Potato tuber corky cracks caused by multiple Rhizoctonia species

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Potato (*Solanum tuberosum* L.) is the most consumed and economically important vegetable crop in the world. Nutritionally, potato is ideal for human consumption and provides a balanced source of starch, high-quality proteins, vitamins, trace elements and dietary fibre. This makes it an ideal crop to feed many communities and ensure food security.

To increase potato production, research is focused on disease control, soil health, good farm management practices, seed quality and breeding of high-yielding varieties. However, the potato crop, as with many other agricultural crops, is susceptible to devastation by various diseases. Potato diseases reduce the yield and quality of fresh produce and therefore pose a threat to food security.

Potato tuber blemishes constitute a persistent quality problem in the production of potato and contribute to major economic losses in South Africa and globally. They can cause severe yield losses, rejection of seed batches, downgrading of potatoes on the market, or rejection of potatoes for processing.

The demand for washed potatoes by South African consumers highlights the problem of blemished tubers. It is important for farmers to optimise their disease management strategies to avoid yield losses and downgrading of tubers in the fresh produce market in South Africa.

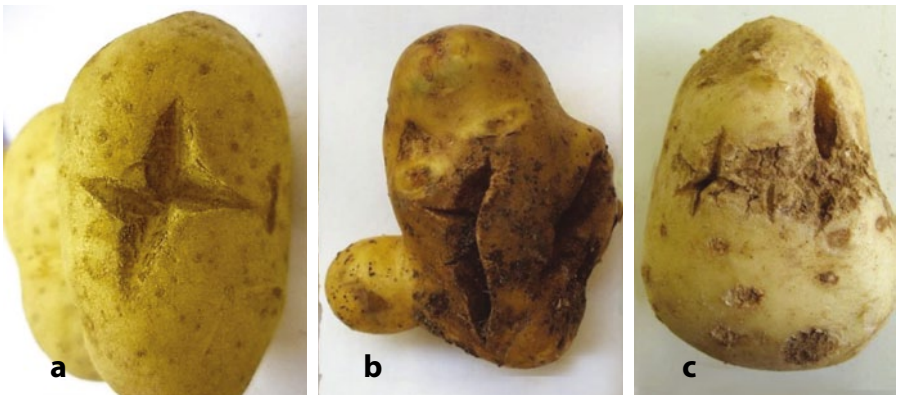
Origin of tuber blemishes

Tuber blemishes can be a result of known causes (typical blemishes), which are manageable; or unknown causes (atypical blemishes), which are difficult to manage. Fungal and bacterial pathogens causing typical tuber blemishes include *Rhizoctonia solani*, *Colletotrichum coccodes, Spongospora subterranea* f. sp. *subterranea, Helminthosporium solani*, *Fusarium* species and *Streptomyces* species. These pathogens cause various symptoms on potato tubers, including black scurf, black dot, powdery scab, silver scurf, dry rot and common scab.

Tuber blemishes can also be caused by viruses and nematodes. In contrast, atypical blemishes have unknown causes, often with contradictory reports on the causal agent, and are thus difficult to manage. Atypical blemishes include corky cracks, star-like corky lesions, corky spots or 'rhizoscab' and 'elephant hide' (*Figure 1*).

Abiotic factors such as water stress (dry conditions followed by high

Figure 1: Potato tubers showing symptoms of fungal and bacterial pathogens. (Source: Gouws and McLeod, 2012)



(a) Elephant hide and growth cracking caused by Rhizoctonia solani AG 3-PT (Muzhinji et al., 2014), (b) deformation and growth cracking caused by R. solani (Bouchek-Mechiche et al., 2016) and (c) fissure scab caused by an unknown Streptomyces species.

moisture conditions), temperature, humidity, mechanical damage, nutrient deficiency, chemical damage and light are also known to cause tuber cracks, skin discolouration, bruising or enlarged lenticels.

Prevalence of atypical blemishes

In South Africa, there has been an increase in the prevalence of atypical blemishes such as corky cracks (corky skin inside the crack) and growth cracks (smooth skin inside the crack) on potato tubers. Some studies have suggested that the causal agents of corky cracks in South Africa are *Rhizoctonia* and/or *Streptomyces* species.

However, studies specifically focusing on the occurrence and causal agents thereof, point to *R. solani* species as the predominant pathogen isolated from corky cracks on potato tubers in South Africa and elsewhere.

