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General enquiries

ARC-Vegetable, Industrial and Medicinal Plants
Private Bag X293
Pretoria
0001
South Africa

e-mail: vopiinfo@arc.agric.za
website: http://www.arc.agric.za

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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)

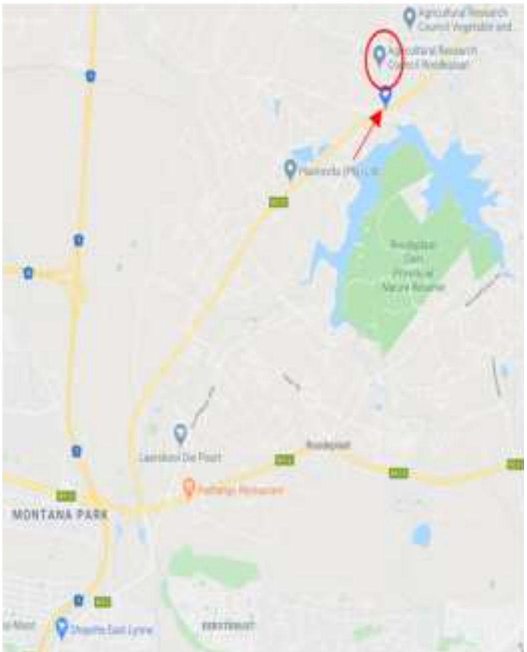
Problems with your plants? Contact our Diagnostic Centre for solutions

Compiled by Rene Sutherland, Julia Mulabisana and Leoka Phillip Mphuthi, Crop Protection Division

Plants are constantly under attack by pests and pathogens, such as viruses, bacteria, fungi and nematodes. These pathogens can cause a wide range of disease symptoms and together with various physiological disorders caused by abiotic factors, such as extreme climatic conditions and chemicals, can negatively influence the functions in plants and ultimately reduce plant growth, affecting yields negatively.

Typical leaf spot caused by fungi, here on tobacco, caused by *Rhizoctonia solani*.

The Diagnostic Centre at the ARC-Vegetable, Industrial and Medicinal Plants (ARC-VIMP) campus at Roodeplaat, aims to assist growers with pest and disease diagnosis of vegetables, medicinal plants, industrial crops (e.g. tobacco, cotton, hemp) and ornamental plants (e.g. flowers). The Diagnostic Centre is situated at the ARC-VIMP Roodeplaat campus, 11km North of Pretoria on the R573, Kwa-Mhlanga road (See map). Apart from plant disease diagnostic services and consultations, we also offer several other important services, such as testing for the presence of pathogens from soil or planting media, irrigation water, propagation material or other plant material. Detection of pathogens is done either by isolations or by molecular-based species-specific detection, depending on the pathogen. Furthermore, we can identify fungi, bacteria and viruses, determine viability of biocontrol agents, evaluate chemical or



Map indicating the location of the ARC-VIMP campus at Roodeplaat. Arrow indicates entrance to the campus from the Kwa-Mhlanga road at coordinates S 25°36'54.0" E28°21'15.0".

Tobacco seedlings infected with the fungal pathogen, *Botrytis cinerea*, and showing grey mould disease symptoms.

biological products for their efficacy against specific plant pathogens, prepare inoculum for field trials and present training. We can also provide advice on integrated disease management strategies for addressing specific problems.

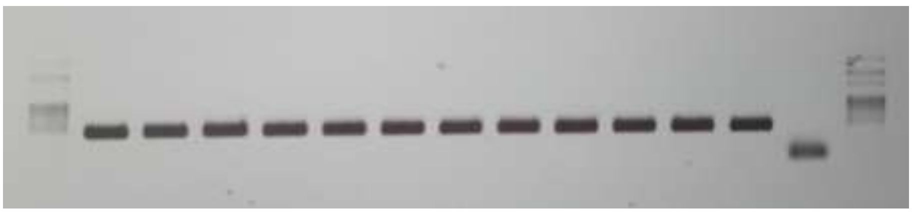
One of the most important factors in the production of agriculture produce, is the source of the propagation or planting material, e.g. seed, seedlings or cuttings. Propagation material is usually obtained from approved or certified nurseries and seed suppliers or from the grower's own cuttings or seeds saved from previous seasons. In all cases, it is important to test the propagation material for the presence of pathogens before planting. Infected propagation material can be a source of bacteria, fungi and viruses, which could be transferred from the previous season to the new season (next generation of crops) and this can reduce the yields and quality of the agricultural produce by up to 100%. Therefore, knowing the status of the material before planting is of crucial importance, especially for crops that are solely propagated by using vegetative material, such as potato, sweet potato and cassava. Although vegetative propagated material can be a source of bacteria, fungi and viruses, viruses are mostly of more concern as the plant material can accumulate different viruses and higher virus loads over several seasons.

