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# Epidemics and control of early & late blight, 2015 & 2016 in Europe

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## INTRODUCTION

The EuroBlight late blight country profile was launched in 2007 to keep track of the development of late blight and its control in Europe in individual countries and over years. This paper reports the development and control of late blight in Europe, 2015 and 2016.

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 Aarhus special attention was drawn to the collaboration between global networks, and colleagues from North-America, South-America 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 *P. infestans,* how these populations evolve, how local strains are spread from one continent to another and how we most effective can control *Phytophthora 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, 2015 and 2016 and thereby describes the foundation for the further insight in the structure and behaviour of the European *P. infestans* (meta) population.

## METHODS

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.

*Estonia*
2015: The first late blight outbreaks were recorded at the end of July. Heavy rainfall and warm nights at the beginning of August created very favorable conditions for the development of potato late blight. The potato growers started applying fungicides in the middle of July, for the first sprays systemic fungicides were used. At the beginning of August rainproof fungicides like Infinito, Ranman and Revus were used for the control of potato late blight.

2016: Heavy rainfall and high humidity during the summer of 2016 favored the development of potato late blight. First outbreaks were recorded in the first half of July. Already at the end of July, the untreated potato fields were severely infected by late blight. The potato growers started with the fungicide treatments at the end of June. The growers sprayed on average 3-6 times with fungicides during the season. Preferred active ingredients for the control were fluazinam, mandipropamid and mancozeb.

*Latvia*
2015: Spring of 2015 was earlier than other years. April and May were warm and wet. Crop emergence was completed by the end of May. Dry weather conditions in June delayed the crop growth and development, the first warning of the development of *Alternaria solani* was received on the 20 June when the temperature and humidity conditions were favourable for the development of the disease. The first warning of the development *P. infestans* of was received in end of June. The first protective fungicide application (systemic + contact) was made just before the infectious period. Beginning of July was warm, some days the air temperature reached 30°C, then entered the cool and wet weather till beginning of August. Temperature and humidity conditions remained favourable for the development of both diseases. Following August was very dry and hot (air temperature above 35°C).

2016: Spring of 2016 was warm and wet. End of May and beginning of June entered the heat (31°C) and drought. Due to colder and wetter weather from middle of June, the first warning of the development of *P. infestans* and *A. solani* was received on the 10 June. Because of frequent rain and favourable temperatures for crop growth, development of early and late blight started on the 11 June. The first protective fungicide application (systemic + contact) was made just before the infectious period. July was hot and wet. Temperature and humidity conditions remained extremely favourable for the development of both diseases all of July and August. At August rainfall reach 128,5 mm support development tuber infection.

*Lithuania*
2015: The potato crop was planted in the beginning of May. The crop fully emerged nearly a month later – at the beginning of June. Summer period was very unusual compared with previous seasons. If average air temperature in June and July was only by 0.6 degree lower compared with the long term mean than amount of rain was significantly lower. By average, amount of rain in June was by 57.8% and in July – 23.7% lower compared with the long term mean. In August, average air temperature was 19.7 degree and it is by 3.0 degree higher compared with long term mean. Over this month, 19 days were with the average air temperature higher than 25.0 degree and 7 days of them were with the average air temperature higher than 30.0 degree. Amount of rain was even more significantly lower than in June and July. In August, were only 2 rainy days with the total 5.6 mm, while the long term mean of the entire month is 74.2 mm. Drop of the amount of rain was by 92.5%. Application of fungicides started in the first week of July. Fungicides were applied with 7-11 days intervals. In total, 5 applications were performed. The last application was performed on 10 August. Due to dry and hot July – August period late blight did not appear in the crop. The crop remained green until the middle of August. Then potato foliage started to wilt and by the end of the month reached full maturity.

2016: The potato crop was planted at the usual timing in Lithuania – end of April or beginning of May. In May, average air temperature was by 2.7 degree higher compared with a long-term mean; therefore potato crop fully emerged around three weeks after planting. Amount of precipitation over this month was relatively lower and consisted 52.5% of the normal. Summer period differed in comparison with perennial means. Average air temperature in June, July and August was higher by 1.8, 0.8 and 0.3 degree, respectively. At the same time amount of precipitation differed over entire period. In June it was only by 4.5 mm lower than normal. July and August were exceptional with unusually high amount of precipitation. In July and August it was by 52.4 and 35.4 mm higher compare to perennial means, respectively. Almost every second day over these two months was rainy. Warm and rainy weather conditions were very suitable for spreading of late blight in potato crops. Application of fungicides started since the beginning of July with 6-10 days intervals. First late blight symptoms were found on 12 July, so 2 applications were already applied before symptoms appeared. In total, 6 applications were needed to control late blight. The last application was performed by the middle of August.

*Russia*
2015: A severe late blight development (yield losses >20%) was observed on potato fields of the Kaliningrad, Leningrad, Vologda, Tver, Moscow, Murmansk, Kirov, Novgorod, and Pskov regions. A moderate disease development (yield losses 10-20%) was registered in the Kaluga, Ryazan, Smolensk, Bryansk, and Arkhangelsk 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 Abiga-Pic, Shirlan, Tanos, Acrobat MZ, Infinito, Revus Top, Kurzat, Sectin Phenomen, and Ridomil Gold MZ. The total number of treatments varied from 2 to 10. Owners of allotment gardens did not use any fungicides. The use of DSSs (Plant-Plus, VNIIFBlight, Agrodozor) was rather rare. The most popular potato cultivars were: Red Scarlett (24%), Gala (8%), Udacha (7%), Rosara (6%), Zhukovskiy ranniy (6%), Nevsky (5%), and

Impala (4%). The volume of foreign and domestic cultivars used by large agricultural companies was ~80 and 20%, respectively.

2016: A severe late blight development (yield losses >20%) was observed on potato fields of the Kaliningrad, Leningrad, Tver, Moscow, Murmansk, Smolensk, Novgorod, Pskov, Kaluga, Bryansk, Yaroslavl, and Kostroma regions. A moderate disease development (yield losses 10-20%) was registered in the Vologda, Ryazan, Ivanovo, Tula, Orel, Kursk, and Nizhni Novgorod 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, Penncoceb, Infinito, Revus Top, Kurzat, Sectin Phenomen, and Ridomil Gold MZ. The total number of treatments varied from 2 to 10. Owners of allotment gardens did not use any fungicides. The use of DSSs (Plant-Plus, VNIIFBlight, Agrodozor) was rather rare. The most popular potato cultivars were: Red Scarlett (14%), Gala (10%), Udacha (8%), Rosara (6%), Nevsky (5%), Impala (4%), and Zhukovskiy ranniy (4%). The volume of foreign and domestic cultivars used by large agricultural companies was ~90 and 10%, respectively.

