ARC • LNR
Excellence in Research and Development

No. 19

Published:
12 March 2024

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Inside this issue:

ARC-Vegetable, Industrial and Medicinal Plants Newsletter

Newsletter of the Vegetable, Industrial and Medicinal Plants, campus in the Crop Sciences Programme of the Agricultural Research Council (ARC)

History of Sweet Potato Breeding in South Africa: 1952-2024

Compiled by Sunette Laurie

Sweet potato (*Ipomoea batatas* (L.) Lam) has over many years build a reputation as a traditional food crop, as well as a mechanised commercial crop in South Africa. The crop's economic value has increased to an estimated R283 million by 2019 (DALRRD, 2022). The ARC -VIMP sweet potato research and development (R&D) program over the past seven decades delivered 33 genetically improved cultivars via demand-led breeding, contributing to the sweet potato economy.

Prior to 1952

Traditional varieties were grown, such as Borrie, "Ses maande wit", "Hoenderspoor" derived from sweet potato imported shortly after colonisation of the Cape by The Netherlands in 1652 (Bester & Louw, 1992). The farmers' selections of that time had crooked shape, veins, grooves and cracks (Fig. 1a); hence the need for formal breeding. The research facilities at Roodeplaat were built in 1947 (Fig. 2).

1952-1980

Formal breeding started in 1952 aimed at providing varieties with improved root quality and yield to the local industry. Initially, hand crosses were made among farmer's varieties and sweet potato germplasm imported from the US (Louisiana and South Carolina) (Bester &

Figure 1 a. Cracked sweet potatoes, b. the first cultivar, Mafutha, c. Mr Tobie Joubert, the first sweet potato breeder.

Figure 2. Research facilities at Roodeplaat in 1949. To the right is a steam tractor as used during the time.

Figure 3. Sweet potato cultivars a. Ribbok, b. Bosbok and c. Blesbok. Blesbok is currently the most popular sweet potato cultivar in South Africa.

Louw, 1992). Mr Tobie Joubert was the sweet potato breeder until 1982 (Fig. 1c). The first release was cultivar Mafutha in 1959 (Fig. 1b). Directed crosses were performed but the seed yield was low hence seed was also harvested from open pollinated plants. Six cultivars followed during the 1960s (i.e. Impala which was popular in the northern provinces and Kudu in the Western Cape). Another four cultivars were released until the 1980s, including Ribbok and Bosbok (Fig. 3a&b), which are still grown today on small scale. At the time, Bosbok was very popular in the Lowveld and was also exported.

1980-1994

In 1980, the polycross system was adopted to improve crossing efficiency and seed yield. It was possible to produce 5 000–10 000 seeds per year. During this time, 10 000 seeds were imported by Dr JT Meynhardt from the US and Taiwan, including orange-fleshed material for processing. On-station multi-location cultivar trials were conducted, as well as semi-commercial evaluations with producers. Dr Ian du Plooy, Mr Andre van den Berg, Mr Errol Bosch, and later Ms Cecilia Bester were briefly responsible for the program. Originating from the 1985-polycross, Blesbok was released in 1989 (Fig. 3c), a variety with very high yield and wide adaptability (Bester et al., 1991). It is today still the major local sweet potato cultivar grown in South Africa, also produced in the SADC region and in Honduras.

1995-2003

New beginnings for the breeding program in 1995 placed more emphasis on informal market traits to provide improvements on Mafutha (sweet taste and drier texture with improved yield and storability) when Dr Sunette Laurie became the sweet potato breeder. The breeding approach here was re-evaluation of clones in the germplasm collection and incorporating African imports into the polycross program, and using evaluation in a participatory fashion in on-farm trials with small-scale farmers. Seven cream-fleshed cultivars were released in 2003 (Laurie et al. 2015). Of these, Ndou and Monate are still popular in the informal market.

Figure 4. ARC orange-fleshed cultivar, Khumo (two front rows), now 50% of the sweet potatoes sold in markets in the Venda area and Ndou (the back row), a cream-fleshed cultivar with 20% of the informal market share.

