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General enquiries

ARC-Vegetable and Ornamental Plants
Private Bag X293
Pretoria
0001
South Africa

e-mail: vopiinfo@arc.agric.za
website: http://www.arc.agric.za

Inside this issue:

Powdery mildew on Swiss chard in South Africa

Compiled by Dr Elsie Cruywagen and Dr Mariette Truter, Crop Protection Division, ARC-VOP

Swiss chard (*Beta vulgaris* L. subsp. *cicla* (L.) Koch), also known as Perpetual Spinach, is a popular leafy vegetable in South Africa. During the spring of 2017 to 2019, outbreaks of powdery mildew were observed on Swiss chard in the Gauteng and North West Provinces of South Africa. Infection of up to 90% of the fields were observed on four farms in the Winterveld region during 2017. However, in subsequent years, lower levels of infection were reported in Gauteng. Ad hoc infections were observed in other areas, including home gardens in Pretoria and at the ARC-VOP, Roodeplaat, Pretoria. Initial symptoms of the disease presented as small white patches on both sides of the leaves and eventual colonisation of the whole leaf (Fig. 1a). This resulted in the crop becoming unmarketable and leading to a substantial loss of income for small-scale farmers.

DNA was extracted directly from conidia (Figs. 1c and d), and the internal transcribed spacer (ITS) region of the rDNA was amplified and sequenced with primers ITS1 and ITS4 (White et al. 1990). The powdery mildew samples from Gauteng showed a 100% sequence identity with the reference *Eryspihe betae* specimens.

Symptomatic Swiss chard leaves collected in Pretoria were used as a source of inoculum to infect healthy plants of Swiss chard cultivars Greenwave and Bright lights in a greenhouse. Similar symptoms developed on the leaves of both cultivars (Fig. 1b) and morphological identification of the pathogen confirmed the presence of *E. betae*. The pathogen *E. betae* has been reported worldwide from *Beta atriplicifolia, B. corolliflora, B. diffusa, B. intermedia, B. lomatogona, B. macrorhiza, B. patellaris, B. patula, B. trigyna, B. vulgaris, B. vulgaris* subsp. *maritima* (Braun & Cook 2012), *B. vulgaris* subsp. *amaranthaceae* (Joa et al. 2017) and *B. vulgaris* subsp. *cicla* (Vakalounakis & Kavroulakis 2017). To our knowledge, this is the first report of powdery mildew on Swiss chard in South Africa. This has not been reported as a problem on Swiss chard from commercial farms, but small-scale farmers have reported huge losses. Further monitoring is needed to determine the best control strategies for small-scale farmers.

Contact: Dr Elsie Cruywagen at CruywagenEM@arc.agric.za or Mariette Truter at TruterM@arc.agric.za