*Poland*

2015: Most of May the weather was cool and dry. The conditions promoting the disease occurred during first ten days of June. The first symptoms of the disease were reported from the provinces Kujawsko-Pomorskie and Dolnośląskie (10 June). After about 10 days the disease has spread on the fields of central provinces (Łódzkie, Mazowieckie), the center of Pomerania (Pomorskie) and the north-eastern part of the country (Warmińsko-Mazurskie, Mazowieckie). The conditions at the beginning of July were not favorable to the development of the disease. The second peak of the spread of late blight occurred in the second half of July. The disease occurred in the following provinces: Mazowieckie, Podlaskie and Świętokrzyskie. Meteorological conditions in 2015 were not favorable to the development of the disease. Potato farmers performed from 1 to 5 control treatments, but most frequently 1-2 treatments were applied. The most commonly used active ingredients were fenamidone + propamocarb-hydrochloride, fluopicolide + propamocarb-hydrochloride, metalaxyl-M + mancozeb, cymoxanil + mancozeb and dimethomorph + mancozeb. The level of infection of tubers by late blight was low.

2016: The conditions in May and the first twenty days of June were not favorable to early infections of potato late blight. The earliest occurrence of the disease was reported in the southern part of the country (30 May, Dolnośląskie). About 10-15 days later, the symptoms were also observed in the central part of the country (provinces: Łódzkie, Mazowieckie and Kujawsko-pomorskie). In Pomerania, the disease appeared during last ten days of June and during first ten days of July. Most favorable conditions for the development of the disease (high rainfall) occurred in the provinces: Zachodniopomorskie and Pomorskie. In the central part of the country, further development of the disease was hampered by the high temperatures and lack of rainfall. Farmers growing potatoes in the growing season usually performed 1 to 5 treatments. The number of treatments on plantations for processing potatoes for chips and French fries, ranged from 10 to 13. Most often were used the following active ingredients: fenamidone + propamocarb-hydrochloride, fluopicolide + propamocarb-hydrochloride, metalaxyl-M + mancozeb, cymoxanil + mancozeb and dimethomorph + mancozeb. The level of infection of tubers was low.

*Serbia*

2016: an unusually mild winter followed by an early and warm spring with a lot of rainy days was favourable to late blight development. Due to the favorable conditions in spring, potato plants were planted a few weeks earlier than usual and the crop development was very fast. High humidity during March, April and May resulted in early outbreaks of late blight being reported throughout the potato growing regions, already in early June. Dry weather in late June and intensive use of fungicides resulted in control of the increasing late blight infection. During July the disease remained at a low level and a major late blight epidemic developed later, in the second half of August. The year had very favourable conditions for potato growing, but infection risks were present throughout the season until harvest and yields were generally at a medium level.

*Switzerland*

2015: Until end of March 2015, weather conditions were rather mild and dry. At the beginning of May ongoing heavy rainfall with mild temperatures started and up to six consecutive days with main infection and sporulation periods (MISPs) were registered for almost all weather stations in the DSS PhytoPRE. The amount of rain during these first days of May was as high as the common rain amount for the whole month. Therefore potatoes suffered from flooding and erosion. On 11 May, the first late blight attack was observed in the western part of Switzerland in a covered potato field. Other primary late blight infections were registered the following four days in the Swiss plateau. Until the end of June, weather conditions were very favourable for late blight and the epidemic could spread fast in all potato growing regions. Late blight pressure was particularly high in the central part of Switzerland. From July until mid of August, it was hot (temperatures > 30°C) and dry with occasional thunderstorms. Hence, late blight pressure was strongly reduced, lesions dried out and the epidemic could not spread anymore - in contrast early blight increased. Due to the changeable weather from mid of August onwards, formation of miniature stolons and new sprouts were observed.

2016: The potato season 2016 was very difficult due to the prevailing weather conditions. From mid of May until the end of June weather conditions were very favourable for late blight. Two first late blight attacks were registered on 18 May in the eastern part and the western central plateau of Switzerland. Within ten days from the end of May until the beginning of June for most of the weather stations 7 or more main infection and sporulation periods (MISPs) were registered in the DSS PhytoPRE. During this period, no fungicide applications were possible due to the wet soil conditions. Therefore, late blight could spread very fast in all potato growing regions. Some potato fields, especially in the central part of Switzerland, were completely destroyed during these days. Within a few days in June, number of registered late blight attacks increased from 10 to 100. Despite some dry weather periods in July, late blight pressure remained high during the whole potato growing season. High yield losses were observed due to these difficult circumstances.

*Finland*

2015: Very normal blight season: first outbreaks during the first week of July, epidemic development in untreated crops at the end of July – beginning of August. End of season not very conducive for blight development. Four to six fungicide applications, no severe blight outbreaks in fungicide treated fields.

2016: First blight outbreaks somewhat earlier than usual, epidemic development in untreated crops during the latter half of July. August was very rainy and conducive for blight development. Four to eight fungicide applications, locally severe blight outbreaks also in treated crops. Problems to apply fungicides at correct intervals due to continuous rain and wet field soils.

*Norway*

2015: There were only a couple of hours in May with high blight risk in the main potato growing areas according to the Nærstad model in VIPS (south east). June had from 2-10 days with infection risk, and the first real period with high risk was late June. By mid-July, late blight was widespread, and both July and August had long periods with conditions favourable for blight. Overall 2015 was an average year for late blight in Norway.

2016: The season was relatively wet, and there were more days with warnings according to the Nærstad model in both June, July and August, compared to the previous years. The conditions were more favourable for blight in the south east (close to the coast) compared to the eastern parts in the inland, especially in July and August. It was a good year for potato producers, with frequent rain but not very high amounts in most areas. The producers managed to keep late blight under control despite these conditions.

*Sweden*

2015: The blight epidemics started around mid to late July in south and mid Sweden, which is normal. Low temperatures restricted the attacks, which stayed at low to moderate levels during the season. Use of fungicides resulted in full control, and organic potato stayed mostly free of blight.

2016: The blight epidemics started around mid to late July in south and mid Sweden, which is normal. With the exception of a wet period in late June after which infected fields were reported, the season was very dry resulting in limited problems with blight. Normal fungicide use gave a very good disease control.

*Denmark*

2015: First observation of blight was recorded on 9 June in the south of Jutland on young plants (BBCH 30) probably infected by oospores. Inoculum sources in Mid-South Jutland were identified as oospores, dumps, volunteer plants and infected tubers. The milder winters increase the risk of attacks from dumps and volunteer plants in Denmark. Infections from oospores in the soil is causing early attacks of late blight in Denmark especially in starch potatoes with narrow crop rotations. Most growers do spray on a weekly schedule and vary the dosage according to the need as calculated by the Danish DSS. Slightly more blighted tubers in ware potatoes than previous years. Wet conditions during harvest of starch potatoes. Due to a change in tax regulation on pesticides, compounds with mancozeb are not attractive for the growers to use anymore. This has caused a shift in the use of compounds to Revus and Ranman and growers are facing the challenge to optimise an integrated control of both late blight and early blight.

