

Currently, there are no registered fungicides for the prevention or mitigation of Sclerotinia head and stem rot of sunflower, neither is there complete resistance in sunflowers, although some genotypes indicate partial resistance (realagriculture.com | Photograph by Samuel Markell, NDSU)

Evaluating sunflower for yield, quality characteristics, and Sclerotinia tolerance

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Sclerotinia sclerotiorum (*S. sclerotiorum*) is a fungal plant pathogen that has the ability to infect sunflower as well as more than 500 other host plants, including weeds. *S. sclerotiorum* on sunflowers is referred to as head rot or stem rot as these are the respective plant organs affected by the pathogen. Sunflower head and stem rot is often linked to major losses, causing total or partial yield loss, as well as potentially affecting quality characteristics.

The severity of *Sclerotinia* diseases is highly dependent on the environmental factors present at the time of inoculum availability and the susceptibility of a host crop. Currently in South Africa, there are no registered fungicides for the prevention or mitigation of *Sclerotinia* head and stem rot of sunflower. In addition, no complete resistance exists in sunflowers; however, there are genotypes that indicate partial resistance (Kim & Diers, 2000; McCaghey *et al*., 2019).

A number of studies report strong interactions between host genotype and environment. The University of the Free State's (UFS) plant pathology division continues to screen for tolerance to *Sclerotinia* under various field conditions. Additionally, the Agricultural Research Council – Grain Crops conducts field trials monitoring yield and quality characteristics across production regions.

Managing *Sclerotinia* diseases through host tolerance or potential resistance may contribute to yield stability and increases, as this is the only available conventional option to our producers. Tolerance to plant diseases is the plant's response to infection through having the ability to endure disease without serious yield loss or death (Agrios, 2015). However, resistance is the plant's ability to completely or partially overcome the damaging effects caused by a pathogen (Politowski & Browning, 1978).

Sunflower field trial evaluations

Sunflower cultivars from the sunflower national cultivar trials were evaluated in field trials in both Delmas (Mpumalanga) and Clocolan (Free State) during 2019/20. Plantings were conducted sequentially from November to January, creating a range of weather conditions during the season of evaluation. Sunflowers in Delmas were inoculated with *S. sclerotiorum* in the form of milled grain mycelium at flowering (Bester, 2018).

In contrast, sunflowers in Clocolan were not artificially inoculated, but natural infection was relied upon in a field with a history of severe head rot.

Figure 1: Mean *Sclerotinia* prevalence (%) in sunflower cultivars during three different planting dates in Delmas from the 2019/20 season.

