

DEPARTMENT OF
PLANT SCIENCES

FACULTY OF NATURAL AND AGRICULTURAL SCIENCES



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OVERVIEW OF 2022

The Department of Plant Sciences is a dynamic department contributing towards research, teaching and learning, community service and entrepreneurial development. The Department has three divisions – Botany (on both Bloemfontein and Qwaqwa campuses), Plant Breeding and Plant Pathology. The unity of the Department is evident from the interdisciplinary research between the

different divisions. Academic staff in the Department showed their commitment and passion for teaching and learning by attending various teaching- and learning-related courses and workshops, including the curriculum renewal programme workshop. Various successful excursions were organised for undergraduate students, providing them with the necessary practical skills and experience needed to excel in their studies, but also in future jobs. Staff published a total of 63 scientific papers in accredited journals, contributed towards four books/book chapters and delivered 70 lectures at national and international symposia, research days and student symposia. Many of these publications were co-authored with national and international collaborators. The Department hosted five Postdoctoral Fellows and nine interns during the year. A total of 111 postgraduate students were registered in the Department, of which 19 were international students. During 2022, 18 Honours, 11 Master's and 9 Doctoral students obtained their degrees.

ACHIEVEMENTS

Staff Achievements

Prof Maryke Labuschagne was selected for the 7th Edition of Science by Women for Africa programme: Visiting Senior Research Fellowships in Spanish Centres of Excellence, for which she spent six months at the Institute for Sustainable Agriculture in Córdoba, Spain.

Prof Wijnand Swart, in his capacity as President of the Southern African Society for Plant Pathology (SASPP), chaired the Biennial General Meeting of the SASPP held at Future Africa on the University of Pretoria campus during August 2022. He delivered the Presidential Address at the Gala function at which he was also elected as a Fellow of the Society in recognition of outstanding accomplishments in Plant Pathology as well as support for and service to the SASPP society and to Plant Pathology in southern Africa.

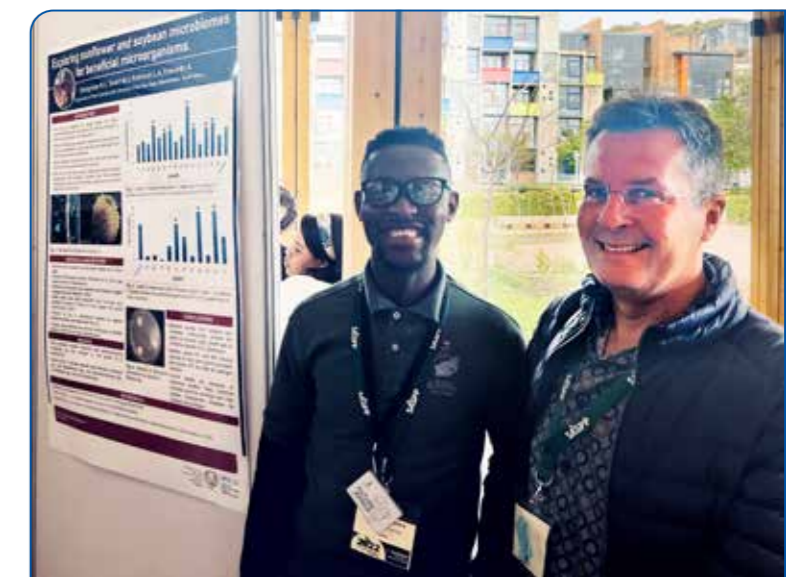
Prof Louis Scott was a guest editor for a collection of 24 articles in *Palaeoecology of Africa* volume 35 (International Yearbook of Landscape Evolution and Palaeoenvironments, CRC Press).

Dr Angeline van Biljon was again elected to serve on the Southern African Plant Breeders' Association (SAPBA) executive committee during the 14th Southern African Plant Breeding biennial conference, that was held at the Protea Hotel by Marriott in Stellenbosch, from 6 to 9 March 2022.

Student Achievements

Mr Henry John Basson was awarded a Plant Breeding internship (field testing) for six months from Bayer, Germany. He participated in the Bayer Winter oilseed rape breeding programme, which included all major processes (trial planning, preparation and maintenance, phenotypic scoring, data collection and analysis). Henry's innovative nature and diligence led to him being recommended for a Plant Breeder's position in Hungary.

Mr Neo Hlongwane was presented with the runner-up Student Poster Award at the SASPP conference, hosted in August by the University of Pretoria.

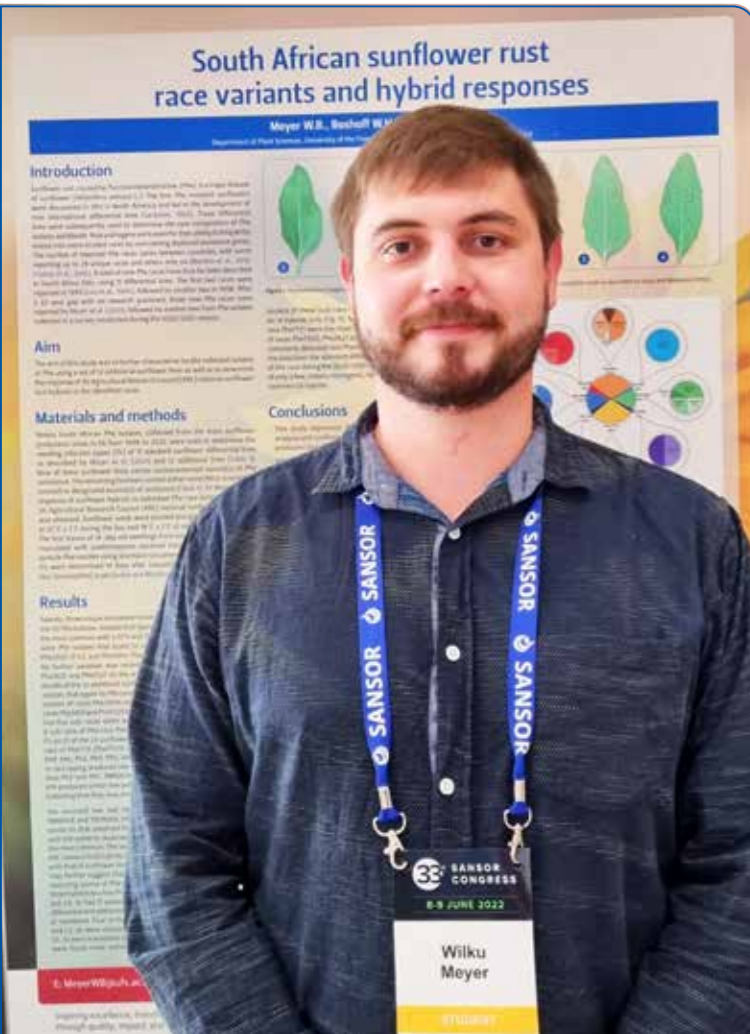


Mr Neo Hlongwane proudly presenting his runner-up SASPP conference poster presentation to Professor Pedro Crous

Ms Jo Cobbold, supervised by Dr Lize Joubert and Dr Lisa Rothmann, won the prize for the best Honours presentation at the 47th Annual Conference of the South African Association of Botanists (SAAB) with her talk titled 'To Bee or Not to Bee'.

Mr Wilku Meyer was invited as one of eight student

finalists to attend the 33rd South African National Seed Organization (SANSOR) Congress held at the President Hotel in Cape Town from 7 to 9 June. Presenting on sunflower rust and hybrid responses, Wilku was announced the winner of the PhD Student Poster Competition judged “to have conveyed the results, and practical outcomes of his research, the best”.



Mr Wilku Meyer at his winning PhD student poster during the SANSOR Congress

Six postgraduate students from the Department of Plant Sciences attended the annual Postgraduate Symposium, hosted by the Department of Botany and Plant Biotechnology of the University of Johannesburg (UJ). Three of these students won awards, namely Mr Tumo Makheta (1st prize in the BSc Honours category), Ms Tsietsjo Khajoane (2nd prize in the MSc category) and Mr Alec Edwards (2nd prize in the PhD category).



Winners at the annual Postgraduate Symposium held at UJ, from the left, Mr Alec Edwards, Ms Tsietsjo Khajoane and Mr Tumo Makheta

During the annual Faculty Prize Giving Function, various under- and postgraduate students received prizes. In Plant Pathology, Ms Amy Coetzer received the second-year incentive prize, Ms Lineo Maphobole the award for the best final-year student and Ms Zizipho Spelman was awarded best MSc in Plant Pathology. In Botany, Ms Carli van Niekerk received the prize for the best second-year student, Ms Rolanka Vermeulen for the best third-year student and Mr Goitseone Sedimo for the best Honours student. In Plant Breeding, Mr Franco Botha received the prize for the best second-year student, Mr Pieter du Preez for the best third-year student, Ms Diana Mngomezulu for the best fourth-year student, Ms Carmen Meyer for the best MSc student and Dr Prince Matova for the best PhD student.

