Asian woolly hackberry aphid has spread to South Africa

The potential of insect species to spread beyond their established geographical ranges, often through international trade in plant produce or fruit, poses an ever-present threat to the natural and cultivated vegetation of any country.

In May 2016, large numbers of small insects with a white fluffy appearance were noticed under the leaves of a nettle tree (Celtis sp.) in Pretoria. Samples were diagnosed at the ARC-PPRI Biosystematics Division as a foreign species known as the Asian woolly hackberry aphid, Shivaphis celti. Until now, this aphid species did not occur in South Africa.

Shivaphis celti is native to Asia, but was detected as an alien introduction in the eastern USA in 1996, and was subsequently found in Australia in 2013. It feeds on various species of nettle or hackberry trees, which are members of the plant genus Celtis. In South Africa, introduced species such as Celtis australis and C. sinensis are cultivated as ornamental trees, and the white stinkwood, Celtis africana, is indigenous here. This woolly aphid seems to occur on all of these trees here. So far, it does not appear to cause significant damage to them, but it is a nuisance as large colonies build up on the underside of leaves (Fig. 1), and quantities of honeydew are secreted which coat the upper leaf surfaces and provide a substrate for the growth of unsightly sooty mould (Fig. 2). Infested young plants in nurseries may become unmarketable due to the growth of the sooty mould, which turns leaves blackish.

This pest is easy to recognize by the fuzzy white wax which is secreted in tufts on the body and legs of the insects, and by the dark borders along the wing veins (Fig. 3). Populations appear in spring during new leaf growth and persist until leaves drop in autumn. The aphid is also conspicuous because of its tendency to fly up in swarms when disturbed, much like whiteflies. The adult stage may be winged or wingless, and measures about two to three millimetres in length. Unlike most aphids, individuals readily fly from one leaf to another. Nymphs are produced parthenogenetically (i.e. without mating) in summer, but mated females may lay eggs to survive the winter months, when there are no leaves on the trees.

Natural control by parasitoids has been reported from abroad, and locally several species of ladybirds have been observed feeding on the nymphs and adults. The occurrence of the “white stinkwood woolly aphid” in South Africa will be monitored to determine the extent of its distribution, and to quantify its potential as a pest of ornamental white stinkwood trees.

Contact: Ian Millar at MillarI@arc.agric.za or Dr Diedrich Visser at DVisser@arc.agric.za

Fig 1. Woolly aphids on new leaf growth on an ornamental Celtis species

Fig 2. Leaves lower down on infested plants covered in a black sooty mould growing on honeydew secreted by the aphids

Fig 3. Close-up picture of winged adult showing fluffy wax and dark-bordered wing veins
VALUABLE FINDINGS FROM HERBICIDE TRIALS ON POMPOM WEED

In South Africa, a herbicide may only be applied to control a target weed if the herbicide has been registered for this purpose by the Registrar, Act 36 (The Agricultural Pests Act, 1983 (Act No. 36 of 1983)). ARC-PPRI is one of the organisations that undertake the registration trials on which such herbicide registrations are based. For a herbicide to be registered for the control of a weed it is a requirement that, in registration trials, it killed at least 80% of the treated plants in a single application. The question arises whether a similar level of control can be expected under more adverse conditions that nature has to offer in the field. We attempted to answer this question, using pompom weed (*Campuloclinium macrorcephalum*) as a test case.

Pompom weed is an aggressive invader of disturbed grasslands, and is a great threat to the grassland biome. The plant survives as dormant rootstocks in the soil during winter, while the shoots are annual and die in autumn.

We ran various herbicide trials on pompom weed from February 2005 until February 2010 at the Swartkop Air Force Base and Rietvlei Nature Reserve, both near Pretoria. Here we report on the efficacy of two registered herbicides, metsulfuron methyl 600 g/kg and picloram 240 g/l. Herbicides were applied at the registered concentrations by knapsack sprayer, calibrated to deliver the spray mixture at 300 l/ha per plot. The herbicides were applied as full cover or broadcast sprays to ensure that all the pompom weed in the plots were treated. Herbicides were applied to fully developed, flowering stems in mid-summer of 2005, 2006 and 2007. Whereafter the sites were monitored for an additional three years after spraying had ended. Monitoring involved counting the number of pompom weed plants and seedlings in each plot annually in late January 2005 to 2010, before the plots were sprayed.

Over the 5-year study period, both sites experienced years of high rainfall with an associated fungal disease (2006, 2008-2010), drought (2007) and wildfires (July 2006). Although we had not anticipated the appearance of the rust fungus *Puccinia eupatorii*, the rainfall variability and wildfires were expected. Plots and permanent quadrats were marked with steel droppers and labels in the event of winter fires. The rust was first observed in the herbicide trials in February 2006. The symptoms were always severe, killing more than 90% of the stems and leaving very few surviving plants in a condition suitable for spraying in 2006. In July 2006, wildfires swept through both trial sites while the pompom weed was dormant in the soil. Seedlings did not appear for six months after the fire. The fire also caused a flush of pompom regrowth, which appeared at least a month before the grasses and native forbs (herbaceous flowering plants). A drought occurred in 2007. By mid-summer, only 200 mm rain had fallen - less than half the long-term average for the area - and pompom was severely drought stressed. Above-average rainfall fell over the remaining years and these events coincided with severe rust outbreaks.

Taking into consideration the effects of the rust and drought during the treatment phase of the study (2005 to 2007), we concluded that the herbicides metsulfuron-methyl and picloram did not differ in efficacy over the study period. However, the combined interactions of these uncontrolled variables had a profound effect on herbicide performance, and both products failed to achieve 80% control of treated plants on an annual basis. Possible explanations for the low performance are that:

1. the rust and drought affected plant condition, which in turn affected herbicide absorption and translocation, and
2. massive seedling recruitment partially replenished weed densities between sprays.

We estimated that 7 years of herbicide application, applied annually, would be required to reduce pompom weed to a level where it can be managed with minimal effort. This level of investment makes chemical control unaffordable for most landowners. To exacerbate matters even further, spraying must be completed before February during years when the rust is present. This presents a very small window of opportunity when pompom weed is in a condition suitable for spraying: essentially only two to three months of the year.

