

# Department of PLANT SCIENCES

## CONTACT DETAILS

Bloemfontein Campus  
Prof Liezel Herselman  
Department of Plant Sciences

Faculty of Natural and Agricultural Sciences  
University of the Free State  
PO Box 339  
Bloemfontein  
9300 South Africa

Telephone: +27 51 401 2514  
Email: [HerselmanL@ufs.ac.za](mailto:HerselmanL@ufs.ac.za)  
Website: [www.ufs.ac.za/plant](http://www.ufs.ac.za/plant)

Qwaqwa Campus  
Dr Sandy-Lynn Steenhuisen  
Department of Plant Sciences

Faculty of Natural and Agricultural Sciences  
University of the Free State  
Private Bag X13  
Phuthaditjhaba  
9866 South Africa

Telephone: +27 58 718 5330  
Email: [SteenhuisenS@ufs.ac.za](mailto:SteenhuisenS@ufs.ac.za)  
Website: [www.ufs.ac.za/plant](http://www.ufs.ac.za/plant)



## OVERVIEW OF 2021

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 (both Bloemfontein and Qwaqwa Campuses), Plant Breeding and Plant Pathology.

The year of 2021 saw both support and academic staff of the Department returning to campus full-time, amid strict COVID-19 regulations. This clearly showed the commitment of all staff members to the 2021 academic project, ensuring that both under- and postgraduate students received face-to-face learning and teaching, as well as research supervision. In spite of international travel restrictions, academic staff showed their commitment towards research by attending virtual conferences, some even contributing towards keynote lectures. During 2021, 14 Honours, 11 Master's and 2 Doctoral students obtained their degrees.

## ACHIEVEMENTS

### Staff Achievements

Dr Sandy-Lynn Steenhuisen won the staff component of the 2021 Natural and Agricultural Sciences (NAS) Faculty Flash Fact Competition, with a three-minute presentation on 'The cheesy side of flowers – Interactions between microbes, pollinators and Proteas'. Dr Mpho Mafa won the third prize in the competition with his presentation on 'Unravelling the protective role of carbohydrates in plants exposed to abiotic and biotic stress'.

Dr Lisa Rothmann was selected to participate in the short learning programme at the University of Stellenbosch: Centre for Research on Evaluation, Science and Technology (CREST) on 'Supervisors of Doctoral Candidates at African Universities'.

Dr Ntombokulunga Mbumba was awarded a certificate of reviewing in October 2021, in recognition of participation in the peer review process for the *African Journal of Food, Agriculture, Nutrition and Development* (AJFAND) as Senior Reviewer.

Mr Ngaka Mzizi, an Officer: Professional Services in the Department (Qwaqwa Campus), received his Master's degree in Botany.

### Student Achievements

A number of students from Plant Breeding won prizes from the Southern African Plant Breeders' Association (SAPBA). Wills du Preez and Tumo Makhetha received the award for

best second-year students in Plant Breeding, Jenna Vos for best third-year student in Plant Breeding, and Henry Basson for the best fourth-year student in Plant Breeding, while St Raphael Banda won the prize for best MSc student in Plant Breeding and Dr André du Toit the prize for best PhD student in Plant Breeding.



Henry Basson

Botany students who were awarded prizes at the Faculty's prize giving function were Robyn Liebenberg, Jo Cobbold and Isabella du Toit, who received Botanical Society of South Africa (Free State Branch) prizes for the best second-year, third-year and Honours students in Botany, respectively. Wilku Meyer received the EM van Zinderen Bakker prize for a student with an outstanding MSc study in Botany.



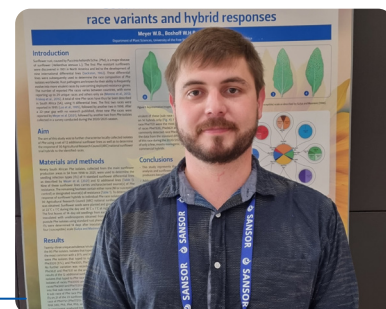
Jo Cobbold

In Plant Pathology, Tumo Makhetha received the incentive prize for Plant Pathology and Kevin Chandler received the award for the best final-year student in Plant Pathology.

Postgraduate students participated in the Annual Postgraduate Student Symposium hosted by the Department of Botany and Plant Biotechnology at the University of Johannesburg that was held virtually from 9-12 November 2021. Jo Cobbold won the first prize for her Honours project presentation titled 'To Bee or not to Bee'. Her supervisors were Dr Lize Joubert and Dr Rothmann. Henry Basson won the third prize in the MSc category for his talk 'A pre-breeding approach towards soybean sudden death syndrome resistance in South African soybeans', for which his supervisors were Dr Adré Minnaar-Ontong and Dr Rouxlene van der Merwe. Finally, Wilku Meyer was awarded the second prize in the PhD category with a talk 'An overview of virulence and genotypic assessment of South

African *Puccinia helianthi* isolates'. His supervisors were Prof Willem Boshoff, Dr Minnaar-Ontong and Prof Botma Visser.

Wilku Meyer was also the co-recipient of the Junior Captain Scott Memorial Medal awarded by the South African Academy for Science and Arts for the best MSc dissertation in Botany awarded at a South African university. The title of his dissertation was 'Phenotypic and genotypic variation of *Puccinia helianthi* in South Africa'.



Wilku Meyer

## TEACHING AND LEARNING

From 16 to 26 February 2021, Dr Joubert and Dr Andri van Aardt led the third-year Botany excursion for 39 students. Due to lockdown regulations and COVID-19, the excursion was held in the Free State, with daily field trips to different field sites, including the Seven Dams Conservancy and the Free State National Botanical Garden in Bloemfontein, Golden Gate Highlands National Park (GGHNP) and De Krantz Wildlife Reserve. During the excursion, the third-year Botany students were trained in several vegetation survey, plant identification, research and specimen collection techniques.

On 12 August, postgraduate students from the Department of Plant Sciences participated in the launch of ShareScreen Africa, a training initiative by Leadership for Conservation in Africa.

On 15 October, postgraduate students from the Taxonomy and Pollination Laboratory visited Kopsie alumnus, Mr Andy Khuo, at Hsiang Chun Orchid Garden, to learn about the business side of growing orchids.



Visiting the Orchid Garden, from the left, Mr Andy Khuo, Mr Charl Cillé, s Emma Ferreira, Mr Goitseone Sedimo and Ms Hantie Grobler

On 29 October, Dr van der Merwe, Dr Minnaar-Ontong and Dr Angeline van Biljon led the combined second- and third-year Plant Breeding excursion to an onion production farm close to Petrusburg. During the excursion, the students were exposed to onion cultivar variety trials that are performed by industry in collaboration with local farmers. Students had to complete a questionnaire based on the production, marketing and economic value, and need for breeding, of the different varieties that were illustrated during the excursion.



Students on the excursion to an onion production farm

Prof Boshoff presented an invited lecture titled ‘Stem rust in wheat – the Southern African perspective’, as part of an on-line 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. As part of the same online seminar, Dr van Biljon presented an invited lecture titled ‘Nutritional improvement through biofortification’, and Prof Visser an invited lecture titled ‘Out of Africa to down under: a study on the proposed inter-continental movement of wheat stem rust’.

## RESEARCH AND INNOVATION

### SARChI Chair in Disease Resistance and Quality of Field Crops

The National Research Foundation (NRF) South African Research Chairs Initiative (SARChI) Chair in Disease Resistance and Quality in Field Crops, headed by Prof Maryke Labuschagne, will continue until 2025. The wheat quality research of the Chair delivered a PhD thesis on the influence of abiotic stress conditions on durum wheat gluten protein composition and quality. Another PhD study on the influence of abiotic stress conditions on bread making quality and gluten protein composition is almost completed. Three MSc projects on wheat quality were in progress in 2021, of which one on the influence of stripe resistance genes on gluten protein composition and selected baking quality characteristics, has been completed. Another on the *wbm* (wheat bread-making) gene in selected South African wheat cultivars has led to three backcross generations. A project on resistant starch in South African wheat cultivars has already

tested molecular markers for the presence of resistance starch genes, and the evaluation of starch, amylopectin and amylose has completed.



In terms of crop biofortification, a project on stacking of genes for iron, zinc, provitamin A and essential amino acids has culminated in the completion of a PhD thesis. Another PhD project on quality protein maize in Ethiopia, and breeding for climate resilience in this maize, is almost complete. Two new PhD projects on sorghum nutritional value started in 2021, one in South Africa and one in Ethiopia. In terms of legumes, four cowpea projects are underway, the first on the influence of drought stress on cowpea nutritional quality, one PhD study in South Africa on heritability and expression of nutritional value, and an MSc project on genetic diversity in a mutant cowpea collection. A genetic diversity PhD project in a West-African cowpea collection is underway in Nigeria and Ghana. A PhD study on genetic diversity in a southern African bambara groundnut collection was completed. This Chair’s research has culminated in 11 accredited papers being published in 2021, as well as three oral and two poster presentations at international conferences.



