ARC-PHP launches locally produced ELISA kits for testing viruses

The ARC-PHP has officially launched locally produced Elisa kits for the detection of tomato spotted wilt virus (TSWV) and cucumber mosaic virus (CMV).

These kits are competitively priced compared to imported kits and are able to detect South African strains of TSWV. We are very excited to be offering this unique solution to the plant health diagnostic community to reduce turnaround time, increase competitiveness and provide good value for money diagnostic solutions to the agricultural industry. The TSWV and CMV kits will form part of the GLRaV3 kits in our portfolio that have been supplied to the grapevine industry for more than a decade. New viruses will be included systematically to increase the offering to the plant diagnostic market locally and abroad.

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Marika van der Merwe at VDMerweMA@arc.agric.za or Nicola Robbertse at WesselsN@arc.agric.za
ARC systematists attend national Biodiversity forum

Thirteen ARC systematists attended the Joint Biodiversity Information Management & Foundational Biodiversity Information Forum in August 2019. The ARC contingent included specialists of bacteria, fungi, insects, nematodes and spiders. This annual Forum is widely considered the most significant South African meeting of working taxonomists and biodiversity information practitioners, regardless of their taxonomic specialty.

The main theme of the Forum was aligned to the currently dominant paradigm of Open Data—Open Science. Several plenary speakers emphasized the need for data to be free and freely available, not least because that leads towards relevance and opportunity. Open data additionally bring about major financial injections, as seen in innumerable cases the world over. The ARC delegates were inspired even more than before to increasingly work towards Open Data—Open Science. Successes brought about by Open Data—Open Science were evident throughout subsequent presentations of research projects. Several talks about successfully completed projects showcased the wide scope of taxonomy being done in the ambit of the FBIP. Excitement among the ARC delegates was tangible, since we were newly exposed to the truly wide array of possibilities available.

Four projects with ARC co-authors were presented, dealing with bacteria, fungi and spiders.

Some of the ARC-PHP systematists who attended the forum

The ARC participants attended either of two educational, hands-on workshops towards the end of the proceedings. One workshop was a rapid but solid introduction to using the Barcode of Life Database for DNA barcode analysis and specimen identification, whereas participants in the other workshop received guidance in the approach to and expectations for writing successful proposals for FBIP funding.

Contact: Dr Isabel Rong at RongI@arc.agric.za

Virology researcher lands coveted invitation to global grand challenges

Dr Tendekai Mahlanza attended the Community Network for African Vector-Borne Plant Viruses (CONNECTED) virus vector vice versa (V4) early career researcher training hosted at the University of Bristol, UK from 10-21 June 2019. The event was attended by 17 participants from 11 African countries. During the meeting, Dr Mahlanza was selected by fellow participants as one of two participants to attend the Bill and Melinda Gates Foundation Grand Challenges annual meeting in Addis Ababa in October 2019. The Global Grand Challenges initiative of several funding partners that aims at solving global health and development problems, and attaining food security. The Grand Challenges meeting, an event attended only by invitation, brings together funders and researchers throughout the Grand Challenges network across the world. It is an opportunity for researchers to interact with funders on current research funded by the Grand Challenges initiative, and to share ideas on potential multidisciplinary and collaborative projects. This will be an excellent opportunity for Dr Mahlanza to build relationships within the network towards collaborative research projects funded by this initiative. The Grand Challenges Annual Meeting Call-to-Action Grants are open only to attendees of the meeting who already collaborate with other attendees.

Dr Mahlanza also attended the Grand Challenges Annual Meeting held in Addis Ababa from 27-30 October 2019.

The initiative seeks to foster innovation to solve key development problems, including in agriculture. Over 1000 scientists, policymakers and funders from across the world gathered to discuss many topics. Discussions included innovative approaches to pest and disease surveillance in low income countries, e.g. smartphone-based offline apps for pest and disease symptom identification.