The wildfire was a serendipitous occurrence, which might open up various research opportunities. Perhaps fires could be used effectively to control seeds on the soil surface and to kill seedlings. Fire might also be used opportunistically to increase the window of opportunity for spraying. In addition, it would be useful to know how and when the rust affects herbicide absorption and translocation. These possibilities warrant further research and would certainly be beneficial to the integrated management of pompom weed in the future, now that more biological control options are becoming available.

Contact: Jeremy Goodall GoodallJ@arc.agric.za

Could drought explain declining populations of a *Chromolaena odorata* biocontrol agent in South Africa?

*Chromolaena odorata*, a shrub native to the Americas, is still amongst the worst weeds in South Africa. The weed is found infesting subtropical areas in the eastern provinces of KwaZulu-Natal, Mpumalanga and Limpopo. Many of these areas, particularly inland from the coast, are seasonally dry, and chromoaiena is known to be at the edge of its climatic tolerance limit there.

A number of biological control agents have been released to control chromolaena in South Africa, but so far with limited success in suppressing the weed. Two problems that have contributed to the failure of biocontrol agents against the weed include biotype incompatibility for insects and pathogens collected from chromolaena plants that are different genetically and phenotypically from the biotype invading southern Africa (the ‘SA biotype’) and climate suitability of the agents, where they have been collected from more tropical and/or higher rainfall areas overseas than compared to the areas where they are released in South Africa. Other factors that could result in an agent failing to establish include predation, mechanical or chemical clearing of release sites, and drought, if the agent is not drought resistant.

*Lixus aemulus* is a stem-boring weevil collected on a pubescent form of *chromolaena* in Brazil in 1995. Rio Branco is a tropical area that lies within the Amazon basin and has high rainfall (average of 2500 mm/yr). The agent was collected because weevils are generally thought to be successful candidates for weed biological control. *Lixus aemulus* was successfully cultured on the SA *chromolaena* biotype by Dr Rob Kluge and Dr Costas Zachariades of ARC-PPRI, Cedara, KwaZulu-Natal and showed that the weevil had a negative impact on the plant and was oligophagous, but adequately host specific to *chromolaena* to be released in South Africa (Zachariades et al., 2002). The newly eclosed adults (fig 1a) are black with females having a longer, narrower rostrum than males; once they start feeding they develop a yellow wax on their cuticle. They feed by chewing semi-circles from the margins of young leaves on shoot tips and leave behind a black tarry substance along the line of feeding (fig1b). The adults are long lived, with a lifespan of about 6-12 months.
Newly emerged females have a pre-oviposition period of about 1 month. After mating and when she is ready to oviposit, the female uses her rostrum to drill a hole in a green, pithy stem, in which she lays an oval orange egg. She then plugs the hole to protect the egg, and all that is visible externally is a small round scar (fig1c). The egg takes 7-8 days to hatch. The larva feeds on the pith inside the green stem. Larval activity within the stem cannot be detected by external examination, because no frass is expelled from the stem during larval feeding and there are no holes made by the larva through the wall of the stem. The mature larva pupates inside the stem and newly emerged adults bore a hole (fig1d) to exit the stem, after which they crawl up to the top of the plant. *Lixus aemulus* overwinters as adults inside the stems; this is followed by a flush of adult emergence at the beginning of spring. For eggs laid in early summer, development from egg to adult lasts about 3-4 months (adults eclose in late summer), whereas those laid later in summer overwinter, so that development takes 6-7 months.

During early culturing, under laboratory conditions, *L. aemulus* was damaging, with a single larva causing death of 67% of infested stems, a 47% reduction in the dry mass of stems and a 94% reduction in achene (seed) production on infested branches. The hope that the insect can persist in drier areas infested by SA *Chromolaena* based on its biology (a stem borer which can overwinter) and hardiness, is another reason the weevil agent was considered as a biocontrol agent for SA *Chromolaena*.

The weevil was first released in South Africa in 2011. In late 2014 (to coincide with the spring flush of adults) a post-release evaluation was conducted at the 11 existing release sites in KwaZulu-Natal, Mpumalanga and Limpopo, at which a total of 2,295 adults had been released. The weevil was recorded at nine (82%) of these, with a total of 96 adults recovered. Because *L. aemulus* is a slow-breeding agent, we decided to conduct post-release evaluation only every two years. This 2-year period will allow sufficient time for the agent to produce new generations, thereby increasing its population; and to prevent counting adults that have already been recorded on the previous survey. Therefore in late 2016, a post-release evaluation was again conducted at the eleven release sites that were surveyed in 2014, as well as at six newer release sites, at which a total of 2,009 adults had been released. The weevil was recorded at only four of the original 11 sites (i.e. they had disappeared from five sites at which they had previously been recorded) and at low numbers (14 adults) compared to the 2014 population. A total of 40 adults were found at four of the six newer release sites, of which 30 were found at one site (Hectorspruit, Mpumalanga).

One explanation of the poor performance of *L. aemulus* at most of the sites could be the severe drought that parts of South Africa experienced between 2014 and 2016 (over and above having a lower average annual rainfall than the collection site in Brazil). Other sites had been cleared for agricultural activities. When we excluded these cleared sites, there was a significant negative correlation between the degree to which drought had affected a site and the number of weevils found there. South Africa is in general cooler than the site in Brazil where *L. aemulus* was collected; this may also have a negative impact on the weevil. However, the weevil is still present at our southernmost release site, at which a relatively small number of adults was released in March 2011 – using a conservative estimate of one year per generation, the adults we found here in late 2016 would have been sixth generation offspring.

For future releases of the weevil, the focus will be around Hectorspruit (probably one of the warmest areas in the country) or sites that have *Chromolaena* infestations that are in similar condition to that in Hectorspruit (a dense infestation in a drainage line which had not been cleared since the release was made). Since this was the first survey at this site, the next post-release monitoring in late 2018 will reveal whether the Hectorspruit population is still high or has declined over time. Given that the drought has now broken, we hope that weevil populations at other sites will also have increased by the next monitoring trip.