2016: Dry and warm May resulted in early crop emergence. First observation of blight was recorded on 2 June in Central Jutland on young plants of the starch variety Eurogrande (BBCH 25) probably infected by oospores. Similar to 2015 early attacks were reported for starch potatoes with narrow crop rotations in the central-south of Jutland and inoculum sources is a mixture of oospores, volunteers and infected tubers. The summer was warmer than normal and with more rain than normal across June, July and August followed by a dry spell in September. The weather based risk for late blight was high during the whole season. Active blight was found in many fields and Proxanil was heavily used and with good effect this year. Due to blight risk, infected fields and rapid new growth it was necessary to decrease to 5 day spray intervals in June and July in some regions (compared to 7 day intervals). Increase in the potato area from 40.000 ha in 2013, to 46.000 ha in 2016, mainly increase in starch potatoes (26.000 ha in 2016). Yield is mean level for all types of potato, but potatoes with narrow crop rotations do senesce earlier and have relatively lower yields than other fields, mainly due to more problems with soil-borne diseases. Two varieties for organic potatoes were tested with good blight resistance – Anouk and Alouette.

*France*

2015: After a winter with mild temperatures and high rainfall, potato planting was possible at the end of March and at the second part of April after a fifteen days rainy period. A very dry and hot period followed after emergence in May up to the middle of August. The late blight pressure was very low and started very late in August with a medium level. 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).

2016: After a winter with very mild temperatures and medium rainfall, potato planting was possible from the end of March to the middle of May (until June in some flooded areas). A very exceptional cold and wet period followed after planting in May and June (except in Brittany), and the crop development was delayed for 2 or 3 weeks. The late blight pressure started late in May or early in June and was extremely high up to early of July. After the middle of July, the late blight pressure decreased to medium to low level, according to the areas. The first late blight outbreaks were observed from the end of May on a cull pile to the beginning or the middle of June in fields according to the regions.

*Belgium*

2015: Due to a mild winter with only a few frost periods, not that much leftover tubers were affected. By the end of April, the first diseased plants were found on different cull piles. Although the number of such inoculum sources continued to rise in the following weeks, the risk of spreading of late blight was low, due to the prevailing dry and sunny weather. The month of June was even drier, with lots of sunshine and very little rainfall, and very unfavourable for the disease. On top of that, a heatwave in the first half of July completely stopped the development of late blight. It was not until the end of August, with the resuming of more substantial rainfall, that late blight attacks were again observed in the fields, requiring sufficient protection against tuber infection.

2016: After – once again – a mild and wet winter, the first diseased potato plants were reported on 20 April, on different cull piles. Cold temperatures hampered the development of late blight during the month of April. From the second half of May however, the increasing number of inoculum sources in combination with very favourable weather for late blight, led to a high disease pressure in the period of emergence of the ware potato crop. High rainfall towards the end of May did not help very much, and made a good crop protection mandatory from emergence forward. This protection was very much hampered or even made impossible by the abundant rainfall during most of June, which also caused flooding and crop losses. The combination of continuous infection weather, active lesions and inoculum sources, a strong crop growth and sometimes inaccessible fields, caused an enormous spread of the disease. Spray when and wherever feasible, was the only possible advice to give. From July on, disease pressure subsided somewhat, although the numerous stem lesions remained a concern and defined the choice of fungicides. Yet, the mostly warm and dry summer weather from then on, eventually brought the late blight situation back to normal. A late heatwave towards the end of August turned out to be the herald for an exceptionally warm and dry September, with low risk of tuber infection. The harvest of the potatoes was delayed until the second half of October.

*The Netherlands*

2015: After a winter without a real frost period the potato season was not really early. After a wet decade at the end of March, most potatoes were planted during the second half of April. Temperatures during spring were average, although May was a little bit colder than normal. After emergence of the crop a dry period started and lasted till half of July. Many field were irrigated. The second half of August and the first weeks of September were very wet. Harvest of the ware potatoes was rather late and started at the end of September. The first reports (South-West and North-West) of late blight on dumps and volunteers were already in May. But in the field the disease was hardly found until half of August. Until the end of the season there were no real blight problems in 2015.

2016: Potatoes were planted during a long period of time across the country. In the Southern part of the country most growers were able to plant at a normal time (April) but to the north most fields were planted in May. The last three weeks of June were very wet. In some regions the total amount of precipitation in June exceeded the 250 mm. Very favourable weather for late blight during a period of a fast growing crop! After first reports in May of blight on dumps, infestations in the field were found all over the country after the first weeks of June. In July the disease pressure decreased due to the weather. After changeable weather during the first two decades of August there was a remarkable sunny and hot period at the end of that month and in September.

*Germany*

2015: Crops were planted in good conditions and the crop emergence was normal between 10 May and 25 May. The first outbreak of late blight in potatoes was recorded by mid of May in plastic covered potatoes. Attacks in different regions and ware potatoes were found beginning of June. The weather conditions for the development of late blight was completely different. The Northern part of Germany had a severe late blight epidemic. On the other hand there was an extremely hot and dry summer in the Southern part of Germany. This resulted that even in untreated control plots no late blight progression was detectable. Overall the number of fungicide treatments was normal. All kinds of products were used. Attacks of early blight (*A. solani*) seem to be an increasing problem in the Northern part of Germany.

2016: The weather condition and the disease development were diverse across the country in 2016. The first late blight outbreak was reported mid of May in the early potato production areas (covered crop). Attacks in conventional fields were found early June. The further development of late blight was completely different. In the Northern parts of Germany there were very favourable weather conditions for the late blight development. The disease pressure was very high till end of August. In the Southern part only few infection periods were observed in July. The use of fungicides was high in the Northern part and normal in the South. All kinds of products were used; especially mixtures were used in the Northern part of Germany.

*Scotland*

2015: The first late blight crop outbreak was in postcode AB30 on 8 July. There were only 19 confirmed outbreaks reported on the AHDB Potatoes-funded blight outbreak maps for Scotland. The progression of crop outbreaks (14 in number) in Scotland was 0% in May, 0% in June, 42.9% in July, 50% in August and 7.1% in September There were two confirmed outbreaks on outgrade piles of potatoes (25 July, 11 August) and three outbreaks on volunteers (31 July [2 cases], 7 August). The last sample was submitted on 24 September.

2016: The number of outbreaks of late blight in Scotland was intermediate. The first outbreak was an outgrade pile on 16 June in postcode IV8. The first crop outbreak was in postcode PH13 on 11 July. Forty-five confirmed outbreaks were reported on the AHDB Potatoes-funded blight outbreak maps, up until 23 September 2016 when the last sample was submitted. The progression of crop outbreaks (36 in number) in Scotland was 0% in May, 0% in June, 38.9% in July, 44.4% in August and 16.7% in September. There were two confirmed outbreaks on outgrade piles of potatoes (16 June & 22 August) and seven outbreaks on volunteers (22 July, 13 September [3 cases], 23 September and 28 September [2 cases]).