2003-2016

Developing provitamin A-enriched cultivars for nutrition security became the major objective of the ARC breeding program. Initially, the ARC promoted US orange-fleshed varieties (e.g., Resisto and W-119) in the absence of widely adapted, sweet tasting, dry textured varieties with good yield. Conventional breeding methods were still predominantly relying on the comprehensive germplasm collection with over 300 accessions and the support of the crop protection division with disease screening. Polycrosses consisted of US varieties and ARC-improved high dry matter material (Laurie et al. 2009). Eight orange-fleshed varieties were released in this period. Impilo and Bophelo became popular, having a pleasant flavour, medium dry texture, and good root quality. A 66g portion of Bophelo meets the daily requirement of vitamin A for 1-3 year olds (Laurie et al., 2018).

2017-2024

The aims of breeding broadened to focus more on Fusarium wilt tolerance of cream flesh, purple skin varieties (Mphela et al., 2022), commercially suitable orange-flesh varieties, and even purple flesh colour for high anthocyanin content; though not excluding previous goals. Khumo (Fig. 4), a 2020 release, is particularly popular on the informal market in Venda area. Recently (2023), six cultivars were released predominantly for improved storability. ARC-SP2 and ARC-SP-10 (Fig. 5) have potential for export, agro-processing and local commercial market, while ARC-SP-11 is a Blesbok -type with pale yellow flesh and moderate wilt tolerance (Fig. 5). The ARC breeding program has released a total of 33 cultivars to date. Current research pertains to studying root architecture, root phenotyping methods and remote sensing. Modern breeding technologies such as genome-wide association studies, metabolomics and genomics are currently being incorporated into the program.

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Figure 5. The latest sweet potato cultivars released (from left to right): ARC-SP-7, AARC-SP-10 and ARC-SP-11.

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Twig wilters as pests of vegetables

Compiled by Diedrich Visser and Abongile Nxitywa

Background and host plants

Twig wilters (also known as tip wilters) belong to the hemipteran family Coreidae. All members of this family are phytophagous, have piercing-sucking mouthparts and can easily be identified by their elongated bodies and protruding “shoulders”, most often ending in sharp spines. The two most common species that attack vegetables in South Africa are *Anoplocnemis curvipes* (known as the large black twig wilter) and *Elasmopoda valga* (known as the common twig wilter). Because of their size and dark colour, they are easily spotted in fields. They are strong fliers and may fly in from adjacent areas. Various vegetables may be attacked, but favoured crops include legumes, tomato, potato, cucurbits and eggplant. Other crops attacked by twig wilters include citrus, cowpea, granadilla, mango, soya bean, tobacco, flowers and ornamental plants.

Description

The large black twig wilter lays eggs in continuous chains of approximately 20 to 30 eggs per chain, on leaf petioles or on the underside of leaves. First instar nymphs aggregate, but disperse after the first or second moult. Nymphs go through four or five instars before they reach adulthood. Adults are blackish with red-tipped antennae. Males have characteristically spined hind legs (Fig. 1). The sizes of adults vary, but males are approximately 29 mm and females 27 mm in length. The common twig wilter resembles the large black twig wilter, but is slightly smaller (24 mm) and its antennae are orange-banded instead of red-tipped (Fig. 2). Depending on prevailing temperatures, twig wilters take approximately one to two months to complete a generation.

Figure 1. A large black twig wilter (*Anoplocnemis curvipes)* male . Like most male twig wilters, it has spiny or enlarge areas on the hind legs.

Figure 2. A common twig wilter (*Elasmopoda valga)* female with a nymph in the back ground. The antennae are characteristically banded.

Damage

Twig wilters have sucking mouthparts with which they extract sap from plant parts. They usually do this near the growth points. While extracting sap, they secrete saliva into the plant tissue, causing wilting of the entire growth point. When young plants are attacked, most growth points of a single plant may be destroyed, resulting in the death of the plant. However, when larger plants are attacked, the damage is usually not that severe. In bean fields, pods may also be attacked, resulting in chlorosis and malformation. Most twig wilters and their young shelter on the underside of leaves during the day.

Control

Removal by hand is an option, but most twig wilters are very aware of their surroundings and when approached, will hide or fly away. When large numbers occur on plants, i.e. when the gregarious young are present, they can be shaken off branches into a container with soapy water or paraffin. Adult twig wilters overwinter under old, discarded plants. Sanitation by burning or burying such plant rests is therefore an option to reduce early infestations in fields.