In the research on disease resistance, an MSc student completed her dissertation on barley leaf rust (*cum laude*). Research highlights from the rust programme for the report period include the acceptance of nine research papers in peer reviewed journals. Two of these papers resulted from contributions made by UFS staff to international studies in the control of wheat stem rust and were published in *Theoretical and Applied Genetics* and *Nature Communications*. The other papers reported on breeding for rust resistance as well as on the occurrence and pathogenic variation of different *Puccinia* species. Through the UFS rust programme, one new wheat leaf rust race and one stem rust race were described. The impact of these new races on wheat cultivar responses has been determined and the data was made available for inclusion in the wheat production guidelines of the Agricultural Research Council-Small Grain (ARC-SG). Data was also made available to wheat producers through the popular media in a recent paper published in *Wheat Focus* titled 'Increased incidence of wheat stem rust in the south-eastern production areas of the Western Cape during the 2020-season'. Another contribution made in the popular media was a paper titled 'Stripe rust 25 years later: Collaboration turned hysteria around', which presented a historic review since the first report of this disease in 1996 in South Africa.

### Botany: Plant physiology/biochemistry and molecular biology

Dr Arun Gokul identified five different endophytic isolates that had significant biocontrol activity against *Fusarium oxysporum* in laboratory trials. Currently research is being conducted to determine their efficacy in controlling phytopathogens in maize plants.

Dr Mpho Mafa's research is based on two pillars – the Carbohydrates and Carbohydrate-Active enZymes (CAZymes) in plant health and the application of CAZymes in the bio-refinery sector. Plant defence responses against a pathogen, pest and environmental stress include morphological, physiological and biochemical changes. In his laboratory, the defensive functions of both structural and non-structural carbohydrates during plant-biotic or plant-abiotic interactions, are being investigated. For instance, carbohydrates (soluble sugars) are involved in plant osmoregulation (osmolytes) during drought. In the biorefinery sector, CAZymes are used to hydrolyse agricultural residue into value-added chemicals such as biofuels. The use of the CAZymes is vital in the biorefinery sector, and the rapid increase of the sector's products validates their importance. In addition, understanding these enzymes hold answers to more environmentally friendly products and chemicals. Hence, the focus includes CAZyme physicochemical characterisation, substrate specificity, kinetics and synergistic application.

Dr Rudo Ngara was awarded an NRF-Thuthuka grant for the period 2021 to 2023 on a new abscisic acid signalling and root transcriptomics project of drought-stressed sorghum. She also continued with her research on the complex responses of sorghum and maize to a range of abiotic stress factors.



Dr Rudo Ngara

Prof Botma Visser, in collaboration with Prof Willem Boshoff (Plant Pathology), studies the genetic relationships between races and isolates of fungi that cause rust diseases of cereal crops. During 2021, microsatellite markers were used to describe the genetic structure of *Puccinia graminis* f. sp. *tritici* (causing stem rust of wheat), *Puccinia triticina* (causing leaf rust of wheat), *Puccinia hordei* (causing leaf rust in barley) and *Puccinia sorghi* (causing leaf rust in maize). A protein kinase encoding gene involved in the adult plant resistance response of wheat against stem rust, was characterised, while a single nucleotide deletion was identified in the *avrSr50* effector protein encoding gene of South African *P. graminis* f. sp. *tritici*, which could lead to *Sr50* virulence in the near future. Phylogenetic studies in collaboration with Prof Zakkie Pretorius, Dr Cathy Aime and Dr Alan Wood, were also used to identify rust pathogens occurring on different *Solanum* species, finger grass and fig trees, as well as a variety of ornamental and native shrubs and grasses.

Dr Makoena Moloi's research focuses on plant-environment interactions – particularly abiotic stress physiology and ecophysiology. Her current research involves the physiological, biochemical and morphological responses of edamame and cowpea to drought and high temperature stress. Another project involves the use of natural bio-stimulants/bio-fertilisers to mitigate drought stress in edamame and spinach. This research is of great importance as it provides solutions for crop production under changing climatic conditions.



Dr Lintle Mohase

Dr Lintle Mohase and her research team investigate plant defence mechanisms in wheat infested by the Russian wheat

aphid (RWA), *Duiraphis noxia*. She collaborates internally with a biochemist (Dr Mafa), molecular biologist (Prof Visser) and plant pathologist (Prof Boshoff) from the UFS, and externally with entomologists at ARC-SG, Bethlehem (Dr A Jankielsohn) and the Lesotho Agricultural Research Unit (Wheat germplasm in Lesotho). 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.

### Botany: Phytomedicine and ethnobotany

Prof Anofi Ashafa and his group is continuing with the evaluation of Basotho medicinal plants to cure and/or ameliorate both infectious and non-infectious diseases. During the 2021 research year, the group developed four herbal remedies into capsules to ease administration and consumption for constipation, diabetes and high blood pressure. In the near future, they will be collaborating with both local and international collaborators to work on neglected tropical diseases, using medicinal plants.

### Botany: Plant taxonomy and molecular systematics

Dr Lize Joubert collaborated with Prof Carlien Pohl-Albertyn (UFS Department of Microbiology and Biochemistry) in an application for a NRF-National equipment plan (NEP) grant, which funded the purchase of a new Zeiss LSM900 confocal microscope for the UFS Centre for Microscopy.

Dr Joubert and one of her Honours students, Ms Jo Cobbold, conducted a pollination efficiency assessment of macadamia cultivars in South Africa, in a study funded by Macadamias South Africa (SAMAC). This study highlighted the value of using managed beehives to supplement pollination in macadamia orchards, as well as the role cultivar selection plays in pollination efficiency and yield.



Macadamia nuts

Dr Joubert continued collaboration with Dr Mariëtte Jackson, Dr Andri van Aardt (UFS) and Mr Pieter Bester from the South African National Biodiversity Institute (SANBI) on the study of flower structure and diversification of the genus *Nemesia* (Scrophulariaceae). This project explores the intersection between the fields of plant systematics, ecology, pollination biology and evolutionary development to gain a better understanding of the origins of South Africa's most diverse plant groups. Progress has been made on compiling a complete taxonomic revision and phylogenetic analysis of the genus. The research results have also elucidated the developmental mechanisms that control aspects of floral structure, and potential diversification, in *Nemesia*.



The Cape jewel – *Nemesia strumosa*

Dr Jackson is heading the Molecular Systematics Research group. An initial project has been completed in a new field of research which investigated the retrieval of genetic data from fossil soil sediments from the fossil pollen collection of Prof Louis Scott. Dr Jackson was also involved in an MSc Plant Pathology project, with Dr Lisa Rothmann, in which fungi within sorghum kernels were identified using molecular techniques. Dr Jackson also collaborates with Dr Joubert on her *Nemesia* project.

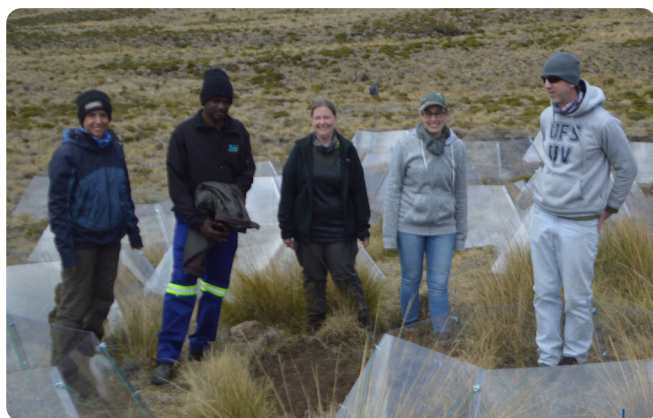
### Botany: Palaeo-botany and ecology

Prof Scott is the co-editor and co-author of chapters in the book *Quaternary Vegetation Dynamics – The African Pollen Database*, an open access publication available online since November 2021. Prof Scott's research on palaeoenvironments derived from alluvial deposits in the western Cape at Uniondale, appeared in *Palaeogeography, Palaeoclimatology, Palaeoecology*. He was also involved in a publication in *Ambio* of the work of Kenyan student, Veronica Muiruri.

Dr van Aardt's research focused on terrestrial and aquatic studies in the GGHNP in the Free State. She also started to collaborate with SANBI on the VegMap programme on

vegetation type mapping and ground truthing in the Free State. Research on palaeoenvironments in the Grassland and Savanna biomes is ongoing. She also collaborated on a research paper on food plants in the Cradle of Humankind.

Dr Sandy Steenhuisen continued collaborations with University of KwaZulu-Natal (UKZN) through two Honours projects, co-supervised with Dr Ruth Cozien, on the effect of variation in plant gender on reproductive success in the lizard-pollinated plant, *Guthriea capensis*, and the pollination ecology of the rare subalpine endemic, *Nerine bowdenii* subspecies *wellsii*, on the slopes of Sentinel Mountain in the northern Drakensberg. Her research group's focus on invasive plant species continues to grow with the start of two MSc projects and co-supervision of a PhD student working on the reproductive ecology and invasion potential of alien Rosaceae (*Cotoneaster* sp., *Rosa* sp.), an MSc project on the effectiveness of the Working for Water Programme in the Blyde River catchment (Department of Forestry and Fisheries, Mpumalanga), and a near completed PhD on the impacts of invasive *Nassella* species on montane grasslands. A new co-supervised PhD project on the generic definition and pollination ecology of the genus *Galtonia*, with Prof Glynis Goodman-Cron (University of the Witwatersrand) commenced in October. Experiments were set up with a large international team investigating the effects of climate change on biodiversity and ecology of range-expanding plant species in alpine ecosystems. This BiodivERSA project (RangeX) is funded by a European Union Horizon2020 grant and involves a comparative experimental setup in South Africa, Switzerland and Norway, with plans to expand to China, Canada and Sweden. This is led by Dr Jake Alexander (University of Zurich) and Dr Ralph Clark (Afromontane Research Unit [ARU]). Dr Steenhuisen is a South African co-principal investigator responsible for investigating the effects of climate change (warming) on pollinators and reproductive success of focal species in the study sites, using phenological patterns and observations from time-lapse camera footage. Through this project, they aim to establish the first alpine research station in South Africa, located on the Amphitheatre plateau in the Maloti-Drakensberg mountains.



