Sclerotinia impacts on chickpea yield and the role of Predicta®B to differentiate between species and inoculum load of sclerotinia

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Take home message
- There are three species of *Sclerotinia* present in chickpea crops in the northern cropping region. Sclerotinia populations may increase under susceptible crops including canola and chickpeas
- Of the three species, in two years of chickpea yield loss experiments *Sclerotinia minor* consistently caused higher grain yield loss (34–54%) than *Sclerotinia sclerotiorum* (10–26%) or *Sclerotinia trifoliorum* (7–15%)
- A new Predicta® B soil test can be used to identify which Sclerotinia species are present in paddocks. Predicta B results may allow paddocks to be monitored over time to gauge *Sclerotinia* inoculum concentration responses to changes in crop rotations.

Background
Infection of the stem base by *Sclerotinia* causes stem rot of chickpea, whilst a second infection route occurs from aerially dispersed ascospores infecting chickpea foliage. Analysis of over 100 Sclerotinia disease records for northern NSW chickpea crops showed that 48% were *Sclerotinia minor*, 32% were *Sclerotinia sclerotiorum* and 24% were *Sclerotinia trifoliorum* (Bithell *et al.*, 2023). It was unknown what scale of yield loss Sclerotinia disease of chickpea can cause and which *Sclerotinia* species has the most effect on chickpea production.

In addition, the monitoring of soil pathogen populations with the Predicta® B based method did not previously individually identify the three *Sclerotinia* species and distinguishing between *Sclerotinia sclerotiorum* and *Sclerotinia trifoliorum* is time consuming and requires specialist mycological techniques. Therefore, we sought to develop species specific molecular detection and quantification methods to provide Predicta B based monitoring of *Sclerotinia* species and inoculum concentrations in paddocks.

Methods
Four yield loss experiments were carried out on chickpea, PBA Seamer⦶, at the Trangie Agricultural Research Centre. Each experiment was a randomised complete block design, using five-row 15 m^2 plots, with 4 replicates. Treatments were: three *Sclerotinia* species, *Sclerotinia minor*, *S. sclerotiorum* and *S. trifoliorum* applied as sterilised barley and millet grain infected

with the *Sclerotinia* species and included in the chickpea seed packets at sowing; and five inoculum concentrations (0, 0.8, 1.7, 3.4, 6.7 g inoculum/m^2). The two 2022 experiments were not irrigated and there was 398 mm of in-crop rain. The 2023 experiments received 106 mm of in-crop rain. One 2023 experiment was managed with supplementary irrigation using a lateral irrigator and had 18.0, 17.5 and 20.0 mm applied at 55, 76 and 105 days after sowing (DAS), respectively. The second 2023 experiment received salvage irrigation to ensure ongoing survival of the experiment, with applications of 9.0 and 12.5 mm at 76 and 105 DAS, respectively.

Results

Emergence

Emergence counts were made in fixed quadrat areas of each plot. In the wet conditions of the 2022 season emergence of control plots at 21 plants/m^2 was lower than the 35 plants/m^2 target. Combined results for the two 2022 experiments are presented in this report as these experiments did not differ in irrigation management. In 2022 increasing *Sclerotinia* inoculum concentration significantly reduced emergence by 7 to 16 plants/m^2, $P<0.001$, LSD 2.4 plants/m^2, Table 1) although there was no significant effect of *Sclerotinia* species ($P>0.05$, LSD 1.9 plants/m^2).

Table 1. Percentage reduction of a) emergence and b) seedling PBA Seamer population of *Sclerotinia minor*, *S. sclerotiorum,* or *S. trifoliorum* inoculated plots relative to nil inoculum control plots across three experiments: 2022 combined, 2023 supplementary irrigation (SUI) and salvage irrigation (SAI).

a) Emergence reduction (%)				
Species/Exp.	2022 combined	2023 SUI	2023 SAI	Average
S. minor	46	61	60	55.7
S. sclerotiorum	46	30	33	36.3
S. trifoliorum	40	23	25	29.3
Average	44	38	39.3	40.4
b) Seedling population reduction (%)				
Species/Exp.	2022 combined	2023 SUI	2023 SAI	Average
S. minor	10	7	6	7.7
S. sclerotiorum	6	4	0	3.3
S. trifoliorum	3	0	1	1.3
Average	6.3	3.7	2.3	4.1

In the dry conditions of 2023, the population density of seedlings in control plots met the 35 plants/m^2 target. In both 2023 experiments for species effects across all inoculum concentrations, *S. minor* (19 plants/m^2) had significantly ($P<0.001$, LSD 2.33 plants/m^2) less emerged seedlings than both *S. sclerotiorum* and *S. trifoliorum* (26 and 28 plants/m^2, respectively). There was also a significant species by inoculum concentration interaction ($P<0.01$), whereby for all four *Sclerotinia* inoculum concentrations (0.8 to 6.7 g/m^2) there was a significant reduction in emergence for *S. minor* inoculated plots relative to *S. sclerotiorum* and *S. trifoliorum* emergence at the same inoculum concentrations. For the supplementary irrigation experiment at the highest inoculum concentration *S. sclerotiorum* had less plants that *S. trifoliorum*.