Seed producers, nurseries or vine growers are welcome to submit samples to be tested for common pathogens before distribution, to ensure that disease-free seeds and planting material are distributed to growers to prevent the spread of pathogens and production losses. As an example, the ARC-VIMP at Rustenburg, previously known as the ARC-Industrial Crops, has been screening and testing tobacco seedlings for common diseases for several years. Various commercial nurseries and seedlings of tobacco producers were routinely tested for fungi (*Rhizoctonia solani*, *Fusarium oxysporum*, *Sclerotinia sclerotiorum, Phytophthora nicotianae, Pythium* species*, Botrytis cinerea*, *Thielaviopsis basicola*, *Alternaria alternata* and *Colletotrichum tabacum*), bacteria (*Pseudomonas syringae*) and viruses (*Potato virus Y*, *Tobacco mosaic virus* and *Tomato spotted wilt virus*) before being distributed and planted in the field.

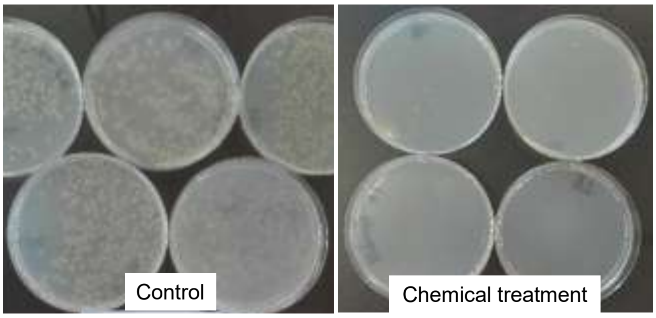
Symptoms of plant diseases can be mistaken for physiological disorders, and before money is wasted to treat the wrong causal agent, the ARC-VIMP Diagnostic Centre can be consulted to confirm the cause. During consultation, specialists with experience in a specific field of study (fungal, bacterial, viral, pest identification, etc.) will provide the right advice and recommendations to the producer, to assist with the prevention of production losses. It is also crucial that farmers/producers contact us as soon as a problem is identified, so that solutions can be implemented in time to prevent total crop failures. An integrated disease management plan to address specific problems can be provided. In addition, we can also provide training to small groups of people on pest and disease scouting, disease diagnosis and disease management.

The laboratories at the ARC-VIMP Diagnostic Centre are well equipped with state of the art equipment. As examples, these includes stereo and compound microscopes fitted with digital cameras for the morphological characterisation of fungal and bacterial pathogens. Furthermore, nucleic acid based molecular techniques are used to identify fungal, bacterial and viral diseases by means of polymerase chain reac-

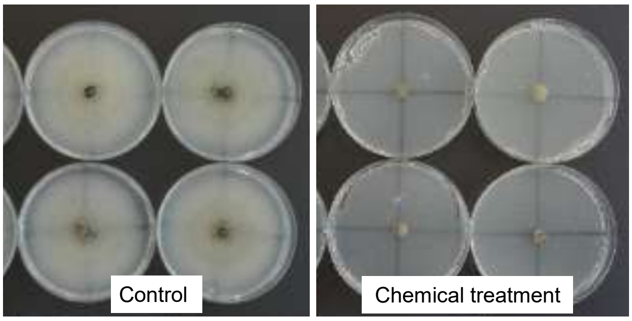
Some of the equipment at the ARC-VIMP Diagnostic Centre laboratories that are used for pathogen detection and identification. On the left, a differential interference contrast compound microscope (with magnification up to 1 000x) and a stereo zoom microscope (with magnification up to 50x), both fitted with digital cameras and linked to a computer. On the right, a real time PCR (qPCR) thermal cycler for the molecular characterization of bacterial, fungal and viral isolates and species-specific identification of these pathogens.



Gel electrophoresis of amplified DNA fragments, used for molecular characterization and identification of bacterial, fungal and viral isolates.