Inspecting the RangeX project at the open top chambers on the Maloti-Drakensberg, from the left, Evelin Iseli, Dr Onalenna Gwate, Dr Sandy Steenhuisen, Dr Stephanie Payne and Dr Ralph Clark

Apart from plant-focused research, Dr Steenhuisen also conducts research on the soundscape of Afromontane wetlands using sound recorders to assess avian diversity in wetlands in the GGHP, surrounding mountains and into Lesotho, through a collaboration with the ARU, BirdLifeSA, National University of Lesotho (NUL), SANParks and the Department of Entomology and Zoology (UFS Qwaqwa).

## 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 three different breeding backgrounds, have been identified with unknown rust resistance. The three breeding backgrounds include the International Maize and Wheat Improvement Center (CIMMYT) rust resistant nursery, Morden Research and Development Centre – Agriculture and Agri-Food Canada and CM-82036/AvocetS. This research is funded by the NRF-Thuthuka and Winter Cereal Trust (WCT). Further progress has been made with cross breeding and application of molecular markers to enhance rust and Fusarium head blight (FHB) resistant wheat lines with a higher number of resistance genes to ensure durable resistance in wheat.

Dr Rouxlene van der Merwe's research is 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 Adré Minnaar-Ontong and Dr Maré, who assist with marker-assisted selection of progenies grown in field trials. An MSc student, Kelvin Hlatswayo, works on this project.



Edamame – a vegetable type soybean

Dr Minnaar-Ontong's research focus is on breeding for resistance against fungal diseases across multiple crops with specialisation on resistance breeding against: *Sclerotinia sclerotiorum* diseases in both sunflower and soybean, soybean sudden death syndrome (SDS) and associated phytotoxins and mycotoxins produced by FHB causal pathogens. The South African economically important crops (soybeans, sunflowers and wheat) are evaluated for resistance to these different diseases (sclerotinia diseases; soybean SDS and associated phytotoxins; FHB and associated mycotoxins), to promote the improvement of disease control strategies.

The NRF-Thuthuka as well as GrainSA fund the *Sclerotinia* resistance research. This research also forms part of the South African *Sclerotinia* Research Network (SASRN) and includes the maintenance of a *Sclerotinia sclerotiorum* culture collection, derived from a population genetics study on >1000 isolates collected from eight of the nine South African provinces, across multiple crops. Dr Minnaar-Ontong and her team (Dr Chrisna Steyn, postgraduate students and collaborators) drive this research. Part of the population genetic study was completed as an MSc study. The culture collection expands continuously as more *Sclerotinia* infections are reported every season.

The soybean SDS resistance research includes the evaluation of the 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 as part of a successfully completed MSc study. 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 in South Africa.

Breeding for resistance against the mycotoxins associated with FHB causal species, was funded by the SARChI Chair in Disease Resistance and Quality of Field Crops. Several *Fusarium* species associated with FHB were identified, but *F. graminearum* was identified as the predominant causal species. The mycotoxins involved, deoxynivalenol (DON) and nivalenol (NIV), pose a threat to both human health and food security; therefore resistance breeding against these secondary metabolites should be prioritised. A part of this research was completed successfully as Honours and PhD studies. Knowledge gained from analyses will assist with the development of effective control strategies for resistance breeding against FHB and the associated mycotoxins. This will provide an incentive to farmers to plant wheat, thus improving wheat production in South Africa.

### Plant Breeding: Conventional breeding

In her research, Dr van der Merwe's focus is on breeding for tolerance to drought and heat stress in vegetable-type soybean (in collaboration with the Edamame Development Program [EDP]). This research continued to make progress on the characterisation of vegetable-type soybean cultivars in terms of drought and heat stress tolerance. The project is

undertaken 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 has been funded since 2021 by the NRF-Competitive Support for Unrated Researchers. One MSc student (Drikus Coertzen) is enrolled for his degree on this project, while one final year BSc Agric student (Jenna Vos) performed heat stress screening activities as part of her research project.



*Leaf sample collection on vegetable-type soybean plants exposed to a drought stress treatment under field conditions*

A project on the impact of water-limited-stress (WLS) on the morphology, physiology and nutritional quality of dry bean, commenced in 2021 and aims to characterise dry bean cultivars in terms of drought stress tolerance and nutritional quality. This project is done in collaboration with Dr van Biljon who assists with nutritional quality analysis and Dr Moloï who assists with physiological response analyses. One MSc student (Lesole Sefume) is enrolled for his degree on this project.



*Drikus Coertzen showing the root system of a vegetable-type soybean seedling after exposure to drought stress in the glasshouse*

## Plant Breeding: Wheat–quality and crop–nutritional value research

The PhD project on the influence of heat and drought stress on durum wheat quality and gluten protein was completed, under supervision of Prof Labuschagne and Dr van Biljon. The research on the influence of abiotic stress conditions on bread wheat quality and gluten protein composition continued, under supervision of Dr van Biljon and Prof Labuschagne and Prof Garry Osthoff (UFS Department of Microbiology and Biochemistry). A joint project with the division of Plant Pathology (Prof Labuschagne, Prof Boshoff and Dr van Biljon) on the influence of stripe rust resistance genes on gluten protein composition and some baking quality characteristics, was completed as part of a completed MSc dissertation. A project on the influence of the bread-making gene in South African wheat cultivars in terms of protein composition and quality, has progressed well and backcrosses are in progress (under supervision of Dr Maré, Dr van Biljon and Prof Labuschagne). They also supervised the project on resistant starch in South African wheat, which included testing for starch, amylose and amylopectin in wheat, and testing of molecular markers on the material.

A project with CIMMYT, Harare, on biofortification of maize with iron, zinc, lysine and tryptophan, and provitamin A through gene-stacking, was completed as part of a PhD thesis. Another project is underway on biofortified maize in Ethiopia, and on improving abiotic stress resilience of this material (supervised by Prof Labuschagne and Dr van Biljon). A PhD project on genetic diversity in bambara groundnut germplasm in southern Africa was completed as part of a doctoral study. Two PhD projects are underway on genetic diversity, and enhancement of nutritional value of cowpea germplasm in southern and West Africa, and students are in the process of doing field trials. An MSc project on cowpea mutants is also in the field trial stage. Another MSc project on genotype and environmental effects on maize grain yield, nutritional value, and milling quality has progressed well (supervised by Dr Mbuma and Prof Labuschagne). Two PhD projects, supervised by Prof Labuschagne, Prof Herselman and Dr van Biljon, on nutritional value of sorghum in South Africa and Ethiopia are underway, using both conventional and molecular breeding.

Dr Ntombokulunga Mbuma and Prof Labuschagne collaborated with researchers from the ARC on a project that focuses on the development and improvement of high yielding cowpea genotypes/cultivars with improved protein content and mineral elements, in combination with good agronomic performances through bio-fortification breeding techniques. The research aims at understanding the adaptability and stability of cowpea varieties under South African conditions, as well as on improving cowpea genotypes for nutritional value under abiotic stresses, such as drought and heat.

Dr Mbuma and Prof Labuschagne also collaborated with researchers from Bayer – focusing on the development and improvement of high yielding maize genotypes/cultivars with improved nutritional value and milling quality. The research

also involves understanding the adaptability and stability of maize varieties under South African conditions.



Dr van der Merwe also investigates green pod yield and nutritional content of large-seeded (vegetable-type) soybean in collaboration with the EDP. This research is making progress towards the development of an improved South African vegetable-type soybean cultivar that shows high yield potential and with improved nutritional value. Promising cultivars are being evaluated on agronomic performance and consumer acceptability in order to be promoted for production by small-scale farmers. This project is done in collaboration with Dr van Biljon, who assists with sugar analysis, and Dr Hugo, who assists with fatty acid analysis. From this project, one MSc student (Jacques van der Merwe) obtained his qualification in 2021.

## Plant Pathology: Cereal rust diseases

Prof Willem Boshoff was involved in the WCT project 'Evaluation of wheat cultivars and lines for genetic resistance to rust disease', carried out annually by the UFS rust pathologists. This research involves annual greenhouse and field screening with selected races of the three rust pathogens of wheat. During 2021 field trials were carried out in the Western Cape, with the support of Syngenta staff; cereal varieties were rated with the assistance of Prof Pretorius. Field trials were planted near Greytown, KwaZulu-Natal with support from Corteva. Data from these trials is annually included in the national wheat production guidelines of ARC-SG.



*From the left, Prof Zakkie Pretorius (UFS), Dr Renée Prins (CenGen) and Prof Willem Boshoff (UFS) during a visit to field trials planted in collaboration with Corteva*



Newly initiated projects include a study of the maize rust pathogen, *Puccinia sorghi*, a collaborative project with Prof Visser and researchers at Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria and funded by the Maize Trust.

