. 15 days after symptoms appearance, disease severity sharply increased and was 26.7% in the untreated control. On 3rd of August, disease severity was 100% in untreated control. Application of fungicides helped to retain significantly less infected plants for a longer period.

2018: Application by fungicides started on the 9th of July. In total, 7 times fungicides were applied. The last application was performed on the 22nd of August. Fungicides were used with around 7-day intervals. At the moment of the first fungicide application, the crop foliage fully covered rows; therefore, suitable conditions prevailed for late blight infection. First late blight symptoms were found on the 25th of July in the trial area. But unfortunately, dry and hot weather conditions did not allow spreading of the disease on much larger scale. In fact, late blight symptoms disappeared in a period of 2 weeks. In August only a few rainy days were recorded, while in September – no significant (>1 mm) rain occurred for three weeks.

Russia

2017: A severe late blight development (yield losses >20%) was observed on potato fields of the Kaliningrad, Leningrad, Vologda, Komi, Tver, Moscow, Murmansk, Kirov, Novgorod, Smolensk, Bryansk, Yaroslavl, Kostroma, Arkhangelsk and Pskov regions. A moderate disease development (yield losses 10-20%) was registered in the Kaluga, Ryazan, Tambov, Belgorod regions. The development of the late blight infection on the other territories of the European part of Russia was rather weak (yield losses <10%). Infected seed tubers represented the main source of the primary infection. The most popular fungicides were Shirlan, Tanos, Acrobat MZ, Infinito, Revus Top, Kurzat, and Ridomil Gold MZ. The total number of treatments varied from 3 to 10. Owners of allotment gardens did not use any fungicides. The use of DSSes (Plant-Plus, VNIIFBlight, AGRODOZOR) was rather rare. The most popular potato cultivars were: Red Scarlett, Gala, Udacha, Rosara, Zhukovskiy ranniy, Nevsky, and Impala. The volume of foreign and domestic cultivars used by large agricultural companies was ~80 and 20%, respectively.

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Poland

2017: The first potato late blight infections in the 2017 season were recorded in the third decade of May and the 1st decade of June. The development of the disease was favored by meteorological conditions prevailing in June (average air temperatures 21°C, rainfall about 60 mm). In July, with a similar amount of average air temperatures, higher amounts of precipitation were observed, which favored a more rapid development of the disease. Higher air temperatures in August and smaller amounts of rainfall created less favorable conditions for the late blight development. The year 2017 can be considered as a year with favorable conditions for the development of the disease. In Bonin (West Pomeranian Voivodeship) in 2017, over 54% higher rainfall was recorded compared to multi-year.

2018: The year 2018 was characterized by high air temperatures and a small amount of rainfall. In Bonin (West Pomeranian Voivodeship) in 2018, the amount of precipitation was reduced by more than half compared to multi-year. Average air temperatures calculated for the growing season (April - September) were higher by around 3°C compared to multi-year. Higher air temperatures and lower amounts of rain were not conducive to the development of late blight in June. More favorable conditions occurred in July when the number of precipitation increased. In August, as in June due to smaller amounts of rainfall and high air temperatures (on average around 23°C) no rapid development of potato blight was observed.

Serbia

2017: Spring of 2017 was warm and wet and due to the favorable conditions, potato plants were planted earlier and the crop development was rapid. The wet conditions were favorable for the disease development and the first warning of late blight occurred at the end of May. From mid of May until the end of June weather conditions were very suitable for *P. infestans* infection. The weather conditions in July and August were very dry, with high temperature and very little rainfall which completely stopped the development of the disease. Potato growers performed from 2 to 5 control treatments during the season.

2018: The potato season 2018 was not easy for potato farmers. High humidity during May and June resulted in early outbreaks of late blight being reported in the potato growing regionsion the south of the country at the end of June. During the summer heavy rainfall and high humidity favored the further development of potato late blight. Due to the prevailing weather conditions, the untreated potato fields were severely infected by late blight at the end of June. First outbreaks were recorded in the fields intensively treated with fungicides on second half of July. The potato growers started with the fungicide treatments at the mid of May. The growers sprayed on average 6-12 times with fungicides during the season.

Romania

2017: The weather conditions were favourable for potato and for foliar late blight development also. Rainfall was close to average during the season in most areas. The first outbreaks in Brasov area was reported in 7 June and subsequently blight was reported in all potato growing areas. A cause of early disease can be the blighted seed tubers due to the high infection pressure of 2016. At the time of the late blight appearance the plants were protected and continued sustained with the treatments, as favorable conditions to the development of the epidemic were met in July. In the majority of crops late blight was well controlled, low levels of tuber blight were reported. Growers used a wide range of active ingredients.

2018: Since March, after exceptional quantities of rain, in April and May was a dry period and potato crops could be established and maintained with difficulty. The first infection in field in Brasov area was found in 3 July. In Harghita area (eastern part of Transylvania in the central part of Romania) in the same period were fields seriously affected by late blight. The disease spread fast in all potato fields and the epidemic pressure was high. In average the potato fields was treated 8-10 times with different fungicides.

Switzerland

2017: During the month of April 2017, it was cool and rainy, even with some snow down to the lowlands. In the first two weeks of May 2017, milder temperatures prevailed and two periods with up to four consecutive main infection and sporulation periods (MISPs) were registered for almost all weather stations considered in the DSS PhyotPRE. The first LB attack was observed on 17th of May in a covered potato field in the central region of Switzerland and late blight epidemic spread over the main potato-growing region. Two longer warm and dry periods in June and beginning of July with temperatures above 30°C reduced sporulation and, therefore, the development of the LB-epidemic. From mid-July, weather conditions were more favourable for *P. infestans* and some late LB-infections occurred. Based on the DSS PhytoPRE and plant protection officers' evaluations, LB-pressure was classified as low in 2017 and farmers could control LB.

2018: In 2018, weather conditions were extraordinary: it was one of the most dry and warm years in Switzerland since the official climate recordings of 1864 (Klimabulletin 2018, MeteoSwiss). Spring started with cool conditions and with some rain. However, from mid-June until November, it was not only exceptionally warm, but also very dry. These exceptionally warm and dry weather conditions also affected the development of the late blight (LB) epidemic: the first LB attacks was observed on 18th May in a covered potato field in the eastern part of Switzerland. At the beginning of June, a LB attack was registered in the central part of Switzerland. Due to several main infection and sporulation periods (MISPs) at the end of May and during the first two weeks of June, the LB epidemic could spread over the potato growing region. However, with the long lasting drought during summer and autumn, LB did not spread further and potatoes suffered more due to the drought or *Alternaria* attack. Overall, LB-pressure was very weak in 2018, and conditions were comparable to 2003 and 2015.

Italy

2017: The potato crop was planted in in mid-April and fully emerged nearly a month later while tomato was transplanted in the first week of May and harvested from August to September depending on the varieties. An unusual mild and dry winter followed a warm spring but rainy events were concentrated in the May. June was dry and July and August were characterized by hot climate with few rainy events (thunderstorms) in mid-July and mid-August. Such dry weather was not favourable for early and late blight infection for most the growing season even when crops have been frequently irrigated in summer. IPI index reached the threshold for the first spray in June and only 1 MISP infection was recorded until July. Then MISP events have been recorded only mid-August and September. Only early blight occurred at the end of the growing season, in July and August, but without causing severe damages on the crops, with disease remaining at low level until harvest. The number of late blight applications were concentrated in May and June on potato, while on tomato they were concentrated from June to the beginning of August. On average, on potato 5 to 7 fungicide applications were carried out.