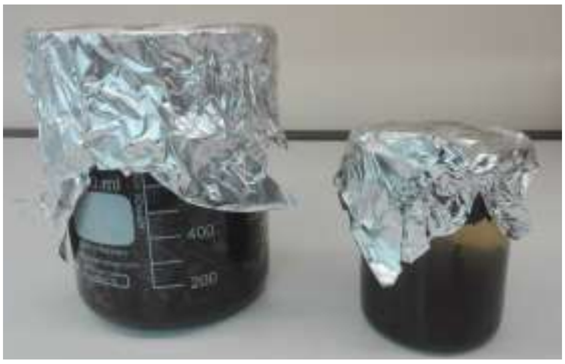


Evaluation of a chemical to inhibit fungal growth. Left: control agar plates seeded with fungal spores (fungal colonies visible), and right: treatment agar amended with a chemical and seeded with fungal spores (no colonies developed).



Evaluation of a chemical to inhibit fungal growth. Left: control agar plates with an agar plug (fungal growth visible), and right: treatment agar amended with a chemical with an agar plug (no fungal growth).

Evaluation of chemicals to inhibit bacterial growth. Left: inhibition zones of no bacterial growth developed around the agar wells filled with chemical A. Right: no inhibition of growth around agar wells filled with chemical B.



Growth media are often tested for the presence of soil-borne pathogens, such as *Pythium*, *Phytophthora* and *Rhizoctonia* species through baiting techniques.

tion (PCR) and reverse transcription PCR. A real time PCR (qPCR) thermal cycler is used for the molecular-based species-specific detection of pathogens.

For registration of a biological control product with the registrar, the viability of the product needs to be tested over a period of time. The Diagnostic Clinic can test for the viability of bacterial and fungal based biological control products. The viability also needs to be confirmed after transportation or storage under unfavourable conditions. Agricultural and related companies are also welcome to submit chemical or biological products for testing of their efficacy against specific plant pathogens. A further service provided by the Diagnostic Centre is preparation of inoculum for field trials.

A sample that is not properly collected in the field and properly transported will arrive in poor condition, making it very difficult to diagnose the disease correctly. For more information on how to collect and send samples, as well as costs of these services, contact Dr René Sutherland at SutherlandR@arc.agric.za or 012 808 8000. The sooner the sample is submitted to the Diagnostic Centre, the more accurate the diagnosis will be, and the sooner you will be able to control plant diseases.

Plant Pathologists to contact for inquiries on different diseases are as follows:

Fungal diseases
Dr Mariette Truter
012 808 8281
TruterM@arc.agric.za

Fungal diseases
Dr Elsie Cruywagen
012 808 8000
CruywagenEM@arc.agric.za

Bacterial diseases
Dr René Sutherland
012 808 8000
SutherlandR@arc.agric.za

Viral diseases
Dr Julia Mulabisana
012 808 8000
mjmulabisana@arc.agric.za

Tobacco and seedling diseases
Mr Phillip Mphuthi
012 427 9999
MphutiL@arc.agric.za

Ms Zama Nkosi, processing symptomatic leaf material for fungal isolation and identification.

Improvement in the establishment and early growth of sweet potato cuttings

Drs R Sutherland[1], S Laurie[2] and M Truter[1]; [1]Crop Protection Division, [2]Plant Breeding Division

Sweet potato is a popular traditional crop in South Africa. The crop is grown by large numbers of subsistence and emerging farmers, while also having considerable commercial value. The exploitation of plant growth-promoting rhizobacteria (PGPRs) to improve crop production has immense potential in the industry. PGPRs are the bacteria in the soil rhizosphere (around the plant roots) or endophytes (bacteria growing inside plant tissue) that directly or indirectly benefit the plant. There are five ways in which the plant can benefit from these PGPRs, namely, 1) plant growth enhancement by an increase in nutrient uptake, 2) altering phytohormones, 3) regulating ethylene levels, 4) Nitrogen (N) fixation, and 5) induced systemic resistance.

In the case of growth improvement, rhizobacteria have the ability to provide better uptake of poorly soluble nutrients, such as phosphorous and iron, as the rhizobacteria secrete siderophores or change the pH of the rhizosphere. With the increase in nutrients, the plants have the ability to increase their growth rate. By altering the phytohormones, the plants can develop more roots, which leads to increased nutrient uptake, leading to the enhanced growth. Rhizobacteria can regulate the ethylene concentration, as too high concentrations can limit root growth. As plant growth is limited by the availability of N, certain rhizobacteria can fix N from atmospheric N and provide it for increased uptake by the plant. Lastly, rhizobacteria can protect plants against pathogens by competing for nutrients, producing antibiotics or by induced systemic resistance.