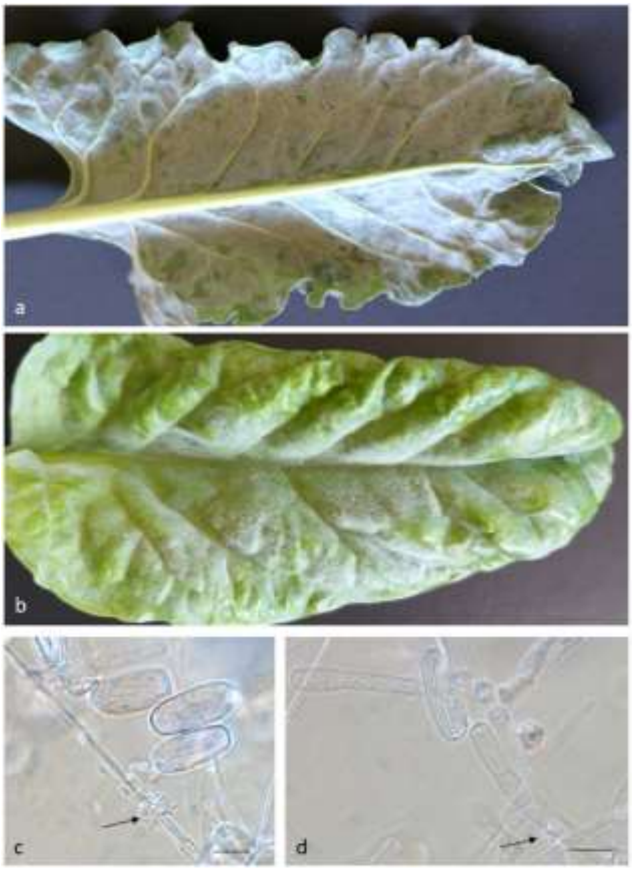

Figure 1. a. Swiss chard leaf with powdery mildew from Gauteng (Spring 2017); b. Swiss chard leaf with powdery mildew after infection in a glasshouse; c and d. Microscope photos of *Erysiphe betae* from *Beta vulgaris* showing oblong conidia and lobed appressoria (arrows) in opposite pairs (c), and solitary (d). Scale bars = 20 µm.

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Common Lepidoptera pests of vegetables

Compiled by Dr Diedrich Visser, Crop Protection Division, ARC-VOP

At least 44 species in the insect order Lepidoptera (moths and butterflies) attack vegetables in South Africa. Some occur as polyphagous species complexes, while others occur as single species that feed on specific crops or on crops in only one family. Nearly all lepidopteran pests are moths (only two butterfly species occur as minor pests), and all are indigenous or have been naturalised over the decades. However, two species, i.e. *Tuta absoluta* and the fall armyworm, were introduced recently. Below is a short description of seven of the most common and important lepidopteran vegetable pests, or pest complex groups, in South Africa (sorted alphabetical), with visuals on the next page. For a complete list of all vegetable pests, and for more information, see: Visser, D. 2009. A Complete Guide to Vegetable Pests in South Africa. ARC-Roodeplaat, Vegetable and Ornamental Plant Institute, Pretoria (available from the ARC-VOP).

Common caterpillar complex
Many caterpillars feed on the foliage of vegetables. The most common and important species are: African bollworm (*Helicoverpa armigera*), semi-loopers (most commonly the tomato semi-looper, *Chrysodeixis acuta*, and the plusia semi-looper, *Thysanoplusia orichalcea*), the lesser armyworm (*Spodoptera exigua*), and the tomato moth (*Spodoptera littoralis*). Crops attacked: Most vegetables. Damage: These caterpillars mostly feed openly on foliage, but sometimes tunnel into and feed inside the fruit. It is usually only when they occur in high numbers that significant damage is inflicted. Control: Several insecticides are available for caterpillar control on vegetables. In small plots, scouting, combined with the removal of caterpillars, is advised.

Cutworm complex
At least seven cutworm species attack vegetables in South Africa. The three most common species are: the common cutworm (*Agrotis segetum*), the brown cutworm (*Agrotis longidentifer*), and the black cutworm (*Agrotis ipsilon*). Crops attacked: Cutworms are polyphagous and will attack most crops. Damage: Damage is mostly by older individuals that emerge from their hiding places at soil level, or just below soil level, at dusk. Any plant part near soil level, including the stems of young plants, as well as tubers located shallowly below soil level, are vulnerable. Cutworms may "cut off" several seedlings at ground level, without consuming the rest of the toppled plantlets. Control: Insecticides are available for cutworm control, including bait granules that are scattered between plants. Cutworms readily feed on weeds - sanitation will therefore be important, usually well ahead of planting time.