Contact: Dr Tendekai Mahlanza at MahlanzaT@arc.agric.za
Collaboration with Victus Bio (Pty) Ltd

The Agricultural Research Council (ARC) has entered into a licensing agreement with Victus Bio (Pty) Ltd on the development and production of a biological product for the management of crown gall on vines. Victus Bio recently invested in the design and construction of a state of the art bioreactor for the purpose of formulating biological products with excellent quality and shelf life. In accordance with the bio-economy strategy of the Department of Science and Technology, the benefit of the National Collections should be developed to support agricultural productivity in South Africa, while simultaneously supporting and growing the National Collections within the required legislative framework. This collaboration between the ARC and Victus Bio aims to benefit the expansion and development of the National Collections as the South African national depository of microbial diversity, while delivering sustainable crop production solutions to the agricultural sector. The ARC’s Plant Health and Protection campus is the custodian of various National Collections, which include the South African Rhizobium Culture Collection (SARCC) that houses nitrogen fixing bacteria and other beneficial rhizobacterial strains with plant growth promotion traits. As part of the collaboration between the two organizations, scientists from Victus Bio (Pty) Ltd and the ARC are working closely to screen and develop new biological products that will contribute to sustainable crop production practices and mitigate environmental risks in agriculture.

Contact: Dr Elna van der Linde at VDLindeE@arc.agric.za

The team also presented training in the application of pesticides for the control of the (FAW) and the calibration of knapsack sprayers.

Contact: Elize Lundall-Magnuson at LundalE@arc.agric.za or Etienne van der Walt at VDWaltE@arc.agric.za for more information

Selected agricultural advisors received accredited training on control of FAW

The Department of Agriculture, Land Reform and Rural Development (DALRRD) is currently funding research on the recent outbreak of the Fall Army Worm (FAW) in southern Africa. ARC-PHP presented an accredited course from 30 September to 4 October 2019 on the recognition of pests, diseases and weeds on crops to selected agricultural advisors from all districts of Limpopo.

The team also presented training in the application of pesticides for the control of the (FAW) and the calibration of knapsack sprayers.

Contact: Elize Lundall-Magnuson at LundalE@arc.agric.za or Etienne van der Walt at VDWaltE@arc.agric.za for more information

From left to right, Stefan van Wyk (Victus), Elna van der Linde (ARC), Teresa Goszczynska (ARC), Philip Spies (Victus), Ansa van Vuuren (ARC) and Dieter van Jaarsveld (Victus)
ARC-PHP Cedara hosts delegation from eSwatini to discuss the management of invasive alien plants

From 13-16 August 2019, the Weeds Research Unit at ARC-PHP Cedara hosted a delegation of 14 officers from the eSwatini National Trust Commission in order to foster cooperation on the biological control and management of invasive alien plants (weeds) in South Africa and eSwatini. The Cedara researchers first hosted a workshop on 13 August 2019 where the eSwatini delegation, along with South African colleagues involved in weed management from the DEA: Natural Resource Management Programme, researchers from the University of KwaZulu Natal and the South African Sugar Research Institute, who were invited to share a range of presentations and participate in discussions on the implementation of biocontrol against invasive alien plants in the field. Weed management policies and implementation structures were also discussed. During the remainder of their visit, the eSwatini delegation viewed the ARC facilities and were trained on the mass-rearing of biocontrol agents relevant for the weed infestations present in eSwatini. They visited the ARC-PHP field biocontrol sites in Pietermaritzburg, Umkomaas, Mtubatuba and KwaJobe in KZN on their way back to eSwatini.

The visit was very valuable as it is important for South Africa to build capacity in weed management in neighbouring eSwatini, because invasive weeds know no borders and we need to build regional awareness and capacity to manage these invaders.

Biosystematics Open Day 2019 – “A whole new world”

To celebrate the International Day of Biodiversity, which is held annually on the 22nd of May, ARC-PHP Biosystematics held an Open Day. The theme was “A Whole New World – looking at biodiversity through a microscope”.

There were two main objectives for the day: 1) to open the Biosystematics Training Center in collaboration with Carl Zeiss (Pty) Ltd.; and 2) to explain how taxonomic knowledge benefits South Africa. The second objective of the day involved talks and displays at various stations.

Biosystematic staff demonstrated the process, from collecting in the field to the point where a publication is produced. The first station in the displays was the ‘Collecting Station’, where different methods of collecting and preserving specimens were demonstrated, involving sweep nets, insect sorting, preparation and pinning.

The ‘Identification Station’, was held at the upgraded training center, where the new microscopy ‘digital classroom” was used to facilitate and show the detailed work required to get to a species name.

The next station was the “Cataloguing and Databasing Station”, where the work that is done to get a collected specimen into a national collection was demonstrated.