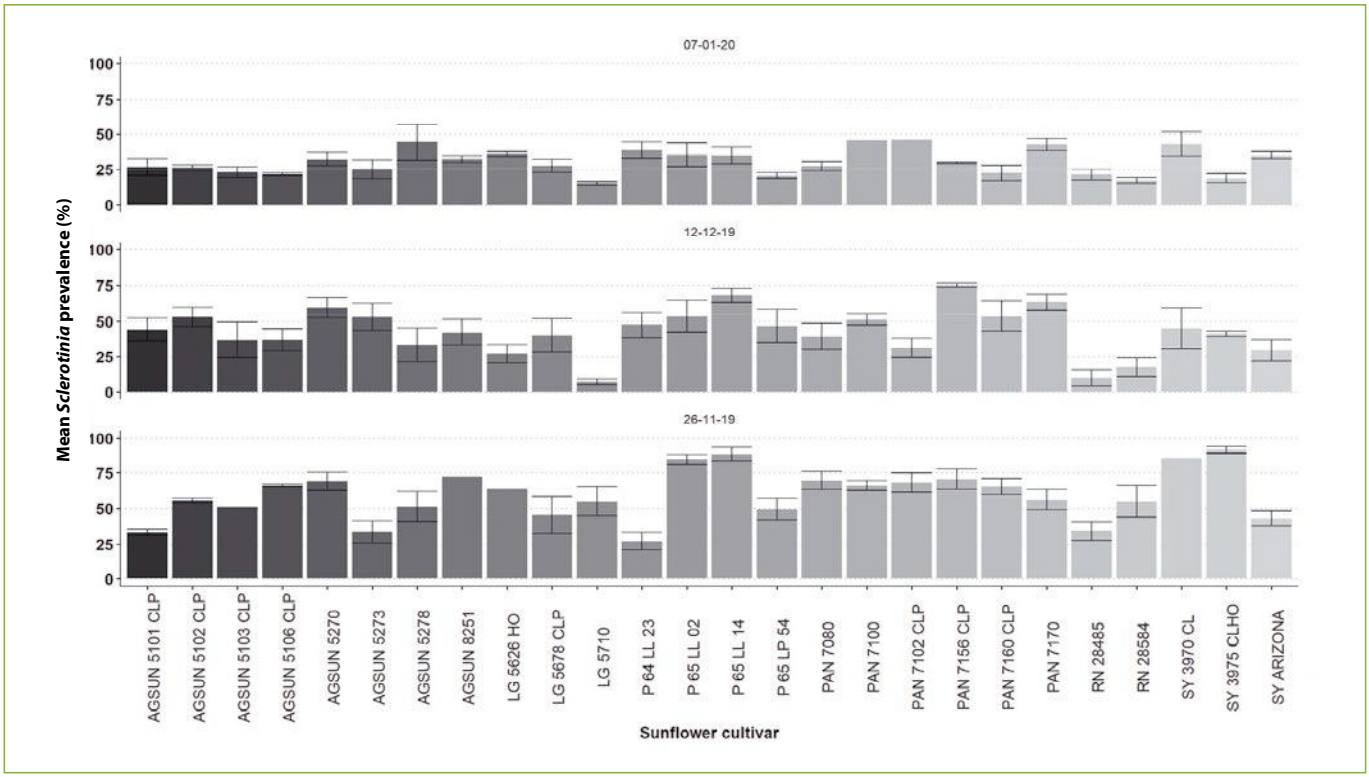
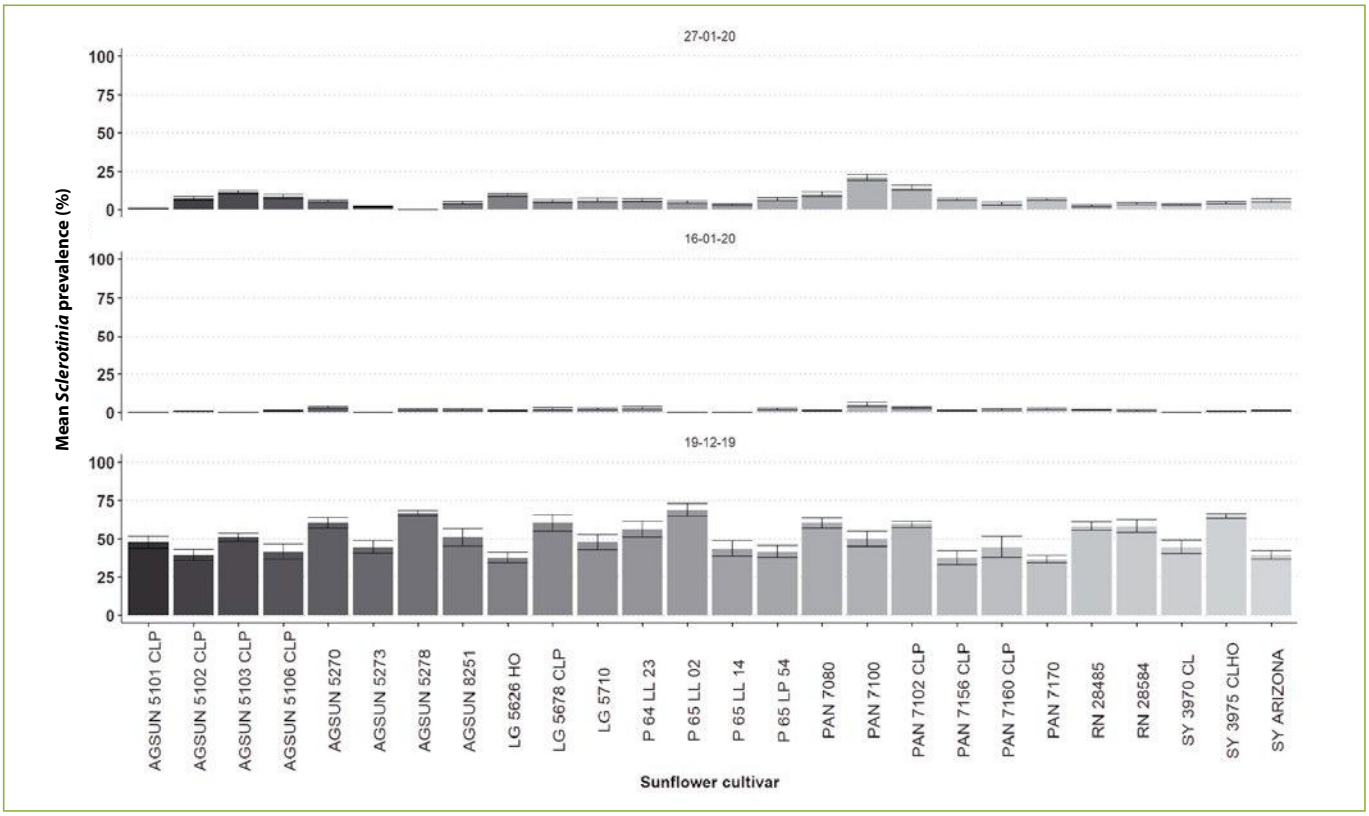