References:

Contact: Slindile Nqayi at SitholeS@arc.agric.za

Fig. 1a. *Lixus aemulus* adult beetle; 1b. adult feeding damage; 1c. holes drilled and plugged using her rostrum during oviposition; 1d. adult emergence hole

Diagnostic laboratories of bacteriology and virology registered with the Department of Agriculture, Forestry and Fisheries (DAFF) as the “Test Lab for Plants”

The Division of Microbiology and Plant Pathology at the ARC-PPRI possesses diagnostic laboratories that are dedicated to providing plant disease diagnostic services to the agricultural industry in South Africa. We employ traditional diagnostic techniques, as well as modern technologies to diagnose diseases of crops that are grown in the country. The laboratories are equipped to test for plant pathogenic viruses and bacteria. We also provide various specialty testing services for certain plant pathogens. These specific focus areas are supported by specialised skills, resources and experts in plant microbiology, pathology and soil health. The experts investigate plant diseases that attack various crops such as maize, beans, ornamental plants, deciduous and subtropical fruit trees, grapevines and vegetables. In addition to accurate diagnosis of the crop diseases, customers are provided with the most current information and recom-
mandations. Our laboratories have been registered with the South African Department of Agriculture, Forestry and Fisheries (DAFF) to provide plant pathogen diagnostic and advisory services. As part of this responsibility, the Division supports DAFF with phytosanitary matters in terms of biosafety and trade issues. Since the registration with DAFF has to be renewed every two years, the DAFF inspectors visited our laboratories in June 2016 to evaluate the diagnostic methodology and facilities. Registration of the Division’s laboratories with DAFF as the “Test Lab for Plants”, has been renewed until 31 May 2018.

For more information about the services, please contact Dr Teresa Goszczyńska (bacterial diseases) at Goszczynskat@arc.agric.za and Ms Marika van der Merwe (viral diseases) at VDMerweMa@arc.agric.za

TWENTY-SIXTH ANNUAL SYMPOSIUM OF THE SOILBORNE PLANT DISEASES INTEREST GROUP OF SOUTH AFRICA

SOIL REHABILITATION AND SOILBORNE PLANT DISEASES

The Soilborne Plant Diseases Interest Group of South Africa hosted the 26th Interdisciplinary Symposium on Soilborne Plant Diseases on 21 and 22 September 2016 at the Vredenburg Research Centre of the ARC-PPRI in Stellenbosch. The topic of the symposium was Soil rehabilitation and Soilborne Plant Diseases. The event was attended by 57 representatives of Research Councils, National and Provincial Departments of Agriculture, private companies, universities and farmers. Participants represented a wide range of disciplines including agronomy, botany, economy, entomology, genetics, horticulture, microbiology, soil microbiology, nematology, plant pathology, plant physiology, soil science and zoology.

The following aspects were introduced and discussed in depth:

1. Soil – A sustainable deciduous fruit production perspective
2. Systems-based approaches for the management of soilborne plant pathogens
3. Soil health: Are we improving or harming our soil’s physical properties?
4. Management of soil compaction as a contributing factor in citrus decline
5. Influence of soil reaction on soilborne plant disease: A review
6. Common scab and its rocky relationship with pH
7. Effect of degree of soil disturbance and crop rotation on selected soil physical and chemical parameters
8. The Butterfly Effect: Agricultural systems and soil microbial communities
9. Multiplicity of mechanisms govern efficacy of anaerobic soil disinfestation for soilborne disease control
10. The role of conservation versus conventional agriculture on nematode assemblages
11. Sorghum root and grain diseases associated with legume rotation systems
12. Soil rehabilitation and induced suppressiveness in agricultural practice (organic amendment and solarization)
13. A multi-pronged approach for the management of plant-parasitic nematodes
14. Applications of high resolution remote sensing imagery in agricultural management: A case study from the lower Orange river area.

The opening address was delivered by Prof Wiehann Steyn (Crop Production Programme Manager, HORTGRO Science and Department of Horticultural Science, Stellenbosch University).

Conclusions reached by the delegates to this symposium can be summarized as follows:

1. Soil is important to fruit growers and soil-related research fits into the overarching research strategy of the deciduous fruit industry of South Africa. HORTGRO, as a grower-funded industry body, is tasked to develop research strategies and identify research needs that will increase profitability and ensure the long-term sustainability of deciduous fruit growers. Soil health per se is not a key focus area in the Crop Production and Crop Protection research programmes and is not considered a major risk to the “Orchard of the Future” unlike, for example, water availability and climate change. However, aspects of soil form an integral part of many high-priority projects on, for example, water saving, breeding nematode tolerant stone fruit rootstocks, identifying climatically adapted apple rootstocks, root growth flushes, cover crops and nursery tree quality. The need for researchers working on complicated, industry-funded, multidisciplinary projects to clearly and at the appropriate level, communicate their research to growers is important.

2. Conventional production of many high value crops became dependent upon the extensive use of inputs to maintain crop productivity. The increase in crop production costs, competition for diminishing natural resources and the continuation of disease outbreaks despite the use of pesticides, have created the need for a systems-based approach to pest manage-
ment, which evolved from the Integrated Pest Management (IPM) concept. A systems-based approach to predicting pest outbreaks by maximizing the potential of natural pest suppression mechanisms; incorporating natural disease suppression; restricting the use of, and minimizing the impact of pesticides, bio-pesticides and other agents; minimizing the negative attributes of intervention activities; adopting measures that assure harvest and post-harvest food safety. Examples are available where systems-based approaches for management of soilborne diseases have been successfully adopted and applied.

3. Soil quality has of late been seriously impacted by heavy equipment use in agriculture. Higher soil compaction leads to higher soil bulk densities and lower porosities. This negatively influences water storage capacity, water and air movement and root growth. Cultivation practices which alleviate soil compaction enhance soil quality. No-till is not a long term solution, as it tends to increase compaction and enhance soil acidity in the deeper soil layers. Conservation tillage, correctly managed, can solve some of these problems.

4. It has previously been determined that restricted root depth due to soil compaction is a major limiting factor in citrus orchards in South Africa and is an aggravating factor in Phytophthora root rot of citrus. Failed trials have demonstrated that profile modification through deep tillage of soil alleviated the detrimental effects of soil compaction but also that deep ploughing in existing orchards is not always beneficial.