Diamond back moth
The diamond back moth, *Plutella xylostella*, is a worldwide key pest of brassicas. Crops attacked: Only members of the cabbage family (Brassicaceae). Damage: The caterpillars have a characteristic way of feeding – they mostly strip the lower leaf area, leaving the upper epidermis intact. This results in window-like damage. However, larger larvae may chew irregular holes right through the leaf. The window-like areas also soon turn into large irregular holes as the leaf grows and expands. Although one larva consumes only a small amount of leaf surface, their occurrence in high numbers causes the serious damage for which they are known. Many larvae may feed on one plant, leaves may be skeletonised and head formation may be affected when young plants are attacked. When older, head-forming brassicas are attacked, damage may be less severe. Larvae are not known to tunnel into already formed heads (unlike some other pests), and such plants may still be usable. Control: Various insecticides are available for diamond-back moth control. Unfortunately, the diamond-back moth is notorious for developing resistance to most pesticides registered against it. Protection of young plants should be given priority, because if plants are not attacked during the first three weeks, head formation will be minimally influenced. Removal of brassica weeds in the vicinity of crops is recommended.

Fall armyworm
The fall armyworm, *Spodoptera frugiperda*, invaded South Africa from our northern neighbours in early 2017. It originated from the tropical Americas and was first detected in Africa in 2016. It is a tropical pest that does not survive in cold environments. It is suspected that it currently survives in "hotspots" in mild locations from where it re-infests new areas after winter. Crops attacked: Although the caterpillars will consume nearly all crops when given the opportunity, females mainly lay eggs on maize (including sweet corn), sorghum and a few grass species. Dispersal of the small first instar larvae by the wind is often observed, giving rise to their occasional occurrence on other nearby corps. Damage: The caterpillars hide in the whorls of maize and sorghum during the day, but at night feed on young leaves near the growth point. Fall armyworm infestations often are only noted at a later stage, when large holes, accompanied by larval droppings (excrement), are noticed in the whorls and on surrounding leaves. When dry, the excrement takes on a very characteristic appearance, that of sawdust. It is mainly young plants that are chosen by the females to lay their eggs; young plantations may be completely destroyed. Control: Many insecticides are available for fall armyworm control. Other control options include monitoring with pheromones, removal of egg packets by hand, and using resistant cultivars.

