Common Scab: A Review

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Grand Forks, ND
21 February 2013
• I have worked with potatoes since 1971 (that’s 42 years for those mathematically challenged) and mostly I have tried to avoid scab, because it seemed there were only four things you could do about scab, and none of them worked
  – Avoid high pH soils; you have to farm what your grandparents homesteaded
  – Don’t put livestock manure on your soils; what to you do with it?
  – Keep soil moisture high and even; without irrigation, going to church is the only option
  – Use resistant varieties; do you know any?
• During my career, I have been asked more questions about scab control than any other disease, regardless of where I am in the world
• Now I have to think about scab since Andy asked me to do this overview
• My job is to provide an overview of common scab that will give you some education about this disease – probably more than you want to know
The disease

- The disease occurs wherever potatoes are grown; Americas, Europe, Africa, Asia
- First unmistakably identified in US in the early 1890’s (Hooker)
- Affects tubers, lower stem, roots, stolons
- Main damage due to the formation of lesions on the surface of tubers that detract from appearance and can lead to market rejection
  - Affects grade and quality, rarely yield
- Huge range of symptoms
• Symptoms may resemble those of powdery scab, and laboratory examination is required to determine the cause; confusing even to experts
• Microscopic structures or PCR
• Scab affects other soil crops including beets, carrots, parsnips, radishes, rutabagas, turnips, sugar beets (Hooker) sweet potatoes (Wanner) and peanut pods (Lambert and Loria)
• Common scab is a disease incited by an actinomycete named **Streptomyces**
  – An unusual group of Gram positive filamentous bacteria
  – Produce branched filamentous mycelia
  – Spiral sporophores
  – At maturity produce spores
  – Produce secondary metabolites
    • Antibiotics (streptomycin), anti-tumor agents, immunosuppressants (Loria et al)
    • Phytotoxins
Streptomyces plicatus
by: K. Furihata & T. Shomura.

The filamentous mycelium of Streptomyces

http://microbewiki.kenyon.edu/index.php/Streptomyces

http://www.apsnet.org/Education/IllustratedGlossary/PhotosA-D/actinomycete.htm
• The traditional cause of common scab is *Streptomyces scabies*

• First described in 1891 (Loria et al.)

• Most *Streptomyces* are saprophytes that do not cause disease; those that cause disease arise periodically

• Within last few years other species of *Streptomyces* causing potato scab have been described (Wanner)
- S. acidiscabies (Lambert and Loria, 1989); grows in acidic soils in the maritime US and Canada (Manzer et al, 1977)
- S. europascabiei
- S. stellascabies  Star crack scab
- S. bottropensis  Egypt
- S. turgidiscabies  Pitted scab
- S. aureofaciens  Netted scab
- S. reticuloscabiei  Netted scab
- Three species from Korea
• The pathogen is
  – Tuber-borne
  – A soil inhabitant, not a visitor
• Infection occurs through lenticels, stomata, wounds and insect feeding injury
• Over winters in soil and tubers
• Persists many years; indefinitely
Pathogenicity Factors

- Thaxtomin; main toxin responsible for pathogenicity and symptoms
  - Nitrate dipeptides A and B
  - Tyrosine:tryptophan (thaxtomin A)
  - Phenylalanine:tryptophan (thaxtomin B)
- Enzymes
- Virulence factor; nec1 protein
Thaxtomin A

- Inhibits cellulose biosynthesis enzymes;
  - Prevents normal cell wall synthesis; results in cell death;
  - All plant cells have cell walls
- Thaxtomin plus the other virulence factors form “pathogenicity islands”
- These islands can move among Streptomyces species creating new scab pathogens by converting non-pathogenic Streptomyces to pathogens
- May explain variability in symptoms
Control

• Now we understand the pathogen and how it causes disease better, what does this mean for control?
• This is the area that needs some creative work

• **Control Strategies**
  – Clean Seed
  – Chemical Protection
  – Resistant cultivars
  – Cultural Practices
    • Maintaining soil moisture
    • Soil pH
    • Crop rotation
Scab free seed

- Prevents introduction into virgin fields
- Scab free seed is preferred
- Difficult to find totally scab free seed
- How much is too much?
  - What is the threshold?
- Certification not based on scab, not a cause for rejection, but type and coverage are noted
Chemical

• Fungicides
  – Mancozeb, coppers, streptomycin, PCNB seed treatment or in furrow application purported to reduce scab
  – Generally not effective; not consistent
  – May reduce seed-borne inoculum, but no effect on soil-borne inoculum, which is probably the main source
• Insecticides
  – Mocap (etheprop) purported to reduce scab by controlling soil insects (springtails, flea beetle larvae) feeding on tubers that make injuries that can act as entry sites; importance not known

• Soil amendments
  – Many sold to control scab, but most do not work
  – Growers beware; example
• A product is recommended at 1 gal in 250 gal of water to cover 10 acres and guarantees “a reduction in the incidence of scab if the above instructions are met”
  – If you do the math, that turns out to be 2 ml/sq ft or 40 drops /sq ft
  – Do you think that will work?
Chemical (Cont.)

• Soil fumigation
  – Vapam (sodium isothiocyanate) may actually make scab worse by killing suppressive soil micro-organisms
  – Continuing work with chloropicrin (tear gas) shows good control of pitted scab (ON, WI, MI, FL)
    • >45°F and 30-day interval post-application planting restrictions would require fall application in most seasons.
Resistance

• Many cultivars with resistance have been released

• Resistance may vary between locations:
  – example: scab resistant in ND, when planted in NE, is susceptible
  – different scab species or biotype?

• Best and most effective control if it can be identified
  – Major effort by most breeding programs
  – Durability of resistance??
Soil moisture

• Best cultural practice to reduce scab
• Known since 1923 (GB Sanford, University of Alberta)
• Even and high soil moisture beginning at tuber initiation and continuing 4-6 weeks
  – Need irrigation
Rotation
May help, but S. scabies is a soil inhabitant and persists in soil basically forever

Soil pH adjustment
Adjusting soil pH with lime or sulfur difficult/expensive; not a good option
Unanswered questions and challenges

- How important is seed-borne inoculum?
  - Is there a threshold of coverage that contributes to disease of progeny tubers?
- The need for a seed treatment that controls seed-borne inoculum.
- An understanding of soil antagonists and suppressive soils. A huge soil microbiology area.
  - Example: Disappearance of scab from scab nurseries in ND
- Development of soil fumigation: biological (glucosinolates) or chemical (chloropicrin).
- Durability of host resistance.
- New control methods that work consistently.