5. A study on the impact of 75 years of continuous irrigation on the quality of soils, expressed as waterlogging, sodicity and salinity, in the Vaalharts and Orange-Riet Irrigation scheme, showed that waterlogging was generally associated with sandy and loamy fields with a gentle, concave slope shaped terrain and impermeable underlying material. Some clay soils, like the Vaalrivier form, performed reasonably well, while others like the Semane form, required artificial drains. Sodicity poses no threat due to the good to medium quality of the irrigation water sourced and the soil salinity was generally lower than the threshold of most of the popular field crops, except peas.

6. Soil reaction has a definitive effect, whether direct or indirect, on the soil environment in which biotic factors exist. The ways in which soil pH in particular affects so many diseases in such a variety of ways, requires cooperative experimentation by both soil chemists and plant pathologists. Further, it is crucial that management practices be monitored accurately in order to maintain an optimal soil reaction to curb soilborne disease incidence.

7. Common scab is a potato disease that is here to stay. It is imperative to include the latest developments on management methods in an integrated approach in order to get a handle on reducing disease incidence. It is also of value to re-visit the potential of Brassica amendments in influencing soil pH and its potential effect on common scab incidence to shed light on the elusive question regarding the reason for reduced common scab incidence where biofumigation was applied as management tool.

8. A study on the effect of the degree of soil disturbance in different cropping systems on various physical and chemical soil parameter showed that after 7-8 years of applying the different treatment combinations, degree of soil disturbance was fundamental in reducing aggregate stability and active carbon content. No definite trend(s) in the effect of cropping systems could be found. Definite stratification of the less mobile elements, in this case organic carbon, was recorded under zero-till. This study confirms current information that the advantages and disadvantages of adopting conservation agricultural practices are not instantaneous but will develop over time and progress is site specific.

9. Healthy soils rely on a delicate and well-balanced ecosystem to function optimally. Due to their sensitivity to environmental changes, the characterization of soil microbial communities’ functional diversity and activity can be used as suitable assessment criteria for the evaluation and management of agricultural soils by monitoring and evaluating the consequent improvement and rehabilitation of soils for sustainable agriculture.

10. Anaerobic soil disinfection (ASD) demonstrates capacity to control a diversity of soilborne pathogens through multiple functional mechanisms. Effective application of ASD requires identification of appropriate carbon source inputs that must be tailored for use against specific target pathogens. ASD-induced changes in composition of the rhizosphere microbiome are associated with disease control efficacy and influenced by host-genotype.

11. The diversity and population densities of beneficial, non-parasitic soil nematodes generally increased over a 4-year period at two sites under conservation practices as opposed to those where conventional agriculture was practised. Nonetheless, high population densities of the nematode-pest species Meloidogyne incognita and Rotylenchulus parvus were also recorded at the respective sites.

12. It is apparent from field trials conducted in the Alma region of Limpopo province, that legumes in crop rotation systems with sorghum, result in a slight reduction in root rot levels but greatly enhance root development resulting in significantly enhancing yields. These effects are associated with changes in soil nutrients although biodiversity factors may also play a significant role and requires quantification. Still requiring considerable elucidation is the increase in sorghum grain mold severities and associated mycotoxins in legume rotations systems, which may have food safety implications. Epidemiological studies and the identification of driving variables are required in order to develop appropriate intervention technologies.

13. Combining soil solarization with organic amendments, as a tool for improved control of plant pests, represents a fusion of two approaches which were independently developed. Today, the adoption of this approach has been extended to various cropping practices in a broad spectrum of cropping systems. This approach can be considered as a way of improving the performance of both solarization and amendments. Heating soils by covering them with transparent plastic film and amending with appropriate organic material, actuates a chain reaction of chemical and microbial processes in the soil, leading to effective control of a wide range of soilborne pathogens. The degradation of the organic matter, the release of various volatile and soluble compounds, and the changes in the soil’s microbial balance, result in improved control of soilborne pests. Additionally, an important issue in pest control, which accompanies the use of this approach, is the creation of soil suppressiveness, which adds important value to the pest control equation.

14. Key to any approach on managing nematodes is knowledge of the particular organism. The success of an integrated pest management programme is based on six principles: prevention; monitoring; risk determination; decision-making; intervention and evaluation. The most important aspect of any Integrated Pest Management programme is the final evaluation which determines whether the programme used was successful or not.

15. High resolution remote sensed imagery has become more accessible to agricultural researchers with the development of remotely piloted aircrafts (RPA) and can be used as a tool in crop management. A RPA can be fitted with various sensors that measure light reflectance from vegetation and other objects in the visible and near infrared regions of the electromagnetic spectrum. Monitoring and evaluation of vegetation conditions can be done by applying algorithms such as normalized vegetation condition index and red edge analysis amongst others. In comparison to broad band reflectance, the results indicate that RED EDGE measurements are valuable for assessment of vegetative chlorophyll status and leaf area index independently of ground cover variations and are particularly suitable for stress detection.

Contact: Sandra Lamprecht at LamprechtS@arc.agric.za
The ARC-PPRI living fungal culture collection: advances over the past five years

The PPRI living fungal culture collection was established in 1981 by Dr. Cecile Roux. This collection currently comprises 27,800 strains, and includes the Medical Research Council (MRC) PROMEC and the University of Pretoria Fungal collections (UPFC) which were incorporated into the PPRI collection in 2012. The fungal strains represented in the collection were isolated from plants, insects, soil, environmental samples and other sources. Cultures were obtained from South Africa and neighbouring countries, the United States of America, Mexico, Australia, Brazil and Canada. The different groups of fungal specimens in the collection comprise the Ascomycetes, Basidiomycetes, Deuteromycetes and Zygomycetes.

Different methods of preservation are used to preserve isolates in the living fungal culture collection.

- **Agar punches in sterile water**
  About 5 to 8 punches from pure, mite-free cultures are cut with a sterile scalpel blade and placed into sterile water bottles. The bottles are labelled with PPRI collection accession numbers and stored at 15-17 °C.

- **Agar slants with paraffin oil**
  McCartney bottles with appropriate medium slants are inoculated with pure, mite-free fungal cultures. When the culture has grown sufficiently, paraffin oil is poured onto the culture. The bottles are labelled with PPRI collection accession numbers and stored at 15-17 °C.

