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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)

Applying molecular markers at ARC-VOP for onion breeding

Compiled by Dr Inge Gazendam and Dr Sunette Laurie, Plant Breeding Division

ARC male sterile onion lines are marketed to seed companies for development and commercialization of F1 onion hybrid cultivars and are therefore a potential source of royalty income. Some of the main attributes of the ARC onion lines are long keeping ability, multiple bulb scales and straw-brown color. Onion seed production entails a two-year process, in which bulbs are produced in year one, which are then planted for seed production in year two (Fig. 1). Male sterility (Fig. 2) is important to prevent self-pollination and loss of the onion hybrid genotype. Classic methods require 4-8 years of progeny testing before the cytoplasm type can be determined. An accurate and time-saving method was needed where the breeder does not have to wait for seed production, bulb generation and subsequent evaluation of the male sterility status at flowering time. Molecular markers were therefore tested for application to ARC onion parental lines of hybrid cultivars, and which could determine male sterility and maintainer genotypes accurately and easily with large numbers of samples. Five cytoplasmic and four nuclear markers were sourced from the literature, and applied to ARC-VOP onion parent line seedlings for the first time in 2015. These markers were polymerase chain reaction (PCR) or single nucleotide polymorphism (SNP) markers, the latter linked to the nuclear *Ms* locus and detected with custom TaqMan® SNP genotyping assays.

Fig. 1. (A) Onion bulb production, (B) in the subsequent year's bulbs are planted and produces seed stalks

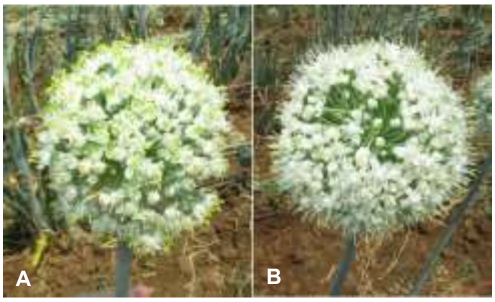

Fig. 2. Onion flowers exhibiting (A) male fertile (pollen-producing) or (B) male-sterile phenotypes.

Nine onion breeding parents, a total of 232 samples, were screened with all the markers in 2016. One PCR marker (*orfA501;* Engelke et al. 2003) proved useful as a presence/absence marker for cytoplasmic male sterility, and could be run on a high density agarose gel at high throughput without having to separate differently sized fragments with long electrophoresis times. TaqMan® SNP genotyping assays were superior to the *jnurf13* nuclear PCR marker (Kim, 2014) in terms of rapid throughput for nuclear genotyping. Both are efficient in distinguishing between the dominant and recessive alleles of the nuclear restorer-of-fertility gene (*Ms*), but only 30 *jnurf13* amplification products can be analysed per day through denaturing polyacrylamide gel electrophoresis (PAGE) on a large gel system, compared to 68 TaqMan® SNP assays in 2 hours on a Rotorgene real-time PCR machine. These PCR molecular markers and custom TaqMan® SNP genotyping assays were efficient in screening the onion lines rapidly and accurately for their cytoplasmic and nuclear male sterility genotype.

Since molecular marker screening of reference onion lines in 2015 indicated some seedlings to have the wrong cytoplasmic male sterility genotypes and nuclear *Ms* allele contamination, all bulbs of four ARC onion lines (R101B, seed lot S03-2; R301A, seed lot S07-3; and R301B, seed lots S07-4 and S09-4), that were planted to produce seed in 2016, were genotyped in order to select individuals with the correct genotypes before flowering commenced in September 2016. DNA were extracted from a total of 745 onion plants from the four breeding lines and the PCR molecular marker *orfA501* and TaqMan® SNP genotyping assay A applied to the DNA. Similarly, a total of 1005 individual plants of two onion parents (S09-1 and 2), whose seed were requested by commercial seed companies, were screened in 2017. The results enabled the rogueing of plants with *Ms* nuclear allele contamination, and grouping plants with similar cytoplasmic genotypes. This enabled seed production to proceed only with correct plants, resulting in pure maintainer and male sterile seed for future use. For line S03-2 a mere 1.7% (1 out of 60) of the plants were correct and thus their seed production was aborted.

The research performed in 2015 and 2016 was recently published in the *Journal of Agricultural Science*. The full reference is:
"Gazendam, I., Greyling, M.M. & Laurie, S.M. 2018. The application of molecular markers to accelerate the recovery of cytoplasmic and nuclear male sterility in South African onion (*Allium cepa* L.) hybrid parental lines. *Journal of Agricultural Science* 10(7): 95-109." The latest impact factor is 1.291 according to www.scijournal.org.

This season, nuclear and cytoplasmic onion male sterility genotyping were combined into one multiplex PCR, as an advancement on the current practice in both cost and time. Nuclear *AcSKP1* genotypes (Huo et al. 2015) correlated to TaqMan SNP assays and the *jnurf13* PCR marker in all tested cases. The nuclear *AcSKP1* marker could successfully be combined with the cytoplasmic male sterility marker *orfA501* in a multiplex PCR and the products separated on large agarose gels (Fig. 3), eliminating the need for TaqMan reagents, and reducing the number of PCR reactions, reagents and time required to perform cytoplasmic and nuclear genotyping separately. Quicker, cheaper and accurate genotyping will advance onion breeding by enabling the selection of the correct genotypes of male sterile and maintainer lines more quickly and cost-effectively. The multiplex PCR was successfully applied to genotype 652 onion bulbs from line S14-8 harvested in 2017. Bulbs were categorised as male sterile or maintainer genotypes before planting in the field in 2018, to facilitate the production of correct seed.