At the ‘Research Station’, the process of studying a specimen to produce a taxonomic paper was explained. From this point, other staff from ARC-PHP explained how they make use of taxonomic research to do their work. The

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Four new spider species described

Robin Lyle of PHP Biosystematics recently concluded a study on four new species of sac spiders belonging to the genus *Planochelas*. The results of this study were published in a scientific article, “Four new species of the sac spider genus *Planochelas* Lyle & Haddad, 2009 (Araneae, Trachelidae) from Central and Southern Africa” in “African Invertebrates”, which is a journal focusing on biodiversity research in Africa.

Typically, these spiders are small, between 1.9-4.5mm in size, and dark brown to reddish brown in colour. In the recent scientific paper, two of the four species that were discovered had been found previously in South Africa, but had not been described. These two species have been named *Planochelas haddadi* and *Planochelas neethlingi*. Both were collected in two KwaZulu-Natal provincial nature reserves, namely the Ndumo Game Reserve and the Isimangaliso Wetland Park. The other two new species, *Planochelas brevis* and *Planochelas jocquei*, were collected in the Democratic Republic of the Congo.

This research was conducted in partnership with the South African National Biodiversity Institute (SANBI) and the Agricultural Research Council, as part of a mentorship relationship between the two authors. Additionally, this work was presented at the 39th Zoological Society of Southern Africa Congress held at Skukuza, Kruger National Park from 7 to 10 July 2019.

Contact: Robin Lyle at LyleR@arc.agric.za
The return of the lantana mirid, *Falconia intermedia*, to the mix

Sporadic outbreaks of insects are a common occurrence and biocontrol agents of weeds are not an exception. The sap-sucking mirid, *Falconia intermedia* Distant (Hemiptera: Miridae), one of the 14 *Lantana camara* (Verbenaceae) biocontrol agents that have been approved for release from quarantine by the ARC, has displayed such a behaviour. Imported from Jamaica in 1994, *F. intermedia* was first released in South Africa in 1999, followed by initial establishment at many sites throughout the country. With the exception of two sites, one near Port Alfred in the Eastern Cape and the other at Tzaneen in Limpopo, the establishment of the sup-sucking mirid was short-lived; and subsequently its population appeared to have crashed nationwide.

In recent years (2018 – 2019), field observations coupled with various reports from members of the public have confirmed the resurgence of the sup-sucking mirid, with noticeable leaf damages symptomatic of *F. intermedia*. Adults and nymphs congregate on the underside of leaves and feed on the intercellular tissue of leaves, causing severe chlorosis leading to defoliation and a significant reduction in fruit production. Under intense attack, leaves turn pale white (Fig 1), with scattered dark faecal spots on the underside (Fig. 2). *Falconia intermedia* is, however, still confined to the warm and wet low-lying regions of the country.

In recent years it has been consistently spotted at several sites in and around South Coast in KwaZulu-Natal, Port St Jones and Coffee Bay in the Eastern Cape, and Tzaneen in Limpopo. Plans to measure the isolated impact of this ‘once considered lost agent’ on lantana growth under field conditions are underway.

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First report of soft rot of squash fruits caused by *Pseudomonas syringae* pv. *syringae* in South Africa

During the 2017/18 growing season, a new and damaging disease of squash was observed in several commercial plantations in the Northern Cape Province of South Africa. Soft, water soaked lesions, 3-6 cm in diameter, were present on the rind of fruits. Many fruits were rotting inside (Fig. 1). Fifty to 80% of fruits were affected per field. Soft rot of numerous crops is usually caused by *Pectobacterium* and *Dickeya* species. However, from all diseased fruits, almost pure culture of fluorescent bacteria was isolated on Milk-Tween and King’B media. Isolates were identified as *Pseudomonas syringae* based on the LOPAT tests. Several pathovars of *Pseudomonas syringae* have been reported to cause foliar blights and fruit spots. Usually, the outbreaks of foliar diseases on Cucurbits are assumed to be caused by *P. syringae* pv. *lachrymans*.

