BLACK DOT

(*Colletotrichum coccodes*), the elusive disease

Dr Julie Pasche (North Dakota State University) calls black dot the Silent, Early Yield Robber. Silent because it is often confused with other diseases, and Early because infection that occurs early in the season has lasting effects on both yield and quality.

Black dot is a widespread disease caused by the fungus *Colletotrichum coccodes*. While known since the 1920's, it was seen as a weak soil pathogen of little economic importance. However, it is now recognised as a significant pathogen in Europe, the Americas, the Middle East, Africa and Australia.

Yield losses can be considerable, especially as early infections of black dot can make plants more susceptible to damage from other diseases. There is also a strong association between *C. coccodes* infection and early dying.

Symptoms of black dot infection may not appear until relatively late in the season, or remain hidden right up to harvest. Despite this, significant yield loss can still occur.

Infection stunts plants and can cause wilting and premature senescence. In Australia this has been shown to reduce yields by at least 12%[1], with similar results reported from the USA and Israel[2]. Not only is total yield reduced, but the percentage of small tubers tends to be increased.

While symptoms may not be visible at harvest, they can develop during storage. Fortunately, the disease does not spread between stored tubers. However latent infections can develop and expand, especially under humid conditions.

While symptoms on tubers are often superficial, infected tubers lack the smooth, attractive skin finish consumers want. This is a big problem for packed ware potatoes, which are likely to be downgraded if not rejected outright. Moreover, disease that develops during storage can penetrate deeper into the flesh, resulting in problems for processors.

SPOT THE DOT

One factor that has limited recognition of the scale of black dot related problems is that it is so easily mistaken for other diseases. Symptoms on the tubers are often mistaken for silver scurf (*Helminthosporium solani*), while rots on leaves can resemble Early blight (*Alternaria solani*) and diseased stems misidentified as Fusarium wilt.

The key to identification is the presence of tiny, dot like sclerotia (resting structures) on the tubers, stems and leaves (Figure 1). These can be seen with a hand lens and are quite different to the "Christmas tree" conidiophores of silver scurf. Other key identification factors include:

- Internal tissues in the roots turn a reddish-purple, amethyst colour (Figure 2)
- Outside of the main stem detaches from the inner core, so can be easily rubbed away
- Watersoaked lesions on leaves that turn dark brown to black
- Leaf lesions that tend to be darker than those of early blight, and lack concentric rings (Figure 3)
- Reduced growth and rotting of underground stems and roots
- Discoloured areas are frequently over the heel end of the tuber, including roundish spots >5mm diameter
- Discoloured areas / spots have diffuse edges, compared to the more sharply defined margins characteristic of silver scurf (Figure 4)
- Discoloured areas have a dull appearance, whereas silver scurf spots tend to be shiny
- Dead stems collapse, rather than remaining erect, as is typical of verticillium wilt
- Infected stems eventually turn black to grey due to the large numbers of sclerotia emerging from them

Associate Professor Julie Pasche from North Dakota State University has considerable experience in managing black dot. She recently presented an excellent webinar on the disease for the Ontario Potato conference. This included a number of the specific identifiers for black dot which allow it to be differentiated from other diseases.

"Black dot often infects tubers from

Figure 1. Black dot results in formation of tiny dot like black sclerotia (spores) on stems and tubers - *Photo left: Ontario Crop IPM*

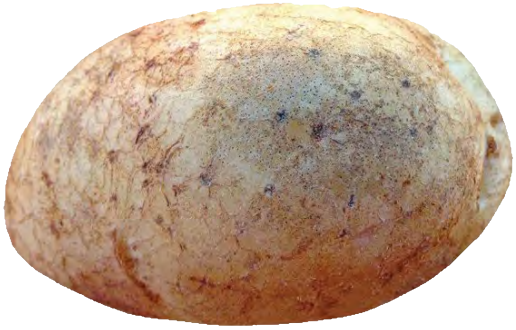

Figure 2. Roots are stunted, and both stems and roots can turn a purplish colour - *Photo: Ontario Crop IPM*

Figure 3. Leaf lesions lack the concentric rings typical of early blight - *Photo: J. Pasche*

Black dot

Silver scurf

Figure 4. Black dot lesions (left) tend to be duller and more diffuse than those of silver scurf (right) - *Photo: J. Pasche*

Figure 5. Infected stolons tend to hang onto tubers after harvest *- J. Pasche*

the stem end. The stolon then tends to hang on after harvest, like a 'piggy tail' (Figure 5). You can often see the black sclerotia on that tail, and if you cut the tuber open you can see the discolouration spreading through the tuber vascular system. Infection can exacerbate sugar end development, with dark colour at the stolon end after frying" explained Julie.