### Plant Pathology: Soil microbial ecology

Prof Wynand 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

After the lockdowns of 2020 due to COVID-19, Dr Gert Marais and the Pecan Research Group resumed their regular field trips to all the pecan production areas in South Africa in 2021. These areas ranged from Orania along the Orange River to Upington, Vaalharts, Schweizer-Reneke, Jacobsdal, and a number of areas in Limpopo, Mpumalanga, Kwazulu-Natal, Eastern Cape and North West. Farmer's days were kept to a minimum to limit large gatherings, but student research projects in the field were still conducted. Currently, six MSc and two PhD projects are studying the role of fungal pathogens in causing diseases, such as overall decline, Alternaria black spot, die-back, black blotch and scab on pecans. In addition, the resistance of pecan cultivars based on the metabolites they produce, is being investigated in a separate study. Three MSc students graduated in 2021. One project showing that the scab disease in pecans in South Africa is associated with as many as 12 different species of *Cladosporium*. The second project confirmed that *Neofusicoccum parvum* is the causative agent of dieback in pecans; although other fungal species of *Botryosphaeria*, *Dothiorella* and *Lasiodiplodia* were also isolated from dieback trees. The third project concluded a study that evaluated essential oils as potential to control crown and root rot in maize.

### Plant Pathology: Epidemiology

Dr Lisa Rothmann leads the McLab Epidemiology Group, which focuses on diseases associated with summer grain crops – sorghum, soybean and sunflower. In an internal collaboration with Dr Jackson (Botany), Mr Thabiso Masisi, supported by the Sorghum Trust, completed his MSc Agric degree in 2021, titled 'Assessing the effect of decortication on sorghum grain mold fungi and concomitant mycotoxins'. Under the supervision of both Dr Rothmann and Prof Neal McLaren, Ms Marlese Meiring submitted her PhD titled '*Sclerotinia sclerotiorum* disease potential and management responses in soybean and sunflower'. This research was supported by the Department of Science and Innovation

(DSI), the Oil and Protein Seeds Development Trust (OPDT), Sasol Agricultural Trust, and Winfield United South Africa, as well as GrainSA. The project to evaluate soybean and sunflower cultivars for escape resistance towards *Sclerotinia sclerotiorum*, is ongoing in collaboration with Dr Derick van Staden (Agronomy Info Services, Mpumalanga) and Mr Koos Strydom (producer in the Free State). In 2021, a project was initiated to identify and assess soybean seed borne diseases, in order to improve seed health through reducing prevalent fungal pathogens.



## ENGAGED SCHOLARSHIP

Prof Labuschagne served as Speciality Chief Editor of *Frontiers in Sustainable Food Systems*, and Associate Editor of *Cereal Chemistry* and *Journal of Cereal Science*. She is also a member of the Academy of Science of South Africa (ASSAF) and the Expert Working Group (gluten proteins) of the International Wheat Initiative.

Dr Joubert and Dr van Aardt are working with the UFS Department of Otorhinolaryngology and the Lung Institute at the University of Cape Town on monitoring pollen in the atmosphere to provide pollen counts on a weekly basis, that are posted on the website: <https://pollencount.co.za/> to inform allergy sufferers about the current risk.

Dr Steenhuisen was involved in mentoring emerging women researchers through the Mountain-to-Mountain Mentorship Programme run through UFS and Appalachian State University. She also serves on the Faculty's Institutional Audit Committee and was selected by the Rectorate as one of twelve academics on a panel to develop the future trajectory of the UFS through

the UFS Vision2030 project. Dr Steenhuisen continues to serve as an executive member and Treasurer for the South African Association of Botanists (SAAB). She has been promoted to Review Board Editor for the *South African Journal of Botany*, and is an Associate Editor for the *American Journal of Botany*. She also is the external moderator for undergraduate and Honours modules at UKZN (School of Life Sciences, Pietermaritzburg) and Rhodes University (Department of Botany).

Dr Rothmann's research forms part of the official Memorandum of Understanding (MoU) between GrainSA and the UFS Department of Plant Sciences, for administrating the SASRN. 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. Ms Marlese Meiring (PhD student in Plant Pathology) and Dr Rothmann led one virtual farmer's day and three information sessions on Sclerotinia diseases with industry partners under the auspices of the SASRN, supported by GrainSA. These sessions, which have been conducted chiefly in the Free State and Mpumalanga, are aimed not only at connecting producers with the current research, but also to hear from the producers what their needs from academia and industry are. The focus of the interaction with producers is to develop and communicate practical management strategies for diseases caused by Sclerotinia for local producers. Dr Rothmann and Marlese Meiring also contributed popular articles to *SA Grain* and *Oilseed Focus* magazines, on topics related to Sclerotinia cultivar evaluations and potential interventions of diseases associated with *Sclerotinia sclerotiorum*.

Dr Rothmann was invited by the OPDT and Oilseed Advisory Committee to deliver a presentation at the Soybean for Human Consumption Symposium in September 2021. Her presentation was titled 'Jack and the (soy)beanstalk: slaying disease giants'.

Dr Joubert presented a talk and a guided walk for the Friends of Seven Dams Conservancy, as well as an online talk for the Leadership for Conservation in Africa weekly seminar series.

The Geo Potts Herbarium completed barcoding all specimens in the main collection, while 3 415 specimens have been digitised in a project funded by the International Association of Plant Taxonomists. 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 worked with Parr Farm, investigating the extraction, quantification and partial characterisation of peroxidase from horseradish (*Armoracia rusticana*) root tissue and also wrote a technical report for Parr Farm.

Dr Mbuma served as Senior Reviewer of the *African Journal of Food, Agriculture, Nutrition and Development*.

Dr van der Merwe was a panellist in the online webinar section, 'Investigations of water deficit interactions with heat and elevated carbon dioxide in wheat (*Triticum*

*aestivum*)', that was held by the University of Fort Hare as part of their Research Week of Excellence, held from 15 to 18 November 2021.

Dr Minnaar-Ontong participated as reviewer for NRF student project funding applications. She reviewed industrial research project reports on Maize Trust projects on *Fusarium* and the impact of these fungi on maize, and reviewed articles for international journals, such as *Molecular Diversity* and the *European Journal of Plant Pathology*.

Prof Swart, in his capacity as President of the Southern African Society for Plant Pathology, was invited to present and interact as Chairperson with an international audience at the National Science and Technology Forum (NSTF) discussion forum on 'Plant Health – threats to biosecurity, biodiversity and food security', hosted virtually on 10 and 11 June 2021. The NSTF is a non-profit stakeholder forum representing the science, engineering and technology (SET) and innovation community in South Africa, representing 120 organisations ranging from research institutions, universities and state entities to business, professional societies (proSET) and civil society. The title of his presentation was 'Whither (or wither) Plant Pathology in the next 50 years' in which he outlined the vision for Plant Pathology. The presentation can be viewed at: <http://www.nstf.org.za/discussion-forum/plant-health-in-south-africa-threats-to-biosecurity-biodiversity-and-food-security/>.

Prof Boshoff was also invited to present a talk titled 'Disease resistance in small grain cereals: The South African approach' as part of the discussion forum.

The H3ABioNet Next Generation Sequencing Bioinformatics course for 2021 (presented by the UFS Department of Genetics) adopted a distance-based learning approach and brought together hundreds of participants from over 30 institutes in Africa. The teaching assistants for the course were Postdoctoral Fellow, Dr Castelyn, and PhD student, Wilku Meyer.

## NATIONAL AND INTERNATIONAL COLLABORATION

Prof Labuschagne collaborated with Dr Carlos Guzman, Cordoba University, Spain, on durum and bread wheat gluten composition and quality under heat and drought stress conditions. Dr Guzman co-supervised two PhD students in 2021. Prof Labuschagne also collaborated with Dr Dennis Eriksson, Agricultural University of Sweden on the AgriFoSe (Agriculture for Food Security) project on adoption rates of newly bred staple crop varieties in Africa. Collaborators from CIMMYT included Dr Itria Ibba (Mexico) on durum wheat quality, Dr Thoko Ndhlela (Harare) on biofortification of maize in Africa and Dr Dagne Wegary (Harare) on maize breeding. She also continued collaboration with ARC-Pretoria on cowpea and Bambara groundnut breeding, ARC-Bethlehem on wheat quality and ARC-Potchefstroom on maize and

cowpea breeding. Together with Dr Mbuma she collaborated with Dr Abe Gerrano and Dr Alina Mofokeng from the ARC on cowpea projects, and with Dr Sanesh Ramburan, from Bayer South Africa, on maize breeding.



After the African Pollen Database (APD) was discontinued in 2007 due to lack of funds, and after an October 2019 meeting in Paris attended by Dr van Aardt, it resumed its activities recently. It is a tool used in long-term global environmental simulation of climate change, in collaboration with international databases Neotoma (USA), Pangaea (Denmark) and the Institut Pierre Simon Laplace (France). The APD was started in 1996 in Paris by a group which included Prof Scott, in cooperation with its European counterpart, the European Pollen Database (EPD) and the Global Pollen Database hosted at the National Oceanic and Atmospheric Administration (NOAA) Paleoclimatology Database. As part of the re-launch of the APD, during 2021 Prof Scott revised, updated and submitted new fossil and modern pollen data sets from numerous southern African and Southern Ocean sites, which have been accumulated at the Palynology Laboratory in the Plant Sciences Department since the 1960s

Dr van Aardt and Prof Scott were invited to collaborate on a Spanish project 'Paleo-biodiversity and climatic fluctuations in the northern (Spain) and southern (South Africa and Argentina) Hemispheres: 150 000 years of change' by principle investigator Dr Yolanda Fernandez-Jalvo, of the National Museum of Natural Sciences in Madrid.

Dr van Aardt collaborated with Prof Marlize Lombard, Professor in Stone Age Archaeology at the University of Johannesburg on a project about the foodplants growing in the Cradle of Humankind Fossil Hominin Site. She was also invited by Anisha Dayaram from SANBI to collaborate on the VegMap for the Free State Province.

