Fungicide Resistance Management in Potatoes: Tuber diseases

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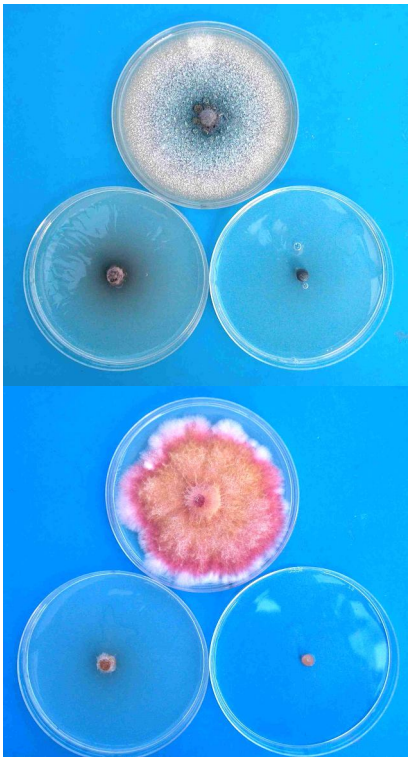
Introduction

Fungicides are used to control a range of pathogens responsible for rots and blemishes of potato tubers:

- Dry rot (*Fusarium* spp.)
- Gangrene (*Phoma foveata*)
- Silver scurf (*Helminthosporium solani*)
- Black dot (*Colletotrichum coccodes*)
- Skin spot (*Polyscytalum pustulans*)
- Black scurf and stem canker (*Rhizoctonia solani*)



The range of fungicides available for controlling these pathogens is limited. Imazalil is the most widely used seed tuber treatment. Thiabendazole (TBZ) is now mainly used in mixtures with imazalil, since resistance to thiabendazole has been found in the UK in *H. solani*, *P. pustulans*, *Fusarium sambucinum* (formerly *F. sulphureum*; a cause of dry rot, but much less common in the UK than *F. coeruleum*) and, occasionally, in *F. avenaceum*. When used alone, imazalil has been shown to increase levels of black scurf in progeny crops.

To maintain effective control of fungal tuber diseases and minimise the risk of further resistance development, it is vital to adopt an integrated approach to their control. Because the potato is clonally propagated, this must consider all stages of the production cycle.

Resistance terminology

Resistance occurs when a pathogen becomes so insensitive to a fungicide that the fungicide's performance is impaired in practice. Resistance can arise rapidly and completely so that disease control is lost in a single step. More commonly, resistance develops gradually so that the pathogen becomes progressively less sensitive. When this happens there is usually no initial detectable loss of control.

Laboratory testing can reveal a number of things about fungal strains isolated from diseased plant material. They can tell us about the genetic make-up of the isolate and how it has changed (mutated) by comparison with sensitive "wild-type" isolates from many years ago. Growth tests on laboratory media with different doses of fungicide can show how sensitive that isolate is compared with the wild type. Where selection has taken place, it is often very difficult to find any 'wild type' isolates because such isolates would be very sensitive to fungicides and may have been removed from the population by frequent fungicide use. The isolates that remain are less sensitive than the wild type – often by a large factor – up to 200 times less sensitive in lab tests, but these isolates are not 'resistant' in practical terms as they are still well-controlled using recommended label doses.

FRAG-UK

The Fungicide Resistance Action Group - UK (FRAG-UK) is a forum to look at fungicide resistance issues and to publish information and advice relevant to the UK. The group combines the expertise of industry with the independent sector to produce up-to-date information on the resistance status of important diseases in UK agriculture and to suggest ways of combating resistance once it has occurred.

Resistance Management Guidelines

The points listed below are relevant to both seed and ware producers. It is imperative that fungicide treatment histories of a stock throughout the production cycle are made fully available so that effective anti-resistance strategies can be adopted at all stages of both seed and ware production.