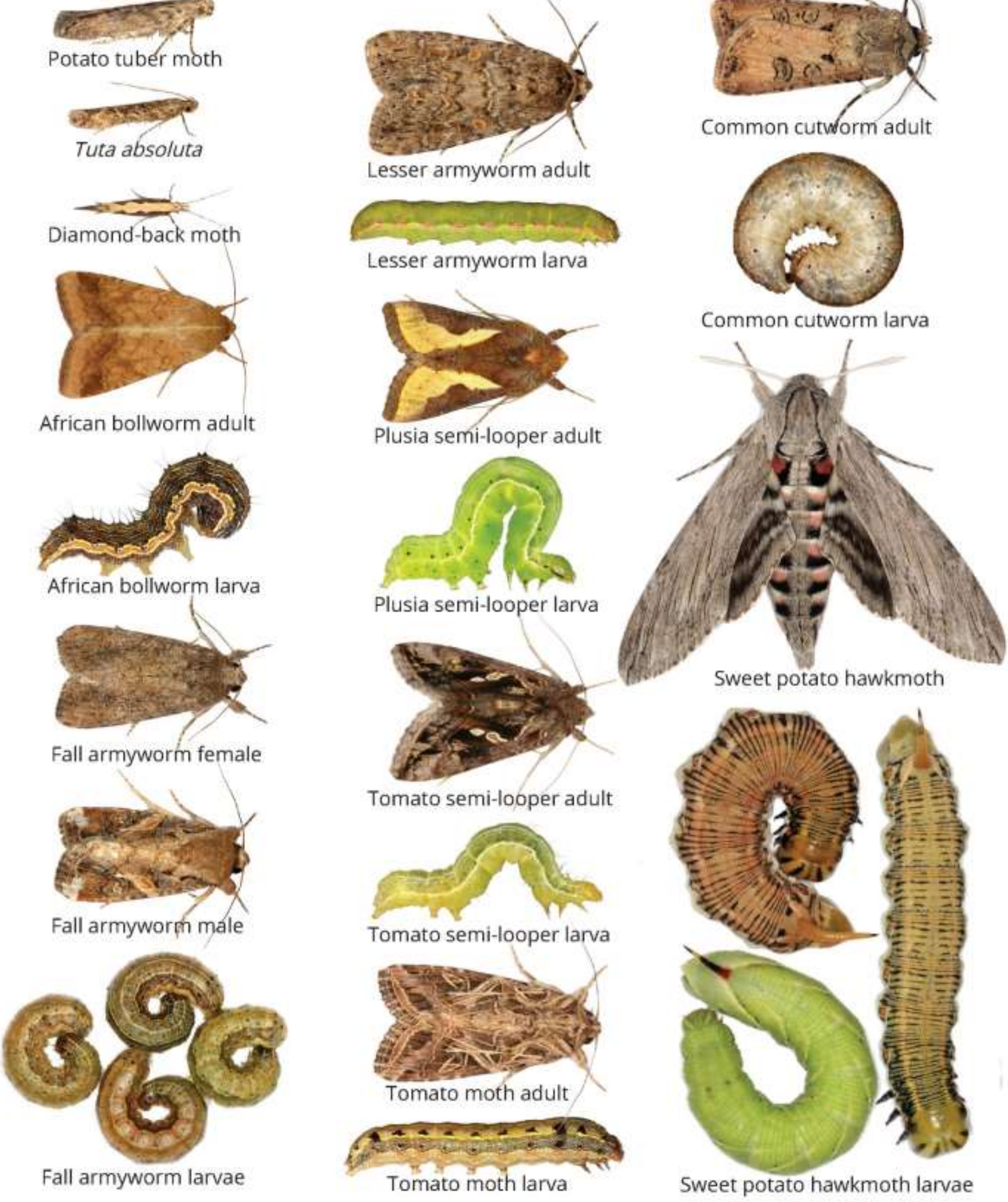
Potato tuber moth
The potato tuber moth, *Phthorimaea operculella*, is a major pest of potato worldwide. Crops attacked: Mainly potato, but other crops in the family Solanaceae, e.g. tomato and eggplant, are vulnerable. Damage: The potato tuber moth is a leaf miner that makes blotch (broad) leaf mines, and mine into potato tubers, both under field conditions and in stores. Infestations of tubers under field conditions are usually due to the very small first instar larvae that are actively searching for feeding sites when the foliage is dying down naturally near the end of the season. Small cracks in the soil that appear at this time, due to tuber bulking and the drying out of soils, contribute significantly to the ability of the small larvae to reach and infest tubers in soils. Damage to the foliage is insignificant compared to the high yield losses experienced when tubers are attacked at the end of the season. Control: Control is mainly with insecticides. Other integrated options include ridging, preventing or closing of cracks in the soil near harvest time, removing of cull piles (to eliminate breeding areas), and monitoring the occurrence in fields with pheromone traps.

Sweet potato hawk moth
The sweet potato hawkmoth, *Agrius convolvuli*, is a large and robust moth, occurring in most countries, but is absent in the Americas. Crops attacked: Only sweet potato. Alternative hosts include morning glory and a few species of bindweed. Damage: The caterpillars, especially the later instars, destroy considerable amounts of foliage. The larger caterpillars move down to the lower canopy where they rest during daytime, and are therefore not often seen. Control: Insecticides are available for control. In small plots, the caterpillars can be removed by hand when searching in the lower canopy.