In order to determine the pathogenic micro-organisms associated with corky crack blemishes on potato tubers in South Africa, morphological and molecular identification methods, and subsequent pathogenicity tests, were conducted with fungi and bacteria isolated from these blemishes. Furthermore, the presence of Potato virus Y (or PVY) in these tubers was assessed.

Potato tubers showing corky crack blemishes (*Figure 2*) were collected from potato growing regions with different agro-ecological climates in South Africa. Greenhouse pathogenicity trials using disease-free mini tubers (cv. Mondial)

Figure 2: Potato tubers sampled in different regions in South Africa showing symptoms of corky cracks. (Source: S Gush)

were conducted to confirm the causal agent/s of corky cracks. In these pot trials inoculations were done using individual micro-organisms, as well as all possible combinations of the isolated micro-organisms.

Species isolated

Binucleate *Rhizoctonia* (BNR) AG-A and BNR AG-R as well as *Fusarium oxysporum* were the most predominant fungal species isolated from the corky crack symptoms, while no fungal species were isolated from growth cracks. *Streptomyces collinus*, *S. yaanensis*, *S. corchorussi*, *S. viridochromogenes* and *S. griseorubens* were the most predominant bacterial species isolated from growth cracks and no *Streptomyces* species were isolated from corky cracks.

The *Streptomyces* species identified are not known to be pathogenic to potatoes and were, therefore, not considered to be the causal agents of the growth cracks from which they were isolated. It can furthermore be provisionally confirmed that PVY is not associated with the corky crack disease in South Africa, as PVY was not identified from corky crack blemish tissue using molecular techniques.

Corky crack symptoms were not observed in single inoculations for fungal or bacterial isolates. However, corky crack symptoms (*Figure 3*) were observed on the progeny tubers of plants inoculated with a combination of *Rhizoctonia* species. This suggests that the three *Rhizoctonia* species tested in this study are together responsible for the corky crack symptoms.

Environmental factors

Soil moisture was included in this study as an environmental factor causing corky crack blemishes on potato tubers. Two different treatments were used – normal watering conditions and water stress conditions.

To induce water stress, plants were watered only once the first sign of wilting was observed. Plants that were only subjected to water stress did not show any corky crack symptoms. However, more severe corky crack symptoms were observed for progeny tubers under normal watering conditions in *Rhizoctonia* treatments compared to potatoes grown under water stress conditions (*Figures 4* and *5*).

Figure 3: Progeny tubers from the greenhouse experiment showing corky crack blemishes caused by a combination of *Rhizoctonia* species. (Source: S Gush)

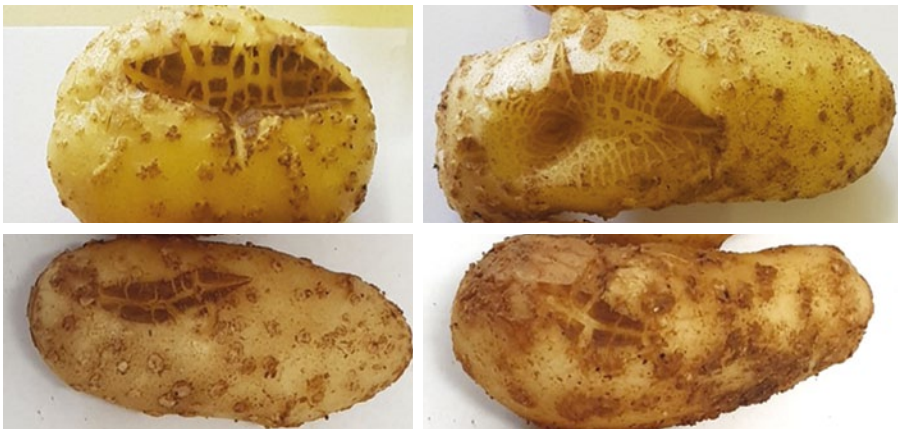


Figure 4: Corky crack disease index mean values from the first greenhouse trial.