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Pests and diseases of cassava

Compiled by M.J. Mulabisana, E. Cruywagen, D. Visser, K. Mabasa, D. Sehlola, L.P. Mphuthi, M.P. Muthevhuli, S.P. Nkosi, M.A. Marageni, A. Assefa, M.W. Bairu

Introduction

Cassava (*Manihot esculenta*) is cultivated throughout the tropical and subtropical regions of Africa, South America and Asia. It is grown for its edible starchy, tuberous roots (source of carbohydrates), animal feed, bioethanol and for industrial purposes. In South Africa, it is an important staple food crop, commonly grown by small-holder farmers in KwaZulu Natal, Mpumalanga and Limpopo provinces. Pests and diseases of the cassava crop have a wide range of social and economic effects such as food and nutrition security.

Viral Diseases of Cassava

Viruses are the most prevalent, and important diseases known to significantly affect production. Cassava has been recorded to be affected by more than 20 species of viruses. The most important viruses are African cassava mosaic virus and Cassava brown streak virus.

African cassava mosaic virus

- African cassava mosaic virus (ACMV) is a begomovirus, belonging to the family Geminiviridae and is one of the most important viruses of cassava.
- It is transmitted by whitefly species (*Bemisia tabaci*) and through virus infected cuttings/vines that are used by farmers as planting material.
- Yield loss of about 50% to 70% have been reported in African countries.
- ACMV have been detected in samples collected in KwaZulu Natal, Mpumalanga and Limpopo provinces.
- Symptoms include yellowing of the mid veins, general yellowing, rolling, stunting of leaves and reduction in leaf sizes (Fig. 1).

Cassava brown streak disease (CBSD)

- CBSD is reported in the coastal East Africa, but since 2004, it has started to spread more broadly across East and Central Africa.
- Cassava brown streak virus (CBSV) and Ugandan cassava brown streak virus (Family Potyviridae; Genus Ipomovirus) are the two virus species responsible for the

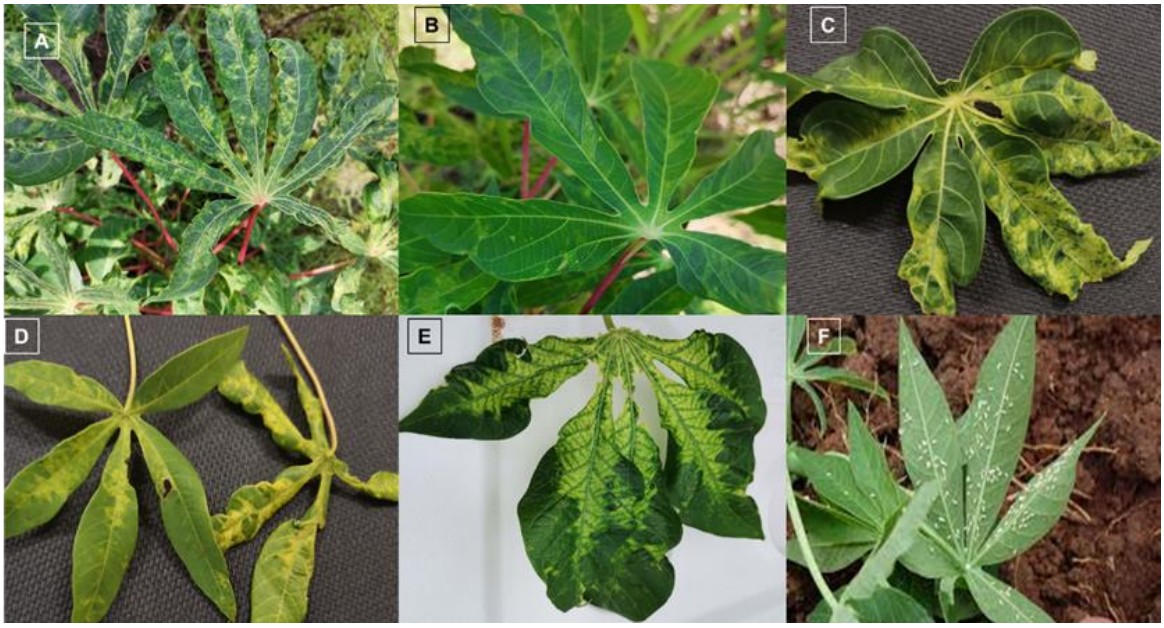

Figure 1. Symptoms associated with African cassava mosaic disease: (A) general mosaic (yellowing), (B) mild yellowing, (C, and D) severe yellowing, (E) yellowing of the mid veins (severe) and (F) whiteflies feeding on cassava leaf.

disease.