TEACHING AND LEARNING

Dr Rothmann was awarded the Scholarship of Teaching and Learning Fellowship and will be part of the second cohort of this initiative of the Vice-Rector: Academic, Dr Engela van Staden.

From 1 to 11 February, Dr Joubert and Dr Andri van Aardt organised the third-year Botany excursion for 10 students. Dr van Aardt and Mrs Magdil Frylinck from the Geo Potts Herbarium took the students on a four-day field trip to Hogsback in the Eastern Cape. During the excursion, the students were trained in several vegetation survey, plant identification, research and specimen collection techniques.



Third-year Botany students during the excursion to Hogsback

Prof Willem Boshoff and Dr van Biljon presented invited lectures titled ‘Stem rust in wheat – the Southern African perspective’ and ‘Nutritional improvement through biofortification’, respectively, as part of an online seminar to MSc students taking the Plant Breeding and Protection for Sustainable Production course in the Department of Plant Protection Biology at the Swedish University of Agricultural Sciences.

Dr Dimitri Veldkornet and Dr Makoena (Boke) Moloi were responsible for the Botany excursion for

second-year students at Amanzi Game Reserve near Bloemfontein. The aim of the field excursion was to determine the ecophysiological response of two species, *Tarchonanthus minor* Less. (small-leaf camphor bush) and *Olea africana* subs. *africana* (wild olive), to variation in daily temperature and across an elevation gradient, in terms of stomatal numbers/adaptations, transpiration capacity, photosynthetic rate, leaf area and diameter at breast height. Students were trained in new plant ecophysiological techniques that are used in the field, to capture and process data collected.

Dr Boke Moloi and Dr Dimitri Veldkornet (on the left of the photo) together with the second-year students who participated in the excursion at Amanzi Game Reserve



RESEARCH AND INNOVATION

SARChI Chair in Disease Resistance and Quality of Field Crops

Research highlights in the rust programme of the National Research Foundation (NRF) South African Research Chairs Initiative (SARChI) Chair in Disease Resistance and Quality in Field Crops' for the report period, include the acceptance of 11 research papers in peer-reviewed journals. Four of these papers resulted from contributions made by UFS staff to international studies in the control of cereal diseases. This includes a paper from a collaborative project with Prof Simon Krattinger's group at the King Abdullah University of Science and Technology (KAUST) and Dr Renée Prins and her team at CenGen in the prestigious journal *Nature Genetics*. This research was funded by KAUST and reported on the first genome sequence for a South African wheat cultivar (Kariega) and the successful cloning of the Yr27 stripe rust resistance gene.

A PhD thesis was submitted from the monitoring of the rust disease causing fungal (*Puccinia*) populations of important crops in South Africa. Rust on green beans in KwaZulu-Natal (KZN) was monitored, and one PhD study is underway on sunflower rust. Stripe rust outbreaks in the warmer irrigation areas were investigated. An MSc student is doing a survey and genotypic characterisation of rust species of South African grasses. In the project on genetic reconstruction of three South African cereal rust populations using herbarium specimens, for *Puccinia triticina* (*Pt*, wheat leaf rust) and *P. graminis* f. sp. *tritici* (*Pgt*, wheat stem rust), microsatellite markers were successfully used to genotype historic and recent collections.

An MSc student sequence analysis of the *avrSr35* and *avrSr50* gene sequences in the South African *Pgt* population. Another MSc student worked on part of the project titled 'Genetic and functional analysis of resistance/tolerance against strobilurin and azole fungicide application in the South African *Pgt*, *P. striiformis* f. sp. *tritici* (*Pst*, wheat stripe rust) and *Pt* populations', and completed her

dissertation. In terms of inhibition of *Pgt*, *Pst* and *Pt* urediniospore germination and growth using two purified compounds derived from smoke, point inoculation on intact leaves confirmed the inhibitory effect on *Pst*. The molecular survey of Berberis species in South Africa was continued on several barberry plants collected from all over the country. For the molecular and biochemical characterisation of the adult plant disease resistance response of two different wheat varieties against *Pgt* infection, the expression patterns of six selected genes were verified in *Pgt* inoculated adult plant resistant (APR) wheat lines W1406 and W6979 wheat. This was part of an MSc study that was submitted.

An MSc study was done on improving combined rust and Fusarium head blight (FHB) resistance in existing pre-breeding wheat lines. *Lr27/Sr31/Yr9* and *Qfhs.ifa.5A-1* were successfully incorporated and a total of 129 F1 seeds were harvested for further studies. In another postgraduate study, comparison of pre-breeding wheat lines with different levels of FHB resistance to the accumulation of Fusarium mycotoxins was done to determine the correlation between FHB resistance in wheat and the level of tricothecenes produced. Thus far, 350 isolates were identified and confirmed as *Fusarium graminearum*, the predominant causal pathogen of FHB in South Africa. The deoxynivalenol (DON) quantification results confirmed that 15 A-DON producers were more pathogenic than the 3 A-DON producers.

Fusarium head blight- (FHB) infected wheat spike



The genotypic and phenotypic validation of FHB resistance in wheat showed a positive correlation between type II resistant lines and disease incidence.

In terms of the quality of field crops, one PhD was completed on genetic improvement of zinc content in grain of normal, provitamin A and quality protein maize, and another on abiotic stress tolerance and nutritional values of newly developed quality protein maize hybrids in sub-Saharan Africa. A paper from the first study was presented in Ireland at the European Federation of Food Science and Technology (EFFOST) conference. An MSc was completed on genotype and environmental effects on maize grain yield, nutritional value and milling quality. Another MSc study is underway on the influence of low nitrogen conditions on the nutritional value of quality protein maize. A PhD study is underway on breeding for high provitamin A content in Zambian cassava germplasm. An MSc study was completed on the influence of the wheat bread making gene on the gluten quality of selected South African wheat cultivars.

A PhD project is underway on the effects of heat and drought stress on bread wheat gluten protein composition and quality, and an MSc project on resistant starch in South African wheat cultivars. A project on the effects of biotic and abiotic stress conditions on wheat gluten, using proteomics, also continues. In terms of the research on legumes, one MSc project was completed, titled 'Evaluating cowpea mutant genotypes for grain yield and nutritional value in South Africa'. Two PhD projects are underway on cowpea, one on genetic diversity in a West-African collection and the other on inheritance of quality characteristics in South African cowpea. Two sorghum PhD projects are also underway, both on sorghum yield and grain quality, one on an Ethiopian germplasm collection, and the other on South African material. Genome-wide association studies are being done on the most important yield and quality characteristics.

Botany: Plant physiology/ biochemistry and molecular biology

During 2022, Dr Arun Gokul focused on candidate microbiological biocontrol agents (identified previously) that were tested on maize. The

experiments showed no adverse effects on the growth or health of maize when the biocontrol agents (endophytic isolates) colonised plants. One of the most notable findings includes two isolates that were able to improve the growth and resilience of a commercial maize cultivar exposed to different *Fusarium* phytopathogens. Currently research is focusing on identifying the mechanisms associated with the improved health of maize under phytopathogen stress.

Dr Moloi conducts research on plant ecophysiology, investigating the effects of drought, high temperature, and a combination of the two stresses on the physiological, biochemical and morphological responses of edamame and cowpea. Another project involves the use of natural bio-stimulants, biodegradable inorganic compounds and micronutrients to mitigate the negative effects of such stresses in edamame and spinach. The research is of great importance as it brings solutions for crop production under changing climatic conditions.

Dr Lintle Mohase and her research team investigated plant defence mechanisms in wheat infested by the Russian wheat aphid (*Uromyces noxia*). She collaborates internally with a biochemist (Dr Mpho Mafa), molecular biologist (Prof Botma Visser) and plant pathologist (Prof Boshoff), and externally with entomologists at the Agricultural Research Council Small-Grain (ARC-SG), Bethlehem (Dr Astrid Jankielsohn) and the Lesotho Agricultural Research Unit (wheat germplasm). Her research concentrates on wheat defence mechanisms to aphids, exploring tolerance mechanisms in various wheat germplasm, including landraces from Lesotho. The influence of environmental factors such as drought on the resistance response to aphids, is also investigated. In addition, the team explores plant protection strategies by investigating the role of inorganic nutrients, such as selenium and silicon, signalling molecules (salicylic acid) and leaf rust isolates in mitigating drought and aphid stress on wheat.