Using molecular markers to screen the male sterility genotypes of onion breeding lines gave accurate genotypic information that was not previously available. These molecular methods reduced the time to identify the correct genotype of male sterile and maintainer lines from two years to one month, proved to be useful on a larger scale and facilitated the production of the correct seed for commercialization of ARC onion lines locally and internationally, a potential source of external income.

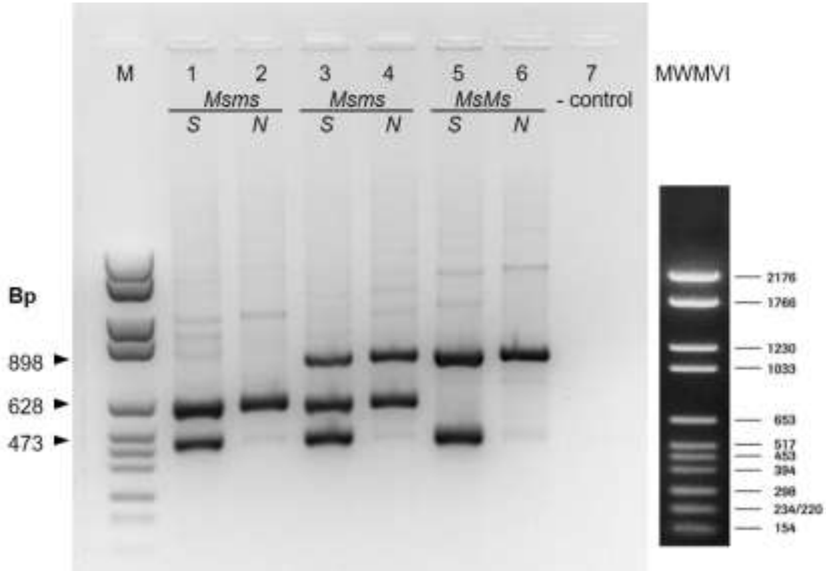

Figure 3. Multiplex PCR products of onion nuclear *AcSKP1* and cytoplasmic *orfA501* male sterility markers on selected samples of onion breeding line R1201 B (seed lot S09-002), harvested from the open field in 2015. M: Molecular weight marker VI (Roche Diagnostics). Lanes 1-6: Individual plants from seed lot S09-002. Their nuclear (*MsMs, Msms* and *msms*) and cytoplasmic (*S* or *N*) genotypes are indicated below the numbers. Lane 7: negative water control. Expected fragment sizes are indicated on the left with black arrows. *Msms*: 898bp; *Msms*: 898+628bp; *msms*: 628bp; *S* cytoplasm: 473bp.

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Huo Y., Liu B.J., Yang Y.Y. & Wu X. 2015. AcSKP1, a multiplex PCR-based co-dominant marker in complete linkage disequilibrium with the male-fertility restoration (*Ms*) locus, and its application in open-pollinated populations of onion. *Euphytica* 204(3): 711-722. https://doi.org/10.1007/ s10681-015-1374-7

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Enhancing agriculture in the Union of the Comoros

Compiled by Ms Erika van den Heever, Crop Science Division

The Union of the Comoros is an archipelago in the Indian Ocean off the east coast of the Mozambique Channel (Fig. 1). The Union comprises of three islands, Grande Comores, Mohéli and Anjouan. Poor access to modern technology continually encumbers agricultural development. Other notable key challenges for the union include lack of modern farming equipment, outdated cultivars and animal varieties, insufficient inputs, insufficient market outlets (Fig. 2), lack of post-harvest skills, and crop destruction by diseases and pests. The Union largely depends on imports for food security. Local producers are largely subsistent farmers who struggle to produce enough to feed their families (Fig. 3). Farmers have limited knowledge and skills required for commercial agriculture. Although annual precipitation is relatively high at over 2,000 millimetres, surface water is scarce in many parts of the Comoros. Climatic change influences, particularly increased rainfall variability, in the last few decades have affected food security via the reduction of yields and increased sensitivity of crops or animals to parasites.

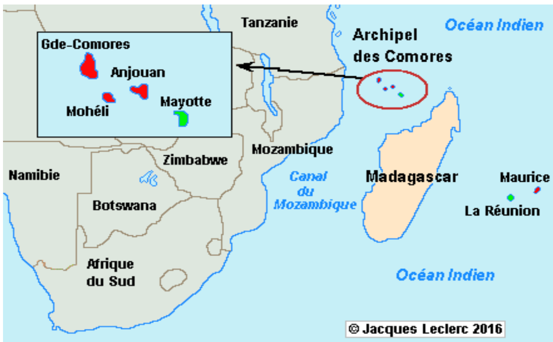

Fig. 1. Geographical location of the Union of the Comoros. http://www.axl.Cefan.ulaval.ca/afrique/comores.htm.

