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ARC-Vegetable and Ornamental Plants Newsletter

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

Nala health bread from Morogo: a tool to combat malnutrition and hidden hunger in South Africa

Compiled by Mokgehle N.S., Kruger F., Araya H. and Matshaya M.

The leaves from Morogo have been a source of food throughout history in South Africa. Some species can be found as weeds or growing wild under severe climatic and soil conditions, but their potential as food sources is still limited. The ARC-VOP team have identified the potential of specific Morogo (*Amaranth*) species as a key ingredient in the production of a healthy bread with essential minerals and vitamins to combat malnutrition and hidden hunger. The team entered their idea into the Innovation Hub (GAP-Gauteng Accelerator Programme) competition and was selected as semi-finalists. The semi-finalists position gave them the opportunity to attend the Executive Education programme facilitated by Emory University's Goizueta Business School. The team had the opportunity to learn various business and entrepreneurship strategies. After the training, the team was assigned a mentor (Ms Anita Jack) who assisted them with preparing for the final business plan and pitching the idea to the Innovation Hub. On 15 November 2018, the team received the second prize in the category of GAP Biosciences at the finalist gala event. The team will be trading as a spinoff business (ARC-VOP productions) and have planned activities to upscale and commercialize the bread, marketed as Nala Morogo bread, for potential entry into the market in the Gauteng Province, starting with their current network.

The Nala Morogo bread is real value for money and contains more nutrients and minerals than standard health breads found on the shelf, especially in beta-carotene, iron and zinc. Bread can be ordered and delivered to various ARC institutes by contacting and placing your order with the Commercialization team at Central Office (ARC-CO).

Contact: Munaka Matshaya at MatshayaM@arc.agric.za

Nala Morogo bread.

From left to right: Mr Francois Kruger, Dr Salmina Mokgehle and Dr Hintsa Araya during the Innovation Hub photo-shoot session.

From left to right: Dr Hintsa Araya, Ms Munaka Matshaya, Dr Salmina Mokgehle, Ms Anita Jack, Mr Francois Kruger and Dr Cynthia Motsi showing the trophy and certificate during the award ceremony at the Innovation Hub.

Medicinal Plant Research at ARC-VOP: Medicinal plant cultivation

Compiled by the Medicinal Plant Research Team, Crop Science Division

Medicinal plants have been identified and used throughout human history. These plants have the ability to synthesize a wide variety of chemical compounds with different biological functions (including healing and well-being maintenance). As a result, many people especially in the rural communities, hold cultural belief about the effectiveness of medicinal plants in traditional medicine. Due to their affordability and accessibility, there is an increasing reliance on the use of medicinal plants by a growing African population for meeting their healthcare needs. Some highly used medicinal plants in South Africa include cancer bush (*Sutherlandia frutescens*), African potato (*Hypoxis hemerocallidea*) and African ginger (*Siphonochilus aethiopicus*).

African ginger, *Siphonochilus aethiopicus,* cultivation.

Medicinal plants are also considered as very important resources for the development of the global pharmaceutical industry. It was estimated that about a quarter of globally prescribed drugs are of plant origin. The current situation is that most medicinal plants (including the endemic ones) are extensively collected from the wild population and are often over-exploited. An ever-growing demand for certain medicinal plants has resulted in market scarcity and critical population decline of many species in their natural habitat. Thus, the conservation or sustainable utilization of these green natural resources is imperative in order for the present and future generations to derive maximum benefit from these medicinal plants.

The cultivation of medicinal plants can be a powerful measure in ensuring a sustainable availability of plant material to meet the growing demand. However, the cultivation of high quality medicinal plants requires intensive care and management. Medicinal plant materials derived from the same species can show a significant difference in quality when cultivated in different ways and/or at different sites. Therefore, systematic cultivation and good agricultural practices are required to ensure that the medicinal quality of cultivated species are not compromised.

Artemisia annua cultivation.