Dr Boke Moloi



Dr Mpho Mafa

Dr Mafa's research team (Carbohydrates and Enzymology Laboratory [CHEM-LAB]) aims to correlate the physiological and biochemical functions of carbohydrates and carbohydrates-active enzymes (CAZymes) to comprehensively understand how they protect plants against biotic and abiotic stress in the greenhouse and

field conditions or produce value-added chemicals in the bio-refinery sector. Their interests focus on three key research niches, namely the identification, characterisation and profiling of the defensive roles of structural carbohydrates (cell wall components) and non-structural carbohydrates (soluble sugars), physicochemical and functional characterisation of CAZymes and their application, and the application of CAZymes in agro-waste processing. Dr Mafa also received an NRF-Thuthuka grant for a project on the formulation of a holocellulolytic enzyme cocktail for hydrolysis of delignified rooibos bagasse to produce value-added chemicals.

Dr Rudo Ngara continued with her two umbrella projects on drought stress in plants, and abscisic acid signalling systems and drought-stressed transcriptome analyses in sorghum. With the general project on drought stress in plants, Dr Ngara is still working closely with Dr Stephen Chivasa from Durham University, UK, mainly for metabolome and proteome analyses. For the transcriptome work, Dr Ngara and her research group work closely with Dr Dirk Swanevelder from the ARC-Biotechnology Platform.

Prof Visser, in collaboration with Prof Boshoff, studies the genetic variation within fungi that cause rust diseases of cereal crops. During 2022, microsatellite markers were used to describe the genetic structure of *Pgt* isolates causing stem rust of wheat in South Africa. This included the genetic characterisation of a new race, as well as the reconstruction of the genetic development of the pathogen in South Africa over the last 120 years, using herbarium specimens. In addition, the gene encoding the CYP51 protein that is targeted by fungicides, was sequenced to identify

possible mutational variants that could lead to fungicide insensitivity or tolerance of the pathogen against the fungicide. Similar sequence analyses of the *avrSr35* and *avrSr50* genes were completed to determine the possibility of the development of virulence within stem rust against the *Sr35* and *Sr50* genes. A biochemical analysis of the interaction between wheat and the leaf rust pathogen (*P. triticina*) was also completed in collaboration with Dr Mafa and Dr Howard Castelyn.

Botany: Plant taxonomy and molecular systematics

Dr Joubert collaborated with Mr Pieter Bester from the South African National Biodiversity Institute (SANBI) on a field trip to the Northern Cape, during which four new *Nemesia* species were collected. Dr Mariëtte Jackson oversaw the DNA sequencing and phylogenetic analysis of the specimens and the new species are now being described and named as part of a taxonomic revision of *Nemesia*, a genus of indigenous snapdragons.

Dr Jackson is heading the Molecular Systematics Research group. The phylogenetic analysis of some genera in the Asteraceae is continuing. Dr Jackson was also involved in a Plant Pathology MSc project with Dr Rothmann, in which fungi within sorghum kernels were identified using molecular techniques and fungi are being identified in soybean cultivars. Dr Jackson is also collaborating with Dr Joubert

Mr Pieter Bester and Honours student, Mr Orateng Sedimo, in the Kamiesberg during field work to study *Nemesia* (snapdragons) in the Northern Cape



on her *Nemesia* project, for which an MSc student submitted her dissertation and obtained her degree *cum laude*.

Botany: Palaeoecology and ecology

Prof Scott continued with his international collaboration with researchers from Namibia, Spain and the USA. He published on fossil pollen research of hyrax dung and owl guano providing a unique record of past environmental changes during the last 10 000 years for the Namib Desert.

Dr van Aardt has ongoing research on pollen cores from Colbyn and the Rietvlei Dam, Gauteng region, supplied by Dr Piet-Louis Grundling and co-workers and dated by Stephan Woodborne at iThemba LABS. She also collaborates with researchers from Spain, Germany and the USA on the Palaeoecology and Open-Landscape adaptations of Pleistocene humans in South Africa (PEOPLE) project. In terms of modern ecology, she is working on mapping of various vegetation types in the Free State in collaboration with Anisha Dayaram at SANBI. She is also investigating soil-plant relationships with Prof Johan van Tol from the UFS Department of Soil, Crop and Climate Sciences.

In affiliation with the Afromontane Research Unit (ARU), Dr Sandy Steenhuisen and Postdoctoral Fellow, Dr Stephanie Payne, continued an international collaborative project on the effects of climate change on range-expanding plant species (RangeX) based in the Northern Drakensberg. This project, funded by the Department of Science and Innovation (DSI) through a BiodiverSA call



Fieldwork in the Drakensberg, from the left, Dr Grant Martin (Centre for Biological Control, Rhodes University, affiliate with UFS Department of Zoology and Entomology), Dr Ralph Clark (ARU), Dr Sandy-Lynn Steenhuisen (Plant Sciences), Ms Evelin Iseli (Swiss Federal Institute of Technology [ETH] Zurich), Mr Georg Valentin Flückiger (ETH Zurich), Dr Stephanie Payne-Smith (Plant Sciences), Prof Jake Maximillian Alexander (ETH Zurich), Dr Onalenna Gwate (Geography) and Dr Jamie Alison (Aarhus University)

(Horizon 2020), and led by South African principal investigator Prof Ralph Clark and Swiss principal investigator Dr Jake Alexander, has resulted in a new research station being built at 3 100 metres above sea level on the plateau of the Amphitheatre near Namahadi Pass. Two summer seasons of data have been collected with remote cameras on the pollinator communities and weather patterns at low and high elevations in these mountains.

Prof Toke Thomas Høye (Aarhus University) and Prof Jake Maximillian Alexander (ETH Zurich) setting up the station



Dr Steenhuisen supervises various research projects with Dr Grant Martin (Director of the Centre for Biological Control, Rhodes University and affiliate of the Department of Zoology and Entomology at UFS), Dr Kim Canavan (Postdoctoral researcher at the Centre for Biological Control, Rhodes University), and Prof Dave Richardson (Centre for Biological Control, Stellenbosch University) on the impacts and spread of invasive alien plants in the Free State and Eastern Cape grasslands. A project development intern, Ms Thembelihle Mbele, funded by SANBI, started research on invasive pampas grass this year and has been awarded a SANBI bursary to pursue her masters on this species from 2023.

Dr Veldkornet's research focuses on the diversity and distribution of estuarine plants and snails and the impact of erosion at the Berg River Estuary. In collaboration with Prof Anusha Rajkaran (University of the Western Cape) and Dr Nasreen Peer (Stellenbosch University), an MSc student (UFS) has found that uncontrolled boating activity and strong winds, often resulting in high-intensity waves, have led to erosion of large areas of intertidal salt marshes. Abundance foundation species, such as *Spartina maritima*, have been significantly reduced and the only refuge for other intertidal plants and animals is in salt marsh creeks. Her results suggest that immediate ameliorating actions are needed to prevent the loss of biodiversity in one of South Africa's most productive estuarine systems.

Plant Breeding: Molecular plant breeding

Dr Ansori Maré collaborated with Prof Liezel Herselman and Prof Boshoff (Plant Pathology) to identify new rust resistance sources in wheat using molecular markers and phenotypic evaluations to evaluate mapping populations. Selected wheat cultivars/lines from two different breeding backgrounds have been identified with unknown rust resistance. The two breeding backgrounds are the International Maize and Wheat Improvement Center (CIMMYT) rust resistant nursery and Sensako cultivars. This research is funded by the NRF-



Sclerotinia on different crops (soybean, cabbage and sunflowers)



Thuthuka and South African Winter Cereal Industry Trust (SAWCIT). Further progress has been made with cross-breeding and molecular markers to enhance rust- and FHB-resistant wheat lines with a higher number of resistance genes, to ensure durable resistance in wheat. This project is funded by the Central Research Fund of the UFS.

Dr Adré Minnaar-Ontong's research focuses on breeding for resistance against fungal diseases across multiple economically important crops, including resistance breeding against *Sclerotinia sclerotiorum* diseases (sunflower and soybean), soybean sudden death syndrome (SDS) and associated phytotoxins and mycotoxins produced by FHB causal pathogens, to promote the improvement of disease control strategies.