The Union in collaboration with the World Bank, India, Brazil and South Africa (IBSA), and the IMF are developing a poverty reduction and growth strategy. In 2012, the then South African High Commissioner to the Union of the Comoros, initiated discussions with the Agricultural Research Council (ARC) of South Africa with a view to have its expertise utilized in the Union of the Comoros, including transfer of skills to farmers. In 2017, IBSA, the Honourable Mr M Bugane, the current SA Ambassador to the Union of the Comoros, United Nations Development Programme (UNDP)-Comoros, and the Government of the Union appointed the ARC as an implementing agency of a project of R21,5 mil to enhance the agricultural capacity in the Union of the Comoros. The project funded by IBSA, is overseen by UNDP as the project manager and implemented by the ARC.

Fig. 2. A food festival in Anjuan

The project is targeting to benefit vulnerable groups, especially small-scale farmers, particularly women and the youth. The broad aim is to establish an agriculture learning school for the Union, which can be supported over time instead of providing a once off project deliverable. The project has three main phases:

1. Feasibility studies: topographic survey at Mimbani, plus soil and water surveys, including chemical and physical analyses (for all

three islands;
2. Irrigation development: irrigation infrastructure and training at Mimbani; and
3. Vegetable production: introduction of new cultivars, demonstrations, and support to commercialization.

The main activities will focus at the Mimbani station in Moheli (Fig. 4). This island offers some advantages for this project, amongst which are its relatively deep soils, and proximity to an irrigation water source, and is thus suited for increased agricultural production. This pilot farm will serve as an epicentre from where sustainable and productive agricultural methods are practiced and learnt. It is expected that this farm shall become the agricultural hub whose impacts should be an improvement of food security, reduction of poverty, and malnutrition. This model will then be extended to other parts of the Comoros starting with Diboini and Bambao Mtsanga. Currently, only a few selected cross cutting activities such as analyses of soil and water chemical and physical properties, crop suitability assessments, training of farmers in vegetable production, and pests and disease management skills have been done. Setting up of demonstration plots and nurseries will be done at Diboini and Bambao Mtsanga. Training on irrigation and water management to specialists, extension officers, and farmers' representatives from all three islands will be carried out at the infrastructure developed at Mimbani. This first phase of the project was the feasibility study phase (field soil and water surveys, collection of soil and water samples for laboratory analyses in South Africa, as well as the topographic survey).

Fig. 3. A typical farm plot.

Fig. 4. Moheli farmers welcoming researchers from the ARC at the airport.

The next phase will be vegetable production and improvement of the production system by demonstrations on the three islands. Translation of training material is essential because of the language barrier. A survey will be executed to understand and profile the smallholder farmers on the three islands. The crops cultivated are: sweet potatoes, lettuce, cabbage, amadumbe, cassava, tomatoes, green beans, pigeon peas, onions and green peppers.

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Vegetable seedling production and nursery management

Compiled by Mr Silence Chiloane, Crop Science Division

Introduction
Healthy seedlings raised under good nursery management practices is an important part of successful vegetable production. The production of good quality vegetable seedlings is essential for optimizing crop growth and yield. Some farmers are producing seedlings of poor quality and stand establishment due to lack of training, poor seedling management skills or lack of proper infrastructure for seedling production.

What constitutes good quality seedlings and why is quality so important in vegetable seedling and nursery management?

The ultimate quality of a seedling is based on two components: physical and genetic aspects. Physical quality is reflective of the nursery seedling cultural practices, and is exhibited by seedling height, root collar diameter, health and root form. Genetic quality refers to the genetic characteristics of seedlings as a result of practices including the collection of germplasm from selected sources such as phenotypically superior seed plants/trees, seed production area, cultivar, etc.

Cultivar choice and seed quality
It is good to discuss the best cultivars suitable for your production region with a nursery manager or seed suppliers. Alternatively, you can also consult other vegetable seedling producers in the area for cultivar recommendations. Seed quality in seedling production is very important because high quality seedlings can only be produced from high quality, viable, pest and disease-free seeds. It is always important to buy seeds from a reliable seed supplier. Seed companies perform a number of different types of tests in order to provide quality assurance of their products. In addition to germination testing, these include tests for vigour, diseases, seed count, genetic purity and physical purity.

The quality of seeds sown will affect seed germination, seedling establishment and yield of vegetable crop. Poor quality seed will result in poor stand establishment and predispose seedlings to insect and disease attack. There are two types of seeds, i.e. open pollinated and F1-hybrids. Open pollinated seeds are the seeds that can be harvested and re-planted. Seeds of F1-hybrids cannot be re-used after harvesting.

Characteristics of good quality seedlings:

- Healthy, free from pests and diseases and with dark green leaves;
- Root system that is free from deformities, dense with many fine fibrous hairs with white root tips;
- The leaves should be vigorous and green in colour without any holes and black or brown spots;
- Seedlings must be uniform in size; and
- Seedlings must be at the right stage for transplanting.

Vegetable seedlings can be raised in facilities ranging from simple shelters like shade nets (Fig. 1), tunnels, etc., to sophisticated greenhouses. All these structures should protect seedlings from heavy rainfall, extreme temperatures (very low or very high), intense sunlight, high relative humidity, and exposure to pests and diseases.

Fig. 1. Good quality seedlings produced under 40% shade net structure.