- An integrated control strategy should be adopted including, as appropriate:
    - use of healthy seed
    - selection of an appropriate planting site
    - managing the crop to avoid stress
    - lifting at the earliest date possible (but allowing a suitable interval after haulm destruction for skin set)
    - dry curing
    - adopting good store hygiene and temperature management (cold storage where possible)
- Use fungicides rationally: routine use is only justified if one or more of the following apply:
    - the variety grown is highly susceptible to a specific disease
    - there is a history of persistent disease on the farm
    - significant levels of the disease were present on mother tubers
    - presence of a disease would have a major effect on marketability
    - treatment constitutes part of a contract
- Minimise repeated use of the same fungicide from year to year throughout a multiplication programme where possible.
- Consider the use of products constituting a mixture of active ingredients.
- Use thiabendazole alone only on ware tubers.
- If treatment is needed on seed tubers destined for pre-pack production, use only imazalil for silver scurf and skin spot control.
- TBZ + imazalil mixture may be used on seed of processing varieties.
- Once-grown seed from ware should not be treated with TBZ

Main fungicides for potato tuber treatment and application at planting

Fungicide group	Active ingredient	Product name (example) and use
benzimidazole	thiabendazole	Storite Excel[1]
DMI	imazalil	Fungazil 100SL[1]
DMI + benzimidazole	imazalil + thiabendazole	Storite Super[2]
dicarboximide	iprodione	Rovral AquaFlo[2]
phenylurea	pencycuron	Monceren DS[3]
phenylurea + DMI	pencycuron + imazalil	Monceren IM[3]
organophosphorus	tolclofos-methyl	Rizolex[3] Rizolex Flowable[2]
carboxamide	flutolanil	RhiNo[2] RhiNo DS[3]
QoI	azoxystrobin	Amistar[4]

1. approved for application to seed in store and both seed and ware post-harvest in store
2. approved for application to seed in store or at planting for seed and ware crops
3. dust approved for application to seed at planting for seed and ware crops
4. approved for application to soil at planting; repeated use on seed during multiplication is not recommended

Diseases controlled by fungicide treatment in the absence of fungicide resistance

Choosing an effective fungicide for the target disease constitutes an important part of the anti-resistance strategy. The following Tables should be used in conjunction with the anti-resistance strategy on page 1 and the information in the disease profiles so that the most suitable fungicide can be selected. Accurate pathogen identification, for example specific diagnostic testing, will aid decision-making for fungicide usage.

At harvest or grading (for control of development in store)

In general, the effectiveness of treatments is progressively reduced during storage. The scores below indicate effectiveness if treatments are applied immediately post-harvest: efficacy will be considerably less if they are applied at grading.

Fungicide	Black dot	Black scurf	Dry rot	Gangrene	Silver scurf	Skin spot
Fungazil	–	–	++	+++	++	+++
Storite Excel	–	–	++	+++	++	+++
Storite Super	–	–	+++	+++	+++	+++

+++ = excellent control, ++ = good control, + = some control, – = not recommended for control or no control

At grading, pre-planting or at planting (for control of spread to progeny tubers)

Fungicide	Black dot	Black scurf	Dry rot	Gangrene	Silver scurf	Skin spot
Amistar	+++	+++	–	–	–	–
Fungazil	–	–	–	–	+	++
Monceren	–	+++	–	–	–	–
Monceren IM	–	+++	–	–	++	+
Rhino	–	+++	–	–	+	–
Rizolex	–	+++	–	–	–	–
Rovral	–	++	–	–	–	–
Storite Excel	–	+	–	–	+	+
Storite Super	–	++	–	–	++	++

+++ = excellent control, ++ = good control, + = some control, – = not recommended for control or no control

Disease profiles

Further information on these diseases can be found at the Potato Council website,
www.potato.org.uk/department/knowledge_transfer/pests_and_diseases/viewer.html

Black dot

Black dot (*Colletotrichum coccodes*) is a dark brown-grey blemish over the tuber surface similar in appearance to silver scurf, but with more irregularly shaped lesions with less well-defined edges. Black microsclerotia just visible to the naked eye are the diagnostic symptoms. Harvesting as early as possible and limiting crop duration from emergence to planting minimises black dot on the harvested crop . Seed-borne inoculum is less important where soil is contaminated.

Resistance status: the only fungicide approved for control of black dot is azoxystrobin and there have been no reports of resistance in *C. coccodes*. Use of azoxystrobin alone as a pre-planting soil incorporation or in-furrow treatment does not need to be taken into account when considering the total number of permitted applications of foliar QoI fungicides for potato blight control (famoxadone in Tanos and fenamidone in Consento).