2018: Climatic conditions, compared with the average, were characterized by the increase of minimum temperature and the decrease of maximum temperature. Climate in April was dry but in May and June were wet. July again was quite dry and rainfalls occurred from mid-August for most of September. The risk of late blight was therefore medium in May and for the first half of June, very low for the rest part of June, July and most of August and turned high during September, when however, most of the tomato crops were harvested. MISP events were concentrated in May and end of August. Late blight occurred on potato in few areas in mid to end of June, while on tomato the first symptom of the disease occurred in August. Early blight occurred at the end of June on potato without causing significant damages and in the second half of August and September due to senescence of the crops. The common disease strategies carried out for late blight and early blight were sufficient to contain the diseases. On average, 6 to 10 fungicide application were carried out.

Finland

2017: The year 2017 was cool and rainy. First outbreaks were detected a little bit later than normal, July 14th and after July 20th several heavy outbreaks were reported also at conventional protected fields. At the end of the season some blight lesions were present at most potato fields. In spite of heavy leaf blight attacks, tuber blight did not cause severe losses. Five to eight fungicide applications were normally used for blight control.

2018: The year 2018 was exceptionally warm and dry. First blight attacks were detected at organic production a little bit later than normal July 14th. However, the blight started to spread as an epidemic only after 10th September at very few locations. In infected fields the blight development was very rapid but most fields remained healthy. At infected fields heavy tuber attacks were observed but mostly also tubers remained healthy. Due to the low infection pressure only few fungicide applications were made but this probably led to heavy late outbreaks in September.

Norway

2017: May and June were a bit wetter than normal, followed by a dry July. Quite a few outbreaks in June, which had above normal number of warnings according to the Nærstad model. August and September were also quite wet, and in many areas a lot of late blight was seen at the end of the season despite a normal, weekly spray schedule. For most of the potato growing regions in Norway, 2017 was a year a bit worse than average concerning late blight.

2018: May, June and July were very warm in most parts of Norway, and in some areas there were no warnings issued at all for the whole of July. The normal number of warnings according to the Nærstad model in eastern Norway was 0-4 for both June and July. On average, the first treatment was applied 2-3 weeks later than normal due to warm and dry conditions. Some growers chose a longer spray interval (14 days) than normal, without having problems with late blight. From the middle of August there was quite a bit of rain, and also September was more normal concerning weather and late blight warnings. Some disease was seen in late August and September.

Sweden

2017: In south of Sweden, the planting was done late and there were reports of frost damage. The late blight reports came in early July. In Mid-Sweden, planting time was normal with a good crop establishment. In late June and early July there were some reports of late blight in this region. In all of Sweden the wet autumn resulted in a difficult harvest, with crops left unharvested due to wet field conditions. In the southern part of Sweden there were some problems in controlling late blight, while a normal or less than usual use of fungicides gave complete control in Mid-Sweden.

2018: A cold spring led in south Sweden to late planting, followed by change to warm weather with a good crop development. The summer was extremely dry and the few reports of late blight came very late in the season, late July and August.

Denmark

2017: Generally, the weather in 2017 during the potato-growing season was favourable (many rainy days, high humidity) for the development of late blight. Some fields with indications of infections from oospores. Early attacks were recorded on 9 June and many fields were infected a week later. There was a severe development of late blight in Denmark, especially during late July and August. During the first week of September, most unsprayed plots were totally defoliated by late blight in Denmark. Unexpectedly, very few tuber infections were seen in 2017. Different strategies with different fungicides such as Ranman Top, Revus, Proxanil, and Cymbal were used in 2017. The best protection, with 95% control, of late blight was when Cymbal (0.25 kg/ha) + Ranman Top (0.5 l/ha) was sprayed three times. Spraying Proxanil (2.5 l/ha) +Ranman Top (0.25 l/ha) twice in the season also gave 95% control of late blight. A weekly spray of Revus (0.25 l/ha) gave 79% control of late blight.

2018: In the Danish surveillance network, the first symptoms of late blight were recorded on leaves and stems on the 8 June. However, high temperatures and low humidity characterized the weather conditions subsequent to the onset of the first symptoms. Widely spread attacks in more than five conventional fields were found a month later. Dry and hot weather stopped the attacks effectively until the second half of August, when the rain started from 11-13 of August. This revived the development of late blight perhaps from inoculum that survived in the stems of the potato crops from previous infections in July. The following fungicides were used singly or in combinations to control late blight: Ranman Top, Revus, Proxanil, Cymbal, Zorvec Enicade and Curzate M WG. Due to the low late blight attack, all fungicide treatments resulted in more than 95% late blight control in 2018. Accordingly, we did not see significant differences in yield (both starch and tuber) of the fungicide strategies.

France

2017: After a very dry and moderately cold winter, the spring climate allowed fairly early planting in good soil structures. The emergence was fast and regular. A very dry and hot period followed after emergence in May up to the beginning of August. In most of France, weather conditions remained dry until early August, generating very high irrigation water requirements. The late blight pressure has been low until this date even though some fields with irrigation and/or thunderstorms may have seen some occasional outbreaks of late blight in June. The late blight pressure was very low and started late in August with a medium or high level according to the regions. No significant late blight outbreaks were observed in the fields in the country, except in covered and early planted potatoes in Brittany (mostly in May). The risk of tubers contamination at the end of the season was a medium level. In spite of the dry and hot weather, the Alternaria risk remained at a low level, except at the end of the season, shortly before the haulm killing resulting in very low damages.

2018: After a winter with very mild temperatures and quite high rainfall, potato planting was possible from the middle of April to the middle of May. The emergence was fast and regular. The late blight pressure started late in May or early in June and was extremely high up to middle of June. At the middle of June, many fields showed LB symptoms in most of France. After this period, the LB pressure decreased more or less quickly to low level according to the areas. The weather conditions very hot and dry from the end of June to the middle of August allowed a good control of the LB epidemic. From the middle of August, the weather conditions became wetter and milder allowing a restart of the epidemic, especially in the fields with stem blight symptoms or irrigated fields. A few fields with tuber blight were observed in September. In spite of the dry and hot weather, the Alternaria risk remained at a low level, except at the end of the season, shortly before the haulm killing resulting in very low damages.

Belgium

2017: The month of March was exceptionally warm and dry, marking the beginning of a very dry and also mild spring season. This weather clearly had an impact on the occurrence of late blight – or better, its absence. Moreover, an unexpected late frost period by the end of April not only caused damage to a lot of crops, but also helped to get rid of early volunteer plants (mostly on cull piles). The absence of inoculum sources in combination with extreme and persistent drought led to an exceptional low disease pressure until the beginning of July. Sporadic rainfall from July onwards caused some infection periods, and lesions were observed on volunteer plants towards the end of the month, and in some potato fields from the beginning of August. Regular precipitation periods in August caused almost daily infection opportunities; as a result, disease

was observed here and there in ware potatoes in the second half of this month. The weather was reflected in the advice for growers: spraying interval was 12 days and more until the end of June, 8 days in July and less than 7 days in August.

2018: The year 2018 was exceptional in climatological terms, being the warmest ever, with the warmest summer since the start of observations, a very low number of days with rain, a huge rainfall deficit and extremely high sunshine duration. In the early spring however, this was not yet obvious, on the contrary. A very cold and wet month of March caused a late start of the planting season. From the second week of April, temperatures raised markedly, and together with a very warm month of May it still became a warm spring season. It also became more and more dry, and from June on (and this until August) an exceptional drought period was recorded. Before this drought period however, late blight disease benefited from the presence of inoculum sources (mostly on cull piles, from April 24th) and some conducive weather for infection to develop rather strongly. This caused attacks in some fields early in June, and a strong expansion by mid-June. From then on however, disease pressure dropped to an exceptional low level, allowing for (very) long spray intervals. Only with the return of modest rainfall from August 10, crop growth resumed somewhat, and so did sprayings against both late and early blight. The interval was 6 days in June, 18 days in July, 8 days in August and dropping to 7 days towards the end of the season.