Research studies conducted at the ARC-VOP on various medicinal plants focus on improved propagation and cultivation practices, as well as quality assessment of the medicinal active compounds in the plant material. Research to optimise cultivation practices includes investigations into planting density, irrigation requirements, fertilizer management (organic versus inorganic), pruning, etc. Research on some high demand medicinal plants, including African potato (*Hypoxis hemerocallidea*), African ginger (*Siphonochilus aethiopicus*), Sweet wormwood (*Artemisia annua*), Cancer bush (*Sutherlandia frutescens*), Moringa (*Moringa oleifera*), and Rabassam or Umckaloabo (*Pelargonium sidoides*), have indicated that medicinal plant yield can be increased without compromising the medicinal quality of the harvested material.

Rabassam or Umckaloabo (*Pelargonium sidoides*) cultivation.

Harvested roots of cultivated *Pelargonium sidoides.*

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Control of Fusarium wilt on sweet potato

Compiled by Dr Rene Sutherland and Ms Tintswalo Mathonsi, Crop Protection Division

Sweet potato is a popular traditional and indigenized crop in South Africa. It is grown by large numbers of subsistence and emerging farmers, while also having considerable commercial value. This crop has several advantages such as producing more biomass and nutrients per hectare, per time unit than most other staple crops, being adaptable to a broad range of agro-ecological conditions, as well as producing reasonable yields in low input agriculture. It provides nutritionally significant quantities of ascorbic acid, riboflavin, iron, calcium and protein. These characteristics enable the crop to play a significant role in food security.

However, sweet potato production is hindered by the occurrence of Fusarium wilt, caused by the fungal pathogen *Fusarium oxysporum* f. sp. *batatas*. The disease can be destructive, especially in vine production and results in leaf yellowing, wilting and browning of vascular tissues in the lower stems. No effective control methods are available for the management of this disease. The pathogen can remain viable in the soil for many years, which further impedes the control of the disease. In other crops like banana, Fusarium wilt has been reduced by application of biological control microorganisms that include *Trichoderma* spp. and non-pathogenic *Fusarium oxysporum*. The aim of the research was to isolate non-pathogenic *F. oxysporum* and *Trichoderma* isolates from sweet potato fields and test these isolates' ability to reduce the incidence of Fusarium wilt.

Results indicated that the pathogen, *Fusarium oxysporum* f.sp. *batatas* was significantly inhibited *in vitro* (Figs 1 & 2) by between 14-64% by three commercial biological products, as well as 9 isolates isolated from sweet potato fields. The greenhouse trial indicated that 12 bio-control isolates were able to significantly suppress the disease, as compared to the control (Figs 3-5). Thereby *Trichoderma* species, as well as non-pathogenic *Fusarium* looks promising as bio-control agents for *Fusarium oxysporum* f.sp. *batatas,* but field trials still need to be conducted to determine their efficacy in the field.

Control of Fusarium wilt will contribute to the enhancement of the ability of the agricultural sector to manage and mitigate agricultural risks. This will lead to the prevention of production losses and enable farmers to produce high yielding crops of good quality, which will enhance their competitiveness in the local and potential export markets. Reduction in disease incidence will further contribute to improved nutrition, food security, as well as poverty alleviation when excess, high quality produce can be sold and generate income for the rural poor families.

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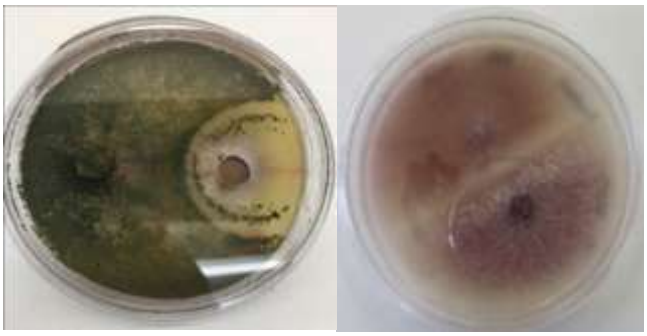

Fig. 1. *In vitro* dual culture assay between *Fusarium oxysporum* f. sp *batatas* and *Trichoderma* sp. on the left and non-pathogenic *F. oxysporum* on the right. The linear fungal growth was measured after seven days and percentage inhibition calculated as the growth in dual culture divided by the growth of the control (isolate grown alone).