Maintenance of vegetable seedlings
Several aspects need to be well managed in order to produce seedlings of high quality. The most critical aspects are discussed in the following sections:

Irrigation is very important and seed trays must be watered with a watering can with a fine nozzle or automated systems three or four times a day during summer and two or three times a day in winter. Seedlings in trays are normally irrigated until water drips out of the bottom of the cavities. Be careful not to wash the seeds out of the cavities when watering them. The medium in the seed trays must be moist and not too wet, but should never dry out. Plants use a lot of water when the temperature is higher. However, do not over-irrigate, since it will result in a build-up of diseases (root rot or damping off) and poor root aeration.

Fertilizer application (nutrient supply): Most growing media have limited nutrients and it is not necessary to apply fertilizer during seed sowing, only water is needed. When two fully expanded leaves have formed, nutrients must be supplied as the seedlings exhaust the little nutrients in the growth media. The nutrient solution can be prepared by dissolving a nutrient mixture into water (e.g. 1 g multifeed into 1 L of water). Nutrient solution can be applied using a watering can by fertigating the seedlings through a foliar spray daily or every other day as a diluted solution.

Provision of proper ventilation (temperature and humidity): Seedlings can be produced in a controlled environment like greenhouses (growth chambers, tunnels, glasshouse, etc.). Shade-net houses can also be used during summer season (Fig. 1). The type of structure should give protection to seedlings against birds, large insects, hail, animals, extreme temperatures and light. Production units should have conditions where temperature, light and humidity are conducive for seedling germination and growth. The lower the temperature, the slower the germination rate. Although higher temperatures speed up germination, there is an upper limit. Different species have different optimum temperatures, and are therefore cultivated at different temperatures for germination. Seedling growers have to take this into account when planning their productions. Seedlings should be raised under sufficient light and exposed to full sunlight before transplanting in order to be hardened off. Seedlings produced under low light intensity become elongated, leggy, weak or spindly.

Sanitation and weed control: The seedling nursery must be clean and free of weeds. If not removed, weeds become hosts for pests and diseases and these will eventually attack the seedlings in the nursery.

Pests and disease control: Sanitation plays a key role in pests and disease management or control. The more the area is kept clean, the less the risks of pests and disease infestation in the nursery. Scouting for pests and diseases is also important because it will assist in identifying the problems early enough before any serious damage is caused.

Steps for vegetable seedling production (Fig. 2)
A suitable seedling growing medium must be selected. Various kinds of growing media are available for seedling production. The growth medium must provide plants with support, good drainage, structure, aeration, and water-holding capacity. The medium should not be too coarse or too fine. If it is too coarse, water will drain too quickly, and if it is too fine, water will drain poorly and can lead to a build-up of algae on top of the seed trays. If algae build up, there is a high probability that a disease called damping-off can occur. Algae will also compete with seedlings for nutrient uptake, resulting in seedlings becoming yellowish and under developed.

Root growth is poor in a growth medium with poor water holding capacity. It's important to use a uniform sterilized disease free or heat-treated seedling medium for germination, which is obtainable from seed companies or nurseries. It must be low in soluble salts (EC of less than 1.0 $mS.cm^{-1}$), with a pH between 5.5 and 6.5, and free of insects, fungi, bacteria and weed seeds.

- Moisten the seedling medium.
- Fill the tray with the seedling medium.
- Compact and make holes using a roller. If a roller is not available, the general rule for planting depth is more or less 3 times the diameter of the seed (tomatoes 6 mm, peppers 6 mm and cucumbers 12 mm).
- Plant only one seed per cavity. If there is more than one seed germinating per cavity, the seedlings should be thinned out as soon as they emerge.
- Cover with the growth medium or preferably with vermiculite.

Fig. 2. Practical step by step demonstration/training on vegetable seedling production.

Vermiculite is preferred because it has a high water holding capacity, does not dry out very quickly, is very light and the seeds will emerge with ease.

- Record by writing the cultivar name and transplanting date on the plastic tag/T marker.
- Take the seedling trays to the mist bed/nursery table.

Transplanting of seedlings

Transplanting is the operation of lifting seedlings from their seedling trays or seedbed and transferring them to the prepared area either in open ground or bags where they will grow and mature. The seedling is pushed from the bottom of the seed tray with a stick while holding the seedling at the base of the stem (Fig. 3). Make a hole just deep enough to cover only the root plug, place the seedling in the hole and only cover the root plug with soil or growing medium. If the seedling is pulled out, all the roots with the medium must come out as well (Fig. 4). Transplant seedlings early in the morning or late afternoon when it is cool to reduce transplant shock. Do not plant out seedlings of inferior quality. Minimize transplant shock as far as possible. Some growers use the same medium for seedling production as for production of mature plants. Growth media should be irrigated well before transplanting is scheduled. To minimize the risk of crown rot diseases, seedlings must be planted with their crowns at the same level as in the growing medium. Seedlings should be irrigated as soon as possible after transplanting to prevent, or minimize water stress. Seedling germination and growth rate differ from crop to crop, e.g. tomato: 4-5 weeks; pepper: 6-7 weeks; cucumbers: 4-5 weeks and lettuce: 3-4 weeks.