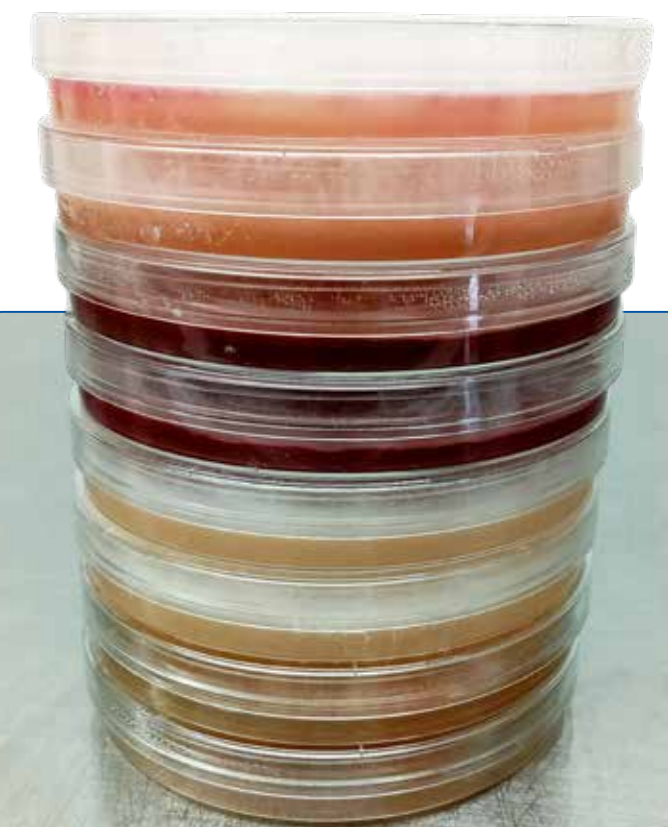
The *Sclerotinia* resistance research of Dr Minnaar-Ontong is funded by GrainSA. This research also forms part of the South African *Sclerotinia* Research Network (SASRN) founded in 2017. The research led to the sampling of more than 1 000 isolates from eight of the nine South African provinces across multiple crops from which the *Sclerotinia sclerotiorum* culture collection was established. This culture collection expands continuously as more *Sclerotinia* infections are being reported every season.

The SDS resistance research includes the evaluation of South African commercial soybean, as well as edamame germplasm for potential resistance to this destructive disease. *Fusarium virguliforme* was identified and concluded as the causal pathogen of SDS. A pre-breeding programme for SDS resistance was initiated using marker-assisted breeding approaches. The outcome of both projects will contribute significantly to soybean production of South Africa.

Evaluation of sudden death syndrome (SDS) resistance after soil inoculation



Breeding for resistance against mycotoxins associated with FHB causal species was funded by the SARChI Chair in Disease Resistance and Quality of Field Crops for 2021 and 2022. Several *Fusarium* species associated with FHB were identified, but *F. graminearum* was identified as the predominant causal species in South Africa. Mycotoxins involved pose a threat to both humans and animals. These mycotoxins also negatively impact food security, therefore resistance breeding against these secondary metabolites should be priority. Knowledge gained from analyses will assist with the development of effective control strategies, i.e. resistance breeding against FHB and the associated mycotoxins. This will assist with improving wheat production in South Africa.



FHB isolates

Plant Breeding: Conventional breeding

Dr Rouxlène van der Merwe focused on breeding for resistance to pod shattering in vegetable-type soybean (in collaboration with the Northeast Institute of Geography and Agroecology, Chinese

Academy of Sciences). This research continued to make progress towards the development of an improved South African vegetable type soybean cultivar that shows resistance to pod shattering. This project is undertaken in collaboration with Dr Minnaar-Ontong and Dr Maré, who assist with marker-assisted selection of progenies grown in field trials. One MSc student (Mr Kelvin Hlatswayo) is working on this project.

Dr van der Merwe also continued to make progress towards the characterisation of vegetable-type soybean cultivars in terms of drought and heat stress tolerance. This project is done in collaboration with Dr van Biljon, who assisted with sugar analysis, Dr Arno Hugo, who assisted with fatty acid analysis, and Dr Moloï, who assisted with physiological response analyses. The project is funded by the NRF-Competitive Support for Unrated Researchers. One MSc student (Mr Drikus Coertzen) is working on this project.

Dr van der Merwe's research on the impact of water-limited-stress on the morphology, physiology and nutritional quality of dry bean is making progress. This project aims to characterise dry bean cultivars in terms of drought stress tolerance and nutritional quality, and is undertaken in collaboration with

Lesole Sefume evaluating his dry bean plants, which form part of his MSc project on the evaluation of drought stress on dry bean yield and nutritional value



Dr van Biljon, who assisted with nutritional quality analysis, and Dr Moloï, who assisted with physiological response analyses. One MSc student (Mr Lesole Sefume) is working on this project.

Plant Breeding: Wheat-quality and crop-nutritional value research

Dr van Biljon continued with research on the influence of abiotic stress on the nutritional profile and quality of various crops, focusing on crops like wheat, maize, vegetable-type soybean, dry bean and sorghum. The nutritional screening includes the study of storage proteins through size exclusion- and reverse-phase high-performance liquid chromatography. The total starch, amylose, sugar, tryptophan, mineral content (especially iron and zinc) and bioavailability of these minerals are also determined. Dr van Biljon also collaborates with Prof Maryna de Wit from the Department of Sustainable Food Systems and Development (UFS) to study proteins in mucilage of *Opuntia* genotypes.

Dr Ntombi Mbumba's research focused on the evaluation of cowpea genotypes for grain yield and nutritional value in collaboration with the ARC and on the genotype and environmental effects in maize in collaboration with Bayer.

Plant Pathology: Cereal rust diseases

Prof Boshoff continued with wheat cultivar and breeding line assessment for resistance to rusts. This project is funded by SAWCIT and results are published annually in the national wheat production guidelines of ARC-SG. Research to characterise isolates of the maize rust pathogen, *Puccinia sorghi*, was carried out with financial support of the Maize Trust. This is a collaborative project with Prof Visser and researchers at the Forestry and Biotechnology Institute (FABI). Researchers in this group delivered sixteen congress contributions, four popular publications, a *YouTube* broadcast and an *RSG* radio talk. Several industry-related research projects were successfully carried out during the year in close collaboration with staff at CenGen, ARC-SG, and seed companies Stark Ayres, Syngenta and Corteva Agriscience. Nine postgraduate students and one fourth-year student

conducted research on rust-related projects, of which most were interdisciplinary.



The UFS rust research group, from the left, front: Dr Cornél Bender, Ms Lineo Maphobole and Ms Karen Venter; middle: Mr Tumo Makhetha, Ms Isabella du Toit, Ms Emily Tsotetsi, Ms Dembe Ramovha and Dr Ansori Maré; and back: Prof Willem Boshoff, Mr Wilku Meyer, Dr Howard Castelyn and Prof Botma Visser

Plant Pathology: Soil microbial ecology

Prof Swart's research broadly focuses on adopting a 'total systems approach' to plant health management by utilising the functional diversity of fungi and bacteria, above- and below-ground, as bio-indicators of soil and plant health. This involves understanding multi-trophic interactions that occur in agroecosystems, with particular attention to the phytobiome and in particular, the rhizosphere microbiome. In so doing, innovative crop production and protection strategies can be developed with particular emphasis on beneficial microbes that influence both plant and soil health.

Plant Pathology: Mycology

Dr Gert Marais leads the Pecan Research Group at the UFS that was established in 2017 to provide support to the pecan industry with regard to pecan diseases and their management. During the 2022 growing season, six field trips were undertaken, including to areas such as Luckhoff along the Orange River to Upington, Vaalharts, Jacobsdal, as well as various other areas in Limpopo, Mpumalanga, Gauteng, Eastern Cape, Western Cape and KZN. During these trips, famer's days were organised at which information regarding the newest findings on student projects were shared with pecan producers and interested parties. In 2022, a three-year project was negotiated with the South African Pecan Nut Producers Association (SAPPA), focussing on the cause of overall decline in pecans. Current studies also investigate the transfer of potential pathogens through the flowers of pecans, eventually affecting seedlings and grafted nursery plants. Studies are also ongoing on the effect of fungal pathogens, such as *Neofusicoccum parvum*, *Alternaria alternata*, *Cladosporium* species, and bacteria on pecan health in South Africa. To support future pecan research at the UFS, a one-hectare pecan orchard was established on the Paradys Experimental Farm and has now entered its third season.