- **Ultralow temperature storage**
  A volume of 4-6 ml of sterile 15% glycerol is poured onto a clean, mite-free culture plate. The spores and mycelium on the plate are scraped off with a 10 ml micropipette tip. The suspension is sucked up and divided equally between three cryovials (with a maximum of 1.8 ml per vial). The vials are marked with PPRI collection accession numbers and placed in Mr Frosties freezing containers in a -70 °C freezer. After 4 hours, tubes are allocated box numbers, packed into the boxes and stored in a -70 °C freezer.

- **Freeze drying**
  A volume of 4-6 ml suspension fluid is poured onto a pure sporulating culture plate. Spores and mycelia are scraped off with a pipette tip. A total volume of 1.5 ml of spore suspension is aseptically pipetted into 5 vials. The rubber stopper is placed loosely on top of each vial and the vials are placed into kidney-shaped trays in a freeze dryer overnight. The freeze dryer is then operated according to the protocol, and the vials are placed inside the chamber. After 24 hours, the rubber stoppers are pressed into the vials with the screw device of the freeze dryer apparatus before the vacuum is switched off. The vials are removed from the freeze drying chamber and sealed with metal caps. The vials are allocated box numbers, packed into boxes and stored at 15-17 °C in a cold room.

The PPRI living fungal culture collection activities include:
- The incorporation of new cultures into the collection using the various methods of preservation
- Maintenance of preserved cultures to verify their viability and to replace missing cultures in the collection
- DNA Barcoding of species
- Provision of cultures to clients
- Record keeping (PPRI living fungal culture collection database, accession register & index cards)
- Verification of the occurrence status of pest fungi in South Africa
The incorporation of the new cultures into the collection represents the major activity within the PPRI living fungal culture collection over the past five years. The greatest number of new accessions was deposited in 2015 (Fig. 4). About 10% of the cultures were barcoded (Fig. 3) and more than 30 fungal genera were included (Fig. 5). A total of 16% of the cultures in the collection was revived as part of our maintenance program, of which 8% of the maintenance has been accomplished within the past five years (Fig. 3). Of the 5% of cultures provided to clients since 2000, 3% were provided in the past five years, with most cultures provided to external clients. The pest occurrence status in South Africa of 37 species was verified for the Department of Agriculture, Forestry and Fisheries (DAFF).

Contact: Grace Kwinda, kwindaG@arc.agric.za

A friend turning into an enemy: a case of *Glyceria maxima* in South Africa

*Glyceria maxima* (reed meadow grass), a native of Eurasia, was introduced into South Africa as a wetland fodder grass in the 1940s. It is a perennial grass that grows vigorously in permanently inundated and semi-aquatic habitats. Reed meadow grass was initially grown and the vegetative propagules (rhizomes) shared amongst farmers in the KwaZulu-Natal (KZN) midlands. It was popular initially because it could be planted alongside streams and in wetlands as an additional source of forage.Prussic acid poisoning in cattle has been cited as one reason why reed meadow grass was fortunately not cultivated widely. The species is invasive and abandoned reed meadow grass pastures became sites for further downstream invasion. Reed meadow grass is predominantly found in the upland regions of KwaZulu-Natal province including the Mkomazi, Mzimkulu and Mzimvubu catchments (Figs 1, 2) and a localised infestation on a farm in Dullstroom, Mpumalanga province (Fig. 3).

Reed meadow grass can grow in water up to depth of 150 cm. It is capable of forming floating mats that remain attached to stream banks, enabling it to cover deeper watercourses to such an extent that no surface water remains exposed.

*Glyceria maxima* is regarded as one of the most invasive wetland species worldwide. It poses a huge threat to wetland biodiversity because it transforms vegetation and creates dense monotypic stands. As such it is a threat to nesting sites of wattled cranes. It has been declared as category 1b invader under the National Environmental Biodiversity: Act (NEMBA).

Infestations expand predominately by vegetative reproduction through the production of numerous tillers from the rhizomes (Fig. 4). Flowering occurs in November and viable seeds can be found on plants from February to March. Most of the seeds are dormant and only about 3% are capable of germinating immediately after seed set. An after-ripening period of about 6 months is required to break dormancy, after which more than 90% of the seeds will germinate. Water is the main dispersal agent carrying propagules (rhizomes and seeds) to new habitats downstream. Floating mats often become detached from the bank/shore and break up in the water column, providing propagating material for new infestations when they are transported downstream (Fig. 5). The seeds can float for about 24 hours before sinking, thus giving them a good chance for dispersal.

*Glyceria maxima* poses a huge threat to riparian ecosystems in cooler high-altitude regions of South Africa. It is likely that most of the infestations in the country are still undocumented. It is recommended that surveys be carried out along the streams that pass through or close to infested farmlands to improve our understanding of its true distribution. This includes invaded streams in the Mpumalanga Highveld, KwaZulu-Natal midlands and streams such as the Mzintlava that flow into the Eastern Cape. Chemical and biological control options should be investigated as a matter of priority as no control recommendations for this species currently exist in South Africa.

Contact: Lutendo Mugwedi at lutendo.mug@gmail.com or Jeremy Goodall at GoodallJ@arc.agric.za
Ms. Thembelihle Mlokoti and Ms. Sivuyisiwe Zondani from the Vredenburg Campus participated in a Science Open Day for approximately 300 Grade 9 learners. The Science Open Day was hosted and organised by Usasazo High School and South African Environmental Observation Network (SAEON), Egagasinini Node, to empower learners through scientific knowledge and skills.

An interactive presentation was conducted whereby learners shared their knowledge and understanding of invasive alien species in South Africa, specifically highlighting the negative impacts of these species.

This was followed by a demonstration of different species of invasive alien plants found in the Western Cape and their biological control agents (mostly insects); discussing the importance of biological control of weeds, the procedures, principles, collecting and monitoring of agents.

Later, the procedures of biological weed biocontrol were presented as an adventure in the form of a well-known and widely played game, “Snakes and Ladders”.