Figure 2: Mean *Sclerotinia* prevalence (%) in sunflower cultivars during three planting dates in Clocolan from the 2019/20 season.



This inoculation technique does not require injuring plants before application, therefore ensuring that no induced resistance mechanisms are triggered through wounding (Bester, 2018).

The presence or absence of *Sclerotinia* on the heads was measured at R7 and the disease prevalence was calculated. Data analyses were conducted using R (v4.0.3; R Core Team, 2020) and RStudio (v1.3.1093; RStudio Team, 2020). The bar graphs illustrate the mean *Sclerotinia* prevalence (%) observed in the different sunflower cultivars at each planting date from the 2019/20 season in Delmas (*Figure 1*) and Clocolan (*Figure 2*).

During the 2019/20 season in Delmas, the least *Sclerotinia* (~30%) was observed in the latest planting date of 7 January 2020, while those of the earlier planting dates of 26 November and 12 December 2019 were ~59 and ~42%, respectively. In Clocolan, the second and third planting dates of 16 and 27 January 2020 yielded the least *Sclerotinia*, ~3 and ~6%, contrasting with the first planting date of 19 December 2019 which yielded the highest level of *Sclerotinia* prevalence, ~50%.

There were no sunflower cultivars planted in Delmas, resulting in the absence of *Sclerotinia* infection. The sunflower cultivars showing the most tolerance to *Sclerotinia* (~10%) were LG 5710 and RN 28485, planted on 12 December 2019. In Clocolan, there were several cultivars planted on 16 January 2020 which had no *Sclerotinia* infection – AGSUN 5101 CLP, AGSUN 5103 CLP, AGSUN 5273, P 65 LL 14, P 65 LL 02, and SY 3970 CL. Only one cultivar from the 27 January 2020 planting date had no *Sclerotinia* infection – AGSUN 5278.

Varied response among cultivars

Some of the sunflower cultivars varied in their response to *S. sclerotiorum* across the different planting dates. This indicates the impact of weather conditions during each planting date and the seasonal variation on disease development.

The *Sclerotinia* disease tolerance results (in addition to the 2018/19 and 2020/21 seasons) are being incorporated into a PhD study at the University of the Free State (UFS), where the response

Figure 3: Seed yield (t/ha^{-1}) of 26 different sunflower hybrids evaluated during the 2019/20 growing season.