Tuta absoluta
In South Africa, the tomato leafminer is better known by its scientific name, *Tuta absoluta*. It was first reported in 2016 in the eastern parts of the Mpumalanga Province, but is today widespread across the country. Crops attacked: Mainly tomato, but to a lesser extent, also other crops in the Solanaceae family, e.g. potato. Damage: Similar to the potato tuber moth, the larvae are blotch leafminers. However, they occur in much higher numbers, and may destroy entire tomato fields when insecticides are not used. Later instars also bore into tomato fruit. Although they also commonly occur in potato fields, they do not move down cracks to infest tubers, and they do not destroy the foliage, as is often the case in tomato fields. Control: Many insecticides are available for control. Because the moth disperses quickly, and because they occur in huge numbers, other control options are less effective.

Contact: Dr Diedrich Visser at DVisser@arc.agric.za

Common Lepidoptera Pests of Vegetables in South Africa



Author: Diedrich Visser, Agricultural Research Council, South Africa (Vegetable and Ornamental Plants). **Note**: Many more lepidopteran pests occur on vegetables in South Africa, these are just selected common ones.

Fissure scab on potatoes in South Africa

Compiled by Dr Elsie Cruywagen and Dr Michele Cloete, Crop Protection Division, ARC-VOP

In South Africa, common scab is caused mainly by *Streptomyces scabiei* and to a lesser extent by *S. europascabiei*, *S. stelliscabiei* and *S. caviscabiei*. Since early 2010, distinct atypical scab symptoms have been observed on potato tubers in some production regions in South Africa. Symptoms were characterised by longitudinal cracks 3 to 12 mm deep containing scab-like lesions (Fig. 1a). The symptoms differed from growth cracks in that the surface inside growth cracks are smooth (Fig. 1b), whereas the surface of atypical cracks is covered by corky tissue. *Streptomyces* species were isolated from affected tubers, but were found to be distinct from those causing common scab on potato (Gouws & McLeod 2012). The disease was named 'fissure scab' and DNA sequencing revealed that the isolates obtained from affected tubers were related to *S. werraensis, S. pseudogriseolus* and *S. gancidicus*. Further studies were needed to identify the *Streptomyces* isolates involved in fissure scab to species level and to determine the role of *Rhizoctonia solani* in fissure scab. This fungus has been associated with similar symptoms on potato tubers, where the disease is referred to as corky cracks of potatoes.

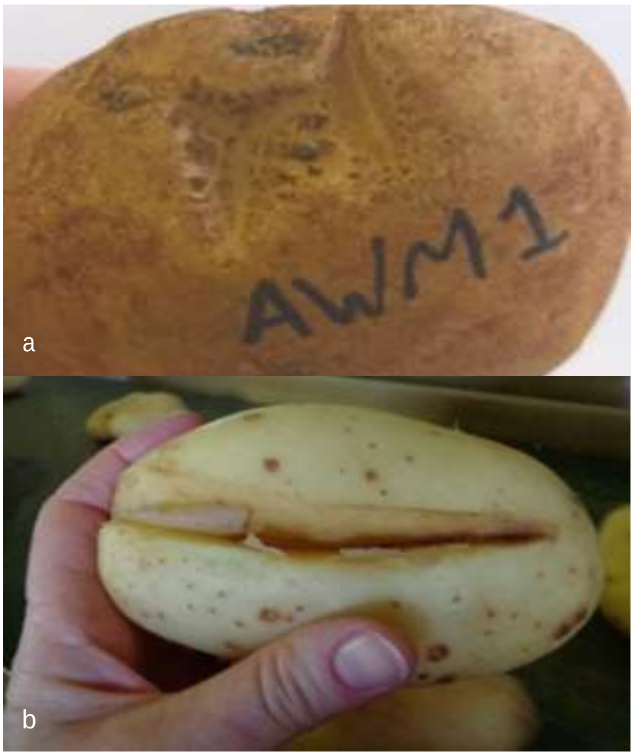


Figure 1. Potato tubers with fissure scab symptoms (a), and a growth crack (b).