- It is also transmitted by whitefly species and through virus infected cuttings/vines that are used by farmers as planting material mostly when whitefly populations are high.
- It is also one of the destructive viruses of cassava, reported to contribute to yield reduction.

Fungal Diseases of Cassava

Several fungal diseases have been reported to cause diseases in cassava. Fungal infections affect the leaves, stems, and tuberous roots of cassava plants. Fungal diseases on leaves can affect photosynthesis, resulting in a decrease in the production of the storage roots.

- Fungal diseases such as brown leaf spot (*Cercospora henningsii*) and white leaf spot (*C. caribaea*), cassava anthracnose disease (CAD) caused by *Colletotrichum gloeosporiodes* f.sp. *manihotis* have been reported to affect cassava production.
- CAD causes stem cankers on susceptible cultivars and have been reported in regions of West Africa and Latin America.
- In the study conducted with samples collected in Limpopo, Mpumalanga and KwaZulu Natal provinces, *Colletotrichum*, *Phoma*, and *Botrytis* were found to cause symptoms on leaves and stems of cassava.
- Pathogens such as *Colletotrichum*, *Fusarium*, *Alternaria*, and *Botrytis* spp. were identified as the causal agents of leaf spots (Fig. 2).
- Die-back on the stem is also a common problem in cassava plants (Fig. 3).

Pests Affecting Cassava Production

- Pests feed on plants, leaves and the stems.
- Insect such as mealybug (*Phenacoccus manihotiis*) (Fig. 4C) are commonly found at cassava shoot tips and under the surfaces of leaves.
- They inject toxins into the leaves, resulting in leaf withering and stunting of the plant, and ultimately yield loss.

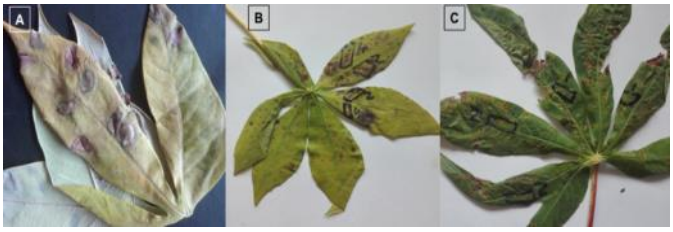

Figure 2. (A and B) Leaf spots due to the fungus *Colletotrichum* sp. and *Alternaria alternata*, and (C) *Alternaria* and *Pestalotia.*

Figure 3. (A, B and C) Die-back symptoms on cassava stem due to fungal diseases.

- Pests such as variegated grasshoppers (Fig. 4E), mites (Figs 4A and 4B), thrips, whiteflies, scale insects, etc., have been observed on cassava in most of the farms in South Africa.

Control Of Pest and Diseases

- Inspect leaves for yellow pattern of symptoms, leaves and shoots for brown spots, stunting and deformation.
- Plant viruses spread through stem cuttings used as planting material and exchange of sick material between farmers. It is important to use virus free (select from symptomless plants) cuttings when planting in a new field.
- For fungal diseases and pests, recommended fungicides and pesticides can be used, however, farmers are advised to always read the instructions written on labels

Figure 4: Insects that affect cassava production: (A and B) mites, (C and D) mealybugs, (E) variegated grasshoppers and (F) damage on the leaf due to pests).

before using chemicals.

- Farmers must always consult with agricultural advisors before using any chemicals.
- Consult the Agricultural Research Council for accurate identification of pests and diseases.

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Plant Pathologist to contact for inquiries on different diseases are follows:

Bacterial diseases: Dr Rene Sutherland, SutherlandR@arc.agric.za
Viral diseases: Dr Julia Mulabisana, MJMulabisana@arc.agric.za
Fungal diseases: Dr Elsie Cruywagen, CruywagenEM@arc.agric.za

PGPR of cannabis in Mpumalanga and Limpopo

Compiled by Alison Moody and Rene Sutherland

Cannabis, including industrial hemp, have a wide array of medicinal, industrial and recreational uses and due to changing legislation around the world, is experiencing rapidly growing consumer demand. Due to the heavy restrictions on cannabis cultivation over the past century, little scientific research has been conducted on this crop. Plant growth promoting rhizobacteria (PGPR) are a group of bacteria capable of actively colonizing the rhizosphere or root systems of plants and improve their growth and yield, especially under stressful growing conditions. In addition, PGPR may also have the potential to provide protection against invading soil-borne pathogens, thus offering an alternative to harmful chemicals used to control diseases.