Dr Marais collaborated with the South African Pecan Nut Producers Association (SAPPA) and FABI (Prof Bernard Slippers and Prof Wilhelm de Beer) to study diseases in the pecan industry in South Africa.

Dr Steenhuis collaborated nationally and regionally with Dr Cozien (UKZN), Department of Forestry and Fisheries (Mpumalanga), Prof Aliza Le Roux (UFS Department of Zoology and Entomology), Dr Grant Martin (Centre for Biological Control, Rhodes University and Research affiliate with the Department of Entomology and Zoology, UFS Qwaqwa), Dr Ralph Clark (Director, ARU), Dr Kim Canavan (Centre for Biological Control, Rhodes University), Prof David Richardson (Centre for Invasion Biology, Stellenbosch University), Prof Colleen Downs (SARChI Chair in Ecosystem health and biodiversity, UKZN), Dr Peter Chatanga (NUL), and Prof Glynis Goodman-Cron (University of the Witwatersrand). Her international collaborators include Dr Jake Alexander (University of Zurich, Switzerland), Dr Jamie Alison and Toke Thomas Høye (Aarhus University, Denmark), Dr Rachel Prunier (University of California, USA), Prof Robert Raguso (Cornell University, USA), and Dr Clara de Vega (University of Seville, Spain).

Dr Gokul maintains national collaboration with Prof Marshall Keyster (Environmental Biotechnology Laboratory) and Prof Ashwil Klein (Plant Omics Laboratory at the University of the Western Cape) on the project 'The isolation and exploitation of endo-symbionts to enhance plant growth, health and biocontrol'. The collaboration has resulted in the graduation of two MSc students as well as five articles in high impact factor journals.

Dr Rothmann and Ms Meiring are in collaboration with AgriSeed/DMS Genetics in Delmas. Soybean and sunflower field trials on the experimental farm are aimed at cultivar and fungicide evaluations. Dr Rothmann is also part of an official MoU between the UFS and the Universidade Federal de Viçosa, Minas Gerais, Brazil. This MoU facilitates research collaboration and potential future exchange opportunities.



Dr Joubert collaborated with Mr Pieter Bester from SANBI, Prof Beverley Glover from the Department of Plant Sciences at the University of Cambridge and Dr Mario Fernandes-

Mazuecos from the Autonomous University of Madrid, on the project 'The role of flower structure in the diversification of the genus *Nemesia* (Scrophulariaceae)'. The collaborators provide expertise on the taxonomy of Scrophulariaceae, floral evolutionary development and molecular systematics respectively. Dr Fernandes-Mazuecos presented an online talk on his research on the genus *Linaria* from the Mediterranean region. Dr Joubert also collaborated with Dr Victoria Ruiz-Hernández from Universidad Politécnica de Cartagena in Spain on a project focusing on the relationship between human, bumblebee and thrips preferences for floral characters in *Antirrhinum*. This collaboration resulted in the publication of a research paper in 2021.

Dr Mafa and Prof Pletschke Brett (Biochemistry and Microbiology, Rhodes University) collaborated on the Enzyme Science Programme (ESP) with Dr Samkelo Malgas, the principal investigator based at the Department of Biochemistry, Genetics and Microbiology, University of Pretoria. The research included biorefinery projects in which they investigated the synergistic application of glycoside hydrolase and carbohydrate esterase enzymes for the effective hydrolysis of agricultural residues.

Dr Moloi collaborated with Prof Ned Bowden from the University of Iowa, USA, on a project involving the use of dithiophosphates on the improvement of drought tolerance in crops of agricultural importance. They are currently co-supervising an MSc student on the project. Dr Moloi also collaborated with Prof Brigitta Tóth of the University of Debrecen, Hungary on crop physiology and improvement and their work produced five publications in peer reviewed journals.

Dr Rudo Ngara initiated new collaborative links with Dr Dirk Swanevelder from the ARC-Biotechnology Platform, Onderstepoort for the transcriptomics analysis of sorghum under drought stress. She also continued working with Dr Nemera Shargie, ARC-Grain Crops, Potchefstroom and Dr Stephen Chivasa, Durham University, UK, on stress biology projects of cereals.

Nationally, Dr van der Merwe continued her collaboration with the EDP, based at Mariannhill in KwaZulu-Natal, on germplasm maintenance of introduced varieties, base seed multiplication, research and training of students, pre-breeding and new cultivar development for South African growing conditions. She also established a 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 conditions. This project is also done in collaboration with Dr Elmarie van der Watt at Agronomy (UFS).

On international level, Dr van der Merwe and Dr Minnaar-Ontong continued their collaboration with Prof Qiuying Zhang from the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences. The project focuses on breeding for resistance to pod shattering in vegetable-type soybean.

Dr Minnaar-Ontong also collaborated with Syngenta (together with Dr Rothmann) on breeding for resistance to Sclerotinia diseases in both soybean and sunflowers, with breeding companies from industry, and researchers from the University of Manitoba, Canada and the University of Nebraska and the United States Department of Agriculture (USDA) in the USA.



Prof Boshoff collaborated with researchers from the Kingdom of Saudi Arabia (King Abdullah University of Science and Technology), the United Kingdom (John Innes Centre), Australia (Commonwealth Scientific and Industrial Research Organisation [CSIRO] Agriculture and Food), and China (Institute of Genetics and Developmental Biology, Chinese Academy of Sciences). Two peer-reviewed papers were published during 2021 from these collaborations and one is under review. Locally Prof Boshoff collaborated with Dr Renée Prins from CenGen, Dr Tarekegn Terefe at ARC-SG and researchers at Stark Ayres and Syngenta.

Prof Visser collaborated with Dr Les Szabo (University of Minnesota, USA) and Dr Cathie Aime (Purdue University, USA), which resulted in two papers that were accepted for publication. Nationally, he collaborated with Dr Alan Wood (ARC-Plant Health & Protection, Stellenbosch) and Dr Terefe (ARC-SG, Bethlehem).

Dr Mohase collaborated with Dr Jankielsohn (ARC-SG, Bethlehem) on projects involving RWA phenotyping under greenhouse conditions and aphid diversity in South Africa and Lesotho. Additionally, she collaborated with the Lesotho Agricultural Research Unit, which provided wheat germplasm in Lesotho.

Prof Ashafa maintained his international collaboration with Dr TO Ojuromi (Department of Zoology and Environmental Studies, Lagos State University, Nigeria) on the molecular characterisation of livestock ticks from Southwest and

Northern Nigeria. Nationally, he collaborated with Prof David N”Da (Centre of Excellence for Pharmaceutical Sciences, North-West University) on a project titled ‘Antileishmanial activity of selected South African medicinal plants against *L. donovani* and *L. minor*’. Other collaborations were with Prof MMO Thekiso (School of Biological Sciences, North-West University) on a project ‘Acaricidal activity of *Artemisia afra*, *Eucalyptus globulus* and *Tagetes minuta* against cattle ticks in Qwaqwa area, Maluti-A-Phofung’ and with Dr S Sabiu (Department of Biotechnology and Food Technology, Durban University of Technology) on *in silico* studies on the antiviral activities of selected South African medicinal aromatic plants.

## POSTGRADUATE STUDENTS

During 2021, 20 Honours, 55 Master’s and 46 Doctoral students were enrolled for postgraduate studies in the Department of Plant Sciences.

At the 2021 graduations, 14 students graduated with the BSc Hons majoring in Botany (10 on the Bloemfontein Campus and four on the Qwaqwa Campus).

Four students graduated with an MSc (Agriculture):

- Carmen Meyer (Plant Breeding)
- Eunica Semu (Plant Pathology)
- Thabiso Masisi (Plant Pathology)
- Zizipho Spelman (Plant Pathology – with distinction)

A further seven students graduated with an MSc:

- Donald Adams (Botany, Qwaqwa Campus)
- Grace Mocholgi (Botany, Qwaqwa Campus)
- Lebohang Moloji (Botany, Qwaqwa Campus)
- Mawethu Ndiki (Botany, Bloemfontein Campus)
- Jacques van der Merwe (Plant Breeding)
- Bongani Mahlangu (Plant Pathology)
- Ngaka Mzizi (Botany, Qwaqwa Campus)

Two candidates from the Department of Plant Sciences graduated with a PhD in Plant Breeding in 2021:

### Matova, Prince

Thesis: Breeding of maize for fall armyworm resistance in Southern Africa

Supervisors: Prof MT Labuschagne, Dr C Magorokosho and Dr C Kamutando

### Phakela, Keneuoe

Thesis: Influence of specific abiotic stress factors on durum wheat gluten proteins and their relation with pasta quality

Supervisors: Prof MT Labuschagne, Dr A van Biljon, Dr B Wentzel and Dr C Guzman

## POSTDOCTORAL RESEARCH FELLOWS

Dr Neila Abdi (Tunisia) continued with her postdoctoral fellowship at Plant Breeding during 2021, while Dr Tesfaye Mekonnen (Ethiopia) was appointed as a new Postdoctoral Fellow at Plant Breeding in 2021, both working on projects within the SARChI Chair.

Dr Howard Castelyn (South Africa) was appointed as a Postdoctoral Fellow in the laboratory of Prof Visser for a final year, to continue with the bio-informatics analysis of the adult wheat-stem rust interaction. He provided guidance for an MSc study on the characterisation of the adult plant resistance response of wheat after stem rust infection, as well as unravelling the role of carbohydrates and carbohydrate active enzymes towards leaf rust resistance in wheat.