Squash fruits showing the rot symptoms were collected from four fields in the Northern Cape. Isolations were done from the soft, water soaked lesions. Tissue from lesion margins of infected fruits was removed with a sterile scalpel and macerated in 1 ml of sterile distilled water for 15 min at 25oC. Plant extracts were streaked onto

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NA, CVP and Milk-Tween media. Bacterial growth on plates was evaluated after four days of incubation at 25°C. Suspected colonies were purified by streaking onto King’s B. Production of fluorescent pigment on King’s B agar medium, Gram stain reaction, production of levan, oxidase activity, ability to cause potato rot, arginine utilization and production of a hypersensitive reaction on tobacco (LOPAT tests) were determined for each bacterial strain. Gram negative bacteria fluorescent under UV light on Milk-Tween medium were consistently isolated from diseased tissues. They were Levan-positive, oxidase, potato rot, and arginine dihydrolase negative. All induced HR reaction in tabaco leaves and were tentatively identified as \textit{P. syringae}.

Genomic DNA of four strains isolated from squash fruits was extracted with the Wizard Genomic DNA purification Kit (Promega, Madison, USA) according to the manufacturer's instructions. The primers used for PCR amplification and sequencing of the cts and gyrB genes were developed by Hwang et al. (2005, App Environ Microbiol 71:5182-81). PCR amplification was done as reported by Morris et al. (2008, Int Soc Microbiol Ecol 2:321-34). Sequencing was performed by Inqaba Biotechnology (Pretoria, South Africa). The cts and gyrB nucleotide sequences obtained in this study were aligned with sequences of eleven \textit{Pseudomonas syringae/savastanoi} reference strains from the Plant Associated and Environmental Microbes Database using the MAFFT 7 online alignment tool. Phylogenetic trees were constructed with the neighbour-joining method and evolutionary distances calculated according to the method of Kimura. Bootstrap analysis of the data, based on 1000 permutations was used to assess the stability of relationships. The trees were viewed and edited using MEGA 7.

A BLAST search of the EMBL/GenBank database conducted with the sequences revealed a high degree of sequence identity (97-99%) with previously determined sequences of \textit{P. syringae pv. syringae}. Figure 2 shows the phylogenetic relationship derived from a neighbor-joining analysis of the pairwise comparison among the gyrB and cts sequences of four strains from this study with ten sequences of described pathovars of \textit{P. syringae}. \textit{Pseudomonas chicorii} was used as an outgroup taxon. Phylogenetic trees constructed for two genes were identical. Four strains isolated from rotting squash fruits grouped with \textit{P. syringae pv. syringae}.

Pathogenicity screening of four strains was performed on the store-bought squash fruits. A sterile needle was dipped into a bacterial colony of the strain growing on King’s B and then inserted under the epidermis of a fruit. Three fruits were used per strain. Pathogenicity tests were repeated. Three fruits were used for the negative control treatment (sterile water). Inoculated fruits were placed in a sterile plastic box, incubated at 25°C and observed daily for the development of symptoms. Bacteria were re-isolated from the developing lesions on King’s B, fluorescence under UV light and LOPAT tests. From all symptomatic fruits fluorescent \textit{P. syringae} was isolated and confirmed by LOPAT, thus fulfilling Koch’s postulates.

**CONCLUSION**

We describe a new disease on squash in South Africa, soft rot of fruits, caused by \textit{Pseudomonas syringae pv. syringae}. Koch’s postulates were confirmed using four strains, which were subjected to further taxonomic investigations. Morphological and biochemical characterisation using the Gram-stain, colony morphology, fluorescence and LOPAT tests showed that the four strains from squash had similar biochemical characteristics and resembled those of \textit{P. syringae}. The gyrB and cts sequences of all isolates were 98 to 99% homologous to that of \textit{P. syringae pv. syringae} and all clustered with \textit{P. syringae pv. syringae} in neighbor-joining phylogenetic trees. We conclude that the bacteria associated with the soft rot of squash fruits in South Africa are \textit{P. syringae pv. syringae}.

**Contact:** Dr Teresa Goszczynska at GoszczynskaT@arc.agric.za
New leafhopper species described

Several leafhopper species are significant agricultural pests, some of which vector plant disease microbes. South Africa’s leafhoppers are highly diverse but only partly known. The newly described leafhoppers, belonging to the new genus *Discolopeus*, occur only in south-western South Africa and southern Namibia. Some of them feed on medicinal plants and on plants that are poisonous and at times dangerous to livestock.

Recently published papers are lavishly illustrated with colour photographs of these minute but beautiful insects, created with the Zeiss microscope/camera apparatus of Biosystematics.