Rhizospheric soils (soil around the roots of the plant) have been considered a reservoir for PGPR. Trips to Limpopo and Mpumalanga were conducted over the course of October, November and December 2023 with the purpose of visiting various commercial and smallholder cannabis growers across both provinces in order to sample cannabis roots and soil (Fig. 1) from the rhizosphere from which PGPR are isolated and characterized. While engaging with the growers, various pests and diseases were also scouted and sampled for diagnostic analysis (Fig. 2). Moreover, the team made up of technicians, interns and research assistants from ARC-VIMP also got the opportunity to gain insight on the various cultivation methods used by different cannabis growers and the wide range of medicinal products produced. The field trips highlighted the role that engagement with growers plays in furthering research towards understanding the relationship between the microbiome, cannabis yield and disease resistance, as well as to identify the pests and diseases most prevalent on cannabis and vegetable crops in these regions.

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Figure 1. Greenhouse and open field Cannabis production areas sampled

Figure 2. Plants of various vegetable crops sampled for diagnostic analysis

ARC Researchers attend SASPP 2024

Compiled by Rene Sutherland, Elsie Cruywagen and Julia Mulabisana

The Southern African Society for Plant Pathology held their biannual conference at the Golden Gate Hotel, Clarens from 21-25 January 2024. The conference is the most prestigious conference in the field of Plant Pathology in southern Africa. The congress hosted about 170 attendees, with 69 oral presentations and 75 posters in the field of plant pathology. The congress provided a platform for plant pathologist in the country to share their work, learn from each other and form collaborations.

Figure 1. The Crop Protection team at the ARC-VIMP attending SASPP

Keynote speakers from all over the world were invited. Professor Molapo Qhobela, who is the Deputy Vice-Chancellor of the Institutional Change, Strategic Partnerships and Societal Impact, University of Free state welcomed the attendees with words of encouragement. Prof Emerson del Ponte from Brazil enlightened the audience on managing plant health emergencies through epidemiology. Prof Lindsey du Toit from Washington State University focussed on conquering recalcitrant diseases using the art and science of plant pathology. She highlighted the importance of linking plant pathology and extension (stakeholder engagement and training) for successful implementation of integrated disease management. Prof Diane Saunders from England gave an insight regarding cereal pathogens, whereas Prof Clive Bock from England presented on the visual assessment of plant disease and the future of phytopathometry. Prof Juliana Freitas-Astúa from Brazil presented a talk on coexistence between citrus, mites, and the leprosis virus complex. Prof André Fleißner's (Germany) presentation focussed on molecular genetics and cell biology of fungi. Prof Theo Smits from Switzerland gave more information on the comparative genomics to elucidate the case of the Jekyll and Hyde organism *Pantoea agglomerans*. The last keynote address was from Prof Dan Bebber from England, who's presentation focused on climate change effects on plant pests and pathogens.

Several researchers from various ARC campuses including, VIMP, attended. Colleagues from the Leguminous, Leafy and Fruit Vegetables (LLFV) division presented posters on various topics, including 1) Population genomic insights into *Alternaria alternata* isolates from different hosts in South Africa (Dr Elsie Cruywagen), 2) Understanding the current diversity of cassava viruses in South Africa (Dr Julia Mulabisana), 3) Soil health in potato early dying (PED) disease (Dr René Sutherland), 4) *Fusarium* populations causing dry rot of potato in the Free State (Ms Zama Nkosi), 5) Identification of mutations responsible for fungicide tolerance in *Alternaria solani* and *Alternaria grandis* (Ms Kgothatso Chauke), 6) CRISPR/Cas9 gene editing towards resistance to the Banana bunchy top virus in banana (Ms Sinethemba Nkosi) and 7) Resistance to sweet potato virus disease using CRISPR/Cas9 technology (Ms Otlotleng Moloto).

One of the highlights of the conference was the ARC-VIMP/PHP team winning second place at the quiz night (just behind Prof Lindsey du Toit's team of one). Teams of four competed in the quiz that comprised of 30 plant pathology related questions covering everything from general disease and symptom recognition to new technologies in plant pathology. There was strong competition from various Universities and Research Institutions, but the honours went to the ARC team consisting of Drs E. Cruywagen, J Mulabisana, R Sutherland from the ARC-VIMP and Dr F Jami from the ARC-PHP.

Figure 2. The winning ARC team (second place) at the SASPP quiz night together with the quiz master, Dr Wilmarie Kriel (on the left).