Hardening-off

Hardening-off can be explained as a process whereby the plant's soft tissues are toughened to withstand harsh natural conditions. Seedlings that have been grown indoors cannot grow and adapt well in harsh conditions without injury. They are normally subjected to high humidity and low light. These factors will cause thin cuticles, poor stomatal functioning, chloroplasts not adapted to high light intensity and this, consequently, forms 'soft' seedlings. When these types of seedlings are subjected to harsh environments (cold, heat, wind and water stress), they suffer a severe transplant shock.

Fig. 3. Practical demonstration on how to remove seedling from a seed tray.

Fig. 4. Good quality and healthy tomato seedlings produced using good seedling mix.

Hardening-off usually begins two weeks before transplanting in the field. Ways of hardening off are gradual reduction of water by less frequent irrigation, without allowing the growth media to dry out, withholding fertilizer during that period, and removing all forms of protection. Slight drying of seedlings before irrigation is important to reduce tender, tall seedlings which do not do very well when grown in the field. Withholding nitrogen causes the plant growth to cease. A plant of a certain size can be held for some time with little damage being done to its productivity. The disadvantage of this method is that plants will have no spare nutrients when transplanted, for either leaf or root development. Seedlings should be given a nitrogen boost before pulling the seedling for transplanting so as to reverse the hardening effect. If the seedlings do not receive a boost before transplanting, slow plant development in the field will result. Hardening off should not take too long, otherwise the transplants will not renew their growth rapidly when set in the field. In summer, shade cover should be gradually reduced until there is no shade for at least a week prior to transplanting.

A well-hardened plant can be recognized by a darker green colour and development of a slight purple tinge in the leaf veins on the lower side of the leaf. When the whole leaf on the underside is purple it indicates that the plant was not only hardened-off but also stunted. Care should be taken not to allow seedlings to be stunted as it leads to poor quality transplants.

Farmers can also buy seedlings from registered seedling nurseries.

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Important points to consider when buying or producing seedlings:

Seedling Nursery	Own production
Specializes in seedling production.	Require/lack of specialized skill/knowledge.
Quality and service is good but varies between nurseries.	Quality may be poor due to lack of seedling production and management skills.
Have specialized facilities to produce seedlings anytime of the year.	If you want seedlings early or out of season, special facilities may be required.
Visit the nursery to see practices and facilities.	Have full control over sanitation and practices.
Discuss cultivar choice and planting date and this cannot be changed later. Once decided, it is fixed. Sowing may coincide with other work.	Can plan the seedling production to suit the farmer's situation.
Cost of seedlings may be high.	Can save cost by producing own seedlings.

Damage caused by root-knot nematodes on medicinal plants

Compiled by Dr Kgabo Pofu, Crop Protection Division and Prof Phatu Mashela, University of Limpopo

The root-knot nematodes (RKNs), especially *Meloidogyne* species (Fig. 1), causes tremendous yield losses in cultivated crops including medicinal plants. Trade in medicinal plants in South Africa constitutes a multi-billion rand industry (over R2.9 billion), which in the early 2000s represented at least 5.6% of the National Health budget. The medicinal plant trade is a potential rural development industry. However, due to the destructive harvesting nature of the plants from the wild, certain indigenous medicinal plants are becoming extinct. Therefore, researchers at the ARC-VOP are determined to assist communities to domesticate the plants by investigating cultivation and propagation methods. However, the project is threatened by the presence of plant-parasitic nematodes in South African soils, especially the RKNs. Therefore, it is of utmost importance that the host-status and host-sensitivity of selected medicinal plants be tested in order to avoid losses during mass production.

Fig. 1. Second stage juvenile of *Meloidogyne* species, that tunnels into the root system to establish a feeding site (***Courtesy of Nemapic***).

Pelargonium sidoides (Fig. 2) is a very important medicinal plant that has been clinically proven to be effective in the treatment of ailments such as coughs, upper respiratory tract irritations and gastrointestinal problems. However, the plant is a good host to the root-knot nematodes, *Meloidogyne incognita* and *M. javanica* (Fig. 3; Sithole et al. 2016).

Fig. 2. *Pelargonium sidoides* study under greenhouse conditions.

Fig. 3. Highly galled *Pelargonium sidoides* root system.

Another selected medicinal plant with economic potential tested against the RKNs was *Artemisia afra,* which is a common species in South Africa (Fig. 4). The plant has a wide distribution from the Cederberg Mountains in the Cape, northwards to tropical East Africa and stretching as far north as Ethiopia. The herb has recently attracted worldwide attention of researchers for its possible use in the modern diseases like diabetes, cardiovascular diseases, cancer, respiratory diseases, etc. However, like other cultivated crops, *A. afra was* found to be a good host to all *Meloidogyne* species, and therefore, management strategies should be implemented whenever the plant is grown to avoid production losses (Mashela & Pofu 2017).

Fig. 4. *Artemisia afra* study conducted under greenhouse conditions.

References

Mashela P.W. & Pofu, K.M. 2017. Degree of nematode resistance to *Meloidogyne incognita* race 2 in *Artemisia afra* ethno-medicinal plant**.** *Research on Crops* 18 (3): 508-512.

Sithole N.T., Pofu K.M., Mashela P.W. & Araya H. 2016. Overall sensitivity of *Pelargonium sidoides* and Root-Knot Nematodes to Nemarioc-AL phytonematicides. *Transylvanian Review* 11: 2996-3001.