Photos are complemented by meticulous line drawings for which dissections were required. The new species were subjected to comprehensive phylogenetic analyses using three approaches, this being only the second time that any such an approach has been followed in the study of African leafhoppers. Additional sophisticated analyses lead to hypotheses of the historical biogeography of the *Discolopeus* species, and enabled the generation of maps showing the complete potential distribution of the species far beyond what is known from collecting localities alone. Another feature of these leafhopper publications is the wealth of invaluable host plant information, stemming from dedicated collecting and surveying over many years.

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New species of the new leafhopper genus *Discolopeus*. 

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22nd Symposium of the Nematological Society of Southern Africa

The 22nd Symposium of the Nematological Society of Southern Africa (NSSA) took place at the Gooderson Kloppenheim Country Estate, Machadodorp, Mpumalanga, South Africa from 12-15 May 2019. The symposium was attended by about 100 delegates both local and abroad, of which 35 were students. Delegates represented universities, science councils and agro-chemical companies from The Netherlands, Switzerland, Belgium, Greece, Norway, Venezuela, Swaziland, Kenya, Nigeria and Benin. South Africa was represented by delegates from the Agricultural Research Council (ARC-Plant Health and Protection, ARC-Infruitec-Nietvoorbi, ARC-Tropical and Subtropical Crops, ARC-Industrial Crops, ARC-Grain Crops, ARC-Small Grains and ARC-Vegetable and Ornamental Plants), Universities (Free State, Stellenbosch, North-West, Limpopo, South Africa and Johannesburg) as well as agrochemical industries (Syngenta SA, Bayer Crop Sciences, Villa Crop Protection), farmers (ZZ2 Natuurboerdery), crop industries (Citrus Research International, South African Sugar Research Institute, SEDA Essential Oils Business Incubator, Potato South Africa) and analytical laboratories (NEMLAB).

During the symposium, both Drs Mariette Marais and Antoinette Swart acted as adjudicators of the best student paper and the best student poster, respectively. Ms Chantelle Girgan was chairperson of one of the sessions. Dr Riana Jacobs was invited by the NSSA to present a workshop on the National Environmental Management: Biodiversity Act No 10 of 2004 (NEMBA) and the implications of this legislation. Dr Marais acted as chairperson of the workshop. Drs Swart, Marais, Esther Van den Berg and Mme Girgan, Mavis Haji and Adoration Shubane were the authors of five posters and five papers presented at the Symposium.

The presence of delegates from different countries, universities, agrochemical industries and crop industries lead to many meaningful discussions on mutual studies. Dr Nabil Majdi (Germany) even promised to send the Nematology Unit one of his custom made sediment-sampling tubes for collecting soil samples in rivers and streams.

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Dr David Simelane and Mrs Lulu Madire attended the 27th Asian-Pacific Weed Science Society Conference (APWSS) held in the city of Kuching, Sarawak, Malaysia from the 31th August to 8th September 2019. The APWSSC is held every two years, and this years’ conference was held in Malaysia, following the one held in Japan two years ago. Dr Simelane’s talk was entitled, “Biological Control Initiatives Against poisonous South American ink berries (Cestrum species) in South Africa” and that of Mrs Madire was entitled, “Release and establishment of leaf-feeding lady beetle Mada polluta on Tecoma stans in South Africa”. Although the APWSS is traditionally dominated by weed sciences in agroecosystems, there has been a steady growth of interest in biocontrol research of environmental weeds during the past two conferences. The conference talks covered a wide range of research areas, including ecology, biology, chemistry related to weed control and management. The theme for the 27th APWSS conference was, “Weed Science for Sustainable Agriculture and the Environment”. Over 400 delegates from 24 countries participated in the conference.

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INSECT ECOLOGY WINS BEST GDARD POSTER AWARD

Dr Robert Nofemela and Mr Tebogo Mailula of ARC-PHP Insect Ecology won the award for best poster presentation at the GDARD Agricultural Research Symposium held on 7 June 2019 at the Saint George’s Hotel and Conference Centre, Irene. The title of their poster was, ‘The use of synthetic sex pheromone traps for mass trapping Tuta absoluta (Lepidoptera: Gelechiidae) male moths and development of an action threshold in greenhouse tunnel tomato’. The invasive Tuta leaf miner has become a major pest of tomato crops, especially of tomatoes grown by emerging commercial farmers who may not have adequate resources to repeatedly apply pesticides to manage the pest. It is hoped that we can use the pheromone traps to reduce the population of male Tuta moths in greenhouses and shade house tunnels as a preemptive control measure, and then to also use the trap catches to develop an action threshold for pesticide spraying. This would enable farmers to make pest management decisions based on the action threshold numbers caught in the traps, so that they only spray their tomatoes against Tuta when necessary. This will dramatically reduce the need for repeated spraying and the negative economic and environmental costs of controlling the pest.