Annual student capacity building workshop/seminar for the ARC-VIMP students

Compiled by Julia Mulabisana

The post graduate committee of the ARC-VIMP held a student seminar for the post graduate students on the 01 December 2023. During the event, students were given an opportunity to present their research (Figs 1 and 2) to fellow students and supervisors/mentors. The seminar provides students with a platform to interact and to get assistance from fellow students and researchers. The platform gives them an opportunity to be exposed to public speaking, enhancing presentation and communication skills. Students also learned from positive experiences by former student (Mr Thabo Nkuna).

As the guest speaker, Ms Thembi Ngotho (Training Manager, Smallholder Agricultural Development unit, Impact & Partnerships Division, ARC-Central Office) motivated the students on how to stay resolute in their journey and how to navigate the emotional stresses that comes with being a student. Dr Dean Oelofse (Specialist researcher/ Deputy Chair of the Post Graduate Committee) delivered an overview of the ARC-PDP program.

The presentations were evaluated by a panel of evaluators for the content, communication aids used, presentation delivery, time management and presentation defense. Winners are as follows:

- Winner of the first prize-best presenter for the PhD category: Taryn Armfield
- Winner of the second prize-best presenter for the PhD category: Kgothatso Chauke
- Winner of the first prize-best presenter for the MSc category: Otlotleng Moloto
- Winner of the second prize-best presenter for the MSc category: Consolerlia Makhuvha

Presentation titles and authors

1. Seerane, M.K.F, Mofokeng, M.M, Matsiliza-Mlathi, B. & Kleynhan, R. 2023. Effect of plant spacing and fertilizer application on the growth and yield of Greyia radlkoferi.
2. M.C. Makhuvha, M.C., Laurie, S.M., Mosala, M. & Silun, H. 2023. Effect of orange-fleshed sweet potato (Ipomoea batatas l.) and bambara groundnut (Vigna subterranea) composite flour on quality properties of pasta.
3. Armfield T.J, Cruywagen, E.M., Kritzinger, Q. & Steyn, J.M. 2023.The impact of cover crops on soil health and biological soil quality within potato crop rotation systems.
4. Matlala1, M.V., Amoo, S., Koetle, M.J., Moyo, M. & Olowoyo, J.O. 2023. Optimizing the in vitro propagation for industrial utilization of Cannabis sativa L. genotypes.
5. Moloto, O.T., Mulabisana, M.J., Mahlanza, T., Gazendam, I. & Motaung, T.E. 2023. Development of translation initiation factor based resistance to sweet potato virus disease using CRISPR/CAS9 technology. ARC-VIMP annual post graduate seminar.
6. Chauke, K.A., Roux van der Merwe, M.P., Thaoge, M.L., Engelbrecht, J. & Cruywagen, E.M. 2023. Mutations conferring QOI, DMI and SDHI resistance in Alternaria alternate.
7. Mashitoa, M.F., Makhuvha, M.C & S. Laurie. 2023. Expansion of orange fleshed sweet potato (OFS) enterprise development: orange-fleshed sweet potato product development.
8. Voko, M.P, Aremu, A.O., Makunga, N.P., Masondo, N.A. 2023. The potential role of two novel cytokinin oxidase/dehydrogenase inhibitors in alleviating salinity stress in Lessertia frutescens (l.).
9. Ntwe, O.H, Oyekale, A., Maselwa, A. & Matsaunyane, L. 2023. Fertilizer Utilization Preferences and Adoption of Bioslurry Organic Manure among smallholder cabbage farmers in the North West Province West Province, South Africa.