Over all, the Open Day demonstrated the exciting research that scientists carry out, and the fascinating facts they generate in their careers, using simple materials in different ways; enhancing the learner’s research skills and analytical thinking.

Many thanks to the SAEON education officer, Mr Thomas Mtontsi, for the invitation to present a small component of the research carried out at the PPRI, as well as to the facilitators from the various institutions involved, teachers and learners, for the great teamwork and for making the day a huge success.

Contact: Thembelihle Mlokoti at MlokotiT@arc.agric.za

**Bringing the fascinating world of science to learners**

**Beekeeping development training**

The PoloAfrica Development Trust is a capacity building programme established in Ficksburg, Free State, to encourage children to remain in school and work hard through the sport of polo. Part of the programme involves teaching life skills, including beekeeping. The trustees believe that beekeeping cultivates personal commitment and self-discipline, qualities fostered in PoloAfrica learners. It also encourages empathy with animals and an understanding of nature. The trust has several junior beekeepers, who have managed to trap nine swarms in the last two years (2015/2017) at the Uitgedacht Farm. The trust has obtained a grant from the National Lottery and has used the funds to purchase protective clothing, Langstroth hives, trap hives, honey supers, smokers, and a honey extraction machine. The learners assembled the hives, and put out trap hives to catch wild swarms. They then transferred the bees into the Langstroth hives.
A lot has been achieved in South Africa since the commencement of the biological control programme against the invasive alien shrub *Chromolaena odorata* (locally known as triffid weed), which originates from southern USA to northern Argentina. Several biological control agents (mainly insects) were considered for host specificity testing and a few of these were rejected due to insufficient specificity. Some were released but failed to establish, due to several reasons including (i) ant predation, (ii) climatic or (iii) biotype incompatibility. So far, two biological control agents have been successfully established: a fly with leaf mining larvae and a moth with defoliating larvae. The latter two species have dispersed into Swaziland. Although the weediness of this weed declined in some parts of KwaZulu-Natal, these biocontrol agents have failed to establish in the cold interior regions and Limpopo Province. Recently, a stem boring weevil (*Lixus aemulus*), a moth with shoot tip boring larvae (*Dichrorampha odorata*) and the stem chopping cerambycid beetle (*Recchia parvula*) were released, but their establishment has not been confirmed.

The PoloAfrica Development Trust beekeeping training began in 2011/2012 when 10-15 learners attended a basic introductory beekeeping course. However, some have dropped out and/or graduated from high school over the years. One of the mandates of the trust is that the learners must be in school in order to participate in the sport of polo and life skills training. Those currently interested in beekeeping are between the ages of 12 and 20. One of their matric students is also very keen to work in the beekeeping industry to gain more experience, and to become a professional beekeeper one day.

As the beekeeping hives belong to the trust, the junior groups needed to be professionally trained to look after the hives when their seniors will be leaving to further their studies. All the learners live in rural farm villages, but attend school in town. The intensive teaching time for polo and other activities occurs during school holidays.

A two-day refresher course was provided by the ARC-PPRI, Beekeeping Development to 15 children on the 4th October 2016 at the Uitgedacht Farm, and the advanced training followed on the on the 5th at the same venue. Practical training followed on the 6th October where learners were taught how to follow the correct procedure for lighting a smoker; wearing protective clothing; approaching a hive before opening; opening the hive and checking for brood, pollen and honey; checking the requirements for placing honey supers; checking for pests and diseases; closing the hive; and switching off the smoker. All learners had a chance to see the life cycle of honeybees inside the colonies and one of the learners was able to identify the queen honeybee with no assistance. During the practical training, learners were allowed to transfer the trapped swarms into Langstroth hives under our supervision.

Following training on the procedures for hive management, learners were taught how to assemble Langstroth hives (with a honey super each) and to rewire the frames using a wiring board. On the last day, learners completely assembled 5 hives together with their frames and two supers each. Learners also requested ARC-PPRI to assist with the harvesting of honey in the future, should funds be available.

**Contact:** Tebogo Mailula at MailulaT@arc.agric.za

---

**Gall forming tephritid fly from the Caribbean possess interesting biological features and seems host specific to triffid**

A lot has been achieved in South Africa since the commencement of the biological control programme against the invasive alien shrub *Chromolaena odorata* (locally known as triffid weed), which originates from southern USA to northern Argentina. Several biological control agents (mainly insects) were considered for host specificity testing and a few of these were rejected due to insufficient specificity. Some were released but failed to establish, due to several reasons including (i) ant predation, (ii) climatic or (iii) biotype incompatibility. So far, two biological control agents have been successfully established: a fly with leaf mining larvae and a moth with defoliating larvae. The latter two species have both dispersed into Swaziland. Although the weediness of this weed declined in some parts of KwaZulu-Natal, these biocontrol agents have failed to establish in the cold interior regions and Limpopo Province. Recently, a stem boring weevil (*Lixus aemulus*), a moth with shoot tip boring larvae (*Dichrorampha odorata*) and the stem chopping cerambycid beetle (*Recchia parvula*) were released, but their establishment has not been confirmed.

---

**Fig. 1 & 2. The opening of the hive and wiring of frames**

**Fig. 3 & 4. Learners after practical training**

**Fig. 5. Tebogo (future beekeeping expert) explaining to fellow team members why honeybees are important to the environment**

**Fig. 1. Dry stems with eclosed Polymorphyia basilica adults**

**Fig. 2. Polymorphyia basilica adult**
Following evidence that the southern African biotype of triffid weed originates from the Caribbean islands, more insect herbivores with Caribbean origin have been studied. Although not used as a biological control agent elsewhere in the world, a gall forming fruit fly, *Polymorphomyia basilica*, was recollected from Jamaica in November 2012 after earlier culturing attempts had failed. This time it bred successfully, although it is not clear whether this was due to the spacious quarantine facility at Cedara, or the mating stimulating enzymatic hydrolase yeast, which stimulates mating, or a combination of both. This agent has features almost similar to those of the related tephrīd, *Cecidochares connexa*, which is popular for its management success on the Asian/West African biotype of triffid weed.