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POTATOES SA PRIZE FOR BEST POSTER

At the PSA Research Symposium, the poster “Specimens of an entomophytic species of the genus Cruznema found in a maize field in Free State Province, South Africa” by A. Swart, E. Shookoohi, C. Visser, and M. Marais. won the Potatoes South Africa prize for best poster.

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From PDP to PhD: The nematode fauna of the Telperion nature reserve

Dr Chantelle Girgan started her career as a Professional Development Programme (PDP) student in the Nematology unit of Biosystematics in 2015. She received a Ph.D. degree in Environmental Sciences – Nematology in July 2019. In her thesis, “Nematode fauna of the Telperion Nature Reserve”,
Dr Girgan studied the diversity of plant, soil and freshwater nematodes using classical morphological and morphometric methods.

She identified over 100 nematode genera and described two new species, *Aphanolaimus strilliae* and *Makatinus africanus*, and found another six species yet to be described.

Her thesis consisted of seven chapters, two of which have been published in peer-reviewed journals, while a third chapter is being prepared as a manual for the identification of members of the family Pratylenchidae, one of South Africa’s most agriculturally important nematode families.

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**PHD DEGREE IN ENTOMOLOGY**

Nompumelelo Prudence Mtsweni from the Nitrogen Fixating Bacterial Unit, ARC-PHP, attended an award ceremony held in Port Elizabeth, during which she received the South African Women in Science Award (SAWiSA) from the Department of Science and Technology (DST) for her outstanding academic and research achievement.

The award theme, "*Making the fourth industrial revolution work for women*", sought to recognize excellence by women scientists.

The DST funds the annual South African Women in Science Awards to recognise and reward excellence by women scientists and researchers, and profile them as role models for younger women.

The event was held at the Boardwalk Hotel in Port Elizabeth on the 15th of August 2019. Ms Mtsweni was selected as a finalist for 2019 SAWiSA prior to the event. During the award ceremony she was awarded the DST- Albertina Sisulu fellowship in recognition for her academic performance and research ability.

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Nontembeko Ntensie Dube of the PHP Weeds Division was awarded her PhD degree in Entomology by the University of KwaZulu-Nata (UKZN). The title of Ntensie’s thesis was “Understanding the fitness, preference and performance of the specialist herbivores of the southern African biotype of *Chromolaena odorata* (Asteraceae), and the impacts on phytochemistry and growth rate of the plant”. The thesis was evaluated by specialist local and international referees. The PhD degree was conferred at a Graduation Ceremony at UKZN on 12 September 2019 through the School of Life Sciences. The *Chromolaena* weed is one of the worst invasive alien plants in South Africa and Dr Dube’s research findings will help us to understand why some insect biocontrol agents do better than other agents on this weed in the field.

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Attendees at the South African Women in Science Award ceremony hosted by the Department of Science and Technology
Technology Transfer

Scientific publications


Scientific publications (continued)


Theses

Dube, N. 2019. Understanding the fitness, preference and performance of specialist herbivores of the southern African biotype of Chromolaena odorata (Asteraceae), and impacts on phytochemistry and growth rate of the plant. Ph.D: Entomology. School of Life Sciences, UKZN.


Theses supervised by our researchers

Mpenge M.J. 2019. Disease characterisation, epidemiology and genetic diversity of Pseudomonas syringae pathovars causing angular leaf spot of cucurbits in South Africa. Master of Technology, Tshwane University of Technology

Nqayi, S.B. Climatic suitability of Dichrorampha odorata Brown and Zachariades (Lepidoptera: Tortricidae), a shoot-boring moth for the biological control of Chromolaena odorata (L.) R.M. King and H. Robinson (Asteraceae) in South Africa. Master of Science cum laude, Rhodes University.


Newsletters