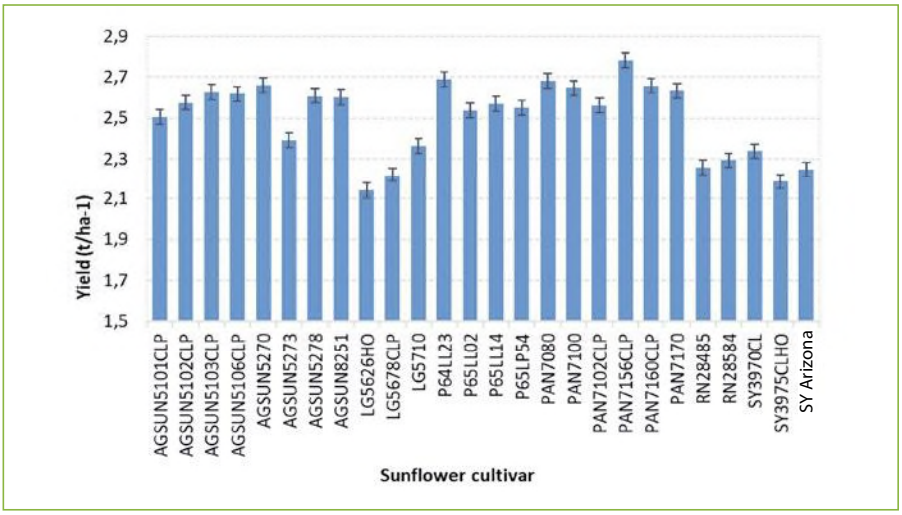


Figure 4: Oil content (% dry matter) of 26 different sunflower hybrids evaluated during the 2019/20 growing season.

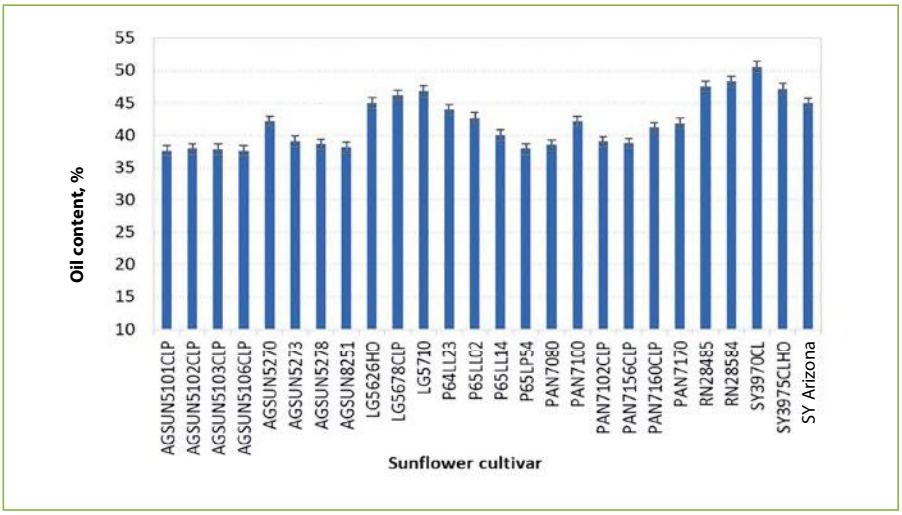
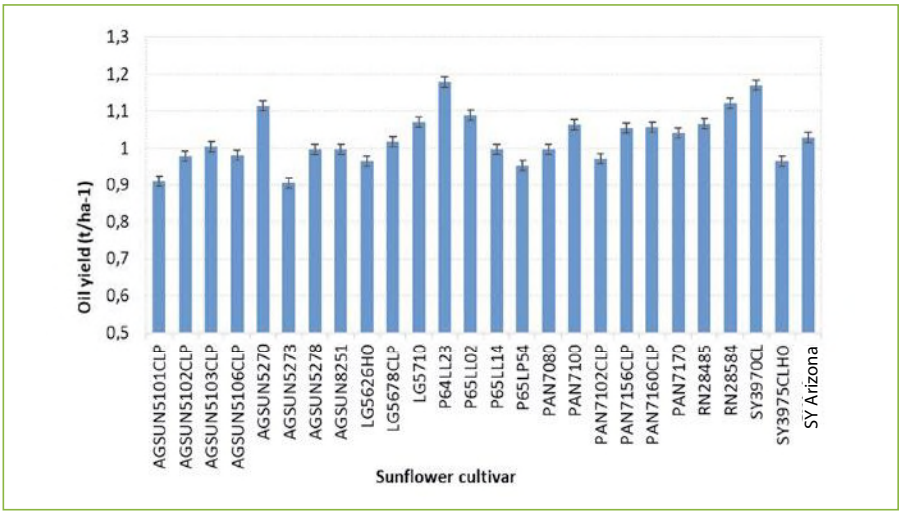


Figure 5: Oil yield (t/ha^{-1}) of 26 different sunflower hybrids evaluated during the 2019/20 growing season.



type of each cultivar at changing disease potentials will be determined. Disease potential is defined as the mean disease incidence in a planting across all cultivars at a specific locality.