The objective of this study was to identify PGPRs for improving the establishment and early growth of sweet potato cuttings. Three hundred endophytic and rhizospheric bacteria have previously been isolated from sweet potato roots and rhizospheres from various locations in Gauteng. To test for growth promotion, sweet potato cuttings (10 cm in length) of cultivar Blesbok, were obtained from the ARC sweet potato disease-free nursery at Roodeplaat. Cuttings were planted into the seedling trays filled with sterilized soil and placed in the greenhouse (25ºC) and watered once a day. The sweet potato cuttings were separately inoculated with the different PGPR isolates. After three weeks, the lengths of the sweet potato cuttings were measured to determine the effect of PGPRs on the growth of the sweet potato vines (Fig 1).

The results showed that 29 PGPR isolates increased the growth of sweet potato compared to the control plants (Fig. 2). The resulting growth promotion of sweet potato, e.g. increase in root and shoot weight and total root length, will enable farmers to produce crops of good quality with higher yields, leading to improved food security and improved nutrition.

Contact: Dr René Sutherland at SutherlandR@arc.agric.za

Figure 1. Sweet potato cv. Blesbok cuttings planted in seedling trays in the greenhouse. A) One day after treatment with the different PGPRs, and B) three weeks after treatment with the different PGPRs.

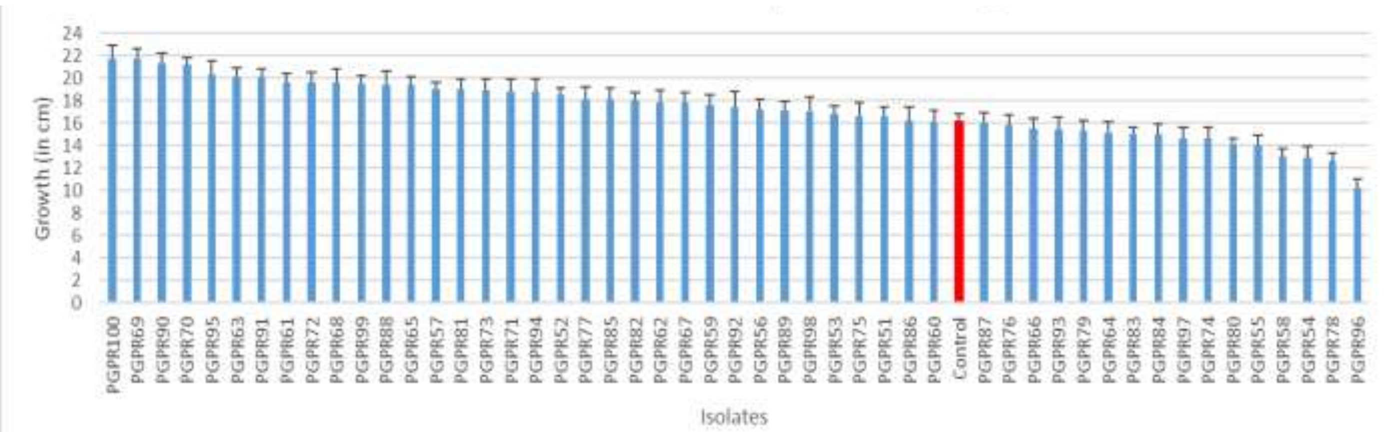


Figure 2. The effect of 50 different isolates of plant growth-promoting rhizobacteria (PGPRs) on the growth of sweet potato cv. Blesbok cuttings.

Adoption of climate smart agricultural practices for vegetable production in Limpopo: A case study of the Vhembe and Capricorn districts

Compiled by Batizi Serote[1,2], Tshiamo Mawela[1,2], Hintsa Araya[1], Manaka Makgato[1], Khomotso Maboka[1], Phomolo Maphothoma[1], Stephen Amoo[1], Motiki Mofokeng[1], Ian du Plooy[1], Granny M. Senyolo[2] and Salmina N. Mokgehle[1]

[1]ARC-VIMP, Crop Sciences Division; [2]Tshwane University of Technology, Department of Crop Sciences

The production of vegetable crops produced in South Africa from 2016/2017 to 2017/2018 has increased by 1.8%, from 2 984 104 tons to 3 037 412 tons. The consumption expenditures of fresh vegetables increased by 5.5% during 2017/2018. The increase in the production of vegetables is mainly driven by a growing demand for food based diversification, coupled with the initiative to promote the consumption of vegetables. From a financial standpoint, the diversification of vegetable crops may mitigate risk and improve financial sustainability.