The Netherlands

2017: The last two weeks of February had a short period of frost. The potatoes were planted at a normal time, mostly during the first two weeks of April. The months April, May and June were very sunny and the temperatures in May and June were two or more degrees higher than the 30 year average. The start of the season was dry and in June many growers started irrigating their fields. The second half of the growing season the weather was warm but more humid and changeable weather. Especially during the last weeks of August the conditions for blight were favourable. In some regions we received reports of aggressive attacks which were hard to control.

2018: In the Northern part of the country most growers were able to plant at a normal time (first weeks of April) but to the south most field were planted end of April and the first weeks of May. In this region we also had some heavy rain showers during the first weeks after planting. In many fields the potatoes on lower parts of the field didn't emerge because of flooding. The summer of 2018 was record breaking. High temperatures and much sunshine during the whole summer. In the beginning of August the national average precipitation deficit was 300 mm, significantly greater than the 280 mm experienced in 1976, the year with the previous highest deficit. Where possible farmers were irrigating their fields to keep the potatoes growing. After a few weeks of changeable weather at the end of August attacks of Phytophthora were found in production fields with late regrowth.

Germany

2017: The weather condition and the late blight disease progression were diverse across Germany in 2017. The Northern and Western part had a normal late blight epidemic. In the Southern part it was warm and dry during the summer months therefore early blight was a major problem. The crop emergence was normal (5 -20 May). The first outbreak of late blight was recorded end of May. Attacks in conventional fields were found late May to early June. The further development of late blight was completely different. In the Northern parts of Germany there were favourable weather conditions for the late blight development. The disease pressure was high till end of August. In the Southern part only a few infection periods were observed in

July and August. The use of fungicides was normal in 2017. All kind of products were used; especially mixtures were used in the Northern part of Germany. In the southern part the fungicide treatments mainly focussed to control early blight.

2018: Crops were planted in good conditions but the crop emergence was normal from 3 to 25 May. The first outbreak of late blight in potatoes was recorded by end of May (late in comparison to the previous years). Attacks in different regions and ware potatoes were found in June. Due to the very dry and very hot period between May and August the weather conditions for the development of late blight were very unfavourable. In some regions it was even too dry (only a few hours of leaf wetness during the night was recorded) for the development of early blight (*Alternaria solani*). The number of fungicide treatments was lower than normal. Several farmers focused the fungicide treatments (choice of product and spray interval) on early blight control. Attacks of early blight especially in irrigated fields seemed to be an increasing problem in several potato growing areas.

Scotland

2017: For recent reports up to 2016 the average monthly risk for Scotland was estimated using Met Office Smith Period information from the same seven stations. This was no longer possible from 2017 onwards. Instead the average monthly blight weather risk for Scotland was estimated using BlightWatch Hutton Period information from 10 stations. It's important to note that comparisons of estimated risk from 2017 onwards compared with before 2017 are not valid. In 2017 the average number of Hutton Periods per station was 0.9, 2.5, 4.6, 4.8 and 3.7 in May, June, July, August and September respectively. In 2017 the first late blight outbreaks were both detected on 29 June, in postcode AB30 (crop) and IV8 (outgrade pile). In total there were 40 confirmed outbreaks reported on the AHDB Potatoes-funded blight outbreak maps for Scotland. The progression of crop outbreaks (26 in number) in Scotland was 0% in May, 19% in June, 27% in July, 54% in August and 0% in September There were two confirmed outbreaks on outgrade piles of potatoes (29 June & 30 August) and three outbreaks on volunteers (8 & 9 August and 23 October). There was a high number of confirmed outbreaks in gardens: two in July (7 & 25), four in August (15, 24, 28 & 29) and one in September (6). The last sample was submitted on 23 October.

2018: There were on average 1.1, 2.4, 3.1, 4.6 and 1.0 Hutton Periods per station per month for May to September respectively. The similar risk profile for May to August in both years was not very accurately reflected in the number of confirmed blight outbreaks in crops. The number of confirmed outbreaks of late blight in Scotland was low, the number in crops was very low. The first outbreak (the only crop outbreak) was in a seed crop on 14 August in postcode DD9. Only 10 confirmed outbreaks were reported on the AHDB Potatoes-funded blight outbreak maps, up until 25 September 2018 when the last sample was submitted. The progression of natural infection outbreaks in Scotland was two in August (seed crop and trial plots) and eight in September (four on volunteers [7, 7, 18 and 18 Sep], three in gardens [5, 8 and 25 Sep] and one in trial plots).

England & Wales

2017: One hundred and forty five outbreaks of late blight were reported in 2017 as part of the AHDB Potatoes funded Fight against Blight outbreak maps. One outbreak was reported in April, one in June, 21 in July, 59 in August, 38 in September, 16 in October and one in November. Nine of these outbreaks were from outgrade piles and reported from April to October. General epidemic onset was late, with the earliest outbreak in England and Wales in a commercial crop reported on

5 July in Yorkshire in the north of England. Thirty-three outbreaks were reported on volunteers: 1 in July, 8 in August, 9 in September, 14 in October and 1 in November. Fungicide programmes were well underway by the time the epidemic started so control was generally good. This was the first year that potential issues with late blight control and fluazinam were reported. It was also the year when 37_A2 was more widely reported, particularly in the west and midlands of England. The most frequently applied active ingredients were mancozeb/cymoxanil, fluazinam, cyazofamid, mandipropamid and cymoxanil to both seed and ware crops.

2018: Seventy-eight outbreaks of late blight were reported in 2018 as part of the AHDB Potatoes funded Fight against Blight outbreak maps. Three outbreaks were reported in April, one May, 12 in June, 10 in July, 22 in August, 17 in September, 12 in October and one in November. Three of the outbreaks were on outgrade piles. All of these were reported in April in the South East of England. Few outbreaks were reported until June. The earliest outbreak in England and Wales in a commercial crop reported on 30 May in Pembrokeshire in Wales. The majority of outbreaks were reported in crops. Seven outbreaks were on volunteers and three on outgrade piles. Fungicide programmes were well underway by the time the epidemic started so control was generally good. Weather was less favourable for disease development during July. Fewer issues with poor control of late blight were reported and agronomists reported using less fluazinam in fungicide programmes. 37_A2 was reported in the west of England, Kent and Norfolk and 36_A2, which is not associated with fungicide resistance, was reported in the east of England and Kent. The most frequently applied active ingredients were mancozeb/cymoxanil, fluazinam, cyazofamid, mandipropamid and cymoxanil to both seed and ware crops.

Ireland

2017: Late blight infections were reported from late June in 2017. This followed a period of weather in late May and early June very favourable to the spread of late blight. However, even though infections were reported in most instances in stems when the crop was in canopy expansion, the application of fungicides in most instances was able to halt the disease. Furthermore although weather conditions remained favourable for the spread of the disease throughout the summer, limited outbreaks of the disease was reported. This is most likely due to the fact that intensive fungicide regimes were applied. Limited tuber blight was reported.

2018: Due a prolonged period of dry weather from late May – mid-late July extremely low levels of late blight were reported. In untreated trial plots natural infection was not reported until late August. Coupled with the low disease pressure, in most instances planting of the main crop was considerably later than normal due to unfavourable planting conditions.