Plant Pathology: Epidemiology

Dr Rothmann leads the MCLab Field Pathology and Epidemiology Research Group, which focuses on diseases associated with summer grain crops –

Dr Lisa Rothmann, Mr Thabiso Masisi, Mr Neo Hlongwane and Ms Marlese Meiring during a visit to a sunflower field trial



sorghum, soybean and sunflower. In an internal collaboration with Dr Jackson (Botany), Mr Thabiso Masisi, supported by the Sorghum Trust, initiated his PhD degree in January 2022, with the title, 'Incidence, management and producer perceptions of fungal diseases in sorghum cropping systems'. An external collaboration with Dr Lindy Rose, from Stellenbosch University, has been initiated for this study. Dr Rose has also been appointed as the co-supervisor for Mr Masisi. Prof André Pelsler, from the UFS Department of Sociology, is a collaborator on this project and will assist in investigating socio-economic factors associated with disease management decision making.

PhD graduate, Marlese Meiring, supervised by Dr Rothmann and Prof Neal McLaren, conducted research titled 'Sclerotinia sclerotiorum disease potential and management responses in soybean and sunflower'. This study was supported by the DSI, the Oil and Protein Seeds Development Trust (OPDT), Oilseeds Advisory Committee (OAC), Sasol Agricultural Trust and Winfield United South Africa, as well as GrainSA. The project aimed to evaluate soybean and sunflower cultivars for escape resistance towards Sclerotinia sclerotiorum and will be ongoing for the 2022/2023 season, with Dr Derick van Staden (Agronomy Info Services, Mpumalanga) and Mr Koos Strydom (producer, Free State). In November, Mrs Meiring was presented with her outstanding 2019 OPDT and OAC achievement award by Mr Gerhard Keun (Chief Executive Officer: OPDT) and Dr Erhard Briedenhann (Chairperson: OAC) for best Master's dissertation.

In January of 2022, the project on 'Identifying and assessing soybean seedborne diseases, towards improving seed health through reducing prevalent fungal pathogens' continued with Mr Neo Hlongwane as a registered MSc Agric student conducting the research. Continued funding has been approved for this study by the Central Research Fund of the UFS.

ENGAGED SCHOLARSHIP

Dr Minnaar-Ontong participated as reviewer for the following international accredited journals: *European Journal of Plant Pathology*, *Frontiers*,

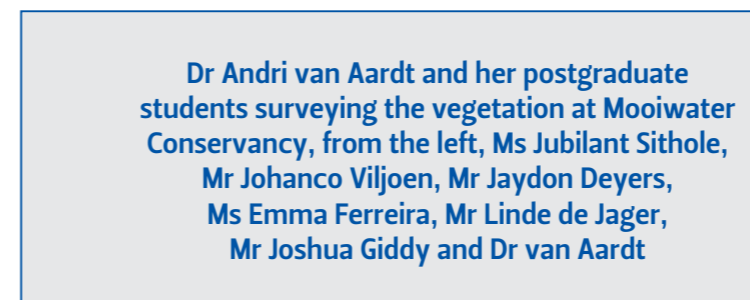
Genetic Resources and Crop Evolution, *Molecular Biology Reports* and the *South African Journal of Botany*. Dr Minnaar-Ontong was a board member of the National Grain Research Programme (University of Pretoria) and was an Agriculture ambassador with regard to the AgriCareers roadshow presented by 'Food for Mzansi' to engage with schools on careers in agriculture, and she presented at the Youth empowerment conference in Kuruman (engagement with scholars, unemployed youth and unemployed agriculture graduates).



Dr Chrisna Steyn and MSc student, Ms Diana Mngomezulu, during a Food for Mzansi road trip



The community of Groblershoop in front of the water tank sponsored by the Crop Research Platform of the UFS



Dr Andri van Aardt and her postgraduate students surveying the vegetation at Mooiwater Conservancy, from the left, Ms Jubilant Sithole, Mr Johanco Viljoen, Mr Jaydon Deyers, Ms Emma Ferreira, Mr Linde de Jager, Mr Joshua Giddy and Dr van Aardt



Dr Minnaar-Ontong acted as the coordinator of the Crop Research Platform (CRP), which was established in the Faculty of Natural and Agricultural Sciences at the UFS. The CRP was established following requests from tertiary institutions, organised agriculture and industry role players. The aim of the CRP is the promotion of all crop-related research and, as coordinator, Dr Minnaar-Ontong is managing the flow of research and research outputs between the UFS and national and international role players.

Dr van Aardt assisted the community of Bainsvlei in surveying the vegetation of Mooiwater Conservancy to determine plant community assemblages. She was assisted by several postgraduate students during the fieldwork for this project. She also presented a talk 'Alien Invasion @ 7 Dams' during the annual meeting of the Friends of Seven Dams.

Dr Moloi reviewed manuscripts for the *Agronomy* journal, which is a Q1 journal.

Dr Rothmann was elected and appointed as the *President Elect* of the American Phytopathology Society: African Division.

Dr Rothmann and Mrs Meiring contributed to a farmers' day in March 2022 with collaborator, Dr Derick van Staden of Agronomy Info Services. The focus was on Sclerotinia diseases with industry partners under the auspices of the SASRN, supported by GrainSA. Shorter information sessions for farmers have been conducted primarily in the Free State and Mpumalanga. The first farmer information day in Mooifontein, North West, was launched with emerging and smallholder producers. These sessions are to connect producers with the current research being conducted, and also to hear from producers what their needs from academia and industry are. The focus of interacting with producers is to develop and communicate practical management strategies for diseases caused by Sclerotinia for local producers.

Scientific communication and popular articles are produced and distributed through the SA Grain magazine, *Oilseed Focus*, and the Dry Bean Producers' Organisation's *SA Drybeans Magazine*. Contributions were made by Dr Rothmann, Mrs Meiring, Mrs Naomi Kleinhans, Mr Masisi and Mr Hlongwane, representatives of the Plant Pathology division. Topics covered include Sclerotinia cultivar evaluations and potential interventions of diseases associated with *Sclerotinia sclerotiorum*.

Dr Joubert presented two talks to the Botanical Society of South Africa's (BotSoc) Free State Branch. The first talk, 'Interesting aspects of the relationship between indigenous flowers and their pollinators', was presented during BotSoc's annual general meeting. The second talk and practical demonstration on the family Lamiaceae, its identification and economic uses, was presented in

the Free State Botanical Garden potting shed.

Dr Joubert and Dr van Aardt were guest speakers on two programmes of Pretoria FM's *Natuur en wetenskap* (Nature and Science programme), during which they answered listener's questions on plants and nature.

Prof Herselman was invited to present a plenary lecture at the University of Limpopo's 12th Faculty of Science and Agriculture Research Day, in September 2022. The title of her lecture was 'The omics of molecular plant breeding'.

Mrs Frylinck continued with the digitisation project of the Geo Potts Herbarium. This project will lead to the more efficient management of the collection and make the digitised specimen records available online for use by the international scientific community.

Dr Mafa acted as reviewer for the following journals: *Journal of Chemical Ecology*, *Biomass Conversion and Biorefinery*, *European Food Research and Technology*, *Genes and Plant Physiology and Biochemistry*.

Prof Labuschagne again served as Speciality Chief Editor for *Frontiers in Sustainable Food Systems* (division Crop Biology and Sustainability) and served on the editorial boards of *Cereal Chemistry* and *Journal of Cereal Science*.

Dr Steenhuisen and Ms Dipuo Mosea joined mentees and mentors in the Mountain to Mountain Women's Mentorship Programme in June 2022 for a workshop to discuss women's mentorship in academia, hosted by Appalachian State University in Boone, North Carolina.

Dr van der Merwe was invited to present an online lecture, titled 'A pre-breeding strategy for drought-stress tolerance in soybean', as part of the SAPBA webinar on Breeding for Climate Change that was hosted by SANSOR in collaboration with the South African Society of Crop Production (SASCP). Dr van der Merwe was also invited to present a talk on 'Legumes in the fight against climate change', and to participate in a panel discussion on 'Responding to the climate crisis with biotechnology', as part of a seminar held by Crop Life South Africa in collaboration with the United States Department of Agriculture (USDA) Foreign Agriculture Service in August at the SA Grain Building in Pretoria.

NATIONAL AND INTERNATIONAL COLLABORATION

Members of the Department of Plant Sciences have strong local, national and international collaborations. Most of these are reported in detail in the chapter on Research and Innovation. In addition, our members have the following noteworthy collaborations.

Dr Gokul has national collaboration with Prof Marshall Keyster (Environmental Biotechnology Laboratory) and Prof Ashwil Klein (Plant Omics Laboratory) at the University of the Western Cape (running for the third year). The collaboration has resulted in the graduation of two MSc students and nine peer-reviewed articles and one book chapter in high impact factor journals.

