Late blight populations in sub-Saharan Africa: threat of introduction of A2 mating type very unlikely

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Late blight (LB), caused by Phytophthora infestans, is a major problem on potatoes in virtually all regions of the world where potatoes are grown, including sub-Saharan Africa (SSA). The disease can be destructive, even devastating, in areas with frequent cool moist weather. It was, for example, responsible for the great Irish famine of the 19th century which resulted in the death of an estimated 1.5 million people out of a total population of 8 million, and the emigration of an equal number, mainly to North America. Worldwide, late blight on potatoes and tomatoes causes an estimated $6 billion yield loss annually.

Origin and spread of P. infestans

Historically, the centre of origin of P. infestans was either Mexico or the Andean region of South America. P. infestans is known as an oomycete pathogen, more closely related to algae than to fungi. It reproduces either by asexual or sexual reproduction. Asexual reproduction occurs when a sporangium germinates by releasing zoospores (indirect) or by formation of a germ tube (direct). Sexual reproduction occurs when two mating types (one of mating type A1 and one of mating A2) pair, forming oospores. Sexual reproduction can also result in the formation of new genotypes that can be more aggressive and metalaxyl-resistant. Oospores provide the means of long-term survival due to its thick-walled, resistant cell wall. Oospores can serve as both inoculum to start an infection, and as a source of pathological variability due to sexual recombination.

In the 1840’s, the A1 mating type of P. infestans was accidentally spread to Europe and North America by infected tubers, and late blight then spread to other potato production areas of the world, including South Africa. The earliest report of Late blight (LB) in South Africa was 1913 (Pretoria, Gauteng), with the disease soon reported from other provinces.

In the 1970’s, a second accidental spread of the A2 mating type of P. infestans occurred from Mexico, again via the export of contaminated tubers. In some countries where both mating types were present, sexual recombination between the A1 and A2 mating types resulted in the appearance of more virulent, recombinant genotypes of the pathogen that have developed resistance to certain commonly used fungicides.

Late blight in South Africa

In South Africa, LB continues to be a problem on potatoes growing in suitable environments that favour LB such as the KwaZulu-Natal Midlands and the Mpumalanga Lowveld. Although genetic resistance is available, many producers prefer using varieties with low LB tolerance (as they are more resistant to other important pathogens). This practice can open the door to high risk situations for farmers if the particular growing season is LB conducive, and is mitigated for by the use of fungicides registered against LB. However, if the fungicides are not effective, or the pathogen develops tolerance to the fungicide, the producer can face a crippling epidemic.

Do both mating types occur in sub-Saharan Africa?

To better understand the changes that can take place in LB populations, disease surveys should regularly be undertaken to document the genetic diversity of P. infestans in potato production areas (country or region). The population genetics of the LB population in SSA as a whole has been incompletely documented. There have been small, regional studies done in a number of central African countries, with the most detailed study done in South Africa in the late nineties by Dr Adele McLeod of the ARC-Roodeplaat VOPI. This study showed that the LB population in South Africa was the “old” US-1 population, with only the A1 mating type present. Studies in central Africa reported the A2 to be present, but the reliability of these results remains questionable.

Potatoes South Africa (PSA) was concerned that the A2 mating type, or other more virulent clonal (asexual) genotypes of P. infestans, may have spread to South Africa from northern SSA countries since the studies done by Dr McLeod in the middle/late 90’s. The Crop Protection Program at the ARC-Roodeplaat VOPI, Pretoria therefore initiated a study of LB in eight SSA countries, including South Africa, between 2007 and 2009. This large study was done in collaboration with
• the University of Stellenbosch;
• Cornell University, Ithaca, USA; and
• the Australian National University, Canberra, Australia.

Other organisations that provided help in this research study were:
• the International Potato Centre (CIP) in Kenya, Uganda and Malawi;
• the Institut des Sciences Agronomiques, Rwanda;
• the Kenya Agricultural Research Institute; and
• the Department of Agricultural Research Services, Malawi.

The countries sampled were:
Tanzania, Kenya, Uganda, Rwanda, Burundi, Malawi, Mozambique and South Africa. The study was again supervised by Dr Adele McLeod (University of Stellenbosch, Department of Plant Pathology).

Our results relating to South Africa have clearly shown the following:
• The A2 mating type of *P. infestans* was not detected in any of the SSA countries sampled, including South Africa, so the chances of its introduction into South Africa via migration from northerly SSA countries is extremely unlikely.
• The late blight populations in South Africa, and in the rest of the SSA countries sampled, were very similar, and still consisted of the US-1 genotype or variants, with only the A1 mating type detected in all countries sampled.
• Metalaxyl resistant strains on potato were still detected in the Western Cape, despite the withdrawal of this product in 1996.

The implication of our results on the control of late blight in SA is that the introduction of new, more virulent genotypes of *P. infestans* from northern African countries is very unlikely. The late blight population in South Africa hasn’t changed, and is still the US-1 population (A1 mating type). Therefore the present control strategies used by growers should remain effective.