EARLY ATTACKS OF LATE BLIGHT

The dates of the first observations of late blight in more than 5 conventional, normally planted potato fields in 2017 and 2018 are presented in Figure 1 and 2. In Figure 3 the Late Blight weather in May, June, July and August 2017 and 2018 is indicated with yellow (low risk), orange (medium risk) and red (high risk).

In Figure 4 and 5 the dates in 2017 and 2018 are presented when attack was recorded for the first time (blue circles) and when attack was observed in 5 or more conventional fields (red triangles).

In Figure 6 the dates are presented when attacks were recorded in 5 or more conventional fields in 2017 (blue triangles) and in 2018 (red triangles).

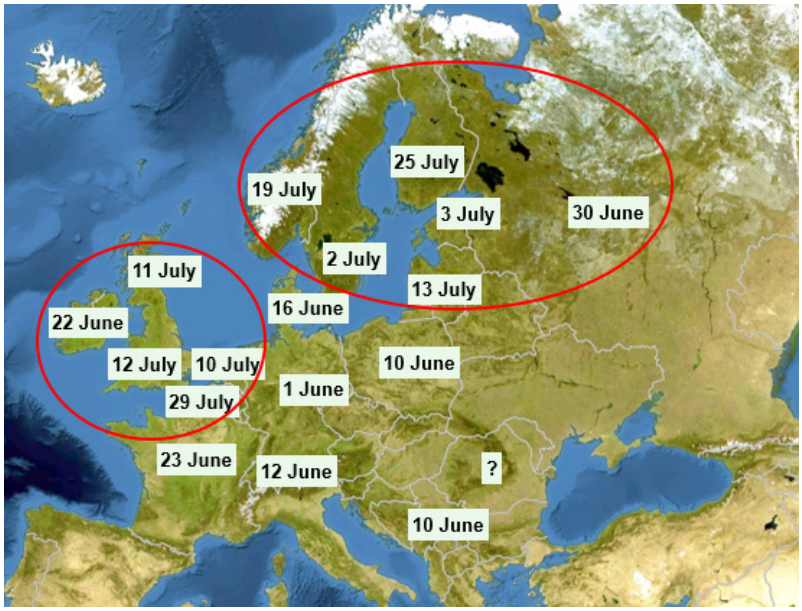

Figure 1. *Date of first observation of late blight in more than 5 conventional, normally planted potato fields, 2017*

Figure 2. *Date of first observation of late blight in more than 5 conventional, normally planted potato fields, 2018*

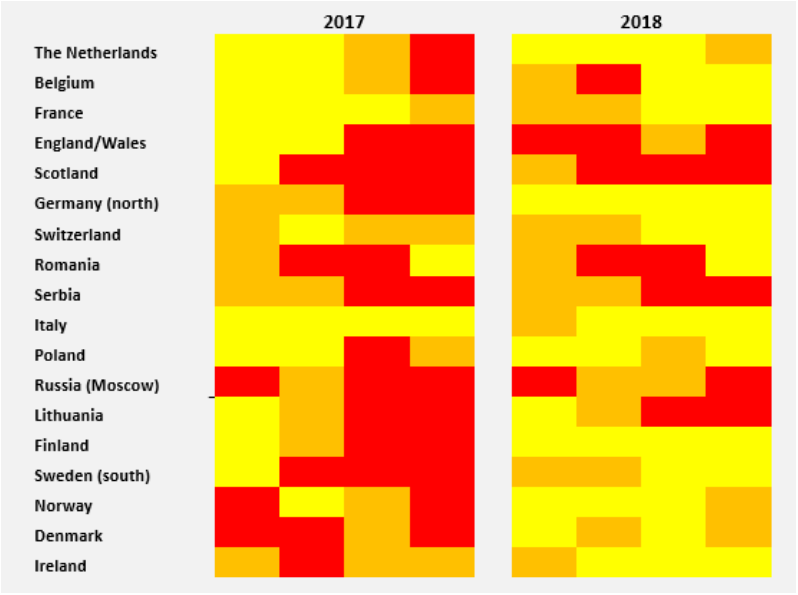

Figure 3. *Blight weather in May, June, July and August 2017 and 2018. Low (yellow), medium (orange), high (red) risk*

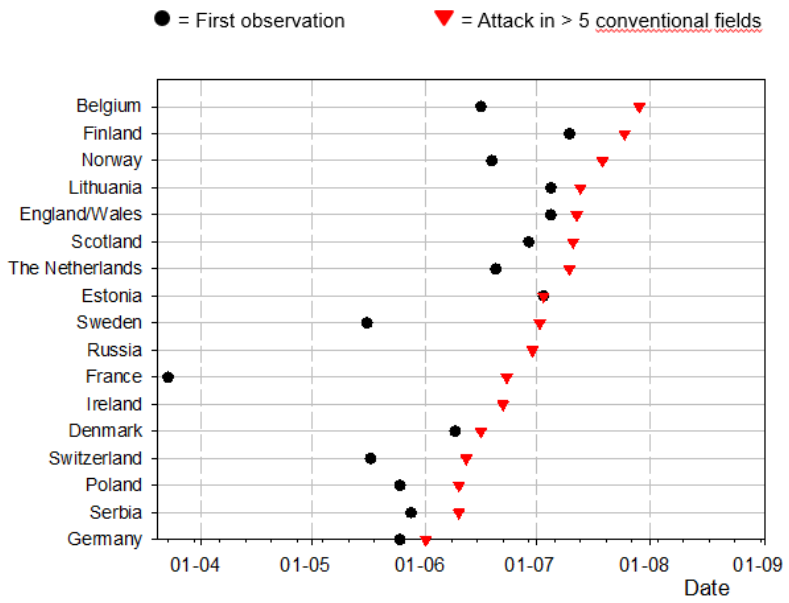

Figure 4. *Dates in 2017 when attack was recorded for the first time (blue circles) and when attack was observed in 5 or more conventional fields (red triangles)*

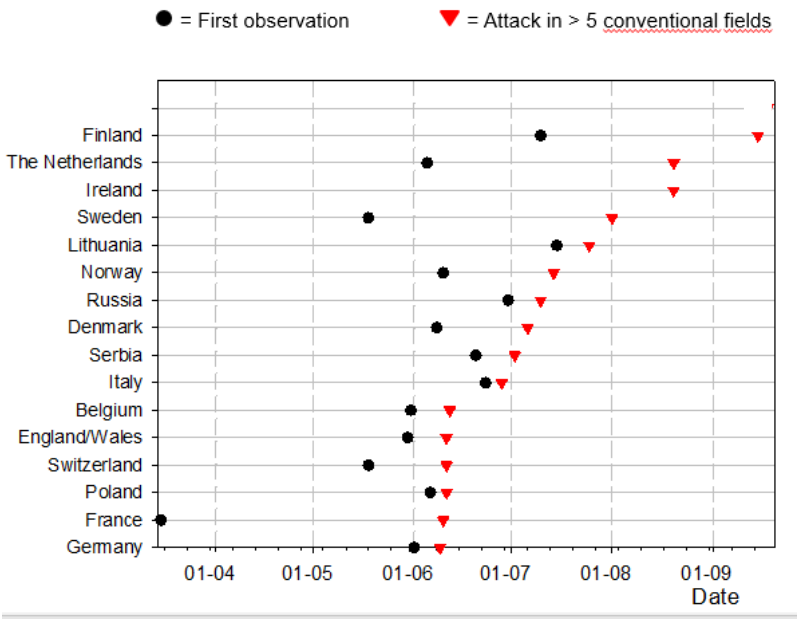

Figure 5. *Dates in 2018 when attack was recorded for the first time (blue circles) and when attack was observed in 5 or more conventional fields (red triangles)*