Dr Minnaar-Ontong collaborated with Syngenta on breeding for resistance to Sclerotinia diseases in soybean, with other breeding companies from industry, and researchers from the University of Manitoba, Canada and the University of Nebraska as well as the USDA, USA.

Prof Scott submitted fossil pollen data produced over several decades in the Department to the African Pollen Database (<https://africanpollendatabase.ipsl.fr/#/home>), a data repository for reconstructing past vegetation and climate during the Quaternary period on the continent.

Dr Moloi collaborated with Prof Ned Bowden from University of Iowa, USA, on a project involving the use of biodegradable dithiophosphates for the improvement of drought tolerance in edamame. They are currently supervising an MSc student on the project. She also collaborated with Prof Brigitta Tóth of the University of Debrecen, Hungary and their work produced one publication in a peer reviewed journal.

Dr Rothmann is involved in the official Memorandum of Understanding (MOU) between GrainSA and the UFS, which states that Plant Sciences was reappointed for administrating the SASRN, composed of a community of practice and a research consortium. The SASRN has continued

their website and social media activities since the launch in September 2019. This Network provides a platform for South African researchers, industry, and producers to work together towards a management solution for Sclerotinia diseases in South Africa. Dr Rothmann also collaborates with AgriSeed/DMS Genetics in Delmas, where soybean and sunflower field trials on the experimental farm are aimed at cultivar and fungicide evaluations.

Dr Joubert and Dr Jackson collaborated with Ms Hanlie Grobler from the Centre for Microscopy at the UFS and Prof Beverley Glover from the Department of Plant Sciences at the University of Cambridge on the project titled 'The role of flower structure in the diversification of the genus *Nemesia* (Scrophulariaceae)'. This project yielded novel insights into the developmental mechanisms that produce different spur shapes and the role of spur variation in the evolution and diversity of *Nemesia*.

Dr Mafa collaborates with Dr Samkelo Malgas (University of Pretoria's Department of Biochemistry, Genetics and Microbiology – Division of Biochemistry) and Prof Brett Pletschke (Rhodes University's Department of Biochemistry and Microbiology) on a project on carbohydrates or CAZymes application in the biorefinery sector for the production of value-added products. Dr Mafa also collaborated with Dr Orbett Alexander with regard to Fourier-Transformed infrared spectroscopy and X-ray Diffractometers machines at the UFS Department of Chemistry, and with Dr Gabré Kemp at the UFS Department of Microbiology and Biochemistry, on Liquid Chromatography-Mass Spectrometry.

Prof Labuschagne collaborated with colleagues at the University of Córdoba, and CIMMYT in Mexico, Zimbabwe and Kenya, as well as the International Institute for Tropical Agriculture in Nigeria.

Dr Steenhuisen facilitated the signing of an MOU between Rhodes University and UFS for collaborative research on invasive plant species, principally with the Centre for Biological Control and its Director, Dr Grant Martin. This MOU will provide a foundation for shared funding for project running costs and bursaries being transferred between institutions for postgraduates supervised at UFS and co-supervised by Rhodes University. The first bursary to be used in this manner is to fund Masters' candidate, Mr

Mentees and mentors attending the Mountain to Mountain Women's Mentorship Programme at the Appalachian State University in Boone, North Carolina – back from the left, Dr Mbali Pewa (Geography), Ms Ngitheni Nyoka (Zoology), Prof Aliza Le Roux (Zoology), Ms Dipuo Mosea (Plant Sciences) and Dr Sandy-Lynn Steenhuisen (Plant Sciences); front from the left, Ms Lethiwe Sokhela (Research and Development Office) and Ms Nozipho Kheswa (Zoology)



Tapiwanashe Mashamba, on the current distribution of invasive willow trees in the Grassland Biome of South Africa.

Dr Steenhuisen co-supervises Master's and Doctoral students at other national universities, namely University of Witwatersrand and University of KwaZulu-Natal.

Dr van der Merwe continued her research collaboration with TransfOrmus to evaluate the effect of enOrmus and Soil Life Combo on plant biomass and yield of vegetable-type soybean and maize cultivars under field and glasshouse conditions. The aim of this collaboration is to evaluate the effectiveness of using the different plant biostimulants on crop biomass and yield and also to determine possible phytotoxic effects on plants. The report developed by Dr van der Merwe will assist with the registration of the newly developed biostimulants as group 3 fertilisers with the Department of Agriculture, Forestry and Fisheries. Dr van der Merwe continued her collaboration with Prof Qiuying Zhang from the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, on a project focusing on breeding for resistance to pod shattering in vegetable-type soybean.

Mr Brewis Fourie (left) and Mr Rudi Lombaard (right) collecting soybean leaves for nutrient analyses, which forms part of Dr Rouxléne van der Merwe's collaboration with TransfOrmus



Dr Marais collaborates with SAPPA and FABI (Prof Bernard Slippers and Prof Wilhelm de Beer) to study diseases in the pecan industry in South Africa.

Prof Swart was closely involved in the negotiation and signing of a Collaboration Agreement between the University of Cape Town and the UFS relevant to the diversification of mining land for agricultural use and socio-economic development. Prof Swart has a 30-year track record involving the cultivation and health of cactus pear (*Opuntia ficus-indica*), a crop that forms an integral part of the research to be undertaken under this Collaboration Agreement.

Dr Jackson and Mrs Frylinck collaborate with Dr Madeleen Struwig (North-West University, Mahikeng Campus) on the phylogenetic analysis of genera *Commicarpus* and *Boerhavia* (Nyctaginaceae).

POSTGRADUATE STUDENTS

During 2022, 11 Honours, 57 Master's and 43 Doctoral students were enrolled for postgraduate studies in the Department of Plant Sciences.

Honours graduates

At the 2022 graduations, 15 students graduated with BSc Hons majoring in Botany (eight on the Bloemfontein Campus and seven on the Qwaqwa Campus), two students graduated with BSc Hons majoring in Plant Health Ecology, and one student graduated with BSc Hons in Agriculture majoring in Plant Breeding.

Master's graduates

Ten students graduated with an MSc in 2022:

- Grobler, H (Botany, Bloemfontein Campus – with distinction)
- Hlahla, JM (Botany, Bloemfontein Campus – with distinction)
- Liatile, PC (Botany, Bloemfontein Campus)
- Mokoena, MA (Botany, Qwaqwa Campus)
- Moloi, KT (Botany, Qwaqwa Campus – with distinction)
- Moruri, P (Botany, Qwaqwa Campus)

- Müller, M (Botany, Bloemfontein Campus)
- Ngwenya, SP (Botany, Qwaqwa Campus – with distinction)
- Sibanyoni, RN (Botany, Bloemfontein Campus)
- Sivhada, RA (Plant Breeding)

One student, HS Fosa, graduated with an MSc Agriculture specialising in Plant Pathology.

Doctoral graduates

Nine candidates from the Department of Plant Sciences graduated with a PhD in 2022:

ADEYEOLUWA, Temitayo Esther (Botany)

Thesis: An in vitro comparative study on the antioxidant, antibacterial and antidiabetic potentials of five tropical spices employed as traditional therapy

Supervisor: Prof AOT Ashafa

ENGIDA, Bitew Tilahun (Plant Breeding)

Thesis: Abiotic stress tolerance and nutritional values of newly developed quality protein maize hybrids in sub-Saharan Africa

Supervisor: Prof MT Labuschagne

KWEMOI, Daniel Bomet (Plant Breeding)

Thesis: Genetic analysis of resistance to Maize Lethal Necrosis with emphasis on strategies for improvement of host resistance

Supervisor: Prof MT Labuschagne

MATONGERA, Nakai (Plant Breeding)

Thesis: Genetic improvement of zinc content in grain of normal, provitamin A and quality protein maize

Supervisor: Prof MT Labuschagne

MEIRING, Marlese Christine (Plant Pathology)

Thesis: Sclerotinia sclerotiorum disease potential and management responses in soybean and sunflower

Supervisor: Dr L Rothmann

SENWAYO, Sphamandla (Plant Breeding)

Thesis: Genetic improvement of drought tolerant maize hybrids under a combination of biotic and abiotic stress conditions

Supervisor: Dr R van der Merwe

SIWALE, Julius (Plant Breeding)

Thesis: Phenotypic and nutritional diversity of southern African bambara groundnut germplasm

Supervisor: Prof MT Labuschagne

SWANEPOEL, Jacobus Francois (Plant Breeding)

Thesis: Developing a breeding strategy for butternut squash (*Cucurbita moschata* Duch. ex Poir) in South Africa

Supervisor: Dr R van der Merwe

VOUA OTOMO, Laetitia (Botany)

Thesis: Bioactivity, isolation and characterisation of compounds from plants used against secondary infections associated with elephantiasis in Kwazulu-Natal, South Africa

Supervisor: Dr LV Komoreng

POSTDOCTORAL RESEARCH FELLOWS

In Plant Breeding, two Postdoctoral Fellows were appointed in 2022, namely Dr Tesfaye Mekonnen (from Ethiopia) and Dr Neila Abdi (from Tunisia), both working on projects within the SARChI Chair.