*England & Wales*

2015: Thirty-seven outbreaks of late blight were reported as part of the AHDB Potatoes funded Flight against Blight outbreak maps. Epidemic onset was late, with the earliest outbreak in England and Wales reported on 1 July near Portsmouth on the South Coast of England. Six outbreaks were reported in July, 22 in August, 9 in September and 1 in October. The majority of these were in commercial crops, however, 5 outbreaks were on volunteers, 1 in August, 3 in September and 1 in October. One outbreak was from an outgrade pile in August. Fungicide programmes were well underway by the time the epidemic started so control was generally good across England and Wales. According to the UK pesticide usage survey report 263 using 2014 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 mancozeb + cymoxanil, fluazinam, cyazofamid, mandipropamid and cymoxanil. For seed crops, all those surveyed were treated with fungicide and received an average of 9 fungicide applications. The most frequently applied active ingredients were cymoxanil, cyazofamid, fluazinam, cymoxanil + mancozeb and mandipropamid.

2016: One hundred and thirty-eight outbreaks of late blight were reported as part of the AHDB Potatoes funded Flight against Blight outbreak maps. Epidemic onset was late June with the earliest outbreak in England and Wales reported on the 26 May in the South West of England. Two outbreaks were reported in May, 50 in June, 60 in July, 14 in August and 2 in September. The majority of these were in commercial crops, however, 5 outbreaks were on volunteers (1 in June, 3 in July and 1 in August). One outbreak was from an outgrade pile in June. According to the UK pesticide usage survey report 263 using 2014 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 mancozeb + cymoxanil, fluazinam, cyazofamid, mandipropamid and cymoxanil. For seed crops, all those surveyed were treated with fungicide and received an average of 9 fungicide applications. The most frequently applied active ingredients were cymoxanil, cyazofamid, fluazinam, cymoxanil + mancozeb and mandipropamid.

*Ireland*

2015: The season was a low late blight season with only a small number of reported outbreaks. This was mostly due to weather conditions unfavourable to the development of late blight during the summer months – dry and warm early in the summer followed by wet but relatively cold conditions following. Where outbreaks of late blight did occur the application of preventative and curative fungicide chemistry ensured these outbreaks were kept under check. Low incidences of tuber blight were reported. The Irish *P. infestans* population continues to be dominated by three clonal linages EU13_A2, EU8_A1 and EU_6A1.

2016: Outbreaks of late blight were reported by the end of June, with weather conditions in late May and June favourable to the development and spread of late blight. However the spread of these outbreaks was kept in check through the use of both preventative and curative fungicides. Even though weather conditions continued to favour development of late blight no significant outbreaks were reported. This is mostly due to the prophylactic application of fungicides, in most cases at seven day intervals. Low levels of tuber blight were reported. Again as in previous season the Irish population continues to be dominated by three major clonal linages, although the proportions of each do change between seasons.

## EARLY ATTACKS OF LATE BLIGHT

In 2015 weather conditions in the beginning of the growing season were not favourable for late blight development except in Germany, France and Switzerland where the early attacks resulted relatively quickly in infected conventional fields. In some other countries first attacks were found early (Belgium, Netherlands, Sweden) but because of unfavourable weather conditions for late blight it lasted until July or even August before conventional fields were infected. In conclusion, the year 2015 was not an overall blight year in Europe (Figure 1 and 2).

In the 2016 season the favourable weather conditions for late blight development caused early attacks in many countries. In most countries followed quickly by infections in conventional fields (Figure 3 and 4).

Comparing the date when attacks were recorded in 5 or more conventional fields for 2015 and 2016, in 12 out of 17 countries attacks were earlier in 2016 than in 2015 (Figure 5).

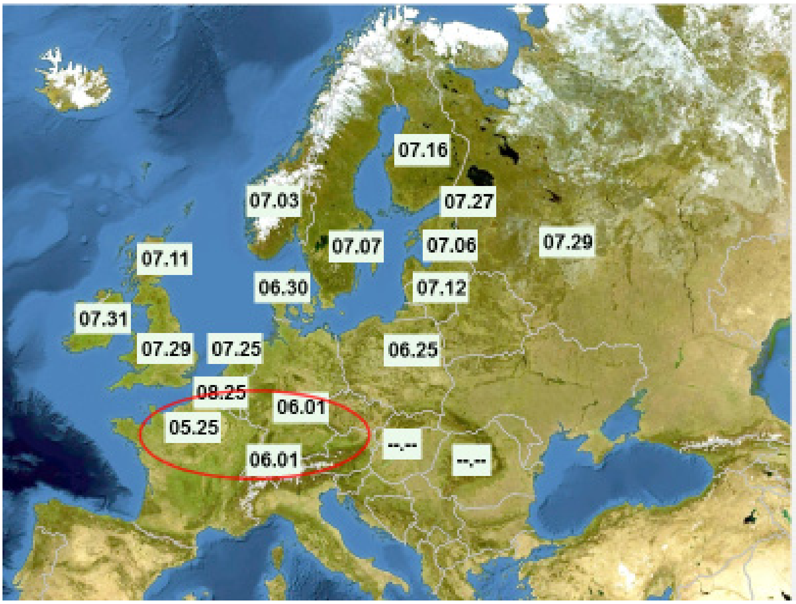


***Figure 1.*** *Date of first observation of late blight in more than 5 conventional, normally planted potato fields, 2015*