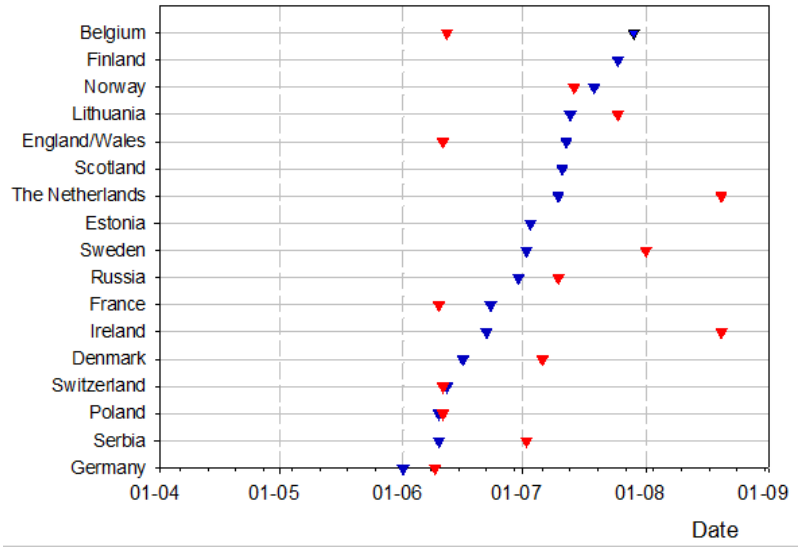

Figure 6. *Dates when attacks were recorded in 5 or more conventional fields in 2017 (blue triangles) and in 2018 (red triangles)*

TUBER BLIGHT

The level of tuber blight in 2017 was reported as low in many countries in Europe, except for some regions in Sweden, Russia, Romania, France, Belgium and Germany where it was reported as medium to high (Figure 7).

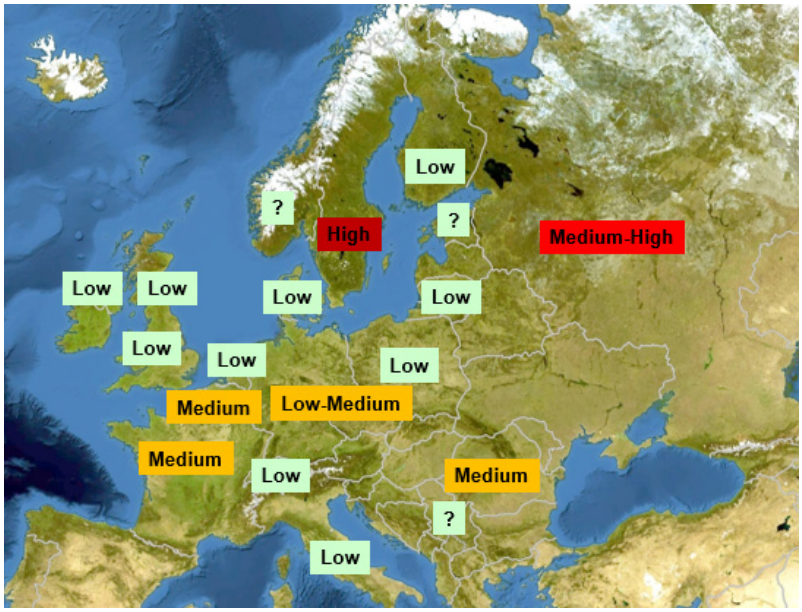

Figure 7. *The level of tuber blight attacks (low, medium or high) in 2017 compared to normal*

INDICATIONS OF OOSPORES

In 2017 infections caused by oospores were reported in Sweden, Finland, Denmark, Estonia and Lithuania (Figure 8).

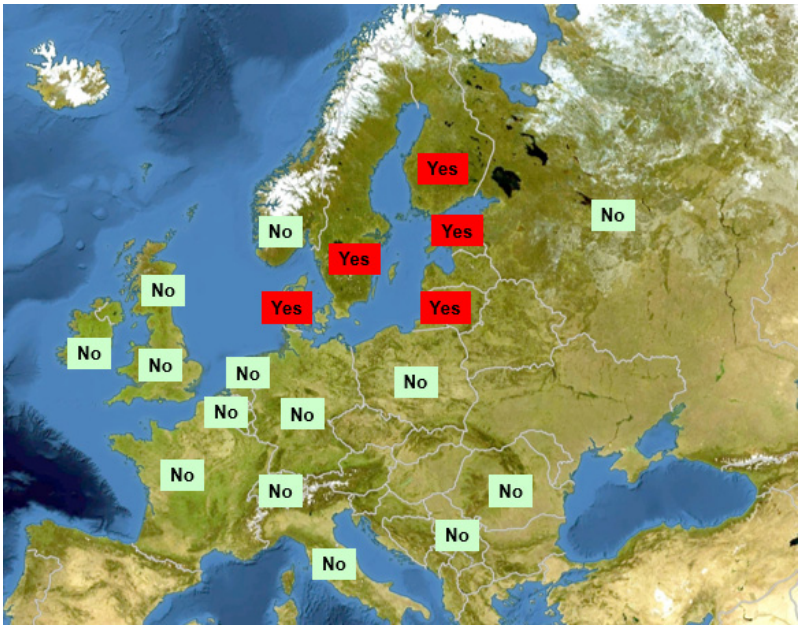

Figure 8. *Indications of oospores in Europe in 2017*

FUNGICIDES AND CONTROL STRATEGIES

In **Estonia** the sprays are mostly conducted based on the weather conditions. Systemic fungicides are used for the first sprays, later contact fungicides are used. The spraying is mostly conducted every 10 days, more often when the weather conditions stay cool and humid. In average the fields are sprayed 5 times per season. In **Lithuania** on average four to six fungicide applications are common practice. First and sometimes second applications are done with contact fungicides. The following two applications are done with systemic fungicides, and followed by one or two applications with contact or translaminar fungicides. In **Russia** in 2017 the average number of fungicide treatments on large agricultural companies was 4-9 for susceptible cultivars and 2-5 for moderate susceptible cultivars. In 2018 the average number of fungicide treatments in large agricultural companies was 3-5 for susceptible cultivars and 2-4 for moderate susceptible cultivars. Farms producing potato for chips used fungicide applications more frequently than other potato-growing farms. The owners of allotment gardens use no fungicides. In **Poland** the number of treatments in 2017 applied against late blight in conventional plantations was up to 5, in seed potato plantations, up to 8 treatments, and in French fries and chips plantations up to 12. In 2018, fewer treatments were applied due to unfavorable conditions for the development of the disease. On fields in the conventional system from 1 to 5, for seed potatoes up to 6. For fries and chips - from 8 to 11. The most common model of controlling late blight was the chemical protection of plants starting at the height of 15-20 centimeters with further continuation. This allowed performing 1-2 preventive treatments. The most commonly applied active ingredients were: propamocarb hydrochloride in mixture with fenamidone, fluopicolide and cymoxanil, metalaxyl + mancozeb, metalaxyl-M + mancozeb, cymoxanil + mancozeb and dimethomorph + mancozeb. Cyazofamid, mandipropamid

+ cymoxanil and cymoxanil + famoxadone were less frequently used. In **Serbia** the most frequently used active ingredients to control late blight were: propineb, propamocarb hydrohloride + fenamidone, mancozeb + cymoxanil, cymoxanil, copper, famoxadone + cymoxanil, metalaxil + mancozeb, cyazofamid, mandipropamid + difenoconazole, dimetomorph + mancozeb, valifenalate + mancozeb, dimetomorph + folpet, ametoctradin+ dimetomorph**,** propamocarb hydrohloride + fluopicolide, difenoconazole. The number of spraying were from two to twelve applications. In **Romania**, an average of 6-10 fungicide applications is a common practice. Usually big farmers do not wait until first symptoms appear and not always the DSS support their decision. The main fungicides applied in ware and seed potatoes are: mefenoxam, propamocarb, fluazinam, cyazofamid, cymoxanil, chlorotalonil.