## STAFF MATTERS

Prof Liezel Herselman was promoted to full Professor in the Department, and Dr Willem Boshoff was promoted to Associate Professor.

Dr Andri van Aardt was promoted to Senior Lecturer and Dr Ansori Maré to Lecturer.

Dr Lisa Rothman was appointed as Lecturer in Plant Pathology and Dr Dimitri Veldkornet as Lecturer in Botany.

Mr Petrus Chakane was permanently appointed as Technical Aid to assist in the Palynology Laboratory and the Geo Potts Herbarium.

Ms Grace Mocholgi was appointed as Academic Facilitator for Botany on the Qwaqwa Campus.

Prof Scott continued to act as mentor in the Department of Plant Sciences.



## RESEARCH OUTPUTS

### Research Articles

**Abdi, N., Labuschagne, M., Ullah, A., Hemissi, I., Van Biljon, A., Hachana, A. & Sifi, B.** 2021. Legume-rhizobia symbiosis under abiotic constraints: performance system. *Agrosciencia* 55(2): 37-61.

**Abdi, N., Van Biljon, A., Steyn, C. & Labuschagne, M.T.** 2021. Morpho-physiological studies of wheat-arbuscular mycorrhiza symbiosis under drought stress conditions. *Plants* 10(9): 1756.

**Adegbegi, A.J., Ashafa, A.O.T., Balogun, F.O., Omonkhua, A.A. & Onoagbe, I.O.** 2021. *In vitro* determination of the inhibition of free radical activity and carbohydrate-hydrolysing enzymes by extracts and phytochemical fractions of *Cymbopogon citratus*. *Academia Journal of Medicinal Plants* 9(3): 30-35.

**Akhtar, S., Labuschagne, M., Osthoff, G., Mashingaidze, K. & Hossain, A.** 2021. Xenia and deficit nitrogen influence the iron and zinc concentration in the grains of hybrid maize. *Agronomy* 11: 1388.

**Bakare, O.O., Gokul, A. & Keyster, M.** 2021. PR-1-Like protein as a potential target for the identification of *Fusarium oxysporum*: An in silico approach. *BioTech* 10(2): 8. DOI: 10.3390/biotech10020008.

**Bakare, O.O., Gokul, A., Wu, R., Niekerk, L.A., Klein, A. & Keyster, M.** 2021. Biomedical relevance of novel anticancer peptides in the sensitive treatment of cancer. *Biomolecules* 11(8): 1120.

**Bender, C.M., Boshoff, W.H.P. & Pretorius, Z.A.** 2021. Infection and colonization of triticale by *Puccinia graminis* f. sp. tritici. *Canadian Journal of Plant Pathology* 43(sup2), S198-S210. DOI: 10.1080/07060661.2021.1931453.

**Chiipanthenga, M.K., Van der Merwe, R., Labuschagne, M. & Fandika, I.R.** 2021. Combining ability and mode of gene action of soybean (*Glycine max* L.) traits under water-limited stress conditions. *Euphytica* 217: 41.

**Chikowore, G., Steenhuisen, S., Mutamiswa, R., Martin, G.D. & Chidawanyika, F.** 2021. Integration of invasive tree, black locust, into agro-ecological flower visitor networks induces competition for pollination services. *Arthropod-Plant Interactions* 15: 787-796.

**Clark, V.R., Mukwada G., Hansen, M., Adelabu, S., Magaiza, G., Le Roux, A., Bredenhand, E., Otomo, P.V., Steenhuisen, S.-L., Franke, A., Van Tol, J., Mathinya, N. & Makombe, R.** 2021. The Afromontane Research Unit: Driving connections and capacity building for the sustainable development of southern African mountains. *Mountain Research and Development* 41(2): 1-5.

**Combrink, H.M., Oosthuizen, J., Visser, B., Chabilal, N., Buccimazza, I., Foulkes, W.D. & Van der Merwe, N.C.** 2021. Mutations in BRCA-related breast and ovarian cancer in the South African Indian population: A descriptive study. *Cancer*

*Genetics* 15: 258-259. DOI: 10.1016/j.cancergen.2021.06.002.

**Crous, P.W., Lombard, L., Sandoval-Denis, M., Seifert, K.A., Schroers, H.-J., Chaverri, P., Gené, J., Guarro, J., Hirooka, Y., Bensch, K., Kema, G.H.J., Lamprecht, S.C., Cai, L., et al.** 2021. *Fusarium*: more than a node or a foot-shaped basal cell. *Studies in Mycology* 98(1): 1-184. ISSN 0166-0616. DOI: 10.1016/j.simyco.2021.100116.

**De Ron, A.M., Cartea, E. & Van der Merwe, R.** 2021. The challenges of some horticultural crops in the International Year of Fruits and Vegetables. *Mol (Sociedad de Ciencias de Galicia)* 20: 1.

**De Vega, C., Álvarez-Pérez, S., Albaladejo, R.G., Steenhuisen, S.-L., Lachance, M.-A., Johnson, S.D. & Herrera, C.M.** 2021. The role of plant-pollinator interactions in structuring nectar microbial communities. *Journal of Ecology* 109: 3379-3395.

**Gokul, A., Fahiem-Carelse, M., Niekerk, L.A., Klein, A., Ludidi, N., Mendoza-Cozatl, D. & Keyster, M.** 2021. Exogenous 3, 3'-Diindolylmethane improves vanadium stress tolerance in *Brassica napus* seedling shoots by modulating antioxidant enzyme activities. *Biomolecules* 11(3): 436.

**Goredema-Matongera, N., Tarekegne, A., Ndhlela, T., Van Biljon, A. & Labuschagne, M.T.** 2020. Multi-nutrient biofortification of maize (*Zea mays* L): current status, opportunities and limitations. *Nutrients* 13: 1039.

**Istain, B., Mokgokong, P.S., Wu, R., Mia, J., Gokul, A., Mendoza-Cozatl, D., Du Plessis, M. & Keyster, M.** 2021. Draft genome sequence of the putative endophytic bacterium *Pantoea agglomerans* R6, associated with *Lactuca serriola* from South Africa. *Microbiology Resource Announcements* 10(10).

**Kovács, G.E., Szőke, L., Tóth, B., Kovács, B., Bojtor, C., Illés, Á., Radócz, L., Jr., Moloi, M.J. & Radócz, L.** 2021. The physiological and biochemical responses of European chestnut (*Castanea sativa* L.) to bight fungus (*Cryphonectria parasitica* (Murill) Barr). *Plants* 10: 2136.

**Labuschagne, M., Guzman, C., Phakela, K., Wentzel, B. & Van Biljon, A.** 2021. Solvent retention capacity and gluten protein composition of durum wheat flour as influenced by drought and heat stress. *Plants* 10: 1000.

**Labuschagne, R., Venter, E., Boshoff, W.H.P., Pretorius, Z.A., Terefe, T. & Visser, B.** 2021. Historical development of the *Puccinia triticina* population in South Africa. *Plant Disease* 105(9): 2445-2452. DOI: 10.1094/PDIS-10-20-2301-RE.

**Mafa, M.S., Malgas, S. & Pletschke, B.I.** 2021. Feruloyl esterase (FAE-1) sourced from a termite hindgut and GH10 xylanases synergy improves degradation of arabinoxylan. *AMB Express* 11(21). DOI: 10.1186/s13568-021-01180-1.

**Mafa, M.S., Pletschke, B.I. & Malgas, S.** 2021. Defining the frontiers of synergism between cellulolytic enzymes for improved hydrolysis of lignocellulosic feedstocks. *Catalysts* 11(11): 1343. DOI: 10.3390/catal11111343.