*Polymorphomyia basilica* females make probes similar to those of *Cecidochares connexa*; however, for the former, the gall always contains one larva compared to the cluster that can be found in the galls of the latter. When a male and female of *P. basilica* are confined to triffid weed, the female probes the stems after 5-11 days. During its lifespan, each female can produce an average of 47 probes, most of which will develop into galls. Some females initiated as many as 160 galls, each. A high percentage of these larvae pupate, and pupae are characterized by the formation of a window in the galls. A large number of adults eclosed from the pupae, even from very dry stems. From 18 females and 14 males considered in this study, females generally lived longer than males. Only females that spent 18 or more days with their mates, deposited viable eggs.

Two types of host range trials were carried out. Under paired choice trials entailing confining an insect to a test and target plant using 9 different test plant species, *P. basilica* galls generally developed on the target plant, triffid weed. However, some galling was also recorded on 2 other South American weeds, viz. *Ageratum conyzoides* and *Campuloclinium macrocephalum* (pom pom weed). In addition, galls on one indigenous relative, *Adenostemma viscosum*. Pupation was also recorded from the 2 South American weeds but no pupation took place on the indigenous plant. After 42 days, trials were terminated and all the pupae from the triffid weed galls had eclosed, 5 adults eclosed from *Ageratum conyzoides* and 1 from the pom pom weed but only after 56 days.

Under single pair adults no-choice trials, where an insect is confined to the test plant in a cage, 25 test plant species, including triffid weed were tested. An average of twenty two *Polymorphomyia basilica* galls were found on the triffid weed compared to not more than 10 that were found on 4 South American weeds (*Ageratina adenophora*, *Ageratina riparia*, *Ageratum conyzoides* and *Campuloclinium macrocephalum*). An average of 3 galls was found from a rare, indigenous *Stomatantas africanus*. Survival to adulthood was also as minimal from the non-target plants compared to triffid weed and only one small dead adult was found from *Stomatantas africanus*. The gall from which this adult eclosed was also smaller than the galls from the American plants including those of the triffid weed. After 25 days, the same adults that were exposed to the test plants were exposed to the triffid weed and immediately laid viable eggs that survived through to adulthood.

*Polymorphomyia basilica* proved to have positive biological attributes including a high rate of increase, long lived and mobile adults, the ability of females to lay viable eggs without repetitive mating and the production of several generations per year. The ability of adults to eclose from dry stems/galls may enable this gall forming fly to persist in relatively drier areas. The poor offspring survival on non-target plants tested so far and the ability of *P. basilica* to postpone oviposition in the absence of target plants forecasts its suitability for release in South Africa. South African weeds biological control practitioners recommended the immediate writing up of the release application for this gall forming fly. However, a few replicates still need to be completed. Overall, the current results suggest that *P. basilica* is suitable for release in SA. The biology studies also showed high levels of gall formation, which may make it highly effective for controlling triffid weed.

This work was presented in several platforms including Entomological Society of Southern Africa 2015 but the highlight was presenting a talk at the 20th Australasian Weeds Conference held in Perth, Western Australia, 11-15 September 2016.

Contact person: Nontemeko Dube at DubeN@arc.agric.za
Lady beetle (*Mada polluta*) fully established on yellow bells (*Tecoma stans*) on the South Coast of KwaZulu-Natal

A lady beetle, *Mada polluta* (Coleoptera: Coccinellidae) (Fig 1) from Mexico was first released against yellow bells (*Tecoma stans*.: Bignoniaceae) (Fig 2) in January 2014. Despite the destruction of various release sites throughout the country, the lady beetle has recently been found to have established widely at two sites on the South Coast of Kwazulu-Natal. High populations of the beetle were found at both sites, having dispersed for up 120m from the release site during the past 12 months. The lady beetle has inflicted significant damage on the plants in one of these sites, causing severe defoliation, and reducing flowering and fruiting (Fig 3). The seedlings were severely damaged (Fig 4), and this is likely to curb the spread and infestation of the weed.

Since the release of this beetle, a number of factors have delayed its establishment, including the destruction of most of the release sites through deliberate felling and burning by landowners after initial establishment. Although the beetles recovered at a few felled sites, none of the beetles were recovered on burned sites. The destruction of the release sites has not only delayed establishment of the beetle, but has also delayed the commencement of its post-release evaluation.

Yellow bells has become highly invasive in seven provinces in the country and it continues to spread in South Africa as well as in neighbouring countries. Its spread is aided by seed dispersal through wind and floods. The seeds are highly viable and they can grow into thousands of seedlings though not all of them develop into mature trees as they compete for space. Many landowners have tried to control this invader mechanically by using fire or felling, but the plants re-sprout into multi-stemmed plants and cause thick infestations that displace the indigenous vegetation. Because of its capacity to spread through seeds, it is imperative that seed feeding agents are actively sought in their native range and prioritised for quarantine screening.

**Contact:** Lulama Gracious Madire at MadireL@arc.agric.za

---

**When will the bees return?**

Bees commonly have high species diversity in arid areas, particularly in regions with a winter rainfall. Nevertheless, they are sensitive to drought; when there are no seasonal rains, and no flowers, they become very scarce. Clearly, in the absence of flowers, and without their pollen and nectar, bees cannot reproduce. Prolonged drought across vast areas must have a devastating effect on bee population size.

The BioGaps project is about documenting Karoo biodiversity. The main fieldwork season was the summer of 2016/2017, but during that time it was devastatingly dry and exceptionally hot in many parts of the Karoo. No solitary bees were found in some of the southern Karoo BioGaps survey sites, and only a few in others. This was very unfortunate because the project has a tight schedule. The absence of bees was not an accurate picture of Karoo biodiversity over time, just of one snapshot during a severe drought. How long it will take for them to recover is unknown. Their recovery period will extend beyond the BioGaps project. Bee populations should nevertheless be documented through long-term surveying.

Reinette Swanepoel on a bee collecting trip north-west of Beaufort West, Western Cape Province, on 2 February 2017 when there was not a flower in sight
There is much concern globally about the loss of pollinators and the result of changing land use and climate on pollination. Issues of declines in pollinator populations are high on the agendas of the Convention on Biological Diversity (CBD), The Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES), the United National Food and Agriculture Organisation (FAO) and other international organizations that share concern over the effect of biodiversity conservation and food production.