Also the big farmers, unfortunately and without recommendation make tank mixes of different commercial products. In **Switzerland**, farmers use fungicide applications to control late blight in addition to preventive control measures (certified seeds, less susceptible varieties, ridge quality etc.). At the beginning of the season, systemic fungicides are often applied, and, afterwards, they use protective or translaminar fungicides (or a combination of both) depending on the weather conditions and on the late blight epidemic pressure. Farmers obtain spraying recommendations through their plant protection officers, our DSS PhytoPRE, or the newspaper. In organic potato production, copper products are often used to control late blight (max. 4 kg/ha and year). There is also a PhytoPRE version for organic production available, but it is rather seldom used. In general, farmers are aware of the possible infection sources and avoid the accumulation of waste piles and volunteer plants. In **Italy**, on potato, the most common strategy is to change some actives depending on the risk of infection and the rate of crop growing. At the beginning of the season and with active crop growth, systemic and translaminar fungicide in mixture are preferred. After bloom, when rate of new growth is reduced translaminar and contact fungicides are used. At the end of the season, QoI, SDHI or triazole fungicides are preferred to delay crop senescence and in the meantime to contain early blight. On tomato, copper based product are applied at the beginning of the season to control bacterial spot diseases which normally occur in that period (May-June). In **Finland**, in 2017 in general 5 to 8 fungicide applications were made. Ranman and Infinito were the most commonly used products. Due to heavy blight pressure also metalaxyl containing fungicides were used. In 2018 only 2 to 5 fungicide applications in general were made. In **Norway**, 2017 was a normal season regarding fungicides, but in some areas a lot of late blight was seen at the end of the season despite a normal, weekly spray schedule. In 2018, the first treatment was 2-3 weeks later than normal due to the warm and dry conditions. Some chose a longer spray interval (14 days) than normal. In **Sweden**, contacts or translaminars are the main products. The number of sprays used in ware potatoes varies from south to north, with substantially more fungicide applications in the south. The number of sprays can be estimated to be about normal in 2017 and lower than normal in 2018. In **Denmark**, we mainly spray the protectant fungicides Ranman Top and Revus either based on the standard weekly from the late June spray or according the blight management DSS. We also use curative Proxanil and Cymbal in combination with protectant Ranman Top or Revus when curative action is need. In **France**, due to a very low late blight pressure, growers achieved a fair control right after emergence with contact fungicides. Later on, because the disease pressure was remaining very low, growers were able to continue with longer delay between fungicide applications of simple protectant products except in irrigated fields. Very few translaminar and curative products have been used later in the season (after the middle of August) when the blight pressure became medium or high. In **Belgium**, the average number of fungicide applications in 2017 (in susceptible varieties, mainly Fontane and Bintje) was 13, which corresponds with an average interval of 8,3 days for the growing season (from min. 6,8 tot max. 14 days interval). In 2018 the average number of fungicide applications (susceptible varieties,

mainly Fontane and Bintje) was 12, which corresponds with an average interval of 9,5 days for the growing season (from min. 6,7 tot max. 18 days interval). In **the Netherlands, m**ost growers are using three or four different fungicides during the season. Starting with Acrobat, Curzate, Valbon or Revus followed by Infinito, Kunshi, Canvas and Ranman Top. On an average use of about 14 sprays over the years, last year many growers sprayed a few times less. The average acreage per grower is increasing over the years. Many use a DSS to support them in decision-making when to spray. But especially the farmers with many hectares do not vary the spray interval but spray according to the calendar, mostly every 7 days. In **Germany** in 2017, 4 to 10 spays in the South and 6-12 sprays in the North were necessary to control late blight. In 2018, the number of fungicide applications was between 4-10 in the South and 4-8 in the North. For the first application a systemic or local systemic fungicide was used. Then local systemic products (e.g. Revus, Revus Top, Infinito, Acrobat Plus, Valbon) were used. After flowering Ranman Top, Shirlan and fungicides containing Mancozeb were commonly used. The spraying interval was according to DSS systems. In **England & Wales**, according to the most recent report available (UK pesticide usage survey report 271 using 2016 figures), 98.4% of ware crops were treated with fungicides with an average of 12 applications per crop. The most frequently applied active ingredients to ware crops were fluazinam, cymoxanil/mancozeb, cyazofamid, cymoxanil and mandipropamid. For seed crops, all those surveyed were treated with fungicide and received an average of 10 fungicide applications. The most frequently applied active ingredients were cyazofamid, cymoxanil, cymoxanil/mancozeb, fluazinam and mandipropamid. Most fungicides are applied at a maximum of 7 day intervals. In **Scotland**, official fungicide usage survey data are only collected for every second year. The data for 2018 are not yet available. In **Ireland** in 2017, intensive fungicide programmes, utilising most available chemistries were applied. Fungicides were routinely applied at seven day intervals throughout the season. Fungicides were selected based on the stage of crop growth and their specific properties, e.g. curativity. A reduction in the amount of fluazinam applied occurred amongst the more intensive growers based on concerns surrounding potential emergences of reduced activity in specific *P. infestans* strains. No data is available to support a reduction in efficacy under Irish conditions or the presence of strains with reduced efficacy. In 2018 a reduction in the amount and types of fungicides applied occurred due to the prolonged dry period during the summer months. During the growing season the biggest issue facing growers was the availability of water, and following rainfall sprouting of immature daughter tubers.

POPULATION CHARACTERISTICS

In **Estonia**, *P. infestans* population is diverse with numerous genotypes, which is the result of sexual reproduction. Both mating types are recorded from the same potato fields and oospore-derived infections are initiating the epidemics. *P. infestans* isolates are highly virulent and aggressive. Late blight epidemics usually start from the small allotments, gardens, fields, where rotation is short, fungicides are not applied and various cultivars are grown from self-propagated seed. In **Lithuania**, the last research about pathogen characteristics was done in 2012 by Runno-Paurson *et al.* (2015). Since that time further activities were not performed. In **Russia**, the majority of the studied *P. infestans* isolates, collected from potato fields, were of the A1 type (65%); the A2 type was reported only within 35% of the total number of isolates. All isolates were identified as of complex races (7-11 virulence genes). The majority of regions were characterized by phenylamide-sensitive isolates, except the Sverdlovsk region (>45% of resistant isolates). In **Poland** in 2017, due to weather conditions, the disease developed rapidly. In Bonin (zachodniopomorskie voivodship) on varieties cultivated without protection, the destruction of plant assimilation area exceeding 75% was found after 20 days from infection for early varieties, 29 days