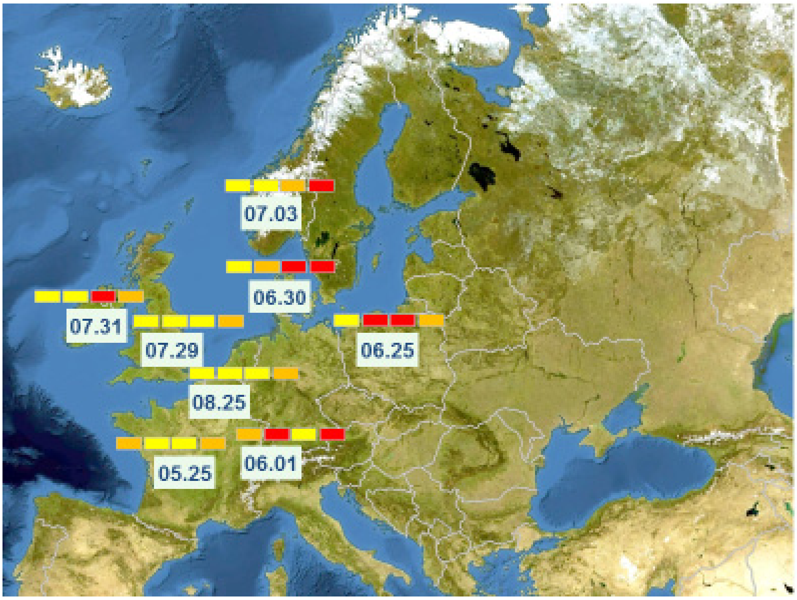


***Figure 2.*** *Blight weather in May, June, July and August 2015. Low (yellow), medium (orange), high (red) risk*

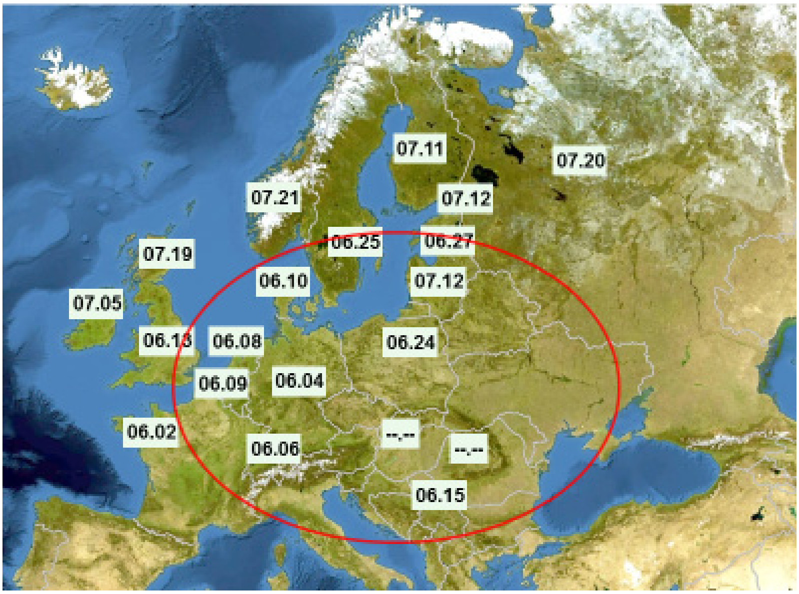


***Figure 3.*** *Date of first observation of late blight in more than 5 conventional, normally planted potato fields, 2016*

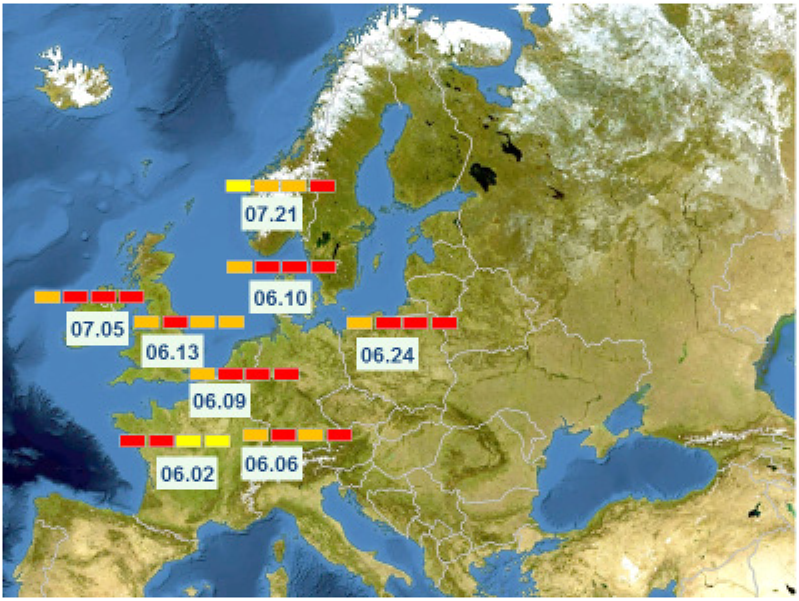


***Figure 4.*** *Blight weather in May, June, July and August 2016. Low (yellow), medium (orange), high (red) risk*

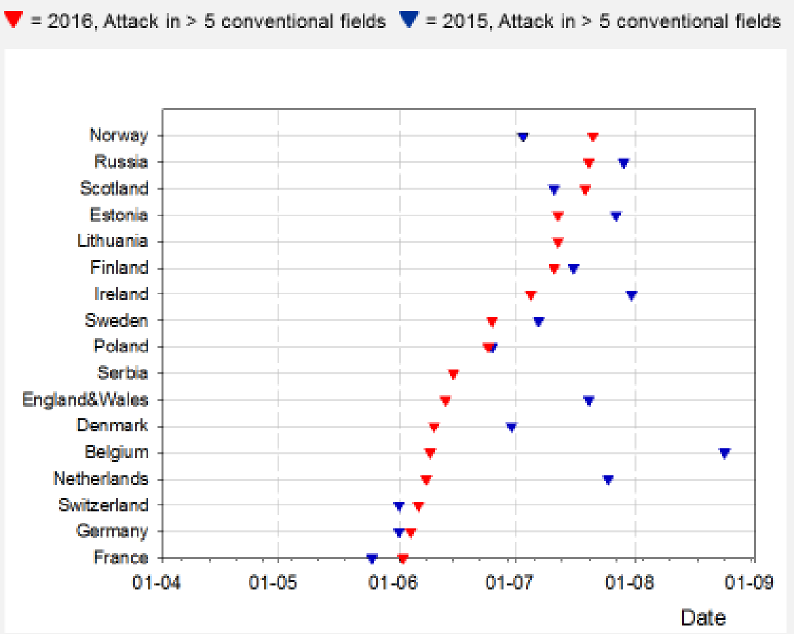


***Figure 5.*** *Date when attacks were recorded in 5 or more conventional fields in 2015 (blue triangles) and in 2016 (red triangles).*

**TUBER BLIGHT IN 2015 AND 2016**

The level of tuber blight in 2015 was reported as low in all countries in Europe, except for some regions and some type of potatoes in Finland, Russia, Latvia and Germany where it was reported as medium. In 2016 the situation was similar in most countries but in some countries the problems were high (Finland, Latvia, Switzerland) (Figure 6).

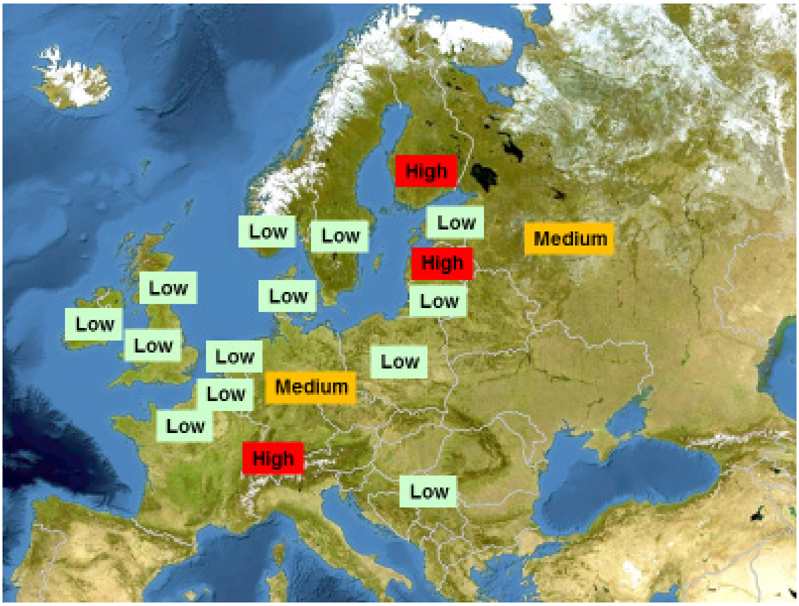


***Figure 6.*** *The level of tuber blight attacks (low, medium or high) in 2016 compared to normal*

## INDICATIONS OF OOSPORES

In both 2015 and 2016, infections caused by oospores were reported in Sweden, Finland, Denmark and Lithuania (Figure 7).