Late blight

Source: *Guide to Potato Production in South Africa*, Chapter 13: Fungal diseases on Potato by FDN Denner, C Millard and JE van der Waals

**Symptoms**

The first symptoms of late blight in the field are small, green to brown, circular to irregularly-shaped water-soaked spots. The spots usually appear first on the lower leaves, near the tips or edges of leaves, where dewdrops accumulate. A pale green to yellow border is often present around the lesions (see arrow in photograph). During cool, moist weather, these spots expand rapidly into large, dark brown or black lesions. When infected leaves are examined in the early morning or during cool, damp weather, a white fungal growth may be seen on the abaxial (lower) leaf surface. In dry weather, infected leaf tissues quickly dry up and the white fungal growth disappears. As many lesions accumulate and unite, entire leaves can become blighted and be killed within a few days. Stem blight has recently become more prevalent in South Africa and is characterised by brown to black lesions on the stems and petioles. Potato tubers can also become infected with late blight, although this is not common in South Africa.

**Conditions Conducive to Disease Development**

Conditions favourable for the development of late blight are typically a 48-hour period with day temperatures of 15-24 °C, and minimum night temperatures > 10 °C. Free moisture must be present on the plant in order for the sporangia to germinate and infect a new plant. Relative humidity needs to be >90% for sporulation (sporangia) to develop. Infection requires cool, cloudy days to keep evapotranspiration low, and frequent rainfall or overhead irrigation or a combination of both. Under optimal conditions infections of leaflets are visible within three days. Wind can disperse spores over a wide area. A small amount of inoculum can contaminate a large area very quickly and together with moisture (rain or irrigation) can transmit spores from diseased plants in the field to healthy plants.

**Disease Management**

• A single infected tuber can cause an epidemic, thus only
Impact on human settlement
The devastating effect of the late blight epidemic caused by Phytophthora infestans (literally meaning: the Plant Destroyer) in 1845-47 in Europe was one of the factors which caused more than 1 – 1.5 million people to starve to death, and forced another 1 – 1.5 million people to emigrate from affected countries.

The first recorded case was in the United States
The most famous case of a late blight epidemic is the Irish Famine in the late 1840’s. A lesser known fact is that the first recorded incidence of late blight was in the United States in 1843 in Philadelphia and New York City. Within months, winds spread the rapidly reproducing airborne spores of the disease and by 1845 it had destroyed potato crops from Illinois east to Nova Scotia, and from Virginia north to Ontario.

Exported to Europe via infected seed potatoes
The disease then crossed the Atlantic with a shipment of seed potatoes ordered by Belgian farmers. The warm damp spring of 1845 enabled late blight to become an epidemic throughout Europe and the British Isles including Ireland’s west coast. The ruin of Europe’s potato crops was complete.

Disaster
Nothing like it had been known before. The failure of the crop was a disaster for everyone in Europe that relied on potatoes. In Ireland, a population that in 250 years had grown from one million to more than eight million, solely because of the potato’s unrivalled quality as a staple food, was threatened with starvation.

British Prime minister out of the office
The British Prime minister, Sir Robert Peel, authorised shipment of £100,000 of American maize for Ireland as hunger relief. Britain’s Corn Laws, however, imposed exorbitant duties on imported grain to ensure that it could never be cheaper than home-grown produce. The bill abolishing the Corn Laws was passed with two-thirds of Peel’s party voting against it and the entire opposition voting in favour. A month later, Peel was out of office. Speculation was rife, with dealers buying grain futures at two and three times the price of a few months before, draining the country’s gold reserves and eventually threatening the stability of the Bank of England itself.

Banking crises and the beginning of free trade
Then, as fate would have it, the summer of 1847 brought news that Ireland’s potato crop, was doing well. The grain harvests also promised to be exceptionally good. Prices tumbled just as the grain bought months before at inflated rates began arriving in the ports. Dealers who had gambled on high prices now found themselves unable to recoup their investments. Many grain trading companies and banks, including three of the biggest in Liverpool were brought down.

The London banks, though, survived and went on to prosperity, for Ireland’s famine, by ending the Corn Laws, prompted the beginning of the free trade that established the success of Britain’s industrial economy. Still, the banking crisis had such an impact on the British mind-set that it is the benchmark against which commentators compare subsequent banking problems.

Another epidemic during World War II
After the disastrous epidemics, it was discovered that late blight can be controlled by copper sulphate sprays. During World War II, however, all of the copper in Germany was used to manufacture ammunition. No copper was available for making copper sulphate to spray potatoes and a major late blight outbreak went untreated. The resulting scarcity of potato subsequently led to the starvation to death of 700 000 German civilians.

Current status
Late blight is regarded as one of the biggest risks to potato production in the humid production regions in the world, including sub-Saharan countries such as Tanzania, Kenya, Uganda, Rwanda, Burundi, Malawi and Mozambique. In South Africa conditions are generally hot and dry. There have however, been a number of isolated severe outbreaks of late blight in regions such as the Sandveld (winter production), the Mpumalanga Lowveld and KwaZulu-Natal midlands.

Sources