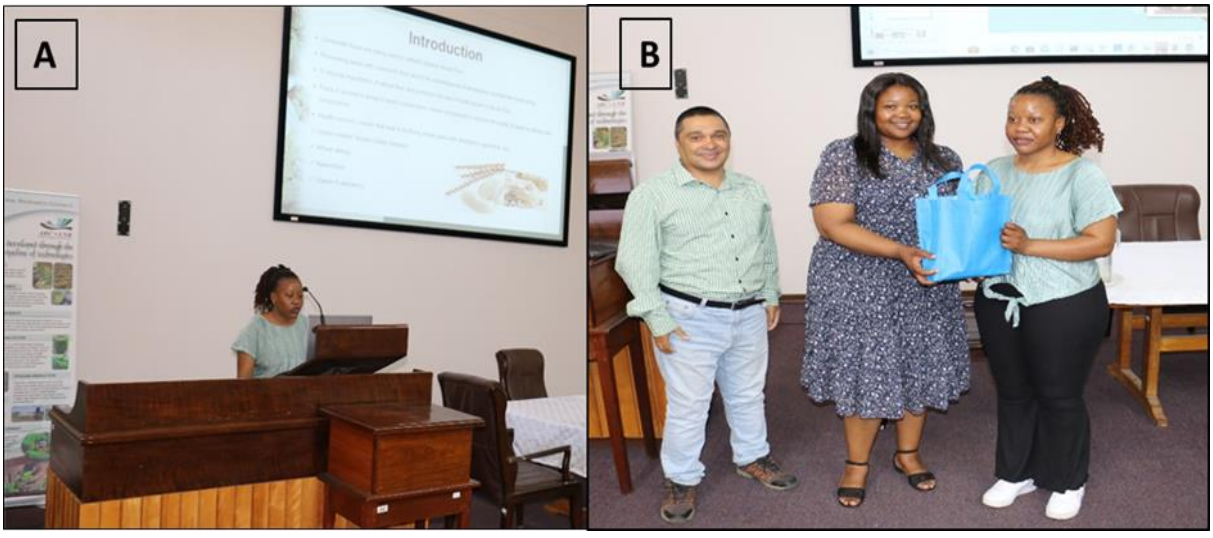

Figure 1. (A) Presentation by students and (B) handing over of prizes to the winners by the presentation evaluator (Dr Ebrahiema Arendse) and Ms Nombulelo Mudau (HCM).

Acknowledgements goes to guest speakers (Dr Mariette Truter, Ms Thembi Ngotho, Dr Dean Oelofse and Mr Thabo Nkuna.), evaluators of the presentations (Dr Juanita Engelbrecht, Dr Ntombi Mbuma and Dr Ibrahiema Arendse), chairpersons (Dr Nqobile Masondo, Dr Inge Gazendam and Dr Beverly Mampholo), HCM team (Ms Faith Borotho, Ms Nombulelo Mudau and Ms Glad Mahlangu).

Support by Dr Mariette Truter, Dr Elsie Cruywagen, Dr Sunette Laurie, ICT team, personnel from the Training and Commercialization division, researchers/technicians and interns who attended and supported the students is acknowledged.

Winners of the 2022 student capacity building seminar were as follows:

- Winner of the first prize-best presenter for the PhD category: Nomathemba Majola. Title: Genetic diversity and population structure analyses of South African Bambara groundnut (*Vigna subterranea* [L]. Verdc.) collections using SNP markers. Authors: N.G. Majolaa, A.S. Gerrano, A. Assefa, H. Shimelisa & Dirk Swanevelder.
- Winner of the second prize-best presenter for the PhD category: Silindile Mkhabela. Title: Characterization of okra (*Abelmoschus esculentus* L.) accessions with variable drought tolerance through simple sequence repeat markers and phenotypic traits. Authors: S.S. Mkhabela, H. Shimelis, A.S. Gerrano, J. Mashilo & A. Shayanowako.
- Winner of the third prize-best presenter for the PhD category: Mbali Gumede. Title: Influence of genotype and environment on grain yield among cowpea (Vigna *unguic-ulata* (L.) Walp) genotypes under dry land farming system. Authors: M.T. Gumede, A.S Gerrano, A.T. Modi & Z. Thungo.
- Winner of the first prize-best presenter for the MSc category: Ms Nthabeleng Phaladi. Title: Molecular characterization of poleroviruses and other viruses infecting Swiss chards, beet greens and mustard spinach in Gauteng Province. Authors: N.L. Phaladi, M.J. Mulabisana, M.P. Roux-van der Merwe & J. Badenhorst.
- Winner of the first prize-best presenter for the MSc category: Sherly Mabena. Title: Characterization and activity of plant growth promoting rhizobacteria associated with sweet potato in South Africa. Authors: S. Mabena1, S.M. Laurie, Q. Kritzinger, M. Truter & R. Sutherland.
- Winner of the first prize-best presenter for the MSc category: Lavhelesani Tshilongo. Title: Bioactive compounds and antioxidant properties in leaves of five purple-fleshed genotypes as influenced by harvesting stage. Authors: L. Tshilongo, S.M. Laurie, T. Shoko & D. Sivakumar.

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Figure 2. A group photo consisting of attendees (interns, researchers and technicians)