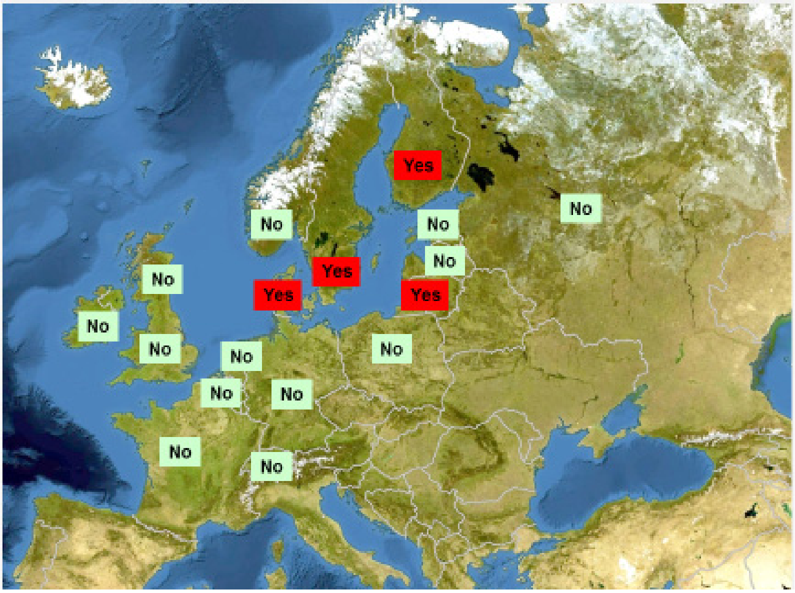


***Figure 7.*** *Indications of oospores in Europe in 2015 and 2016.*

## FUNGICIDES AND CONTROL STRATEGIES

In **Estonia** the first sprays were conducted in the middle of July 2015, in 2016 at the end of June. Fungicides were applied up to five times per season. Most commonly used active ingredients were propamocarb, mandipropamid and mancozeb. Most frequently used fungicides were Glory, Infinito, Revus and Dithane NT. In **Latvia** the number of fungicide applications in ware potatoes ranged between 3 and 5 (2015), 4 and 8 (2016). The conventional farmers do not wait until first symptoms appear. Always used systemic + contact fungicide. The main fungicides applied in ware and seed potatoes are: mancozeb, mefenoxam, propamocarb, dimethomorph, fluazinam, fluopicolid, cyazofamid and mandipropamid. In **Lithuania** on average four to six fungicide application is a common practice. First and sometimes second applications are done by contact fungicides, followed by two applications with systemic fungicides. The last one or two applications of the season are with contact or translaminar fungicides. In **Russia** the total number of fungicide treatments in 2015-2016 varied from 2-10. Farms producing potatoes for chips use fungicide applications more frequently than other potato-growing farms. The owners of allotment gardens use no fungicides. In **Poland**, the number of treatments for late blight in the plantations of general purpose was 1-5. On French fries dedicated plantations: 8-12, depending on the severity of the disease. The most common model of controlling late blight was a chemical protection of plants until the height of 15-20 centimeters with further continuation. This allowed performing 1-2 preventive treatments. A higher number was applied in the plantations dedicated to chips and French fries (2-

3). The most commonly applied active ingredients were: propamocarb-hydrochloride in combination with fenamidone or fluopicolide, metalaxyl + mancozeb, metalaxyl-M + mancozeb, cymoxanil + mancozeb. In **Serbia** in 2016, the most frequently used active ingredients for late blight control were: propineb, propamocarb-hydrochloride + fenamidone, cymoxanil, famoxadone + cymoxanil, fluazinam, metalaxyl + mancozeb, cyazofamid, mandipropamid + difenoconazol, metiram. The number of spraying were six to ten applications. In **Switzerland**, farmers control late blight by fungicide applications. At the beginning of the season, systemic fungicides are often used, afterwards they use protective or translaminar (or both combined) fungicides depending on the weather conditions and the late blight epidemic pressure. Farmers obtain such recommendations by their plant protection officer, the DSS PhytoPRE or the newspaper. In organic potato production, copper products are often used to control late blight (max. 4 kg/ha/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 waste piles and volunteer plants. In **Finland**, fungicide applications are started usually during the first week of July and continued to the beginning of September. Normally 5 to 8 applications are needed to keep late blight in control. Each season there are great regional differences in blight risk and therefore the number of applications is very variable between farms and geographical regions. In **Norway**, most potato farmers are members of the Norwegian extension service system and get their blight warnings through them from the VIPS system. However it is still common to apply fungicides on a weekly schedule, only slightly modified for the blight risk based on warnings. In **Sweden**, contacts or translaminars are the main products, sometimes complimented with one or two treatments with a metalaxyl fungicide in the beginning of the spraying season. 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 2015 and 2016. In **Denmark**, the main fungicides are Ranman Top (0.5 l/ha) and Revus (0.6 l/ha) in the standard spray programs starting last part of June. To a lesser extent Banjo Forte is also used. In situations where there is a need for curative action Proxanil (2.0 l/ha – 2.5 l/ha); propamocarb + cymoxanil) is used in combination with a protectant fungicide (Ranman Top or Revus). In **France**, in 2015, 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 staying very low, growers were able to continue with longer delay between fungicide applications of simple protectant products. Very few translaminar and curative products have been used. The 2016 season was very different since late blight pressure was high starting at emergence. Short intervals of 4 to 5 days, with protectant and curative fungicides and products with efficient rainfastness were needed. Later in the season translaminar and curative activities of the fungicide applications were looked for in order to protect the crop. Important rainfalls and stormy rains in June conduced to difficulties for entering with tractors in some fields and some delayed treatments. In **Belgium** in 2015, the average number of fungicide applications (susceptible variety, mainly Bintje) was 13, which corresponds with an average interval of 8,8 days for the growing season (from min. 6 tot max. 14 days interval). In 2016, the average number of fungicide applications (susceptible varieties, mainly Bintje and Fontane) was 16, which corresponds with an average interval of 6,9 days for the growing season (from min. 4 tot max. 9 days interval). It has to be mentioned, however, that for the season 2016 (a) some applications could not be carried out when necessary, due to inaccessible fields in June and (b) as a result, more tank mixes (i.e. different commercial products) than usual were applied when conditions allowed again for spraying. In **the Netherlands**, most growers are using three or four different fungicides during the season. Staring with Acrobat, Curzate, Valbon or Revus followed by Infinito, Banjo Forte, Canvas and Ranman Top. On an average use of about 14 sprays over the years, in 2016 many growers spayed two times more. Farmers are growing more potatoes in acreage over the years. Most of them use a DSS to support them in decision-making when to spray. But especially the bigger farmers don't differ much from a standard schedule. In **Germany** in 2015, the average number of fungicide applications was between 6 in the South and 12 in the North. In 2016, 7 to 8 spays in the South and 12-15 sprays in the North were necessary to control late blight. 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 263 using 2014 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 mancozeb/cymoxanil, fluazinam, cyazofamid, mandipropamid and cymoxanil. For seed crops, all those surveyed were treated with fungicide and received an average of 9 fungicide applications. The most frequently applied active ingredients were cymoxanil, cyazofamid, fluazinam. Cymoxanil/mancozeb and mandipropamid. Most fungicides are applied at a maximum of 7 day intervals. In **Scotland**, fungicide use and control strategies were similar to previous years. In **Ireland**, all commercial crops are subject to intensive fungicide control strategies, with fungicides applied to most crops from early rosette through to desiccation at seven day intervals. Only in prolonged periods of dry weather will the intervals be stretched to 10 days. Growers utilise all available chemistries. The selection of a fungicide is based on the development of the crop and the characteristics of the fungicide. Agronomists utilise the EuroBlight fungicide table to inform them of the different characteristics of a fungicide. The addition of cymoxanil to routine applications is becoming increasingly frequent especially under high pressure conditions.