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Research excellence from ARC-VOP showcased at the 11th Agricultural Research Symposium

Five ARC-VOP researchers presented findings from their respective GDARD-funded projects at the 11[th] Agricultural Research Symposium held on the 20 June 2018 at the Midrand Conference Centre, Johannesburg.

Ms Julia Mulabisana shared information on the “Survey and identification of vegetable diseases in Gauteng Province: Production of a vegetable disease booklet”. The project started in February 2015 and ended on 28 February 2018. The project investigated and documented fungal, bacterial and viral diseases that are affecting production of vegetables grown by smallholder farmers in the Gauteng Province. Diseases such as Cercospora leaf spot on Swiss chard and beetroot are among some of the fungal diseases identified. Workshops to train farmers on disease symptom identification and how to manage different diseases were conducted in different regions of the Gauteng Province as part of the project. A total of 315 farmers were trained. An A6 booklet listing fungal, bacterial and viral diseases identified during the field surveys conducted in farmers’ fields is currently being developed. The booklet will assists farmers in familiarizing themselves with plant disease symptoms. Farmers will implement different disease management strategies in time to prevent yield losses, thus producing sufficient food to ensure food and nutrition security. The booklet will be distributed to Gauteng farmers by GDARD.

Congratulations to Julia Mulabisana!
GDARD recognizes researchers who disseminated scientific information generated through GDARD funding in media and publication of manuscripts in scientific journals. Ms Mulabisana received an award on the 20 June 2018 to recognize the work she published in peer reviewed proceedings and a scientific journal.

Below are the two scientific publications recognized by GDARD:

- Mulabisana M.J., Cloete M., Mabasa K.G., Laurie S.M., Oelofse D., Esterhuizen L.L. & Rey M.E.C. 2018. Surveys in the Gauteng, Limpopo and Mpumalanga Provinces of South Africa reveal novel isolates of sweet potato viruses. *South African Journal of Botany* 114: 280-294.
- Mulabisana J., Cloete M., Mabasa K., Laurie S.M., Oelofse D. & Rey M.E.C. 2015. Genetic characterization of viruses infecting sweet potato in South Africa. *Acta Horticulturae* 1105: 155-161. ISHS. DOI 10.17660/ActaHortic.2015.1105.22.

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Dr Lerato Matsaunyane presented on “*Lantana camara* L.: Shooting vegetable disease and input costs for smallholder, resource-poor and householder farmers in Gauteng”. **She received an award for best paper presented under the Crop Production and Biotechnology category**. In this study the antibacterial properties of extracts prepared from weed plants were investigated against economically important vegetable bacterial pathogens. Previous studies showed that the most common vegetable diseases found by emerging farmers in the Gauteng Province include rot on cabbage, bacterial speck and spot of tomato, leaf spot on beans, and blackleg and soft rot on potato. Our study selected weeds that were readily accessible to the farmers, and these are *Lantana camara* L. and *Melia azeadarch* L. Anitbacterial studies were done against *Pectobacterium carotovorum* subsp. *carotovorum*, *P. caratovorum* subsp. *brasiliensis*, *Xanthomonas campestris* pv. *campestris* and *Burkholderia andropogonis*. Results from the minimum inhibitory concentration showed that 2.5mg/ml Lantana-and Melia-based extracts inhibited the growth of all selected bacterial pathogens by 100% and 80%, respectively. Evaluation of the mode of bacterial inhibition of the weed extracts, analyzed through microscopy, showed that both extracts caused significant morphological changes to all of the selected bacteria, which was visualized as large outpouching of the bacterial cell wall. The results show that both weed extracts are effective antibacterial agents and have the potential to be used as alternative biological crop protection agents. The use of extracts prepared from these beneficial plants will provide the small scale, resource poor and household farmers with an inexpensive, biodegradable and safer alternative to chemical control to protect their crops from diseases.

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Dr Willem Jansen van Rensburg shared results from research conducted on the “Evaluation of Vitamin A rich tomato Germplasm in Gauteng Province, South Africa”. Tomato is a very popular vegetable that is consumed almost daily in most households in Gauteng. It is therefore an ideal vehicle to use to increase household nutrition. This project evaluated the acceptability of high beta-carotene tomatoes and other heirloom tomatoes rich in flavonoids using participatory approaches. The yields differ significantly between the different lines evaluated. Flame Chillybilly has the lowest yield of 0.087kg per plant and CLN 2366A has the highest yield with 0.477Kg per plant. Three of the four high beta-carotene lines (CLN2366C, CLN 2071C and CLN 2366A) were under the top four lines. The shape of the fruit vary from round to oval and some fruit were irregular in shape. Fruit colour varied from cream to (Cream Sausage) to orange (CLN 2366A) and dark purple red (Purple Russian). Rodade, the commercial control cultivar, is still very popular with all the farmers due to its familiarity. There was mixed feelings between the farmers for Purple Russian, Cream Sausage and Sweetie. The high beta carotene germplasm was acceptable, but did not score the highest in any of the categories in the questionnaire. Some of the farmers liked it for its taste, colour and yield, while others did not like the taste and colour. It is therefore important that farmers evaluate the cultivars they would like to plant themselves. It can be concluded that some of the farmers will be willing to try some of the high beta-carotene and heirloom tomato cultivars, while others would prefer to stay with the cultivars they are familiar with.