Isolation and identification of causal organisms

A total of 142 *Streptomyces* isolates were retrieved from potato tubers displaying fissure scab symptoms that were collected from the KwaZulu-Natal, Mpumalanga, East Free State, Western Free State, Northern Cape and Gauteng Provinces, from 2010 to 2018. The isolates were characterized morphologically and phylogenetically. PCR amplification of the 16S rDNA, and five housekeeping genes were conducted, followed by sequencing and phylogenetic analyses. Three main phylogenetic groupings were obtained and named 'species 1', 'species 2' and 'species 3'. A total of 85 of the isolates obtained from fissure scab lesions belong to three main *Streptomyces* species. Research was therefore focused on *Streptomyces* species 1, 2 and 3. A glasshouse trial was carried out to determine whether isolates from the three main *Streptomyces* species were able to cause the same symptoms as was observed initially. Potato cultivars Mondial and Innovator, which are susceptible to fissure scab, were infected with three isolates from each species. All the isolates from the three species caused similar symptoms as what was originally observed. The other 57 *Streptomyces* isolates comprise of 37 other *Streptomyces* species that need to be investigated further to determine if they are pathogenic and able to cause fissure scab symptoms.

Isolations for both bacteria (*Streptomyces* species) and fungi (*Rhizoctonia solani*) were done from 199 symptomatic tubers. *Streptomyces* was only isolated from 174 tubers and *R. solani* was only isolated from 20 tubers. The fungal pathogen *R. solani* was isolated along with *Streptomyces* from only five tubers, indicating co-infection. It thus seems that co-infection of the two pathogens rarely occurs and that both *Streptomyces* and *R. solani* can cause similar symptoms on potato tubers. There is a lot of overlap in the symptoms observed on the tubers from which *Streptomyces* and *R. solani* were isolated from (Fig. 2). It is therefore not possible to predict which pathogen is responsible for the observed symptoms before isolations and identifications are done.

Control of fissure scab

Control of soil-borne diseases can be achieved with the use of tolerant cultivars, as is the case with common scab. To determine whether fissure scab can be managed in the same way, field trials were conducted over three seasons. Various cultivars were planted in a field that was previously inoculated with fissure scab isolates. The most susceptible cultivars identified during the trial were Mondial, Innovator and Eos. The most tolerant cultivars identified were Arizona, Sifra and Up-to-Date.

Management of a disease can be improved when rapid, cost effective diagnostic tests are available. A diagnostic test was developed by qPCR amplification, followed by High Resolution Melting Point (HRM) analyses of the products. The qPCR-HRM test was able to distinguish between the three *Streptomyces* species associated with fissure scab, as well as between the three species in the *Streptomyces scabiei* complex that are associated with common scab in South Africa. Fig. 3 shows the results of the diagnostic test.

Conclusions

The symptoms of fissure scab on potatoes are caused by a complex of microorganisms that include both various *Streptomyces* species, as well as *R. solani*. Initial results show that Up-to-Date, Arizona and Sifra are cultivars that may provide good tolerance to infection by *Streptomyces* species associated with fissure scab. Further field trials are needed to confirm these findings. Mondial, Innovator and Eos should not be planted in fields with a history of fissure scab, as they tested susceptible in trials at Roodeplaat. It is unfortunate that Mondial, that has good tolerance to common scab, is very susceptible to fissure scab. Currently, none of the cultivars evaluated have shown tolerance to both common scab and fissure scab. Thus, newly developed potato cultivars should be evaluated for tolerance to both of these pathogens in order to provide farmers with the best possible options to obtain maximum disease-free yields.

