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With drought comes charcoal rot

Charcoal rot was first reported in South Africa when found on sunflower in 1969, but had already been detected on maize and sorghum by that time. The first incidence of this disease on soya beans was reported in 1982. Maize and sorghum are frequently planted in rotation with sunflower and soya beans.

Lately, reports of charcoal rot have been increasing in South Africa, especially in warmer parts of South Africa, such as Mpumalanga, the Free State and North West.

This begs the question, why, and the answer is twofold:

- Soya bean and sunflower production has expanded into warmer regions of the country.
- Rainfall is erratic and water is becoming a scarce resource in South Africa, limiting irrigation.

This poorly recognised disease may become more significant in future with the changing climatic conditions that often lead to extreme weather events such as droughts, such as the one currently affecting us. As with most diseases, it is best to follow an integrated disease management programme rather than focussing on a single solution.

Widespread disease

Charcoal rot is caused by the fungus *Macrophomina phaseolina* and is a widespread disease affecting various agricultural crops in South Africa – not only sunflower, soya bean, maize and sorghum, but also canola, cotton, tobacco, strawberries and certain vegetables to name but a few. This pathogen has a host range of more than 500 plant species.

Common symptoms of charcoal rot, which is also known as summer wilt or dry weather wilt, include damping off, stunting, chlorosis, wilting and premature senescence where the dry leaves remain on the stems. Black microsclerotia are often found on the outside of the base of the stem, but are always present inside the stems and roots of infected hosts. The oil content and colour of sunflower seed may be altered, while seed composition and nitrogen fixation are influenced in soya beans.

> Charcoal rot can cause losses of up to 90% in sunflower and 50% in soya bean when favourable conditions persist.

Information on charcoal rot in South Africa is limited, and this impedes the development of key disease management strategies. A research project on the integrated management of charcoal rot on soya bean and sunflower in the country is underway at the University of Pretoria (UP). It aims to investigate some of the characteristics of the disease in soya beans and sunflower.

Diseased soya bean, sunflower, maize and sorghum plants have been sampled from most of these production areas in South Africa. A countrywide survey will be conducted to determine soya bean and sunflower growers' perceptions of the disease, its occurrence and the control practices, if any, that are in place in order to provide a picture of how charcoal rot is affecting production in the country.

Black microsclerotia visible on the outside of a soya bean stem and typical black streaks on the inside. (Photograph: E Jordaan)

Chlorosis and premature senescence of soya bean plants due to charcoal rot. (Photograph: www.plantmanagementnetwork.org)

Black microsclerotia visible on the inside of a sunflower stem. (Photograph: www.plantmanagementnetwork.org)

Maximum temperatures

Temperatures of 25 to 30°C and extended periods of dry weather are optimal for disease development. Most growing regions in South Africa reach these average maximum temperatures in summer. It is expected that average temperatures will increase by 2°C in future due to climate change, and that rainfall events will be fewer and more erratic. With the use of climate prediction models, attempts will be made to predict the impact of these changing climatic conditions on disease development in future.

Although charcoal rot is a soil-borne disease, some evidence points to seed transmission.

The incidence of charcoal rot is almost always coupled with stressors on the host. Drought, nutrient stress, poor weed control and even reproductive stress on the plant due to flowering can result in disease, the symptoms of which are usually observed at post flowering. However, *M phaseolina* infects at an early stage of the plant life cycle, and if conditions are favourable it can result in seedlings damping off.

Although charcoal rot is a soil-borne disease, some evidence points to seed transmission. Due to the production of microsclerotia, this pathogen can overwinter in the soil for years, especially where diseased plant residues are left in the field or incorporated into the soil during field preparation. Sclerotial germination is decreased by low soil C-N ratio and increased soil moisture, as well as increased crop canopy temperatures.

Yield reduction

In the proposed research at UP, the effect of drought on charcoal rot will be investigated and this will also give an indication of the yield reduction caused by the disease. Nitrogen fertilisation will also be evaluated to determine the effect of the nitrogen source used and the quantity of the chemical element added to the soil on disease development. Long- and short-term growers for sunflower and soya bean will be included in the nitrogen trials.

There is currently no reliable control method for charcoal rot. Crop rotation is limited because of the wide host range of *M phaseolina*. Fungicide treatment of the seeds has also proven to be ineffective. Irrigation can be effective to a certain extent. However, water is a scarce and costly resource.

Control programmes include cultivation strategies such as planting dates (avoiding excessively high temperatures or drought during flowering stage), crop rotation (which can sometimes decrease inoculum depending on the crops in the rotation programme) and increasing planting density.

Charcoal rot can cause losses of up to 90% in sunflower and 50% in soya bean when favourable conditions persist. This disease is also not limited to these two crops. Subsequently, most rotation crops are also affected by charcoal rot.

It is important to develop an integrated disease management programme that is sustainable and economically feasible. Knowledge of the pathogen population, environmental conditions and cultural practices can contribute to building an effective disease management programme for charcoal rot.