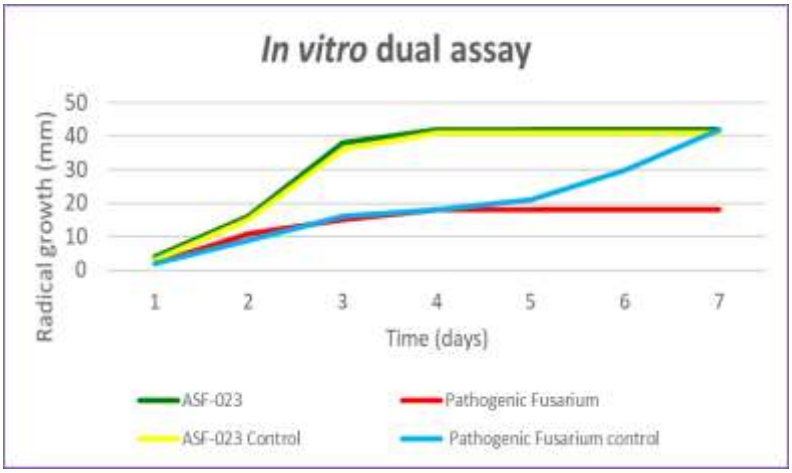

Fig. 2. *In vitro* dual culture assay between *Fusarium oxysporum* f. sp *batatas* and non-pathogenic *F. oxysporum.*

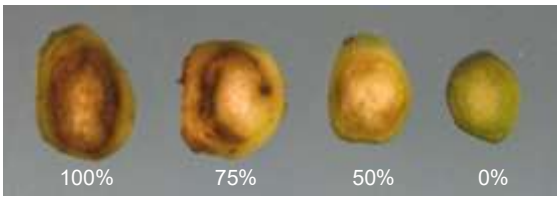

Fig. 3. Disease rating as a percentage of discoloration of the vascular tissue of the sweet potato stems after six weeks. The disease rating was used to determine the effectiveness of the bio-control isolates in the greenhouse study against *Fusarium oxysporum* f.sp. *batatas.*

Fig. 5. Greenhouse trial results of bio-control agents tested against *Fusarium oxysporum* f.sp. *batatas*, after 6 weeks. Difference letters indicated significant difference.

Fig. 4. Greenhouse trial of sweet potato plants before infection with Fusarium wilt.

Potato Research Symposium 2018

Compiled by Dr Elsie Cruywagen, Crop Protection Division

Potatoes South Africa (PSA) held their annual research symposium from 24 – 25 July 2018 at Khaya Ibhubesi, Parys. Approximately 160 – 180 potato producers, researchers, students, personnel of Potatoes South Africa, the Potato Certification Service and the Potato Laboratory Service and others attended the Symposium to learn what progress has been made with research funded by the potato industry. The ARC-VOP and ARC-PHP was well represented by researchers, technicians and students (Fig. 1). The researchers are all engaged in research funded by PSA. The contributions from the ARC-VOP Crop protection division included two talks by Dr Visser on insect pests entitled "The potential of *Tuta absoluta* as a pest of potato" and "Investigations into control strategies of the Potato leafminer." Dr Pofu presented a talk with the title "Integrated nematode management in sustainable potato production." Dr Sutherland gave feedback on her project entitled "Aspects of management of Bacterial wilt of potatoes - survival and sterilization of equipment." Dr Cloete gave feedback on her project entitled "Fissure scab of potatoes in South Africa" while Dr Cruywagen presented a poster with the title "Morphological characterisation of *Streptomyces* species associated with fissure scab of potatoes in South Africa." Ms Chauke is an MTech student and a Potato Industry Trust bursary holder who also works on the fissure scab project. She presented a poster entitled "Characterization of *Streptomyces* isolates causing fissure scab of potatoes in selected potato production regions." The ARC-VOP Plant Breeding division was represented by Mr. Flip Steyn who presented a talk on the "Extent of weight loss of potato tubers during the harvesting and packing process in South Africa" and Ms. Nokuthula Myeza presented a poster on "*In vitro* genebank maintenance of open and sub-license potato cultivars." Dr Mariette Marais of ARC-PHP presented a talk on the "Succession of nematodes in a Free State potato rotation". The symposium concluded with a gala dinner where Dr Visser was awarded the prize for the best oral presentation and Dr Cruywagen received the prize for the best poster.