THE LIFE OF FUNGUS

The most common source of infection is sclerotia in soil. Sclerotia build up over successive potato crops and can remain viable in the soil for at least eight years. High concentrations of sclerotia in soil are associated with high rates of infection in plants. Infection can occur within days of planting, especially under moist conditions. Frequently, however, the disease is initially detectable on above ground stems, but soon spreads to all parts of the plant (Figure 6).

C. coccodes does not restrict itself purely to potatoes, or even just to Solanaceae. The fungus has more than 50 hosts from 17 plant families. While most commonly found in plants such as tomato and capsicum, it can also infect strawberries, cucumbers, mint, canola and legumes (such as soybean) among many others. Barley, maize, wheat and rye are some of the alternate crops that could be used in rotations and which have been shown to be non-hosts[3].

Even without a host, black dot sclerotia can survive for many years in the soil and are resistant to soil fumigation. The amount of sclerotia

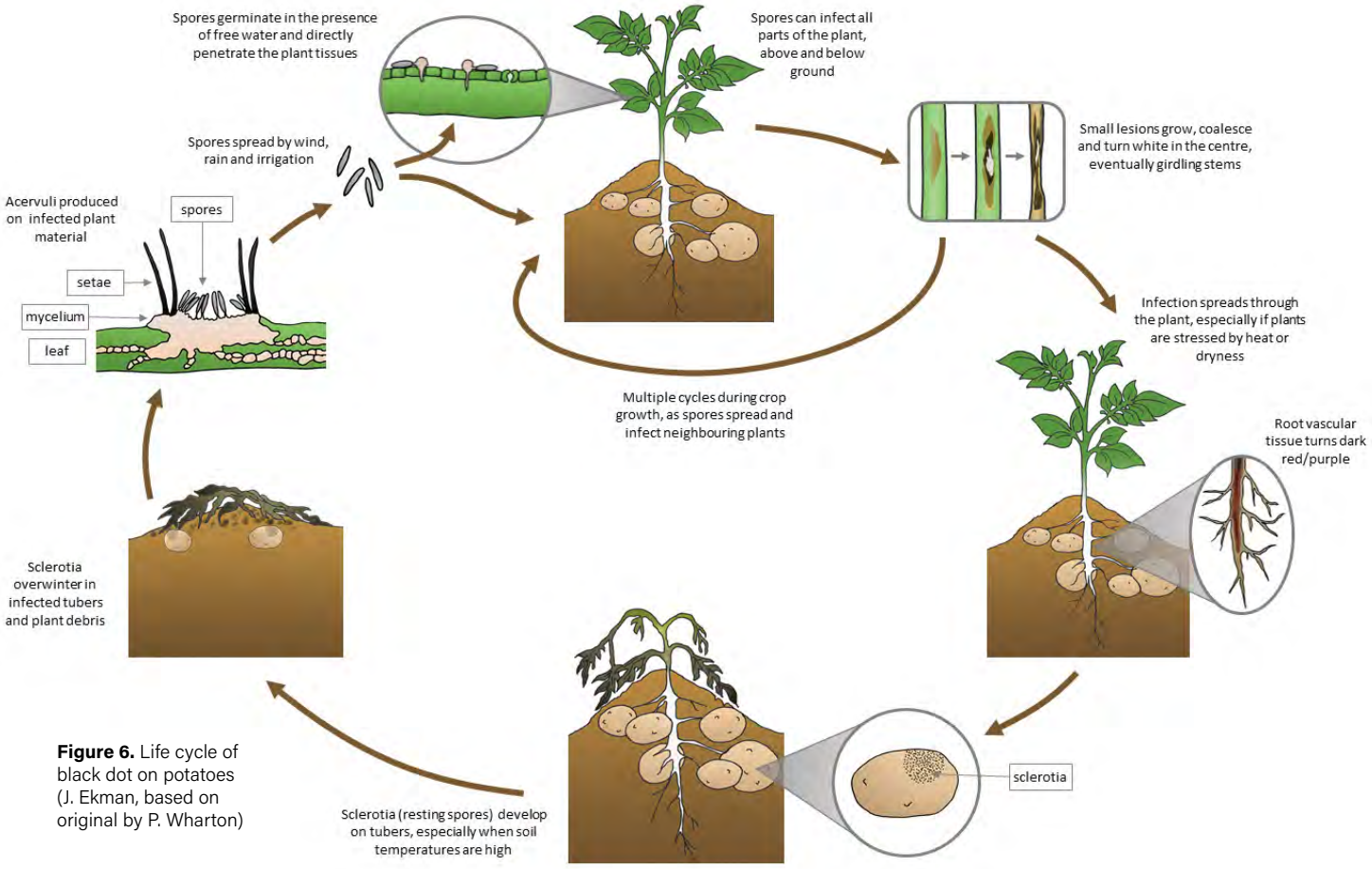

Figure 6. Life cycle of black dot on potatoes (J. Ekman, based on original by P. Wharton)

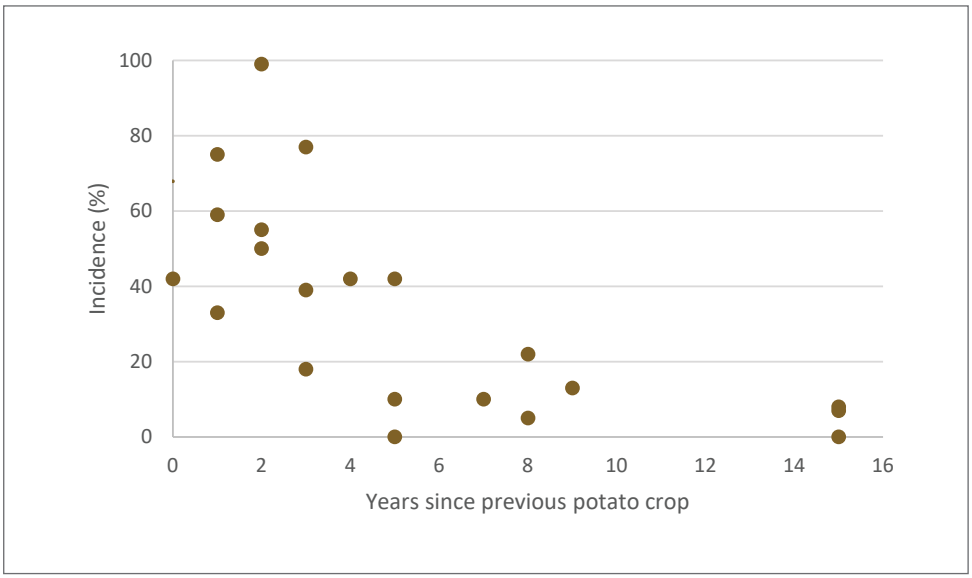

Figure 7. Incidence of detectable black dot on skins of stored Norkotah potatoes relative to the number of years between potato rotations. Data from Johnson and Cummings, 2015.

in the soil increases with continuous potato cropping, as does the incidence of infected tubers (Figure 7). While rates of infection decline if no potato crops are sown, it can take 5 years or more to reduce incidence below 40% if the soil was initially highly infected[4].

Despite this, black dot is generally a weak pathogen that may be resisted by healthy and undamaged plants. However, the presence of wounds – such as those created by windblown soil or sand – aid infection. This is most likely to occur before row closure, when stems are still exposed. The tiny sclerotia carried with the soil can then infect the plants.

REDUCING RISK

Plant stress, especially due to nutrient deficiency, makes plants more vulnerable to infection by the black dot fungus. Low levels of nitrogen and potassium are particularly associated with increased disease[5]. Stress can also be caused by excessive or uneven irrigation, both of which also increase black dot severity, as can co-infection with pathogens such as *Verticillium dahlia* (verticillium wilt) or *Spongospora subterranea* (powdery scab).