## POPULATION CHARACTERISTICS

In **Estonia**, in 2015 no large-scale monitoring was conducted. The small number of samples that were collected were tested all as mating type A1. In 2016 the monitoring showed the results of A1 being the dominant mating type with almost 75% of the population. 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 (70%); the A2 type was reported only within 30% of the total number of isolates. All isolates were identified as of complex races (5-11 virulence genes). The majority of regions were characterized by phenylamide-sensitive isolates, except the Sverdlovsk region (>40% of phenylamide-resistant isolates). The Russian population is very diverse, most of the genotypes are unique and were not recognized by the SSR genotyping with common primers. In **Poland** in 2015, the symptoms of late blight on stems were registered for the 19% of investigated plantations. In one case, infection developed in the bottom of the plant 65 days after planting, and four days prior to symptoms on the leaves. The most common site of infection on the stems was the middle part of the plant and its apex. In 2016, symptoms of late blight on the stems was noticed on 36% of the observed plantations. The most common place of infection was the middle part of the plant and its apex. Recent data indicate that most of the *P. infestans* populations in **Germany** have a latent period between 48 to 72 hours. In **Switzerland** in 2015, a survey concerning *P. infestans* mating types and fungicide resistance was started. As the late blight pressure was only weak in 2015, only 20 isolates could be examined. 15 isolates belonged to mating type A2, three were mating type A1, one was infertile and one could not be clearly assigned. In general, a shift in mating type A2 was registered from 4% in 1997 (Knapova & Gisi, 2002) to 65% in 2007 (Gisi et al., 2011). In the small data set from 2015 the ratio of A2 raised to 75%. Isolates from the eastern part were more aggressive than those from the western part of Switzerland. 60% of the isolates were allocated to the genotype Blue 13 (EU_13_A2). Based on a MSN analysis the Blue 13 isolates were grouped close together which refers to a clonal reproduction. All isolates were sensitive to mandipropamid, almost all Blue 13 isolates were resistant or intermediate to mefenoxam. 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. The 2016 season has yielded some 200 samples, originating from most potato producing areas. The overall genotypic analysis confirms a balanced ratio of the 2 mating types A1/A2 and a predominance of the EU_13_A2 clone followed by the EU_6_A1 and EU_1_A1. 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 with the biggest part of the variation found on the field or disease foci level. There are indications that the oospores are very important as an inoculum source. The population in **Denmark** is very diverse and proportion of the population is sexual recombining and forming oospores that give rise to early epidemics. In 2013 16 MLG out of 16 samples. In 2014 32 MLGs out of 32. In 2015 44 out of 60. Interestingly, a new clone appeared in Denmark in 2014 and 2015 – that was not yet recognised by EuroBlight – and given a name. The Mlg 54 group consists of 19 identical MLGs. Similar holds true for the other Nordic and Baltic countries – divers populations and no shared MLGs between countries. In **Norway**, the population of *P. infestans* is very variable with few dominant clones. In **England & Wales**, *P. infestans* genotypes 6_A1 and 13_A2 continue to be the dominant genotypes identified on samples taken from affected field sites which have been collected as part of the AHDB Potatoes late blight monitoring project across England and Wales. In 2015, the proportion of these genotypes was approximately 45% 6_A1 and 20% 13_A2. In 2016, the proportion was nearly 60% 6_A1 and 20% 13_A2. In **Ireland**, the population continues to be dominated by three clonal linages. The frequency of each of these changes between seasons. All three linages can be found in any given field.

## USE OF DSSs

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

| Country | DSS |
|---|---|
| Belgium | Improved Guntz-Divoux |
| Denmark | Blight Management |
| England, Wales, Scotland | Blight-Watch (Hutton criteria), Plant Plus & BlightCAST |
| Estonia | Estonian Crop Research Institute |
| Latvia | Plant Plus on some commercial farms |
| Finland | National Resource Institute: general LB warnings |
| France | Mileos® |
| Germany | PhytophthoraModel Weihenstephan, ISIP |
| Netherlands | Prophy, Plant Plus, Akkerweb (WUR model) |
| Ireland | Met. Service based on Irish rules (Bourke) |
| Norway | VIPS (Nærstad model) |
| Russia | Plant Plus, VNIIFBlight, Agrodozor |
| Sweden | Plant Plus, Blight Management (DK) & VIPS (NO) |
| Switzerland | Bio-PhytoPRE, PhytoPRE |

## ALTERNARIA 2015 & 2016

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. In the years 2015 and 2016 several European Countries observed severe infections with *Alternaria* spp.

*EB disease observation and EB disease progress*

The date of first observation of early blight symptoms in field trials 2015 is shown in Figure 8. The first symptoms occurred mid of June in Poland and Germany to mid of August in Belgium. In most regions one or two weeks later the disease epidemic started (Figure 9).

In 2016 the EB situation in Sweden and Belgium was similar to 2015. In Germany and Poland, the early blight infection occurred 2016 earlier than the year before (Germany: beginning of June, Poland end of May), but interestingly in most of the countries the epidemic started later than 2015. (Figure 10)

In Table 1 the EB specific disease development from May to September in different countries is shown. Till end of July in most European countries 2015 and 2016 the disease severity in the fields was lower than 20%. Only in Poland and Germany the disease severity was between 20 and 50% at this time. In several countries the EB disease progressed in August and reached more than 50% in Denmark, Germany and Poland.

*EB: Identified Alternaria species*

In most countries the *Alternaria* subspecies *Alternaria solani* and *Alternaria alternata* were identified on infected potato leaves (Tab. 2). In Denmark and Serbia only *Alternaria solani* could be detected. Overall the dominating species during the disease epidemic in 2015 and 2016 was *Alternaria solani* in most European countries.