Fig. 1 ARC personnel and students attending the Potato Research Symposium: from left (back row) Flip Steyn, Rene Sutherland, Elsie Cruywagen, Sonja Venter, Mariette Marais, Diedrich Visser; (front row) Olivia Baloyi, Kgabo Pofu, Nokuthula Myeza, Michele Cloete, Kate Phetla, Kgothatso Chauke.

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ARC-VOP participates in the Presidential Biodiversity Economy Conference to promote research work done on medicinal plants

Compiled by MJ Makgato, MM Mofokeng and HT Araya, Crop Sciences Division

Dr Araya, Mr Mofokeng and Mr Makgato attended the launch and opening of the Presidential Biodiversity Economy Innovation Conference by the president of South Africa- His Excellency President Matamela Cyril Ramaphosa at the Kalahari Waterfront Lodge on 25 August 2018. The Agricultural Research Council was invited by the Department of Environmental Affairs and represented by the Vegetables and Ornamental Plants Division to showcase the research done at the ARC regarding cosmeceutical products and indigenous vegetables. Approximately 70 people and organisations visited the ARC stall where cosmeceutical products were showcased, as well as other products from amaranth, sweet potato and moringa. The ARC exhibition also included information about the research at the ARC-VOP on cultivation and propagation of medicinal and indigenous plants that were used in developing these cosmeceutical products.

The president visited the ARC stall where he was briefed on the research that is being done on cultivation, propagation of indigenous plants and organic products that are developed from these plants. In his speech, he acknowledged the ARC and emphasised the work done by the ARC on cultivation and propagation of indigenous plants, as well as community support. The event provided a strategic opportunity for showcasing the ARC to high level delegates from parliament, but also the important contribution that the ARC is making in biodiversity conservation and economy, use of indigenous knowledge and plants for product development, knowledge holders and community support.

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Mr Manaka Makgato and Mr Meshack Mofokeng briefing the president on the research done by the ARC-VOP regarding cosmeceutical products and indigenous vegetables.

The University of Limpopo postgraduate students' visit to the ARC-VOP

Compiled by Mokgehle N.S., Maphothoma P., Mofokeng M. and Chiloane S., Crop Sciences Division

The University of Limpopo visited the ARC-VOP during July 2018 to expose 11 MSc students in different areas of specializations (pasture science, agronomy, soil science and horticulture) to the different ARC-VOP research activities. Two ARC-VOP students, Mr M. Makgato and Ms J. Moswathupa (PhD and MTech students, respectively) gave presentations on the importance of African leafy vegetables and medicinal plants. In addition to the presentations given, the activities during the visit included visiting laboratories, glasshouses and hydroponics facility. The students were accompanied by Prof Mariga and Prof Ayodele from the Department of Plant Production, University of Limpopo. The students were given practical demonstrations relating to different aspects of tissue culture, laboratory equipment for nutritional and phytochemical analyses of medicinal and vegetable crops, propagation of African ginger, irrigation and growth of medicinal plants, and on the hydroponics production system. The visit expanded the students knowledge on the various opportunities and careers available in agricultural production systems.

Contract: Tsholo Tselapedi at TselapediT@arc.agric.za

Ms N. Hlatswayo (MSc candidate) giving a detailed lecture on the importance of tissue culture, and demonstrated some of the activities involved in plant tissue culture, including how to prepare plant tissue culture medium for different plant species.

Mr S. Chiloane (senior research technician) demonstrating the aquaponics production systems.

Ms P. Maphothoma (junior researcher) explaining her trial involving propagation of African ginger using different growth media.

Mr S. Chiloane (senior research technician) demonstrating the different production systems such as the hydroponics and aquaponics production systems.