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Contact Dr Michele Cloete at cloetemi@arc.agric.za

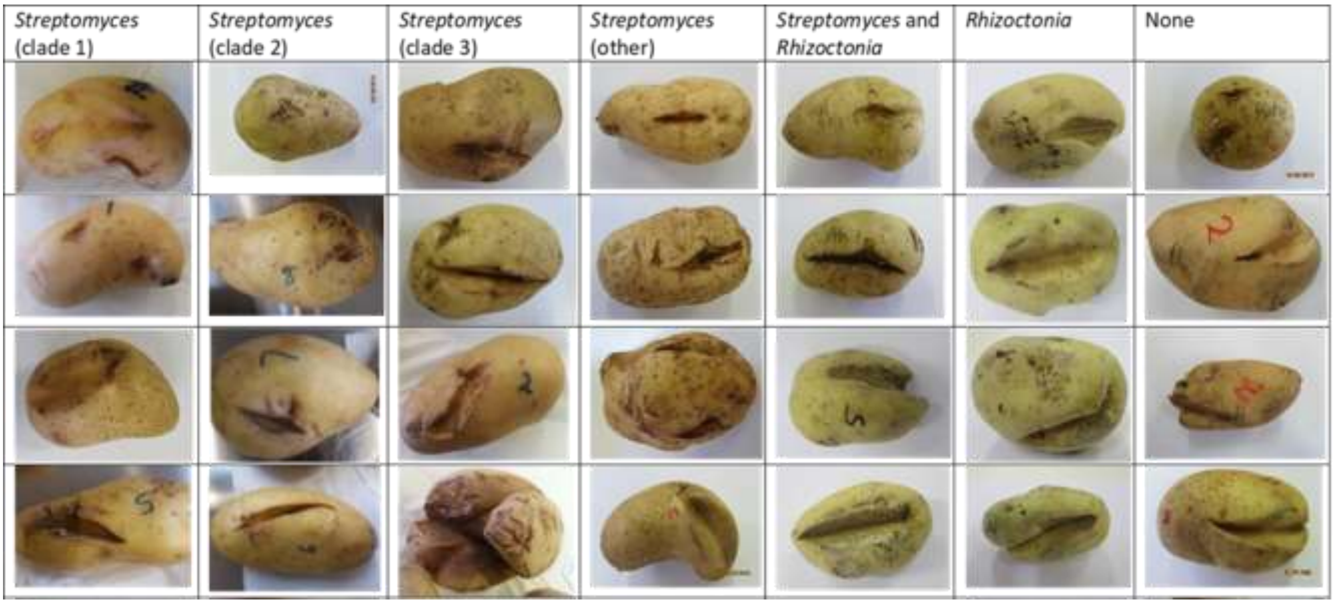

Figure 2. Potato tubers from which *Streptomyces* species and *Rhizoctonia solani* were isolated from.

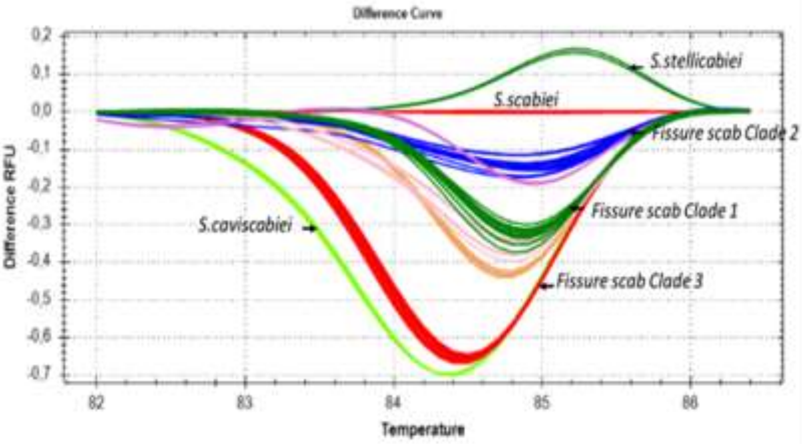

Figure 3. qPCR-HRM diagnostic test that can detect, and distinguish between, all of the fissure scab clades (1 to 3), as well between as *S. scabiei, S. stelliscabiei* and *S. caviscabiei* that are associated with common scab.