for medium early ones and 44 days for late ones. Symptoms were mainly observed on the leaves, although symptoms on the stem were also found. Symptoms on the stems appeared on average 14 days later than the symptoms on the leaves. The most common infection site was the middle part of the plant. Only one case had an earlier infection compared to the leaf infection on the stem. Symptoms occurred in the middle part of the plant on the early VINETA variety. In 2018, due to weather conditions, the disease developed more slowly in June. An increase in the severity of the disease was recorded in July when the amount of precipitation increased (on average 63.4 mm). In August, due to the low amount of rainfall and high air temperatures, no development of the disease was observed. Symptoms of blight on the stem most often occurred in the middle part of the plant. There was no previous disease on stems compared to leaves. In **Serbia** in 2018 three genotypes were present with dominance of EU_13_A2 genotype. In **Romania** in 2016, the two isolates that were characterized belonged to the "other" genotypes. In **France** the population has been monitored in collaboration with the EuroBlight network. With the easy-to-handle *P. infestans* collecting device, the Whatman FTA card, a thorough collection of samples has been possible with the help of professional partners, extension and technical institutes, breeders and advisors. More than 200 FTA cards from most of the potato producing areas were collected in 2018. The overall genotypic analysis showed a predominance of the EU_13_A2 and EU_37_A2 clones in the North, and of the EU_13_A2 and EU_6_A1 clones in the West. Some EU_1_A1 isolates were detected in all French areas, while very sporadic EU_36_A2 was found in Northern France. Population composition was similar in 2017. The diverse clonal structure of the population tends to confirm that the asexual reproduction of *P. infestans* is still prevalent in the country. In **Sweden**, the population of *P. infestans* shows a very high genotypic diversity and there are strong indications that oospores function as an important source of primary inoculum. However, during 2017 a clone (EU_41_A2) was found on fields in South and Mid-Sweden. The low incidence of late blight during 2018 resulted in few sampled fields, but in an intensively sampled field trial in Southwest Sweden EU_41_A2 was dominating. In **Denmark**, in 2017 EU_41 was the dominating genotype, but EU_36 (3 isolates) and EU_13 (1 isolate) were also found but at very low levels. In 2018, all isolates sampled were of the EU_41 genotype. In **Norway**, the new genotype EU_41_A2 was discovered for the first time in 2016. This genotype was also found in 2017 and 2018. In **England**, there has been a substantial change in *P. infestans* genotypes. EU_37_A2, which is associated with decreased sensitivity to fluazinam and was first reported in England in 2016, represented 24% of samples collected in 2017. EU_36_A2 was detected for the first time and represented 2% of samples. EU_6_A1 accounted for approximately 49% of samples and EU_13_A2 10% of samples. In 2018, EU_37_A2 was reported in 17% of samples, with a substantial increase in EU_36_A2 to 17% of samples. EU_36_A2 and EU_37_A2 have only been reported in England, there have been no reports in **Wales**. In **Ireland** in 2017 whilst early infections were reported in main crops, timely applications of fungicides prevented their further spread. Although infections were early the subsequent development of epidemics was relatively slow in comparisons to previous season. Limited genotyping confirms the continued dominance of the population by EU_8_A1, EU_6_A1 and EU_13_A2, with no other genotypes selected. Given the extremely low pressures experienced in 2018 limited data is available on the *P. infestans* population composition.

USE OF DSSs

Several decision support systems for late blight forecasting and control are used in Europe (see Table below).

Country	DSS
Belgium	PCABlight-DSS
Denmark	Blight Management
England, Wales, Scotland	Blightwatch, Fight against Blight, Plant Plus & BlightCAST
Estonia	Estonian Crop Research Institute
Finland	National Resource Institute: general LB warnings
France	Mileos®
Germany	PhytophthoraModel Weihenstephan, ISIP
Ireland	Met. Service based on Irish rules (Bourke)
Italy	IPI + MISP
Netherlands	ProPhy, Plant Plus, WUR Blight APP
Norway	Negative prognosis, Nærstad model
Romania	Plant Plus
Russia	VNIIFBlight, Agrodozor, Plant Plus
Sweden	Blight Management (DK) & VIPS (NO), Plant Plus
Switzerland	PhytoPRE

ALTERNARIA 2017 & 2018

For long time *Alternaria* spp. was a minor problem in North and Western Europe. Since some years, more and more countries report an increasing occurrence of early blight in the fields. Early blight infections in potato results in several European countries (Sweden, Denmark, Poland, Germany, Netherlands, Lithuania, and Austria) in reduced tuber and starch yield. In Italy EB infection on tomato can reduce the marketable yield. In most of the countries tuber infections are not observed or really rare in the field.

EB DISEASE OBSERVATION AND EB DISEASE PROGRESS

The date of first observation of early blight symptoms in field trials 2017 is shown in Figure 9. The first symptoms occurred mid of June in Serbia, Poland and Germany; mid of July in Italy, France, Denmark and Sweden. In most regions two to five weeks later the disease epidemic started (Figure 10).

In 2018 we had an early outbreak of EB in Poland, Serbia, Italy and Germany (second week in June) (Figure 11). Also some observations of EB attacks are reported from Norway. The disease epidemic started again 2-5 weeks after the first outbreak (first observation) (Figure 12).

In Table 1 the EB specific disease development 2018 from May to September in different European countries is shown. In May and June in all countries with the exception of Serbia and Italy the disease severity in the fields was lower than 20%. The disease severity in July increased in Germany, Poland, Italy, Serbia and Russia up to 50%. In Germany and Serbia the EB specific disease level in August was higher than 50%.

EB: IDENTIFIED *ALTERNARIA* SPECIES

In most countries the *Alternaria* subspecies *Alternaria solani* and *Altenaria alternata* were identified on infected potato leaves (Table 2). As in the previous years in Denmark and Serbia only *Alternaria solani* could be detected. Overall the dominating species during the disease epidemic in 2017 and 2018 was *Alternaria solani* in most European countries.

FUNGICIDE USAGE AND FUNGICIDE RESISTANCE

Different products are registered in Europe for the control of early blight. The following active ingredients were used in different countries to control the disease: mancozeb (multisite), chlorothalonil (multisite), azoxystrobin (QoI), pyraclostrobin (QoI), boscalid (SDHI) and difenoconazole (DMI). According to the regional registration also mixtures of these active ingredients or with oomycete active ingredients (mandipropamid) are registered. QoI's and SDHI's have a specific single-site mode of action and possess a high risk to the evolution of fungicide resistance due to point mutations. Loss of sensitivity to QoI's has been reported for *A. solani* in potato (Pasche *et al.* 2004). The monitoring data from 2017 and 2018 confirm that in Germany, Belgium, the Netherlands, Poland and Sweden the F129L mutation in *Alternaria solani* is very dominant. Additionally, in Austria, Denmark and Serbia F129L mutants were found.
SDHI mutants were found in Belgium (Landschoot *et al.* 2017), Germany (Metz *et al.* 2019), the Netherlands, Austria and Serbia.

At the moment different DSS (Decision Support Systems) are available to optimize the use of fungicide applications. In some European countries, disease management is based on computer based systems dealing with calculating favourable weather conditions for an EB infection by *Alternaria solani* or temperature degree-day thresholds. DSS models are existing in Germany (PhytophthoraModel Weihenstephan), the Netherland, Sweden, Poland (DACOM) and Belgium (DSS-Early blight) to optimise the control of EB. Additionally in Germany farmers use threshold values based on the disease progress (Leiminger and Hausladen, 2012) to manage EB.