Gardening for training and team building

Compiled by Dr Elsie Cruywagen and Dr Mariette Truter, Crop Protection Division

The ARC-VOP Crop Protection division, together with some colleagues from Plant Breeding division, started a gardening project in September 2017. The project has multiple objectives, including internal training, teambuilding and beautifying of the area in front of the building. The training aspect of the project is through hands-on experience in soil preparation, planting and caring for the garden. During the first planting day in September 2017 to celebrate Spring day, water-wise ornamental plants, mainly succulents, were used to replant a large island garden. The plants were donated by some of the researchers and from cuttings made from other established gardens on the campus. The following Spring day celebrations in 2018 was used to fill some remaining gaps in the island garden, and in addition, due to ARC-VOP's focus on vegetables and ornamental plants, a garden with both flowers, vegetables and some herbs were planted in front of the building.

Island garden after the winter of 2017, before the start of the gardening project.

Some of the ornamental plants used in the garden, e.g. marigold and wild garlic, have the added benefit of repelling pests that normally plague the home vegetable garden. The gardening exercise also had the added benefit of teambuilding, as the whole division, including researchers, students, technicians and assistants, were working together outside of the normal work environment. The result of the project is a beautiful and functional garden that can also be used as a demonstration area for visitors.

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The garden was prepared by removing all unwanted plants and replanted with water-wise succulents during September 2017.

Gardening team during September 2017. From left back: Lorraine Dube, Meshack Makhwedzhana, Thabo Nkuna, Kgothatso Chauke, Elsie Cruywagen, Inge Gazendam, Thomas Kalulu, William Monareng. From left front: Lucas Mgidi, Mariette Truter, and William Nkadimeng.

Planting additional cuttings of succulents to fill some gaps in the island garden during September 2018.

Planting of ornamental plants and vegetable seedlings in front of building B1 during gardening day in September 2018.

Gardening team during September 2018. From left back: Inge Gazendam, William Nkadimeng, Mariette Truter, Lesego Buthelezi, Kgothatso Chauke, Kenneth Mahlobogoane, Rene Sutherland, Precious Mathebela. From left front: Phillip Mashabela, Tintswalo Mathonsi, Elsie Cruywagen, Zama Nkosi, and Kholofelo Mamabolo.

Technology Transfer

Scientific publications

Aruwa, C.E., Amoo, S.O. & Kudanga, T. 2018. *Opuntia* (Cactaceae) plant compounds, biological activities and prospects – A comprehensive review. *Food Research International* 112: 328–344 DOI:10.1016/j.foodres.2018.06.047.

Hiscock, L., Bothma, C., Hugo, A., Van Biljon, A & Jansen Van Rensburg W.S. 2018. Overall liking and sensory profiling of boiled *Amaranthus* leaves using the Check-all-that-apply question. *CyTA - Journal of Food* 16(1): 822-830, DOI: 10.1080/19476337.2018.1464521.

Lekala C.S., Madani, K.S.H., Phan, A.D.T., Maboko M.M., Fotouoa, H., Soundy, P., Sultanbawa, Y., Sivakumar, D.S. 2019. Cultivar-specific responses in red sweet peppers grown under shade nets and controlled-temperature plastic tunnel environment on antioxidant constituents at harvest. *Food Chemistry* 275: 85–94.

Maboko, M.M., & Du Plooy, C.P. 2018. Yield response of hydroponically grown mustard spinach and non-heading Chinese cabbage to frequency of leaf harvest and flower removal. International *Journal of Vegetable Science* doi.org/10.1080/19315260.2018.1496511.

Mohale, K.C., Araya H.T., Emanuel, M.A. &. Mudau F. N. 2018. Metabolic Profiling of Cultivated Bush Tea (*Athrixia phylicoides* DC.) in Response to Different Pruning Types. *HortScience* 53(7): 993–998. doi.org/10.21273/HORTSCI13023-18.

Morifi, R.R., Maponya, P.I & Van Niekerk, J. 2018. The Sustainability in Training Hydroponic Production to Smallholder Farmers in Tshwane Area, Gauteng Province. *Journal of Agricultural Science* 9(1-2): 11-19, DOI: 11.258359/KRE-153.