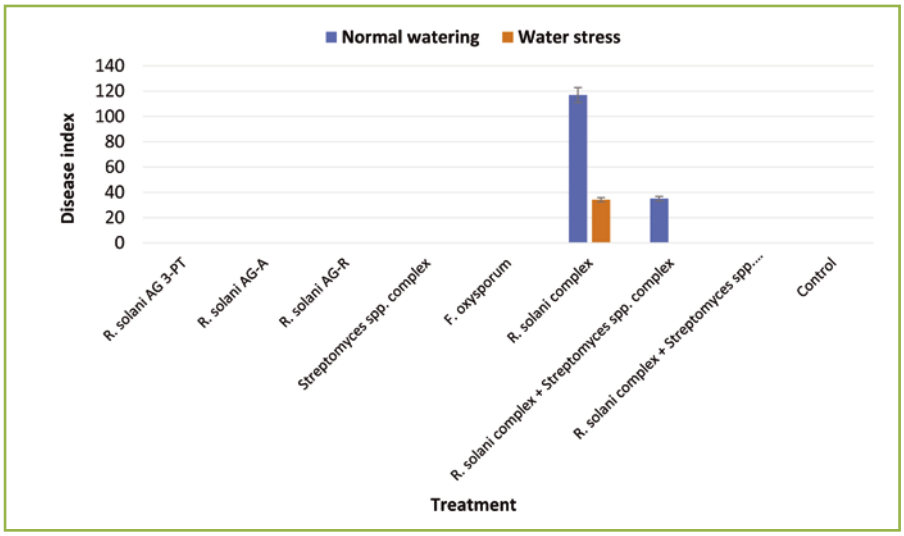
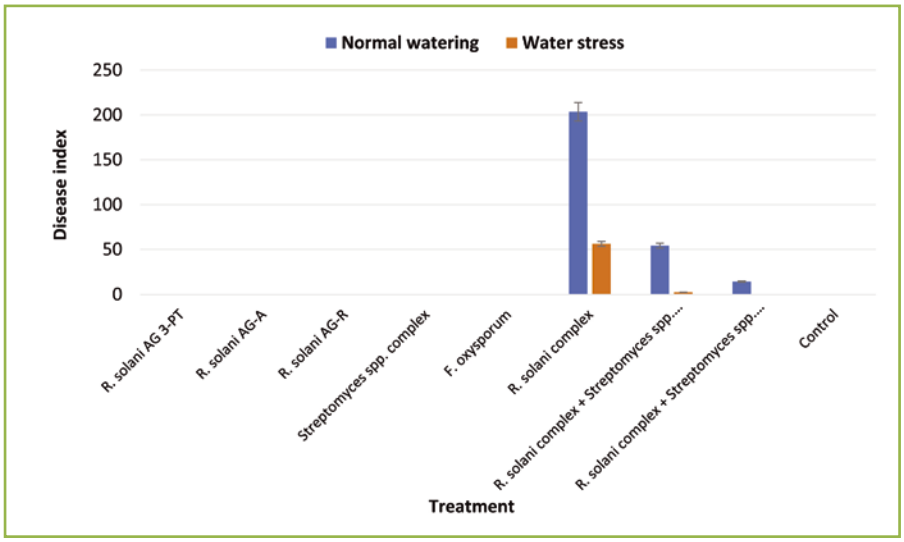


Figure 5: Corky crack disease index mean values from the greenhouse trial repeat.



Growth cracks (smooth cracks), on the contrary, are associated with water stress.

Plant diseases occur as a result of interactions between a pathogen, susceptible host plant and optimal environment. These diseases are often thought to be caused by one pathogen. In nature, microbes form complex communities that have been reported to cause diseases on plants. Only a few reports of interactions between different pathogens to cause a single disease are known.

The results of this study indicate that corky cracks occur due to the co-infection of potatoes by a *Rhizoctonia* species complex which includes *R. solani* AG 3-PT, BNR AG-A and BNR AG-R. This is a synergistic interaction between different *Rhizoctonia* species to cause a single disease. When the *Streptomyces* species complex was combined with the *Rhizoctonia* species complex in co-inoculations, disease severity was significantly lowered compared to the *Rhizoctonia* species complex alone, suggesting a possible antagonistic effect between the two pathogen groups, competing for the same host and nutrients.

The findings of this study are crucial in the development of effective integrated strategies for the management of corky crack disease and to improve the tuber quality in the South African market and globally.

For references, acknowledgements and more information, contact the author at email sashalee.gush@gmail.com.