Three cultivar response types can be observed:

- Tolerance to increasing disease potential.
- Intolerance to increasing disease potential.
- A linear relationship with increasing disease potential – in other words, an unstable response.

This regression methodology can be an effective and accurate tool to quantify the response of cultivars to different disease potentials and subsequently promote the selection process of cultivars for environments which may have a higher risk for *Sclerotinia* disease development. Further seasons will be added to the aforementioned studies to quantify the response of cultivars across multiple localities.

> Managing *Sclerotinia* diseases through host tolerance or potential resistance may contribute to yield stability and increases, as this is the only available conventional option to our producers.

Sclerotinia can be a yield-limiting disease and usually high disease severities are associated with lower sunflower yield. Being informed of the ability of a sunflower cultivar to tolerate *Sclerotinia*, as well as the cultivar's yield potential at different localities, are important factors to consider when choosing a sunflower cultivar. To investigate the yield and quality performance of commercially available sunflower hybrids from different seed companies, 26 sunflower hybrids were evaluated at 21 sites during the 2019/20 growing season in the North West and Free State provinces.



A randomised complete block design with three replicates was executed for each site. Seed yield was individually recorded for each site and seed samples sent to the Southern African Grain Laboratory (SAGL) for oil content analyses. Seed oil yield was calculated by multiplying oil content (% dry matter) with seed yield (t/ha^{-1}). The five best performing cultivars, in terms of average yield calculated over localities, were PAN 7156 CLP, P 64 L L23, PAN 7080, AGSUN 5270, and PAN 7160 CLP.

The overall mean yield for 2019/20 was 2,50t/ha^{-1}. Two high oleic cultivars (LG 5625 HO and SY 3975 CLOH) were entered for evaluation in 2019/20. Eleven Clearfield and Clearfield Plus cultivars were entered and one of these, PAN 7156 CLP, had the highest yield of 2,78t/ha^{-1}. It also performed the best in terms of seed yield. Eight of these cultivars – PAN 7156 CLP, PAN 7160 CLP, AGSUN 5103 CLP, AGSUN 5106 CLP, AGSUN 5102 CLP, PAN 7102 CLP, P 65 LP 54, and AGSUN 5101 CLP – had yields higher than the overall mean yield of all cultivars (*Figure 3*).

Hybrids with higher oil content

Across sunflower hybrids, the moisture-free oil content varied from 37,62% (AGSUN 5105 CLP) to 50,61% (SY 3970 CL), with an overall mean of 42,01%. The following hybrids produced higher oil content than average: SY 3970 CL, RN 28584, RN 28485, SY 3975 CLHO, LG 5710, LG 5678 CLP, SY Arizona, P 64 LL 23, P 65 LL 02, PAN 7100, P 65 LL 02, and AGSUN 5270 (*Figure 4*).

The oil yield per unit is the product of grain yield and seed oil content (t/ha^{-1}), and was calculated by multiplying oil percentage with seed yield. Significant differences were recorded among the sunflower hybrids (*Figure 5*). The oil yield for the 26 sunflower hybrids at the eleven localities during 2019/20 varied from 0,91 to 1,18t/ha^{-1} with an overall mean of 1,03t/ha^{-1}. P 64 LL 23 had the highest oil yield of 1,18t/ha^{-1}, followed by SY 3970 CL with 1,17t/ha^{-1}.

When a high-yielding sunflower cultivar is selected for the following season, it is important for producers to keep in mind that these cultivars still have the potential of being infected by *S. sclerotiorum*. However, being informed of the *Sclerotinia* disease and yield potentials of each cultivar allows producers to select cultivars which may perform best under their production conditions.

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