The International Cotton Advisory Committee 2019 Research Associate Programme

Compiled by Lawrence Malinga, Crop Protection Division, ARC-IC

Mr. Lawrence N Malinga attended the 2019 Research Associate Programme held in Washington DC, the United States of America (USA) from the 20th of September to the 04th of October 2019. The programme was hosted by the International Cotton Advisory Committee (ICAC) and participation was open to individuals from ICAC member countries, including persons from government agencies, universities and the private sector. Ten participants from nine countries, namely, Argentina, Bangladesh, India, Mozambique, Poland, South Africa, Switzerland, Turkey, and Zimbabwe, attended the programme. The ICAC Secretariat conducts the programme in the USA, alternately each year in production research and in economics/marketing of cotton. The theme for the 2019 Programme was "Risk Management in the Cotton Industry". The programme enabled the participants from different continents to share their information on the cotton industry in their respective countries. It also created a platform to engage on how to improve cotton production, and enabled opportunities for networking. The initial part of the programme was conducted at the premises of the ICAC Secretariat in Washington DC, where sessions covered the following topics:

Introduction and ICAC activities – the role and strategy of the ICAC, challenges being faced by the ICAC, as well as the mission of the ICAC to serve the cotton and textile community through promotion, knowledge sharing, innovation, partnerships and providing a forum for the discussion of cotton issues of international significance.

World cotton situation - projections of world supply and demand, as well as international cotton prices.

Cotton pricing and world textile demand - comprehensive presentation on the analysis and projections of the worldwide end-use of textile fibres, mill use, production and trade of cotton yarn and fabric, and production of chemical yarn, for more than 100 countries.

Cotton research in the 21st Century - uptake, distribution, and redistribution of nutrients in the various cotton-growing stages. The key messages for the obtaining of high yields were: i) Increase of the harvest index; ii) High density and canopy management; iii) Reduction of nutrient wastage and improvement of efficient nutrient harvesting.

Major developments in world cotton trade - trade developments in raw cotton, with an analysis of world trade by region, import/export projections by country, and matrices of trade flows.

Price risk management in cotton production and trade - training on price risks, market analysis and volatilities, as well as differences between current farm prices and future prices.

A visit to the United States Department of Agriculture headquarters was undertaken where an overview of cotton production in the USA was presented. The programme also included a visit to some cotton-producing areas in North Carolina and a session on the role of Cotton Incorporated. The session included presentations on:

- ***Gene editing -*** next generation of crop improvement that targets a specific section of DNA to make a gene non-functional.
- ***New insect and disease control systems -*** a new system for pest and disease management by Cotton Incorporated to develop glandless cotton with reduced gossypol.
- ***Cotton seed oil -*** promotion of diet rich cottonseed oil with a unique component that contributes to heart health.
- ***Crop production risk management -*** tools to help growers minimize climate risks, and the use of irrigation sensors for soil and plant water, and short season and high residue cotton production systems.

Presentation by Mr Malinga of the South African country report.

Mr. Malinga presented a country report on cotton production in South Africa and later published an article titled “Situation overview and outlook for South Africa’s cotton sector”, in Cotton: Review of the World Situation.

The following opportunities are available for cotton research in South Africa in collaboration with the ICAC:

- Research on conventional cotton yield improvement.
- Exploring opportunities on gene editing through a cotton breeding programme.
- Collaborations on cotton pest control with the institutes in the region.
- As per the discussion with the ICAC, seeking funding opportunities for collaborative cotton research.

Contact: Mr Lawrence Malinga at lawrencem@arc.agric.za

International Cotton Advisory Committee (ICAC) 2019 Research Associate Programme participants.

Participants visiting a cotton field in North Carolina, USA.

Technology Transfer July 2019 to March 2020

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Training courses:

The Agricultural Research Council – Vegetable and Ornamental Plants, Roodeplaat is offering an accredited hydroponic vegetable production training course. For more information, contact Ms Lulama Vitshima: (012) 808 8000 or LMkula@arc.agric.za