Diversification of crops ensures benefits such as improving the soil quality and crop quality, increases food security, including the nutritional value, provides more knowledge and enhances the skills of the farmers. In both the Vhembe and Capricorn districts, which are located in the Limpopo Province, the majority of the smallholder farmers produce vegetables for home consumption and income generation by selling their products in the informal market, and most of them produce the vegetables in a monoculture agricultural practice (Fig. 1).

Figure 1. Monoculture production of head cabbage in the Capricorn district, Limpopo Province.

The vegetable producing farmers in the Vhembe and Capricorn districts in the Limpopo Province can benefit from the climate-smart agricultural (CSA) practices the ARC-VIMP team has developed. The CSA adoption practices include vegetable crop diversification through the production of indigenous leafy vegetables, such as amaranths, cleome, tepary bean, cowpea and Bambara groundnuts, that would enable smallholder farmers to manage both the price and production risks, provide their households with more nutritious, diverse food options, and income generation through market participation by selling of surplus produce, either the fresh produce or the products from agro-processing. The CSA adoption could be enhanced further through the following: educating farmers on diversification by providing them with knowledge on the benefits of diversification, adaptation and development of resilience to climate change, CSA methods, how crops should be grown and maintained, creating awareness with regards to the importance of vegetable diversity in traditional agriculture to cope with disasters, as well as on the importance of collaboration between commercial farmers, smallholder farmers and seed companies.

The interaction with commercial farmers and seed companies would offer the smallholder farmers different opportunities, such as purchasing a variety of vegetables at a reduced-priced from the seed companies and also allowing for skills transfer from the commercial farmers in terms of different agricultural practices involving vegetable diversification (Fig. 2), thus increasing the flow of diversity.

For more information regarding climate smart agricultural practices ***contact Dr Hintsa Araya at*** ***ArayaH@arc.agric.za***

Figure 2. Diversification of vegetables: Top: Swiss chard, cabbage and onions; bottom: butternut and tomatoes as CSA practices to decrease the risk of crop failure.

Adoption of climate-smart technologies and food security at the household level in the Vhembe and Capricorn districts

Compiled by Manaka J. Makgato[1], Khomotso Maboka[1], Phomolo Maphothoma[1], Meshack M. Mofokeng[1], Batizi Serote [1,2], Tshiamo Mawela[1,2], Hintsa T. Araya[1], Stephen O. Amoo[1], Christian I. du Plooy[1], and Salmina N. Mokgehle[1]

[1]ARC-VIMP, Crop Sciences Division; [2]Tshwane University of Technology, Department of Crop Sciences

Improving the productivity of smallholder farming systems continues to be a significant need in South Africa. Climate-smart technologies in agriculture can serve as a strategy to increase productivity, resilience and food security. Smallholder adoption of technologies is necessary to speed up the transition to climate-smart agriculture. The sustainability of food production systems results from increased water productivity, which will, in turn, help increase agricultural productivity and the incomes of smallholder farmers. The ARC-VIMP, in collaboration with the Water Research Commission (WRC), assessed the determinants of adoption of technologies that can help achieve some of the climate-smart agriculture outcomes on smallholder farms in the Vhembe and Capricorn districts, Limpopo Province. The primary data collection and assessments were done using a questionnaire that was completed by 100 smallholder farmers participating in vegetable production and utilizing irrigation practices to produce vegetables. The assessment included an investigation on the challenges and opportunities faced by smallholder farmers in the adoption of climate-smart technologies for vegetable production. Two farms were selected in each district (Vhembe and Capricorn) to enhance the building up of household resources as a pathway for improved adoption of new technologies. The technologies adopted by farmers include intercropping, and ridge planting to reduce weeding, soil erosion and to improve the soil moisture content. Additional deliverables in progress include the collection of soil samples, the establishment of experimental plots to assess the water requirements of crops, and nutrition composition. The ARC-VIMP is planning to introduce additional climate-smart agriculture technologies and to improve the adaptive capacity of smallholder farmers, which are key in enabling them to increase their productivity and to ensure their food security.

For more information regarding climate smart agricultural practices ***contact Dr Hintsa Araya at*** ArayaH@arc.agric.za

Mr Khomotso Maboka and the team from the ARC-VIMP engaging the smallholder farmers in the Capricorn district, Limpopo Province, on the challenges and opportunities faced in the adoption of climate-smart technologies.

Smallholder farmers in the Capricorn district, Limpopo Province, showcased their farming practices.

Newly prepared field with flood irrigation ready to be planted with additional diverse vegetable crops.