As the amount of inoculum in soil is an important determinant of infection, avoiding heavily infected areas is an important risk reduction strategy. The Predicta PT service can provide an indication of the disease risk in soil, based on DNA testing. Predicta PT is also available for seed, although in this case results indicate population density only, rather than risk.

Young plants need to be protected from coarse, blowing sand, especially if the pathogen is known to be present, as this is very likely to increase foliar infections.

In high risk situations (such as high inoculum levels in soil), early harvest can reduce both initial severity and

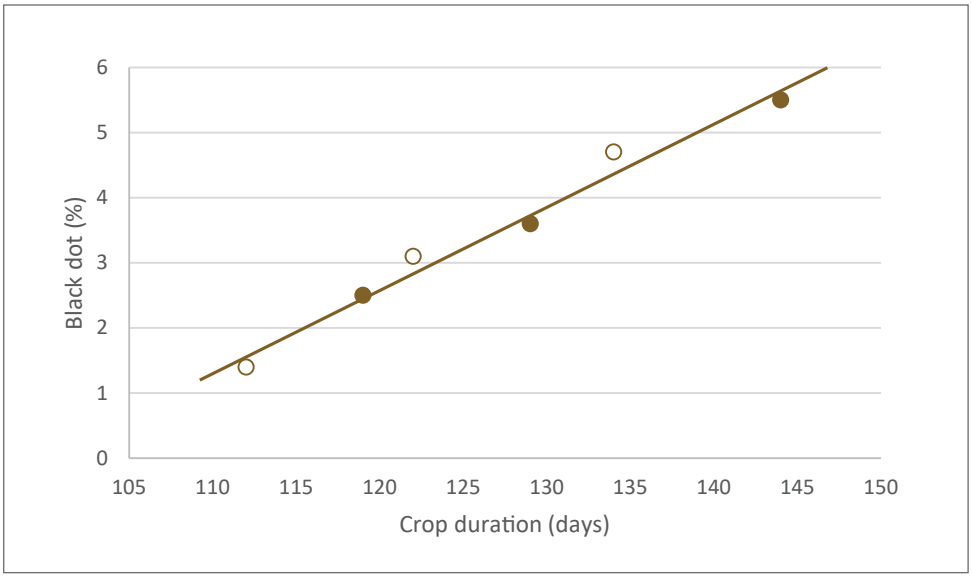

Figure 8. Mean black dot severity (% surface area) on Maris Piper potatoes harvested after different crop durations plus 20 weeks storage. Crops were harvested 21 days (o) or 28 days (•) after vine termination. From Peters et. al., 2016.

that developing after extended (20 weeks) storage[6] (Figure 8). For example, delaying harvest by 2 weeks increased the percentage of tubers with black dot by 10% to 40% in UK trials[7].

Unlike many other potato pathogens, *C. coccodes* grows well at warm temperatures. The optimum temperature range for germination and infection is 22 to 28°C. This means it is favoured by warm to hot conditions. Even in temperate regions, periods of unusually high temperatures have been associated with high incidences of black dot[3].

Dr. Julie Pasche usually recommends an application of a QoI (Strobilurin) fungicide at the mid-rate early in the season. "The key to effective control is to apply fungicides before row closure, as this will protect against infections caused by pathogen-infested soil blowing against plants. In-furrow applications of an SDHI (Group 7) fungicide may provide additional benefit under high disease pressure situations. In organic systems, the biological Serenade may be beneficial as an in-furrow application.

UK trials have also shown that application of Azoxystrobin in furrow at planting is effective at reducing incidence of black dot[7]. However, Azoxystrobin is not registered for this purpose in Australia.

"Crop rotations are a useful control strategy, so we recommend at least three years between potato crops. Reducing plant stress with an effective fertiliser program is also a good strategy. While black dot can be seed borne or soil borne, soil seems to be the most important route of infection. We don't believe that seed treatment fungicides effectively reduce black dot" she said.

In conclusion, managing black dot should not rely on fungicides alone. Rather, an integrated approach that includes risk assessment, accurate management of irrigation, fungicides and early harvest can all contribute to reducing the impact of this elusive disease.

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