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Mr Silence Chiloane presented findings on the "Tomato cultivar evaluation trials linked to AgriParks/smallholder farmers in three Gauteng regions". Tomatoes are the second most important vegetable in South Africa and are grown by small scale farmers for food and as a source of income. Knowledge on the performance of tomato cultivars in different regions in Gauteng local production areas is very limited. New tomato cultivars are released regularly on the South African and international markets, and might not be suitable for South African conditions. This can complicate cultivar choice tremendously. Therefore, the study was conducted to assess 16 hydroponic tomato cultivars with regard to their performance in terms of yield and quality during the summer to autumn seasons in three climatologically different regions in Gauteng. The data from the first trial showed some significant improvement on yield and quality. Some of the farmers selected to participate in the tomato cultivar trial had very little or no hydroponics background. Through the ARC intervention the farmers are supported and capacitated with practical knowledge on hydroponic tomato production and some farmers were able to secure a contract with the local SPAR for marketing their produce. The study will identify the best performing tomato cultivars for each region, resulting in increased yield and quality to increase the income of Gauteng hydroponic farmers, address food security and develop capacity on improved hydroponic production of tomatoes. Research results developed from the project will provide information to small holder and commercial farmers to utilize best performing cultivars to their areas.

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Dr Phokele Maponya shared findings from a successfully completed project that looked at the "Mechanism for improving the sustainability of Homestead Food Gardens in Gauteng Province". Homestead food garden projects are supported by government which attempts to alleviate poverty in food insecure households. Despite the fact that homestead food gardens are seen as a solution to food security in the Gauteng Province and other parts of the world, the issue of unsustainability and failure of these programs after government support ceases cannot be ignored. A survey was conducted in the Gauteng Province to establish a sustainable mechanism for homestead food gardens. The following objectives were addressed: To identify socio-economic factors that influence sustainability of homestead gardens; To identify factors influencing garden availability and to recommend a mechanism for improving the sustainability of homestead gardens. A total of 1150 households participated and quantitative and qualitative designs were used as a questionnaire. Stakeholder discussions and field observations were part of the data collection. Food security status was also in line with the fact that South Africa is food insecure at a household level in contradiction to the national level. It was also established that in terms of sustainability, not all households' gardens are economically viable, socially and environmentally sustainable. Some of the study's recommended activities to be included in the mechanism includes: A regular water supply, pest control, participation of the community in homestead programme design and implementation, training and monitoring. The project will be presented orally during the 7th World Sustainability Forum in China, Beijing from 19th to 21st September 2018.

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Student awarded the best scientific poster at the Bergey's International Systematics indaba Symposium (BISMiS)

Ms Kgothatso Chauke, an MTech student of Drs Michele Cloete and Elsie Cruywagen, was awarded the best scientific poster at the Bergey's International Systematics indaba Symposium (BISMiS). The international conference was held at the Misty Hills Hotel and Conference Centre, Muldersdrift, 8-11 April 2018, with attendees from Belgium, China, France, Germany, India, Mexico, UK and the USA. The poster entitled 'The genetic characterization of *Streptomyces* isolates causing fissure scab on potatoes in the Limpopo Province' forms part of Ms Chauke's MTech studies. The achievement was also posted on Facebook, Twitter and the intranet. It is an outstanding achievement for a Master's student to win this prize at an international conference.

Fissure scab is a newly discovered potato disease, associated with previously unreported *Streptomyces* species in South Africa. The symptoms of fissure scab include deep longitudinal cracks or fissures of up to 12 mm in depth that reduce the cosmetic value and marketability of the potato tubers. Little is known about the causal agent of fissure scab. *Streptomyces* species were isolated from 29 potato tubers obtained from three farms in the Limpopo Province. The aim of the study was to genetically characterize the *Streptomyces* species causing fissure scab on potatoes in the Limpopo Province. The characterization of the isolates was done by DNA sequencing with primers specific for the 16S rDNA gene. The presence of three of the pathogenicity genes commonly found in the pathogenicity island (PAI) of pathogenic *Streptomyces* species were determined using primers specific for these genes. A phylogenetic tree was constructed for the 16S rDNA gene region and it was observed that the *Streptomyces* isolates causing fissure scab were grouped into three clades, where one clade was grouped with *S. werraensis*. About 48% of the isolates were found to have the necrosis-inducing gene on the PAI, but thaxtomin and tominase were absent. Further characterisation of *Streptomyces* isolates associated with fissure scab in South Africa is underway by means of Multi Locus Sequence Analyses of five housekeeping genes. This will be done to determine the diversity of *Streptomyces* species associated with fissure scab.

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From left to right: Dr Michele Cloete, Dr Elsie Cruywagen and Ms Kgothatso Chauke in front of two posters on their *Streptomyces* research

Technology Transfer

Scientific publications

Aina, O.E., Olowoyo, J.O., Mugivhisa, L.L. & Amoo, S.O. 2018. Effect of different soil amendments on growth performance and levels of copper and zinc in Lycopersicon esculentum. Nature *Environment and Pollution Technology* 17: 255-259.

Gazendam, I., Greyling, M.M. & Laurie, S.M. 2018. The application of molecular markers to accelerate the recovery of cytoplasmic and nuclear male sterility in South African onion (*Allium cepa* L.) hybrid parental lines. *Journal of Agricultural Science* 10(7): 95-109.