Muzhinji, N., Woodhall, J.W., Truter, M., van der Waals, J.E. 2018. Variation in fungicide sensitivity among anastomosis groups of *Rhizoctonia solani* and binucleate *Rhizoctonia* recovered from potatoes in South Africa. *Plant Disease* 102(8): 1520-1526. https://doi.org/10.1094/PDIS-09-17-1470-RE

Ncayiyana, M., Maboko, M.M. & Bertling, I. 2018. Nitrogen Fertilizer on Storage Life of Short-day Onion. *International Journal of Vegetable Science.* doi.org/10.1080/19315260.2018.1514448.

Rambuda, A., Araya, H.T. & Mudau, F.N. 2018. The quality of baby spinach as affected by developmental stage as well as postharvest storage conditions. Acta Agriculturae Scandinavica, Section B - Soil & Plant Science doi.org/10.1080/09064710.2018.1492009.

Vimbainashe, E.M., Venter, S.L., Amonsoua, E.O. & Kudanga, T. 2018. Composition, thermal and rheological properties of polysaccharides from amadumbe (*Colocasia esculenta*) and cactus (*Opuntia* spp.). *Carbohydrate Polymers* 195: 163-169.

Scientific proceedings

Kruger, F.J.L., Araya, H.T., Kleynhans, R. & du Plooy, C.P. 2018. Enhancing seed germination of *Ceratonia siliqua* L. for large scale production in southern Africa. Acta Horticulturae 1204. ISHS 2018. DOI: 10.17660. Proc. VII Int. Symp. on Seed Transplant and Stand Establishment of Hort. Crops Eds.: P. Soundy et al.

Kruger, F.J.L. Araya, H.T., Kleynhans, R. & du Plooy, C . P. 2018. Seed germination of *Vachellia tortilis* subsp. *heteracantha*. Acta Horticulturae . 1204. ISHS 2018. DOI: 10.17660/ActaHortic. 2018.1204.14. Proc. VII Int. Symp. on Seed Transplant and Stand Establishment of Hort. Crops Eds.: P. Soundy et al.

Lodama, K.E., du Toit, E.S., Steyn, J.M., Araya, H.T., Prinsloo, G. & du Plooy, C.P. 2018. Breaking seed dormancy in *Lobostemon fruticosus*. Acta Horticulturae 1204. ISHS 2018. DOI 10.17660/ ActaHortic.2018.1204.15 Proc. VII Int. Symp. on Seed Transplant and Stand Establishment of Hort. Crops Eds.: P. Soundy et al.

Lodama, K.E., Gerrano, A.S., Laurie, S.M., Mavengahama S. & Adebola. P.O. 2018. Response of prolonged storage time and growth media on seedling emergence of onion (*Allium cepa* L.) in South Africa. Acta Horticulturae 1204. ISHS 2018. DOI: 10.17660/ ActaHortic.2018.1204.5 Proc. VII Int. Symp. on Seed Transplant and Stand Establishment of Hort. Crops Eds.: P. Soundy et al.

Kandolo, S.D., Aveling, T., Van der Waals, J.E., Truter, M. & Laurie, S.M. 2018. Effects of wetness duration, inoculum concentration and temperature on the development of Alternaria blight on transplants of sweet potato. Acta Horticulturae 1204. ISHS 2018. 211-217. Proc. VII Int. Symp. on Seed Transplant and Stand Establishment of Hort. Crops Eds.: P. Soundy et al.

Book chapter

Gerrano, A.S. 2018. Agronomic Performance, Nutritional Phenotyping and Trait Associations of Okra (*Abelmoschus esculentus*) Genotypes in South Africa. Chapter 5 in: Rediscovery of Landraces as a Resource for the Future, IntechOpen, pp 70-96, DOI: 10.5772/intechopen.70813.

Training courses:

The Agricultural Research Council – Vegetable and Ornamental Plants, Roodeplaat is offering an accredited hydroponic vegetable production training course. For more information, contact Ms Tsholo Tselapedi: (012) 808 8000 or TselapediT@arc.agric.za