The South African Government has membership of these bodies and must take steps to prevent loss of pollinator services seriously. Bio-Gaps should be viewed as a milestone in this process. Long-term monitoring of bee biodiversity is essential to alleviating food insecurity in South Africa.

Contact: Connal Eardley eardleyc@arc.agric.za

Mrs Francina Bopape was recently awarded a short term internship for 10 weeks on the University of Virginia (UVa)-summer research internship program (SRIP), arranged through the University of Venda (UNIVEN). The internship program has been in existence since 1992 and has recruited postgraduate students globally. The program was conducted from May 27 to August 5, 2016. The purpose of this trip was to participate in this program, supported by a grant from the South African Department of Science and Technology and administered by UNIVEN. The SRIP offered the opportunity to network, explore and learn advanced skills and technologies at the University of Virginia. These skills will be applied in Mrs F. Bopape’s PhD project, and also at ARC-PPRI’s South African Rhizobium Culture Collection to improve crop production. Scientific communication, seminars and presentation were also offered as additional courses to improve skills in these areas. The major aim of the SRIP was to train individuals to be outstanding scientists who will pioneer major advances in biotechnology and biomedical research. Each student was matched with a suitable mentor based on their current study projects. Prof M. P. Timko (a mentor) envisaged collaborations with ARC researchers on research opportunities associated with legumes. Future joint collaboration will focus on developing joint research proposals primarily focusing on the edible legumes, inoculation and biotic stresses.

Francina is involved in a project on cowpea, a leguminous crop whose yields are affected by various various biotic stresses. The growth and yield of cowpea is reduced by biotic constraints such as parasitic weeds (Striga species), aphids and Fusarium wilt. The main aim of this research is to produce cowpea cultivars or varieties that are resistant to biotic stresses. A few tolerant varieties are available naturally, and these were crossed with other cowpea cultivars with important traits like higher yield. The generated varieties were evaluated using molecular markers or primers to check whether they inherited resistance to the biotic constraints. This included DNA extraction and polymerase chain reaction methods. Francina also presented the results of her research during the final program at the SRIP symposium in an oral presentation and a poster. She also gave an oral presentation to PPRI Roodeplaat on her return from the trip. The breeding techniques that she learnt during her internship will improve the development of rhizobia for crop production in South Africa. The knowledge and information that she gained will also contribute to achieving key targets or goals set up by the ARC, such as food and nutrition security, and human capacity development and organisational growth.

Contact: Francina Bopape at BopapeF@arc.agric.za

Researchers from Prof. M. P. Timko’s laboratory at the Department of Biology, University of Virginia

Students from various Universities across the world who attended the University of Virginia’s SRIP 2016

Francina preparing to view the agarose and page gels in the geldoc viewer, and performing lysis of plant leaves using a tissue lyser to extract DNA from cowpea leaves utilizing the CTAB method.

Biotic constraints affecting cowpea: Fusarium wilt, cowpea aphids and parasitic weeds (Striga or Alectra)
Rare honour befalls nematologist

In a rare honour in this field, an image from a paper published by Dr Esther van den Berg (retired PPRI colleague), was used on the cover of the international Nematology journal.

The head region of a male of *Scutellonema cavenessi* was used on the cover of the journal. The title of the paper is as follows: Van den Berg, E., Tiedt, L.R., Stanley, J.D., Inserra, R.N., & Subbotin, S. 2017. Characterisation of some *Scutellonema* species (Tylenchida: Hoplolaimidae) occurring in Botswana, South Africa, Costa Rica and the USA, with description of *S. clavicaudatum* sp. n. and a molecular phylogeny of the genus. *Nematology* 19: 131-173.

The genus *Scutellonema* are characterised by enlarged phasmids, called scutella. The largest number of the more than 40 species of *Scutellonema* are recorded from Africa.

Contact: Dr Mariette Marais at MaraisM@arc.agric.za
**Scientific publications**


BIONDI, M., FRASCA, R., GROBBELAAR, E. & DALESSANDRO, P. 2016. Supraspecific taxonomy of the flea beetle genus *Blepharida Chevrolat*, 1836 (Coleoptera: Chrysomelidae) in the Afrotropical Region and description of *Atroblepia* subgen. nov. Insect Systematics & Evolution. Published online: DOI 10.1153/1876312X-48022152


DUBE, N., ZACHARIADES, C., MUNYAI, T.C. & ULY, O.O. 2017. Laboratory studies on the biology and host range of *Dichrorampha odorata* (Lepidoptera: Tortricidae), a biological control agent for *Chromolaena odorata* (Asteraceae). *Biocontrol Science and Technology* 27 (2): 222–236.


Scientific publications (continue)

10.1007/s10658-016-1096-2


SCHULZE, A., ROBERTS, R. & PIETERSSEN, G. 2017 First report of the detection of Bean yellow mosaic virus (BYMV) on Tropaeolum majus; Hippeastrum spp. and Liatris spp. in South Africa. Plant Disease. Published online: DOI: 10.1094/PDIS-10-16-1446-PDN


UYI, O.O., ZACHARIADES, C., MARAIS, E. & HILL, M.P. 2016. Reduced mobility but high survival: thermal tolerance and locomotor response of the specialist herbivore, Pareuchaetes insulata (Walker) (Lepidoptera: Erebidae), to low temperatures. Bulletin of Entomological Research DO1:10.1017/S0007485316001103


Popular publications


Workshops

43rd Annual Workshop on the Biocontrol of Weeds, held at Roodeplatte Conference Resort, Roodeplaat, Pretoria, 25-27 July 2016. (34 delegates)

Newsletters

HENDERSON, L. SAPIA News No. 41. July 2016
HENDERSON, L. SAPIA News No. 42. October 2016
HENDERSON, L. SAPIA News No. 43. January 2017

Handbook


Chapters in books

Nematology in South Africa: A view from the 21st Century


Fact sheets

The fall armyworm factsheet was translated into three different languages. They are available on the ARC website at www.arc.agric.za


MAILULA, T., ERASMUS, A. & VAN DEN BERG, J. 2017. Serurebele Fall Armyworm (FAW), se se swa se oalaang go las Afrika Borwa. ARC Biosystematics Factsheet (Sotho). ARC-PPRI