The effects of *Sclerotinia* on the establishment of chickpea are summarised by comparing the average counts of all Sclerotinia-inoculated treatments relative to the nil inoculum control plots for each species to determine the percentage of emergence reduction from Sclerotinia disease (Table 1a). The overall average percentage of emergence reduction across all experiments from *S. minor* was highest (56%), although substantial reductions also occurred for *S. sclerotiorum* (36%) and *S. trifoliorum* (29%).

Plant population and disease symptoms

Repeat counts of seedlings at approximately one month after the emergence counts (9 August in 2022, 17 July in 2023) were made in the same fixed quadrat areas of each plot each year. Symptomatic or dead seedlings were observed in marked quadrat areas at these times for each of the three *Sclerotinia* species; only plants with stem base infection were observed. Seedlings with stem base symptoms were collected and analysed. Samples of mycelium from the stem base of dying plants provided cultures with typical Sclerotinia characteristics. DNA analysis using SARDI's Predicta B test of stem base tissue from dead seedlings confirmed infection by each of the three *Sclerotinia* species.

The effect of Sclerotinia disease on seedling death of chickpea were also summarised on a percentage of seedling loss basis (Table 1b). The overall average percentage of emergence reduction across all experiments from *S. minor* was highest at 8% whereas the overall values for the other two *Sclerotinia* species were less than 5% on average.

Effects on yield

In 2022 there was a significant (*P*=0.006, LSD 412.2 kg/ha) interaction between the *Sclerotinia* species and inoculum concentration where *S. minor* at the second (2011 kg/ha) and third (1366 kg/ha) inoculum concentration treatments had a significantly lower grain yield than *S. trifoliorum* (2424 and 228 kg/ha) only, but at the fourth and highest inoculum concentration treatment *S. minor* (780 kg/ha) had a significantly lower grain yield than both *S. trifoliorum* (1704 kg/ha) and *S. sclerotiorum* (1352 kg/ha).

In 2023 for the supplementary irrigation experiment *S. minor* had significantly (P<0.001) lower grain yields (range 173 to 1126 kg/ha) than *S. sclerotiorum* and *S. trifoliorum* at all inoculum concentrations, whereas *S. sclerotiorum* (919 kg/ha) had a lower grain yield than *S. trifoliorum* (1064 kg/ha) only at the highest inoculum concentration. For the salvage irrigation experiment *S. minor* also had significantly (P = 0.005) lower grain yields (range 389 to 1073 kg/ha) than *S. sclerotiorum* (range 1080 to 1392 kg/ha) and *S. trifoliorum* (range 1025 to 1433 kg/ha) at all inoculum concentrations, but the grain yields of *S. sclerotiorum* and *S. trifoliorum* did not differ at any common level of inoculum concentration.

The effects of *Sclerotinia* on chickpea grain yield is summarised on a *percentage of grain yield lost to Sclerotinia disease* basis (Table 2). The percentage yield loss to *S. minor* was highest across all three experiments. In two of three experiments *S. sclerotiorum* had a higher percentage loss (18–26%) than *S. trifoliorum* (7–12%), but in one 2023 experiment *S. trifoliorum* had a 5% greater yield loss than *S. sclerotiorum*. Overall the results from two seasons of experiments indicate that *S. minor* can cause proportionally large (>30%) yield loss in both wet and dry seasons, but the largest losses are likely to occur in dry seasons.

Table 2. Percentage grain yield loss of PBA Seamer⦶ in *Sclerotinia minor*, *S. sclerotiorum,* and *S. trifoliorum* inoculated plots across three experiments: 2022 combined, 2023 supplementary irrigation (SUI) and salvage irrigation (SAI). Untreated controls in 2022 yielded 2498 k/ha, untreated controls in 2023 the SUI in yielded 1493 kg/ha and in the SAI yielded 1439 kg/ha.

Species/Exp.	2022 combined	2023 SUI	2023 SAI	Average
S. minor	34	54	48	45.3
S. sclerotiorum	26	18	10	18.0
S. trifoliorum	7	12	15	11.3
Average	22.3	28.0	24.3	24.9

Sclerotinia inoculum measurement

The new Sclerotinia Predicta B species tests successfully detected inoculum of the three Sclerotinia species. Table 3 presents results for one of the 2023 experiments which showed that, at planting, the inoculum concentrations of the three *Sclerotinia* species treatments did not differ significantly. However, following harvest of the 2023 chickpea experiment *S. minor* and had significantly higher values than *S. sclerotiorum* and *S. trifoliorum*.

In addition, the Sclerotinia Predicta B species tests were able to detect inoculum in the roots of chickpeas and other pulse crops from paddocks where isolates of these pathogens had been collected. This new capability may allow paddocks to be monitored over time to gauge Sclerotinia inoculum concentration responses to changes in crop rotations.

Table 3. *Sclerotinia minor, S. sclerotiorum,* or *S. trifoliorum* soil DNA extraction results (kilo copies DNA/g soil) post planting or postharvest in the Trangie 2023 supplementary irrigation experiment of PBA Seamer ⦶, residual df = 42, *P* value and least significant difference (LSD) values presented.

Species	*S. minor*	*S. sclerotiorum*	*S. trifoliorum*	*P*	LSD
Post planting kDNA copies	1094	648	978	0.32	609.9
Postharvest kDNA copies	2712	1181	177	<0.001	1111.7

References

Bithell SL, Devkota R, Moore K and Lindbeck K (2023) Sclerotinia of chickpea in northern New South Wales. Australian Pulse Conference. 21-23 March 2023, Toowoomba, Qld.

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