Disease profiles

Black Scurf / Stem Canker

Black scurf (*Rhizoctonia solani*) appears as particles (sclerotia) of variable shape and size, easily detached from the tuber skin with a thumbnail. The fungus also attacks developing sprouts, stolons and underground stems, causing brown cankers which may result in leaf rolling, wilting, formation of aerial tubers and reduction of crop uniformity. The sclerotia on tubers detract from their appearance and reduce their market value. *R. solani* comprises several groups which are pathogenic to different plant species. The group which most commonly causes potato disease in the UK is known as AG3 and a recent UK study showed that over 90% of isolates from UK potato belonged to this group, but a small proportion of potato isolates belonged to other groups, including *c*. 7% to AG2-1.

Resistance status: there have been no reports of resistance in *R. solani* AG3 to any of the fungicides approved for black scurf control in the UK. Laboratory tests have shown some other AG groups are inherently insensitive to pencycuron, but pencycuron is effective against AG2-1. Occasional isolates from other groups have reduced sensitivity to iprodione, tolclofos-methyl, pencycuron or flutolanil, but as these seldom cause disease on potato, this is unlikely to be significant for control of black scurf or stem canker. Use of azoxystrobin alone as a pre-planting (in-furrow)

Dry Rot

Dry rot, caused by a range of *Fusarium* spp., is the most important fungal rot of potato tubers in the UK. It affects seed and ware quality and provides entry for bacterial soft rotting. In a recent BPC survey (2000-2002), *F. coeruleum* was the most commonly isolated species (*c*. 50%), followed by *F. culmorum* and *F. avenaceum* with *F. sambucinum* (formerly *F. sulphureum*) the least common, particularly in Scotland.

Application of fungicides throughout seed multiplication is recommended where dry rot risk is high (e.g. susceptible varieties, early harvest, high levels of damage, high temperature storage).

Treatment with imazalil and with TBZ in the absence of TBZ resistance have proved effective in reducing disease levels, but results vary and may reflect differences in the relative effectiveness of these fungicides on the different *Fusarium* spp. The combination of imazalil + TBZ has given more consistent disease reductions. Fungicide treatments should only be used in conjunction with good cultural control measures (e.g. planting in warm seed bed, allowing skin to set prior to harvest). For further advice see “Managing the risk of dry rot” BPC, 2006.

Gangrene

Gangrene *(Phoma foveata)* is a tissue rotting fungus that affects potatoes stored at low temperatures. Seed treatments have not proved effective at reducing levels in progeny crops, but treatment at harvest with imazalil or TBZ may reduce development in store. Disease control by cultural methods is recommended including minimising damage at harvest and adequate curing.

Resistance status: there have been no reports of resistance of *P. foveata* to either TBZ or imazalil. Recent tests on isolates from Northern Ireland have confirmed its sensitivity to these fungicides.

Disease profiles

Silver Scurf

Silver scurf (*Helminthosporium solani*) is a surface blemishing disease that affects pre-pack product value. Under damp conditions, black spore-bearing structures at the edge of lesions give a sooty appearance. Skin may eventually flake off and tubers become dehydrated and shrivelled. There is evidence to suggest that the most effective time to control the disease is in the year of ware production. Fungicide applications to seed both into and out of store have provided good disease control. Treatment of the stored ware crop with thiabendazole or imazalil is also permitted. Early harvest and dry curing effectively reduce silver scurf. Where silver scurf is controlled, levels of black dot may increase if soil-borne inoculum is present.

Resistance status: In independent surveys in the 1990s, the percentage of isolates of silver scurf with resistance to TBZ was found to be *c*. 65% in Great Britain and ranged from 33% to over 90% in Northern Ireland. However, usage of TBZ has been much reduced over the last 10 years. There is no evidence of resistance to imazalil.

Skin Spot

Skin spot (*Polyscytalum pustulans*) is a surface blemishing disease affecting both pre-pack and processing product value. It may also cause non-emergence of seed if eyes become infected. If left unchecked, the fungus can increase throughout seed multiplication. Application of fungicide throughout seed multiplication, following anti-resistance guidelines is recommended particularly on susceptible varieties. Best results have been achieved in the past by applying chemical treatments at store loading rather than prior to planting. Cultural control measures i.e. starting with high grade seed, early lifting, maintaining high levels of store hygiene and drying tubers into store are essential components of an effective control strategy.

Resistance status: In independent surveys of Scottish seed in the early 1990s, TBZ-resistant isolates of skin spot were found in most stocks sampled. In Northern Ireland in the mid-1990s the majority of isolates proved to be TBZ-resistant. There is no evidence of resistance to imazalil.

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This leaflet and further information on resistance are available at http://www.pesticides.gov.uk/rags.asp?id=644

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