Dr Stephanie Payne (South Africa), hosted by Prof Sandy Steenhuisen, co-taught BIOL6834: Advanced Biostatistics in 2022, presented at two international conferences in South Africa and Austria, leads the pollination aspects of the international RangeX project in affiliation with the ARU, supervised two Honours projects, and is co-supervising two Master's and one Doctoral candidate in the Department. She was also hosted by the ARU and Swiss collaborators for a research visit to RangeX sites in Zurich,

Switzerland, in September 2022. Dr Payne was selected and represented the Qwaqwa Department of Plant Sciences in the postdoctoral category of the Flash Fact Competition in Bloemfontein in 2022.

Dr Howard Castelyn (South Africa) was appointed as a Postdoctoral Fellow in the laboratory of Prof Visser for a final year in 2022, to continue with the bio-informatic analysis of the adult wheat-stem rust interaction. He was co-supervisor of Mr Christiaan Botha (MSc in Botany) on the characterisation of the adult plant resistance response of wheat after stem rust infection, which was obtained with a distinction. Dr Castelyn participated in a project to unravel the role of carbohydrates and carbohydrate active enzymes towards leaf rust resistance in wheat. He also contributed significantly to the establishment of the MARPLE bio-informatic skill set that was established within the Department.

Dr Conrad Achilonu (from Nigeria) was appointed in November as Postdoctoral Fellow, working on pecan diseases in South Africa.



STAFF MATTERS

Prof Willem Boshoff received an NRF-C2 rating in 2022.

Dr Ntombi Mbuma, Lecturer at Plant Breeding, resigned in November 2022.

The following staff members received long service awards:

- Prof Anofi (Tom) Ashafa (15 years)
- Dr Cornél Bender (20 years)
- Dr Pheello Mojau (>15 years)
- Mr Ngaka Mzizi (>15 years)
- Mr Teboho Pitso (>15 years years)

The Department employed the following interns for a period of six-months each:

- Ms Mamosela Mohotloane
- Ms Mathapelo Masilo
- Ms Patricia Masole
- Ms Matshediso Semela
- Ms Ntombenhle Radebe
- Ms Phindile Msimanga
- Ms Isabella Maseng
- Ms Chumisa Silwana
- Ms Matsatsi Moletsane

RESEARCH OUTPUTS

Research Articles

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Sadler, R., Verboom, G.A., Manning, J., Parker, T., Jackson, M., Van Zyl, J., Bergh, N.G. & Ellis, A.G. 2022. *Phylogeny of the southern African marigolds: the daisy tribe Calenduleae*. Paper delivered at the 47th Annual Conference of the South African Association of Botanists (SAAB). Hosted online by North West University, South Africa. 17–20 January 2022.

Scott, L. & Van Aardt, A.C. 2022. *Updating the African Pollen Database (APD) for the Quaternary in the South African interior*. Paper delivered at the Workshop held of the French Institute of South Africa (IFAS), Pleistocene Archaeology and Palaeoecology of the Free State, Florisbad, Free State. 14 July 2022.

Sedimo, G., Jackson, M., Bester, S.P. & Joubert, L. 2022. *Taxonomic revision and molecular phylogenetic analysis of Nemesia species in the Free State*. Paper delivered at the 47th Annual Conference of the South African Association of Botanists (SAAB). Hosted online by North-West University, South Africa. 17–20 January 2022.

Steyn, C. & Minnaar-Ontong, A. 2022. *Improvement*

of South African soybean cultivars against Sclerotinia stem rot. Paper delivered at the 1st National Grain Research Programme Research Day, Future Africa, University of Pretoria, South Africa. 9 May 2022.

Terefe, T.G., Visser, B., Pretorius, Z.A. & Boshoff, W.H.P. 2022. *The continual emergence of new Puccinia triticina races on wheat in South Africa*. Paper delivered at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Theron, N., Swart, W.J., Gryzenhout, M. & Marais, G.J. 2022. *Members of the genus, Cladosporium, and their role in pecan scab in South Africa*. Paper delivered at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Van der Merwe, R. 2022. *Vegetable-type soybean research and breeding at the UFS*. Paper delivered at the 1st National Grain Research Programme Research Day, Future Africa, University of Pretoria, South Africa. 9 May 2022.

Van der Merwe, R., Van der Merwe, J.B. & Van Biljon, A. 2022. *Combining ability of nutritional components in vegetable-type soybean*. Paper delivered at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6–9 March 2022.

Veldkornet, D.A., Adams, J.B., Boatwright J.S. & Rajkaran, A. 2022. *Barcoding of estuarine macrophytes and phylogenetic diversity of estuaries along the South African coastline*. Paper delivered at the Southern African Marine Science Symposium, Elangeni Hotel, Durban, South Africa. 20–24 June 2022.

Venter, K., Maré, A., Herselman, L., Pretorius, Z.A. & Boshoff, W.H.P. 2022. *Rust response of the Watkins Core Collection of wheat landraces*. Paper delivered at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6–9 March 2022.

Visser, B. 2022. *Rust research at the UFS*. Paper delivered at the 1st National Grain Research Programme Research Day, Future Africa, University of Pretoria, South Africa. 9 May 2022.

Visser, B., Bender, C.M., Boshoff, W.H.P. & Pretorius, Z.A. 2022. *Back to the future: using herbarium*

specimens to reconstruct the genetic development of two wheat rusts in South Africa. Paper delivered at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Walle, T. & Labuschagne, M. 2022. *Trends and advances in maize biofortification in Southern Africa*. Paper delivered at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6–9 March 2022.

Wood, A.R., Boshoff, W.H.P., Visser, B., Bender, C.M. & Pretorius, Z.A. 2022. *The heteroecious life cycle of Puccinia digitariae on Digitaria eriantha and Solanum species, the first to be elucidated in South Africa in a century*. Paper delivered at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Posters presented

Achilonu, C.C., Marais, G.J., Ghosh, S., Cason, E.D., Madisha, T. & Gryzenhout, M. 2022. *Random amplified microsatellites (RAMS) analysis showed no link to geographical location of Alternaria alternata populations causing black spot of pecans (Carya illinoensis) in South Africa*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Achilonu, C.C., Marais, G.J., Ghosh, S., Johar, D., Hassanin, S.O. & Gryzenhout, M. 2022. *In vitro fungicide evaluation and antifungal activities of pecan leaf and husk extracts against Alternaria alternata: HPLC analysis of phenolic compounds*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1–3 August 2022.

Adams, L.D., Martin, G., Steenhuisen, S. & Downs, C. 2022. *Community perceptions on invasive alien plant Pyracantha angustifolia in the eastern South African grasslands*. Poster presented at Oppenheimer Research Conference, Johannesburg, South Africa. 5–7 October 2022.

Basson, H.J., Maré, A., Van der Merwe, R. & Minnaar-Ontong, A. 2022. *Fusarium sudden death syndrome: A pre-breeding approach for resistance in South African soybeans*. Poster presented at the 14th

South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6-9 March 2022.

Chiuraise, N., Visser, B., Maré, A. & Boshoff, W.H.P. 2022. *Status of resistance to Puccinia triticina in Zimbabwean wheat germplasm*. Poster presented at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6-9 March 2022.

Clayton, J. & Swart, W.J. 2022. *Exploring the cannabis (Cannabis sativa) microbiome for beneficial microorganisms*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Coertzen, J., Slippers, B., Gryzenhout, M. & Marais, G.J. 2022. *Neofusicoccum parvum and other members of the Botryosphaeriaceae associated with dieback in pecans in South Africa*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Du Toit, I., Boshoff, W.H.P., Rothmann, L.A. & Visser, B. 2022. *Fungicide sensitivity among South African Puccinia graminis f. sp. tritici isolates*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Edwards, A. & Swart, W.J. 2022. *Characterising the effect of salicylic acid on Sclerotinia stem rot of soybean*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Edwards, A., Swart, W.J., & Rothmann, L.A. 2022. *Characterising plant health promoting microorganisms (PGPM's) and potential biological control agents (BCA's) from the soybean microbiome*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Fosa, H., Swart W.J. & Coetzer, G. 2022. *Biocontrol of Rhizopus rot on spineless cactus pear (Opuntia ficus-indica L.)*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of

Pretoria, Pretoria, South Africa. 1-3 August 2022.