- Malgas, S., Mafa, M.S., Mathibe, B.N. & Pletschke, B.I.** 2021. Unravelling synergism between various GH family xylanases and debranching enzymes during hetero-xylan degradation. *Molecules* 26(22): 6770. DOI: 10.3390/molecules26226770.
- Maré, A., Boshoff, W.H.P. & Herselman, L.** 2021. Molecular and phenotypic evaluation of wheat containing different combinations of rust resistance genes. *Plant Breeding* 140(3): 419–431. DOI: 10.1111/pbr.12913.
- Marivate, V., Aghoghovwia, P., Ismail, Y., Mahomed–Asmail, F. & Steenhuisen, S.–L.** 2021. The Fourth Industrial Revolution – What does it mean to our future faculty? *South African Journal of Science* 117(5): 1–3.
- Matova, P.M., Kamutando, C., Sarsu, V., Ingelbrecht, I., Labuschagne, M. & Magorokosho, C.** 2021. Exploring the opportunity for maize crop improvement with gamma irradiation. *Journal of Crop Improvement* 35(4): 568–581.
- Mbuma, N.W., Gerrano, A.S., Lebaka, N., Amoo, S., Mofokeng, A. & Labuschagne, M.T.** 2021. Variability in the nutritional value of cowpea genotypes for crop improvement. *Acta Scandinavica* 71: 132–144.
- Mbuma, N.W., Gerrano, A.S., Lebaka, N., Mofokeng, A. & Labuschagne, M.T.** 2021. The evaluation of a southern African cowpea germplasm collection for yield and yield components. *Crop Science* 61: 466–489.
- McInturf, S.A., Khan, M.A., Gokul, A., Castro–Guerrero, N.A., Hoehner, R., Li, J., Margault, H., Fichman, Y., Kunz, H.H., Goggin, F.L., Keyster, M., Nechushtai, R., Mittler, R. & Mendoza–Cózatl, D.G.** 2021. Cadmium interference with iron sensing reveals transcriptional programs sensitive and insensitive to reactive oxygen species. *Journal of Experimental Botany* Sep 9:erab393. DOI: 10.1093/jxb/erab393. Epub ahead of print. PMID: 34499172.
- Meyer, W.B., Boshoff, W.H.P., Minnaar–Ontong, A., Young, A., Kong, G., Thompson, S., Pretorius, Z.A. & Visser, B.** 2021. Phenotypic and genotypic variation of *Puccinia helianthi* in South Africa. *Plant Disease* 105(5): 1482–1489. DOI: 10.1094/PDIS-09-20-1903-RE.
- Minnaar–Ontong, A., Gerrano, A. & Labuschagne, M.** 2021. Assessment of genetic diversity and structure of Bambara groundnut (*Vigna subterranea* (L.) verdc.) landraces in southern Africa. *Scientific Reports* 11: 7408.
- Moloi, L.D., Balogun, F.O. & Ashafa, A.O.T.** 2021. Mitigation of free radicals and carbohydrate-linked enzymes by extracts and partitioned fractions of *Elephantorrhiza elephantina* (Burch.) Skeels root. *Journal of Medicinal Plants for Economic Development* 5(1): a109.
- Moloi, M.J. & Van der Merwe, R.** 2021. Drought tolerance responses in vegetable-type soybean involve a network of biochemical mechanisms at flowering and pod-filling stages. *Plants* 10: 1502. DOI: 10.3390/plants10081502.
- Muiruri, V., Marchant, R., Rucina, S.M., Scott, L. & Lane, P.J.** 2021. Late Holocene environmental change and anthropogenic: Ecosystem interaction on the Laikipia Plateau, Kenya. *Ambio* Epub 2021 Jun 16. DOI: 10.1007/s13280-021-01554-6.
- Nafu, M.O., Adewuyi, A.I., Abdulsalam, T.A. & Ashafa, A.O.T.** 2021. Antimalarial activity and biochemical effects of saponin-rich extract of *Dianthus basuticus* Burt Davy in *Plasmodium berghei*-infected mice. *Advances in Traditional Medicine*. DOI: 10.1007/s13596-021-00571-w.
- Ngara, R., Goche, T., Swanevelder, D.Z.H. & Chivasa, S.** 2021. Sorghum's whole plant transcriptome and proteome responses to drought stress: A review. *Life* 11: 704. DOI: 10.3390/life11070704.
- Niekerk, L.A., Carelse, M.F., Bakare, O.O., Mavumengwana, V., Keyster, M., & Gokul, A.** 2021. The relationship between cadmium toxicity and the modulation of epigenetic traits in plants. *International Journal of Molecular Sciences* 22(13): 7046.
- Omóbòwálé, T.O., Oyagbemi, A.A., Adejumbi, O.A., Ugbor, F., Asenuga, E.R., Ajibade, T.O., Afolabi, J.M., Ogunpolu, B.S., Falayi, O.O., Gbadamosi, I.T., Ola-Davies, O.E., Saba, A.B., Ashafa, A.O.T., Yakubu, M.A., Adedapo, A.A. & Oguntibeju, O.O.** 2021. Antihypertensive effect of methanol leaf extract of *Azadirachta indica* is mediated through suppression of renal caspase 3 Expressions on N<sup>ω</sup>-Nitro-L-Arginine Methyl Ester induced hypertension. *Pharmacognosy Research* 12: 460–465.
- Oso, A.A. & Ashafa, A.O.T.** 2021. Compatibility of entomopathogenic nematodes with plant extracts and post-exposure virulence test under laboratory condition. *Turkish Journal of Zoology* 45: 384–394.
- Oso, A.A., Kolawole, A.O. & Ashafa, A.O.T.** 2021. Assessment of pest problems and farmers' perception on the use of botanical pesticides in Ekiti State, Nigeria. *Research Journal of Agriculture and Forestry Sciences* 9(2): 12–17.
- Peprah, B., Parkes, E.Y., Kulakow, P., Van Biljon, A. & Labuschagne, M.** 2021. Genetic analysis of yield and quality characteristics in provitamin A hybrid cassava families in Ghana. *Agronomy* 11: 1911.
- Phakela, K., Van Biljon, A., Wentzel, B., Guzman, C. & Labuschagne, M.T.** 2021. Gluten protein response to heat and drought stress in durum wheat as measured by reverse phase – high performance liquid chromatography. *Journal of Cereal Science* 100: 103267.
- Ruiz–Hernández, V., Joubert, L., Rodríguez–Gómez, A., Artuso, S., Patrick, J.G., Gómez, P.A., Eckerstorfer, S., Brandauer, S.S., Trcka–Rojas, C.G.I., Martínez–Reina, L., Booth, J., Lau–Zhu, A., Weiss, J., Bielza, P., Glover, B.J., Junker, R.R. & Egea–Cortines M.** 2021. Humans share more preferences for floral phenotypes with pollinators than with pests. *Frontiers in Plant Science* 12: 1762. DOI:10.3389/fpls.2021.647347.

- Scott, L., Manzano, S., Carr, A.S., Cordova, C., Ochando, J., Bateman, M.K. & Carrion, J.S.** 2021. A 14 000 year multi-proxy alluvial record of ecotone changes in a Fynbos-Succulent Karoo transition in South Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology* 569: 110331.
- Shamle, N.J., Tella, A.C., Whitwood, A.C., Ashafa, A.O.T. & Ajibade, P.A.** 2021. Synthesis, characterization, electrochemistry, antioxidant, and toxicological studies of Co(II), Ni(II) and Ag(I) complexes of mefenamic acid/tolfenamic acid bearing metronidazole. *Journal of Coordination Chemistry* 74(8): 1255-1271.
- Shawa, H., Van Biljon, A. & Labuschagne, M.T.** 2021. Protein quality and quantity of quality protein maize (QPM) and non-QPM hybrids under optimal and low nitrogen conditions. *Cereal Chemistry* 98 (3): 507-516.
- Szilágyi, A., Radócz, L., Hájos, M.T., Juhász, C., Kovács, B., Kovács, G., Budayné Bódi, E., Radványi, C., Moloi, M.J. & Szőke, L.** 2021. The impacts of woolly cupgrass on the antioxidative system and growth of a maize hybrid. *Plants* 10: 982.
- Szőke, L., Moloi, M.J., Kovács, G., Biró, G., Radócz, L., Hájos, M.T., Kovács, B., Rácz, D., Danter, M. & Tóth, B.** 2021. The application of phytohormones as biostimulants in corn smut infected Hungarian sweet and fodder corn hybrids. *Plants* 10(9): 1822.
- Terefe, T.G., Visser, B., Botha, W., Kozana, A., Roberts, R., Thompson, G.D., Prinsloo, G. & Read, D.A.** 2021. Detection and molecular characterization of wheat stripe mosaic virus on wheat in South Africa. *Crop Protection* 143: 105464. DOI: 10.1016/j.cropro.2020.105464.
- Thoresen, M., Malgas, S., Mafa, M.S. & Pletschke, B.I.** 2021. Revisiting the phenomenon of cellulase action: Not all endo- and exo-cellulase interactions are synergistic. *Catalysts* 11: 170. DOI: 10.3390/catal11020170.
- Tóth, B., Bóka, K., Rothmann, L. & Moloi, M.J.** 2021. The effect of four industrial by-products on the photosynthetic pigments, dry weight and ultrastructure of *Zea mays* L. *Biology Bulletin* 48(3): 296-305.
- Tóth, B., Moloi, M.J., Szőke, L., Danter, M. & Grusak, M.A.** 2021. Cultivar differences in the biochemical and physiological responses of common beans to aluminium stress. *Plants* 10: 2097.
- Toth, B., Moloi, M.J., Szőke, L. & Labuschagne, M.T.** 2021. Low nitrogen and phosphorus effects on wheat Fe, Zn, phytic acid and phenotypic traits. *South African Journal of Science* 117(3/4): 8414.
- Van der Merwe, R., Van Biljon, A., Hugo, A. & Van der Merwe, J.** 2021. Relationships between yield and nutritional components of vegetable-type soybean genotypes using correlations and principal component analysis. *Mol (Sociedad de Ciencias de Galicia)*, 21: 2.
- Vermeulen, M., Rothmann, L., Swart, W.J. & Gryzenhout, M.** 2021. *Fusarium casha* sp. nov. and *F. curculicola* sp. nov. in the *Fusarium fujikuroi* species complex isolated from *Amaranthus cruentus* and three weevil species in South Africa. *Diversity* 2021 13(10): 472. DOI: 10.3390/d13100472.
- Yang, G., Boshoff, W.H.P., Li, H., Pretorius, Z.A., Luo, Q., Li, B., Li, Z. & Zheng, Q.** 2021. Chromosomal composition analysis and molecular marker development for the novel Ug99-resistant wheat-Thinopyrum ponticum translocation line WTT34. *Theoretical and Applied Genetics* 134: 1587-1599. DOI: 10.1007/s00122-021-03796-0.
- Zhang, J., Hewitt, T., Boshoff, W.H.P., Dundas, I., Upadhyaya, N., Li, J., Patpour, M., Chandramohan, S., Pretorius, Z.A., Hovmøller, M., Schnippenkoetter, W., Park, R., Mago, R., Periyannan, S., Bhatt, D., Hoxha, S., Chakraborty, S., et al.** 2021. A recombined Sr26 and Sr61 disease resistance gene stack in wheat encodes unrelated NLR genes. *Nature Communications* 12: 3378. DOI: 10.1038/s41467-021-23738-0.