Giliomee, J.H., Millar, I.M. & Visser, D. 2018. New alien aphid discovered in South Africa: the woolly hackberry aphid *Shivaphis celti* Das (Hemiptera: Aphididae). *African Entomology* 26(1): 242–243.

Kgatle, M.G., Truter, M., Ramusi, T.M., Flett, B. and Aveling, T.A.S. 2018. *Alternaria alternata*, the causal agent of leaf blight of sunflower in South Africa. *European Journal of Plant Pathology* 151(3): 677-688. http://dx.doi.org/10.1007/s10658-017-1402-7.

Maboko, M.M. & du Plooy, C.P. 2018. Response of field-grown indeterminate tomato to plant density and stem pruning on yield. *International Journal of Vegetable Science* https://doi.org/10.1080/19315260.2018.1458265.

Marume, A., Matope, G., Khoza, S., Mutingwende, I., Mduluza, T., Mawoza, T., Chawana, D., Taderera, T. & Ndhlala, A.R. 2018. Antimicrobial and in vitro enzyme inhibitory activities of selected Zimbabwean ethno-veterinary medicinal plants used in folklore animal wound management. *International Journal of Herbal Medicine* 6(2): 97-103.

Mofokeng, M.M., Kleynhans, R., Sediane, L.M., Morey, L. & Araya, H.T. 2018. Propagation of Hypoxis hemerocallidea by inducing corm buds. *South African Journal of Plant and Soil*. https://doi.org/10.1080/02571862.2018.1443350.

Netshifhefhe, S.R., Kunjeku, E.C., Visser, D., Madzivhe, F.M. & Duncan, F.D. 2018. An evaluation of three field sampling methods to determine termite diversity in cattle grazing lands. *African Entomology* 26(1): 224–233.

Nhlapo, T.F., Mulabisana, J.M., Odeny, D.A., M.E.C. Rey & Rees, D.J.G. 2018. First Report of Sweet potato badnavirus A and Sweet potato badnavirus B in South Africa. *Plant Disease*. http://dx.doi.org/10.1094/PDIS-08-17-1235-PDN.

Nhlapo, T.F., Rees, D.J.G., Odeny, D.A., Mulabisana, J.M. & Rey, M.E.C. 2018. Viral metagenomics reveals sweet potato virus diversity in the Eastern and Western Cape provinces of South Africa. *South African Journal of Botany* 117: 256-267. https://doi.org/10.1016/j.sajb.2018.05.024.

Book chapter

Okorogbona, A.O.M., Denner, F.D.N., Managa, L.R., Khosa, T.B., Maduwa, K., Adebola, P.O., Amoo, S.O., Ngobeni, H.M. & Macevele, S. 2018. Water quality impacts on agricultural productivity and environment. *In:* Sustainable Agriculture Reviews 27. Lichtfouse E. (ed.). Springer, Cham. pp 1 – 36. ISBN 978-3-319-75189-4 (print), ISBN 978-3-319-75190-0 (ebook).

Scientific meetings

BISMiS 2018, 8-11 April 2018, Misty Hills Conference Centre in Muldersdrift

Chauke. K., Cruwagen, E.M., Sutherland, R, Roux-van der Merwe, R., Oelofse, D and Cloete, M. 2018. Phylogenetic characterisation Streptomyces species causing fissure scab of potatoes in South Africa. [Oral]

Chauke, KA, Cruywagen, EM, Roux van der Merwe, MP, Oelofse, D and Cloete, M. 2018. The genetic characterization of Streptomyces isolates causing fissure scab on potatoes in Limpopo Province. [Oral]

Cruywagen, E.M., Cloete, M., Chauke KA, Sutherland R, and Oelofse D. 2018. Morphological characterisation of Streptomyces species associated with fissure scab of potatoes in South Africa. [Poster]

11th Annual Agricultural Research Symposium, 20 June 2018, Midrand Conference Centre, Johannesburg:

Chiloane, S., Sithole, M.A., Amoo, S., du Plooy, C.P. & Rakuambo, J. 2018. Tomato cultivar evaluation trials linked to AgriParks/ Smallholder farmers in three Gauteng regions. [Oral]

Jansen van Rensburg, W.S., Gerrano, A.S., Khoza, N.L. Lebelo, R.S., Mgidi, R. & Bairu, M.W . 2018. Evaluation of Vitamin A rich tomato Germplasm in Gauteng Province, South Africa. [Oral]

Maponya, P, Venter, S.L., Du Plooy, C.P., Van Den Heever, E., Kekana, M.V., Manyaga, C. & Nyirenda O. 2018. The Mechanism for Improving the Sustainability of Homestead Gardens in Gauteng Province. [Oral]

Matsaunyane, L. et al. 2018. *Lantana camara* L.: Shooting vegetable disease and input costs for smallholder, resource-poor and householder farmers in Gauteng. [Oral]

Mulabisana, M.J., Sutherland, R., Mabasa, K., Phetla, K., Maserumule, M.M., Mgidi, R., Mokwala, M., Ramusi, M., Oelofse, D. & Cloete, M. 2018. Survey and identification of vegetable diseases in Gauteng Province: production of a vegetable disease booklet. [Oral]

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