Fosa, H., Swart, W.J., & Coetzer, G. 2022. *Isolation and identification of three Bacillus spp. causing soft rot of spineless cactus pear*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Fosa, H., Swart, W.J., & Coetzer, G. 2022. *Root growth promotion of spineless cactus pear cladodes using Debaryomyces fabryi and Aureobasidium pullulans*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Hlongwane, N.V., Swart, W.J., Rothmann, L.A., & Edwards, A. 2022. *Exploring soybean and sunflower microbiomes for beneficial bacterial microorganisms*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Lessing, A., Swart, W.J. & Marais, G.J. 2022. *Evaluation of fungi for dry retting of kenaf*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Masisi T.V., McLaren, N.W., Jackson, M. & Rothmann, L.A. 2022. *Sorghum grain mold: identifying fungal colonisers, quantifying concomitant mycotoxins and exploring conducive weather periods*. Poster presented at the 3rd African Society of Mycotoxicology joint Mytox-South Conference Stellenbosch, South Africa. 3-8 September 2022.

Masisi, T.V., Rothmann, L.A., McLaren, N.W. & Jackson, M. 2022. *Identification and occurrences of fungi and mycotoxin contamination in sorghum grain fractions*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Mbambo, S.T., Tedder, M.J. & Steenhuisen, S. 2022. *Effects of drought stress on flowering phenology and growth of grassland forbs*. Poster presented at the 57th Grassland Society of Southern Africa (GSSA) Congress, Aldam Holiday Resort & Conference Centre, Free State, South Africa. 26-28 July 2022.

Meyer, W.B., Boshoff, W.H.P. & Visser, B. 2022. *Occurrence and pathogenicity of Puccinia helianthi*

on sunflower in South Africa. Poster presented at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6-9 March 2022.

Mishasha, T., Zhou, M. & Van der Merwe, R. 2022. *Family by environment interactions for brix content in sugarcane breeding*. Poster presented at the 14th South African Plant Breeders' Association (SAPBA) Symposium, Protea Hotel, Stellenbosch, South Africa. 6-9 March 2022.

Miya, S., De Wit, M., Van Biljon, A., Venter, S.L. & Amonsou, E. 2022. *Characterization of mucilage proteins and carbohydrates responsible for capacity and stability of foam food systems*. Poster presented at the Xth International Congress on Cactus Pear and Cochineal: Cactus the new green revolution in drylands, Brazil, 26-29 September 2022.

Miya, S., De Wit, M., Van Biljon, A., Venter, S.L. & Amonsou, E. 2022. *Correlation of Opuntia ficus-indica Mill. and O. robusta mucilage yield to different physico-chemical characteristics*. Poster presented at the Xth International Congress on Cactus Pear and Cochineal: Cactus the new green revolution in drylands, Brazil, 26-29 September 2022.

Miya, S., De Wit, M., Van Biljon, A., Venter, S.L. & Amonsou, E. 2022. *Opuntia cladode mucilage: Proteins*. Poster presented at the Xth International Congress on Cactus Pear and Cochineal: Cactus the new green revolution in drylands, Brazil, 26-29 September 2022.

Miya, S., De Wit, M., Van Biljon, A., Venter, S.L. & Amonsou, E. 2022. *Opuntia ficus-indica Mill. and O. robusta cladode mucilage: Carbohydrates*. Poster presented at the Xth International Congress on Cactus Pear and Cochineal: Cactus the new green revolution in drylands, Brazil, 26-29 September 2022.

Mohotloane, M.M. & Mafa, M.S. 2022. *Formulation of holocellulolytic enzyme cocktail for hydrolysis of HRP delignified rooibos bagasse for production of value added chemicals*. Poster presented at the 32nd Catalysis Society of South Africa (CATSA), Champagne Sports Resort, Central Drakensberg, South Africa. 13-16 November 2022.

Spelman, Z., Visser, B., Terefe, T., Pretorius, Z.A. & Boshoff W.H.P. 2022. *Pathogenicity and microsatellite characterization of Puccinia hordei in South Africa*. Poster presented at the 52nd Congress of the Southern African Society for Plant

Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Tsotetsi, M.E., Boshoff, W.H.P. & Visser, B. 2022. *Functional analysis of the AvrSr50 avirulence gene in South African Puccinia graminis f. sp. tritici isolates*. Poster presented at the 52nd Congress of the Southern African Society for Plant Pathologists (SASPP), Future Africa, University of Pretoria, Pretoria, South Africa. 1-3 August 2022.

Research Reports

Van der Merwe, R. & Fourie, J.B. 2022. *Evaluating the effect of enOrmus on plant biomass and yield of vegetable-type soybean under glasshouse conditions*. Report delivered to TransFormus.

Van der Merwe, R. & Lombaard, R. 2022. *Evaluating the effect of enOrmus and Soil Life Combo on plant biomass and yield of maize and vegetable-type soybean under field conditions*. Report delivered to TransFormus.

Industry Papers

Boshoff, W.H.P., Visser, B. & Pretorius, Z.A. 2022. *Barley leaf rust - latest research on rust fungus (in Afrikaans)*. *Koringfokus* 40.4 Jul/Aug 10-11. (Awarded best article in edition)

Pretorius, Z.A. & Boshoff, W.H.P. 2022. In: *History of Plant Pathology in South Africa. Cereal Rust Pathology: 85-89*. 1st Edition. Briza Publications, Pretoria, South Africa.

Terefe, T. & Boshoff, W.H.P. 2022. *New leaf rust races detected on wheat in South Africa*. *SA-Grain* 49(5): 48-49.

Visser, B., Boshoff, W.H.P. & Pretorius, Z.A. 2022. *Lessons from the past: herbarium samples share light on wheat rust in South Africa (in Afrikaans)*. *Koringfokus* 40.6 Nov/Dec 22-23.



STAFF (2022)

Head of Department:
Prof L Herselman

BLOEMFONTEIN CAMPUS

Professors:	Prof L Herselman, Prof MT Labuschagne and Prof WJ Swart
Associate Professors:	Prof WHP Boshoff and Prof B Visser
Affiliated Professor:	Prof PW Crous
Senior Lecturers:	Dr L Joubert, Dr GJ Marais, Dr A Minnaar-Ontong, Dr L Mohase, Dr MJ Moloji, Dr AC van Aardt, Dr A van Biljon and Dr R van der Merwe
Lecturers:	Dr M Jackson, Dr MS Mafa, Dr A Maré, Dr NW Mbuma (Contract), Dr L Rothmann and Dr DA Veldkornet
Senior Researcher:	Dr EP Abdi (Contract)
Mentor:	Prof L Scott (Contract)
Chief Officer – Professional Services:	Dr CM Bender
Senior Officers – Professional Services:	Ms M Frylinck and Mr HP Pretorius
Officer – Professional Services:	Dr C Steyn
Senior Assistant Officers:	Ms LP Mbingeleli and Ms OML Taylor
Assistant Officer:	Ms K Mbatha
Technical Aid:	Mr PR Chakane
Cleaners:	Ms NH Dlamini, Ms NS Macwili and Ms LHA Molale

Research Fellows:	Dr ME Cawood, Dr GP Potgieter, Prof ZA Pretorius, Dr R Ramburan, Dr L Rossouw, Dr AM Venter and Prof HJT Venter
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Subject Head:	Dr S Steenhuisen
Associate Professor:	Prof AOT Ashafa
Senior Lecturers:	Dr A Gokul, Dr R Ngara and Dr S Steenhuisen
Lecturers:	Dr PJ Mojau and Mr TR Pitso
Academic Facilitator:	Ms NG Mochologi
Officers – Professional Services:	Ms D Mosea and Mr NP Mzizi
Research Fellows:	Prof LV Komoreng, Prof RT Moffett, Dr RJ McKenzie, Dr TM Mokotjomela, Dr T Ramakuwela and Dr JD Vidal Jr.



DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY

FACULTY OF NATURAL AND AGRICULTURAL SCIENCES



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OVERVIEW OF 2022

During 2022 we welcomed two new staff members on the Bloemfontein Campus – Dr Ed Netherlands was appointed as Senior Lecturer and Dr Sibonginhlahlala Mahlobo-Shwabede was appointed as Officer (Technician) for the running and maintenance of our molecular laboratory.

Numerous conferences were attended, including some abroad. Staff from Zoology and Entomology,