## Books/Chapters in Books

**Gerrano, A.S., Eifediyi, E.K., Labuschagne, M., Ogedegbe, F.O. & Hassen, A.I.** 2021. Production practices of bambara groundnut. In: *Food and Potential Industrial Applications of Bambara Groundnut*. S.A Oyeyinka & B.I.O. Adeomowaye (Eds.). Springer. pp. 7-25. DOI: 10.1007/978-3-030-73920-1\_2.

**Marais, G.J.** 2021. Managing diseases, pests and other problems: Chapter 22 Diseases. In: *Production Guidelines for Pecan*. A.D. Sippel & H. du Toit (Eds.). ARC-Tropical and Subtropical Crops. pp. 141-151. ISBN No 978-0-621-49137-1.

**Thipe, V.C., Maloney, V., Klein, A., Gokul, A., Keyster, M. & Kati, K.V.** 2021. Chapter 21 RNA interference and CRISPR/Cas9 techniques for controlling mycotoxins. In: *CRISPR and RNAi Systems: Nanobiotechnology Approaches to Plant Breeding and Protection*. K.A. Abd-El Salam & K-T. Lim (Eds.). Elsevier. pp. 463-490. ISBN 9780128219102.

## Conference Contributions

### Conference Papers/Posters

**Basson, H.J., Van der Merwe, R., Maré, A. & Minnaar-Ontong, A.** 2021. A pre-breeding approach towards soybean sudden death syndrome resistance in South African soybeans. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9-12 November 2021.

**Coertzen, R.D., Van Biljon, A. & Van der Merwe, R.** 2021. *Evaluering van opbrengs-verwante eienskappe in groente-soja onderworpe aan geïnduseerde droogtestremming*. Paper delivered at the 20<sup>ste</sup> Studentesimposium in die Natuurwetenskappe deur die Suid-Afrikaanse Akademie vir Wetenskap en Kuns (SAAWK), Noordwes Universiteit,



SAAWK Studentesimposium (virtual). 28–29 October 2021.

**Gerrano, A.S., Majola, G.N. & Mbuma, N.W.** 2021. *Genotype × Environment Interaction and stability of cowpea for leave nutritional values: A prerequisite for cowpea variety development under South African agro-ecological conditions*. Paper delivered at the 2nd African Plant Breeders Association (APBA) Conference. Kigali Convention Centre, Kigali, Rwanda (and virtual). 25–29 October 2021.

**Goredema-Matongera, N., Ndhlela, T., Magorokosho, C., Kamutando, C.N., Van Biljon A. & Labuschagne, M.** 2021. *Multi-nutrient biofortification of maize (*Zea mays* L) in Africa: Current status, opportunities and limitations*. Paper delivered at the 2<sup>nd</sup> African Plant Breeders Association (APBA) Conference. Kigali Convention Centre, Kigali, Rwanda (and virtual). 25–29 October 2021.

**Hlahla, J.M., Mafa, M.S., Van der Merwe, R. & Moloi, M.J.** 2021. *The photosynthetic efficiency and carbohydrates responses of six edamame (*Glycine max.* L. Merrill) cultivars under drought stress*. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9–12 November 2021.

**Hlahla, J.M., Mafa, M.S., Van der Merwe, R. & Moloi, M.J.** 2021. *The photosynthetic efficiency and sugar metabolites provide essential information on the drought responses of six edamame (*Glycine max.* L. Merrill) cultivars*. Paper delivered at Plant Science and Agriculture (PSA-2021) virtual conference, STEM international organization, Belgium. 25 March 2021.

**Istain, B., Mokgokong, P., Wu, R., Mia, J., Gokul, A., Mendoza-Cozatl, D., Du Plessis, M. & Keyser, M.** 2021. *Draft genome sequence of putative bacterium *Pantoea agglomerans* R6, associated with *Lactuca seriola* from South Africa*. Paper delivered at the 4<sup>th</sup> Tunisian-South Africa Mini-symposium on “Biodiversity in Forage and Feed Crops for Sustainable Productivity under Environmental Constraints”, Biotechnology Centre of Borj Cedria, Tunisia. 18–19 March 2021.

**Labuschagne, M.T.** 2021. *Crop biofortification in sub-Saharan Africa. Where are we, and where are we going*. Paper delivered at the International Potato Center SweetGAINS program Annual Meeting (virtual). 1–3 December 2021.

**Labuschagne, M.T., Phakela, K., Wentzel, B., Guzman, C. & Van Biljon, A.** 2021. *Gluten protein response to heat and drought stress in durum wheat*. Paper delivered at the 16<sup>th</sup> International Association for Cereal Science and Technology (ICC) Cereal and Bread Congress (virtual). 29–31 March 2021.

**Labuschagne, M.T., Phakela, K., Wentzel, B., Guzman, C. & Van Biljon, A.** 2021. *Proteomic analysis of durum glutenin protein under heat and drought stress*. Poster presented at the 4<sup>th</sup> Conference of the International Plant Proteomics Organization (online conference). 9–11 March 2021.

**Labuschagne, M.T., Wessels, R. & Wentzel, B.,** 2021. *The relationship of grain and milling characteristics with solvent retention capacity and swelling index of glutenin*. Poster delivered at the 16<sup>th</sup> ICC Cereal and Bread Congress (online conference). 29–31 March 2021.

**Matova, P.M., Kamutando, C.N., Magorokosho, C., Kutwayo, D. & Labuschagne, M.** 2021. *Response of maize parental lines, experimental hybrids, and commercial cultivars to fall armyworm infestation in southern Africa*. Paper delivered at the 2<sup>nd</sup> African Plant Breeders Association (APBA) Conference. Kigali Convention Centre, Kigali, Rwanda (and virtual). 25–29 October 2021.

**Meyer, W.B., Boshoff, W.H.P., Minnaar-Ontong, A. & Visser, B.** 2021. *An overview of virulence and genotypic assessment of South African *Puccinia helianthi* isolates*. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at University of Johannesburg (virtual). 9–12 November 2021.

**Meyer, W.B., Boshoff, W.H.P. & Visser, B.** 2021. *Race diversity of *Puccinia helianthi* in South Africa* (presented in Afrikaans). Paper delivered at the 20<sup>st</sup>e Studentesimposium in die Natuurwetenskappe deur die Suid-Afrikaanse Akademie vir Wetenskap en Kuns (SAAWK), Noordwes Universiteit, SAAWK Studentesimposium (virtual). 28–29 October 2021.

**Nienaber, K., Van Aardt, A.C. & Van Tol, J.J.** 2021. *Phytosociological classification of wetland vegetation in the Golden Gate Highlands National Park, Free State Province, South Africa*. Paper delivered at the National Wetland Indaba (virtual). 20–21 October 2021.

**Spelman, Z., Visser, B. & Boshoff, W.H.P.** 2021. *Phenotypic and genotypic variation of *Puccinia hordei* in South Africa*. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9–12 November 2021.

**Terefe, T.G., Visser, B. & Boshoff, W.H.P.** 2021. *Diversity in *Puccinia triticina* on wheat in South Africa from 2017 to 2020*. Poster presented at the 2021 Borlaug Global Rust Initiative (BGRI) Virtual Technical Workshop – Global Resilience: Science, Pandemics, and the Future of Wheat. 6–8 October 2021.

**Toth, B., Van Biljon, A., Ammar, K., Guzman, C., Lorant, S., Kovacs, B. & Labuschagne, M.T.,** 2021. *The impacts of reduced irrigation on Italian durum wheat cultivars' polymeric and monomeric protein distribution*. Paper delivered at the 18<sup>th</sup> Wellmann International Scientific Conference. University of Szeged, Hungary. 13 May 2021.

**Van der Merwe, R.** 2021. *Drought tolerance indices and their correlation with seed yield in vegetable-type soybean*. Paper delivered at the Meeting of the Working Group Seed Science and Certification (GPZ/GPW) & Section IV Seeds (VDLUFA). Topic of the Scientific Seed Symposium: “Seed Production in Times of Climate Change” (virtual). 9–11 March 2021.

**Vos, J., Van der Merwe, R. & Moloi, M.** 2021. *The impact of heat stress during flowering on the physiological and yield traits of vegetable-type soybean*. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9-12 November 2021.

## Research Reports

**Boshoff, W.H.P.** 2021. Evaluation of wheat cultivars and lines for genetic resistance to rust diseases. Report delivered at the Wheat Trust, Pretoria, South Africa.

**Boshoff, W.H.P.** 2021. Project: #3768 Genomics for Resistance. Report delivered to KAUST, Saudi Arabia.

**Mafa, M.S., Moloi, J. & Mohase, L.** 2021. Extraction, quantification, and partial characterization of peroxidase from horseradish (*Armoracia rusticana*) root tissue. Report delivered to Parr Farm.

**Yilmaz, N., Visagie, C.M., Visser, B. & Boshoff, W.H.P.** 2021. Survey of fungal pathogens affecting maize production in the eastern Cape. Report delivered to the Maize Trust, Pretoria, South Africa.

## STAFF (2021)

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Prof L Herselman

### Bloemfontein Campus:

#### Professor:

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#### Associate Professors:

Prof WHP Boshoff and Prof B Visser

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