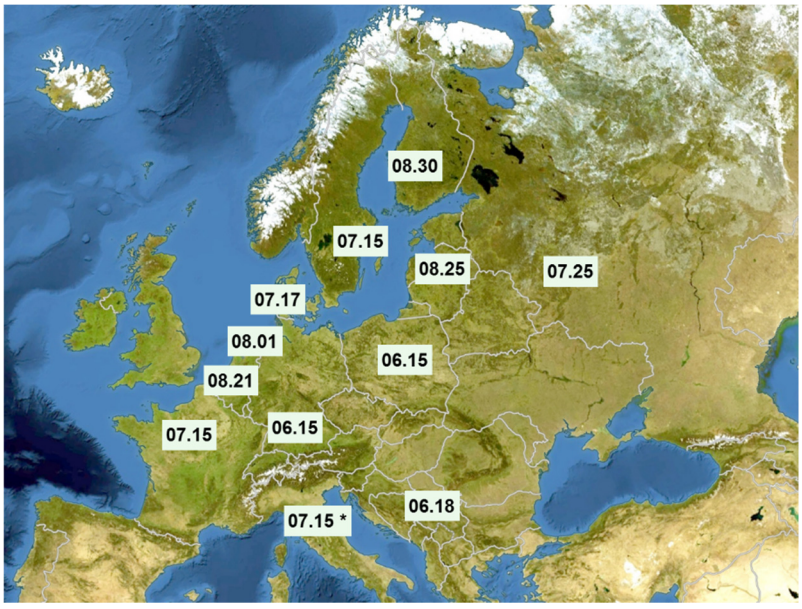

Figure 9. *First observation of early blight in* ***2017*** *in Europe*

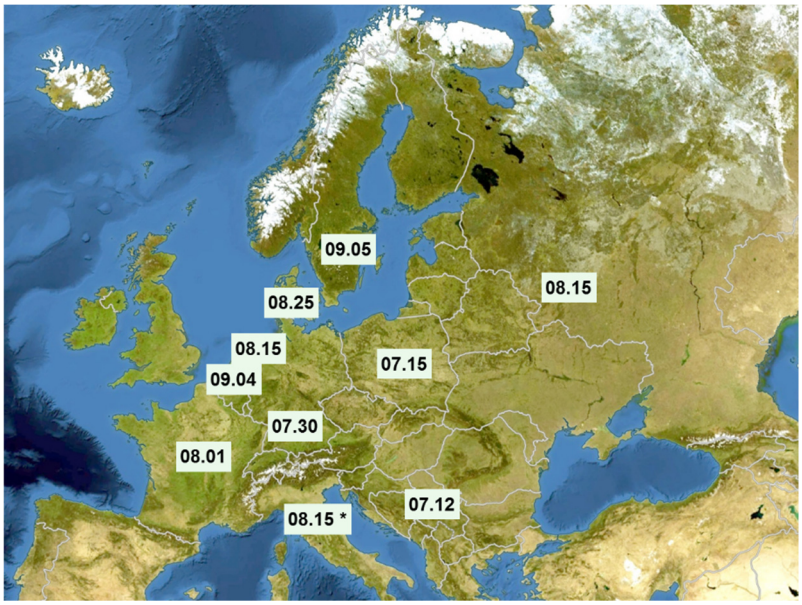

Figure 10. *Start of the early blight epidemic in* ***2017*** *in Europe*

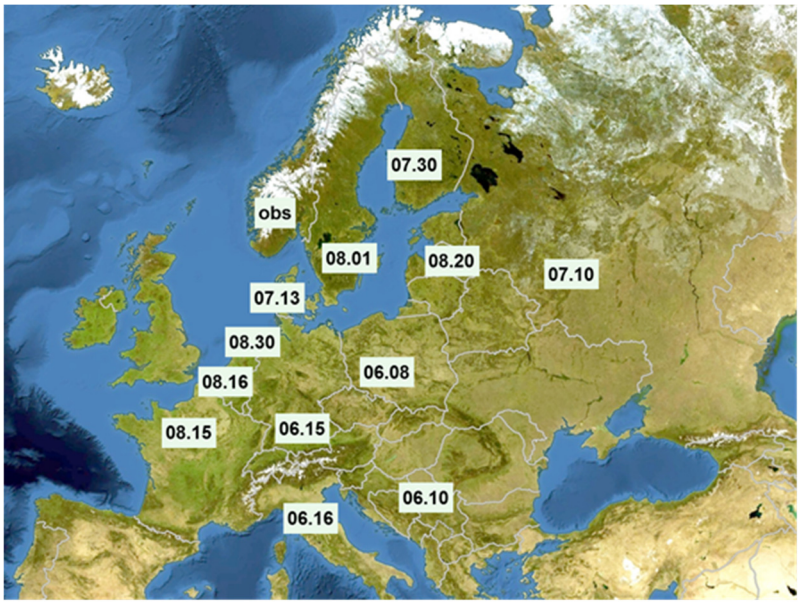

Figure 11. *First observation of early blight in* ***2018*** *in Europe*

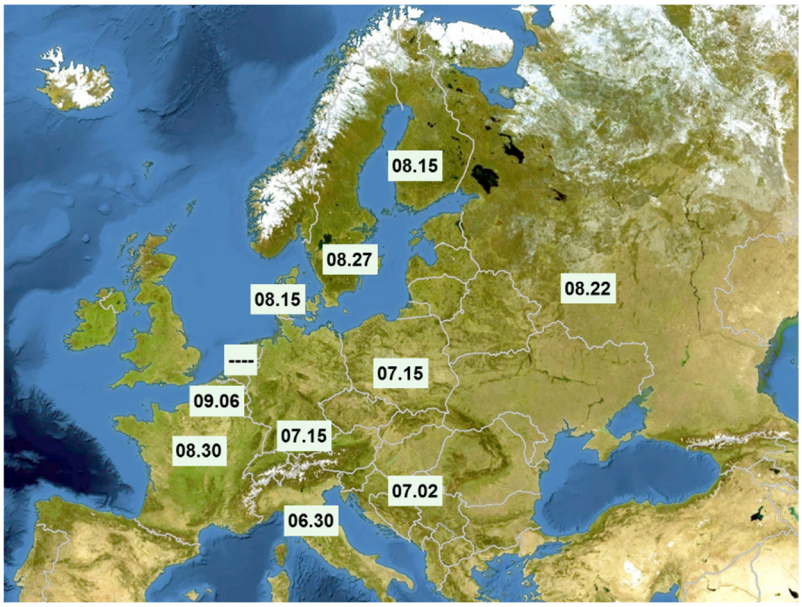

Figure 12. *Start of the early blight epidemic in* ***2018*** *in Europe*

Table 1. *EB specific disease severity 2018 in different European countries*

Low <20%

Medium 20 - 50%

High >50%

no data, no eb

	disease severity				
	May	June	July	August	September
Finland					
Norway					
Sweden					
Denmark					
Estonia					
Lithuania					
Scotland					
Northern Ireland					
England and Wales					
Belgium					
Netherlands					
Germany					
Poland					
Switzerland					
Italy					
Romania					
France					
Serbia					
Russia					

Table 2. *Identified Alternaria species (Alternaria solani / Alternaria alternata) in different European countries*

	A. solani	Jun	Jul	Aug	Sep	A. alternata	Jun	Jul	Aug	Sep
Finland										
Norway										
Sweden	√		√	√	√	√		√	√	√
Denmark	√		√	√	√					
Estonia										
Lithuania										
Scotland										
Northern Ireland										
Ireland										
England & Wales										
Belgium	√		√	√	√	√		√	√	√
Netherlands	√		√	√	√	√		√	√	√
Germany	√		√	√	√	√	√	√	√	√
Poland	√		√	√	√	√	√	√	√	√
Switzerland										
Italy	√		√	√	√	√	√	√	√	√
France	√			√	√	√		√	√	
Serbia	√	√	√	√	√					
Russia	√		√	√	√	√	√	√	√	√

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