*Fungicide usage and fungicide resistance*

The following active ingredients were used in different countries to control EB: mancozeb, azoxystrobin (QoI), chlorothalonil, boscalid (SDHI), pyraclostrobin (QoI) and difenconazole. According to the regional registration also mixtures of these active ingredients 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) and for *A. alternata.* The monitoring data from 2015 confirm the data from the previous year that in Germany, Belgium, Netherlands, Poland and Sweden the F129L mutation in *Alternaria solani* is very dominant. Additionally, in Austria, Denmark and Serbia F129L mutants were found in 2015 and 2016. The G143A mutation in *Alternaria alternata* was identified in isolates from Germany, Netherlands and Sweden.
SDHI mutants were found in Belgium (Landschoot et al., 2017) and Germany.
At the moment only limited DSS models are existing (PhytophthoraModel Weihenstephan in Germany, DACOM in Netherlands, Sweden and Poland, DSS-Early blight in Belgium) to optimise the control of EB.

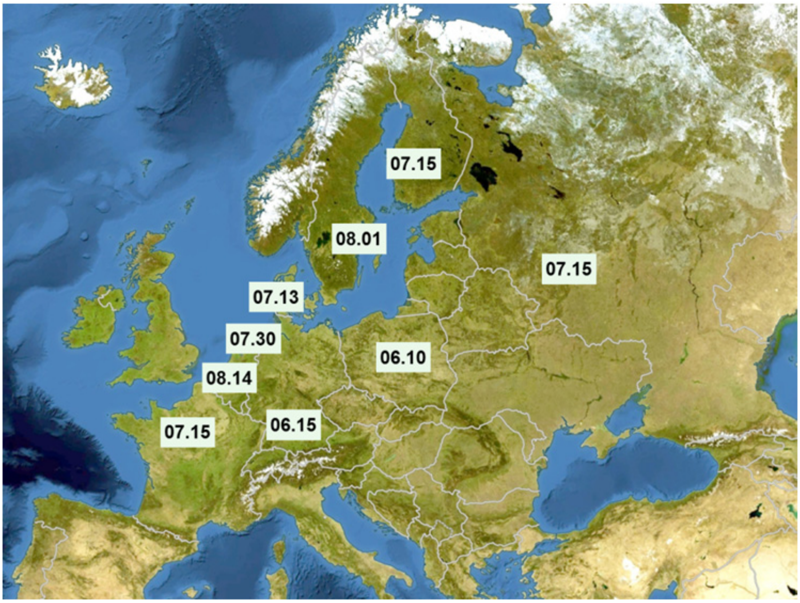


***Figure 8.*** *First observation of early blight in 2015 in Europe*

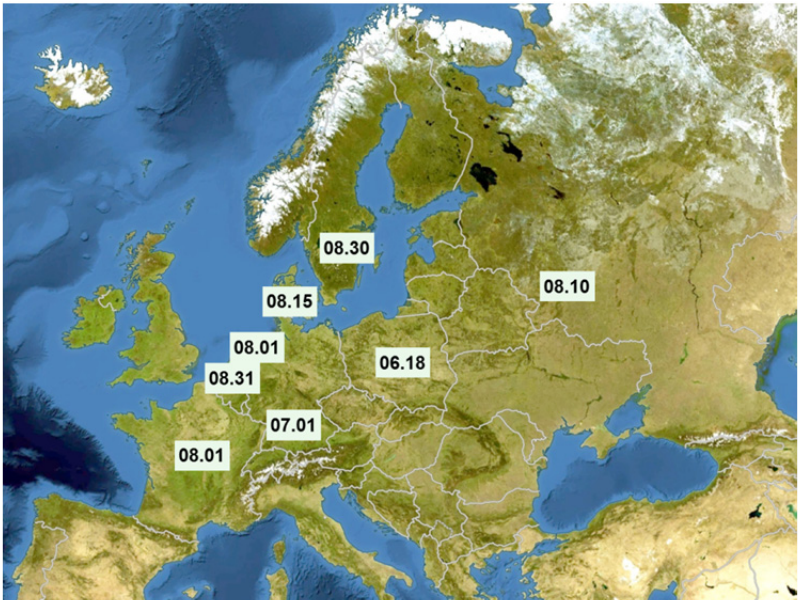


***Figure 9.*** *Start of the early blight epidemic in 2015 in Europe*

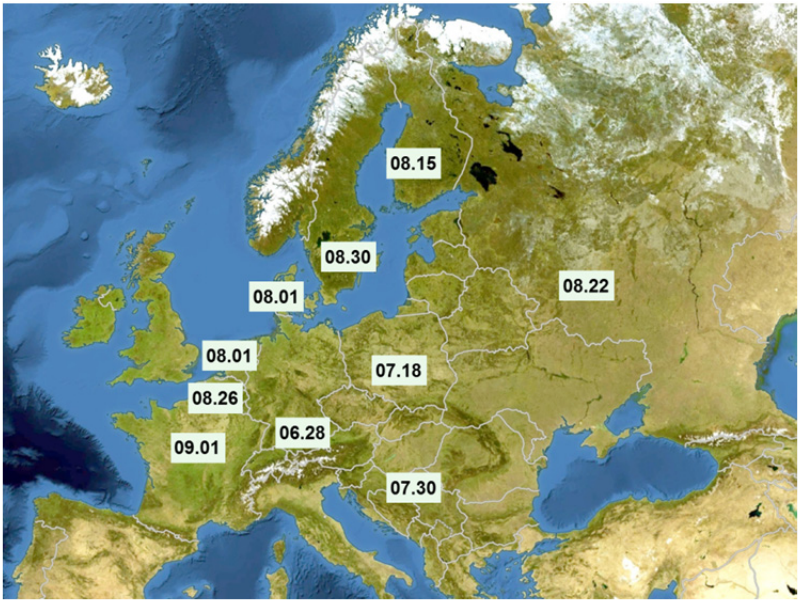


***Figure 10.*** *Start of the early blight epidemic in 2016 in Europe*

***Table 1.*** *EB specific disease severity 2016 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 | | | | | |
| Czech republic | | | | | |
| 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** | | | | | | | | | | |
| **Czech republic** | | | | | | | | | | |
| **France** | √ | | | √ | √ | √ | | √ | | |
| **Serbia** | √ | √ | √ | √ | √ | | | | | |
| **Russia** | √ | | | √ | √ | √ | | √ | √ | √ |

## LITERATURE


Landschoot, S., Carrette, J., Vandecasteele, M., De Baets, B., Höfte, M., Audenaert, K., & Haesaert, G. (2017). Boscalid-resistance in *Alternaria alternata* and *Alternaria solani* populations: An emerging problem in Europe. Crop Protection, 92, 49-59.

Leiminger, J.H., Adolf, B., & Hausladen, H. (2014). Occurrence of the F129L mutation in *Alternaria solani* populations in Germany in response to QoI application, and its effect on sensitivity. Plant Pathology, 63(3), 640-650.

Odilbekov, F., Edin, E., Garkava-Gustavsson, L., Hovmalm, H.P., & Liljeroth, E. (2016). Genetic diversity and occurrence of the F129L substitutions among isolates of *Alternaria solani* in south-eastern Sweden. Hereditas, 153(1), 10.

Pasche, J.S., Wharam, C.M., & Gudmestad, N.C. (2004). Shift in sensitivity of *Alternaria solani* in response to QoI fungicides. Plant Disease, 88(2), 181-187.