ARC • LNR
Excellence in Research and Development

No. 13

Published:
9 September 2022

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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)

First report of *Alternaria arborescens* and *Alternaria grandis* causing leaf spot of potato in South Africa

Compiled by Drs Elsie Cruywagen and Mariette Truter, Leguminous, Leafy and Fruit Vegetables Division, Crop Protection Unit

Early blight (Fig. 1), caused by *Alternaria solani*, and brown spot (Fig. 2), caused by *A. alternata*, are two well-known potato diseases in South Africa that can cause significant yield losses when not controlled effectively. There are however more *Alternaria* species that have been reported to cause disease on potatoes in other parts of the world. These species are *A. arborescens*, *A. cantlous, A. dumosa, A. grandis*, *A. infectoria* and *A. protenta* (Amini et al., 2016; Ardestani et al., 2010; Rodrigues et al., 2010; Simmons, 1986).

The presence of unknown *Alternaria* species on potatoes in South Africa could explain the diversity of symptoms observed in the field. Potatoes South Africa (PSA) funded a study to do a survey of the *Alternaria* species present in the different potato production regions in South Africa to determine which species are causing disease on potatoes in the country.

Potato leaves with characteristic *Alternaria* infection were collected in 13 of the 16 potato production regions in South Africa from 2019 to 2021 (Fig. 3). A total of 1 237 *Alternaria* isolates were obtained and identified to species level based on morphology combined with DNA sequencing and phylogenetic analyses. *Alternaria* can be divided into two main groups based on spore size, namely the large and the small-spored groups. *Alternaria solani* belongs to the large-spored group and *A. alternata* belongs to the small-spored group. Identification of the small-spored isolates were based on the *Alt a 1* gene that encodes for the *Alternaria* main allergen, while large-spored isolates were identified based on the glyseraldehyde-3-phosphate dehydrogenase (*gapdh*) gene together with the RNA polymerase second largest subunit (*rpb2*). Both genes are needed for correct identification as *gapdh* can differentiate between *A. solani* and *A. grandis*, but not between *A. solani* and *A. protenta*, while *rpb2* can differentiate between *A.*

Figure 1. Early blight infection on a potato plant in the field.

Figure 2. Brown spot infection on a potato plant in the field.

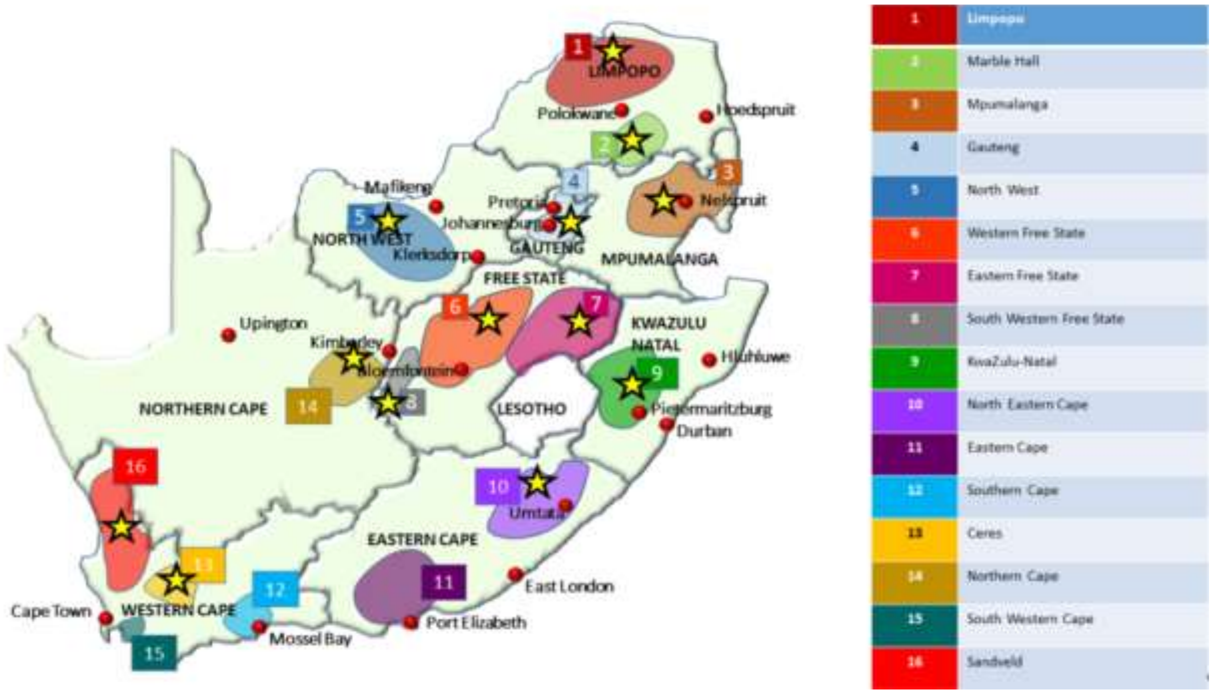

Figure 3. Map indicating the 16 potato production regions in South Africa (www.potatoes.co.za). Stars indicate regions where samples were collected.

protenta and *A. solani*, but not between *A. solani* and *A. grandis*. Results from morphology and phylogenetic analyses revealed that in addition to *A. solani* and *A. alternata*, there are also *A. grandis* and *A. arborescens* present on potatoes in South Africa.

Selected isolates from each of the four species were inoculated onto healthy eight-week-old potato plants in the greenhouse and covered with clear plastic bags for 48 hours. After the bags were removed, disease development was monitored for six weeks. All four species inoculated individually onto the plants were capable of causing disease on the plants in the greenhouse. Isolations were done from symptoms in the greenhouse and the organisms inoculated were isolated again, thereby completing Koch's postulates.

The small-spored *A. arborescens* caused symptoms (Fig. 4a) similar to those of brown spot caused by *A. alternata* (Fig. 4b), while the large-spored *A. grandis* caused symptoms (Fig. 5a) similar to early blight, caused by A. solani (Fig. 5b).

All four of the *Alternaria* species are present in all the different potato productions regions. *Alternaria grandis* is more prevalent than *A. solani* in most of the regions, while *A. alternata* is the most prevalent of the small-spored species. The larger diversity of *Alternaria* species causing leaf spot diseases on potatoes may have implications in the management of the diseases as chemicals used in control of the disease have only been tested against *A. solani* and *A. alternata*.

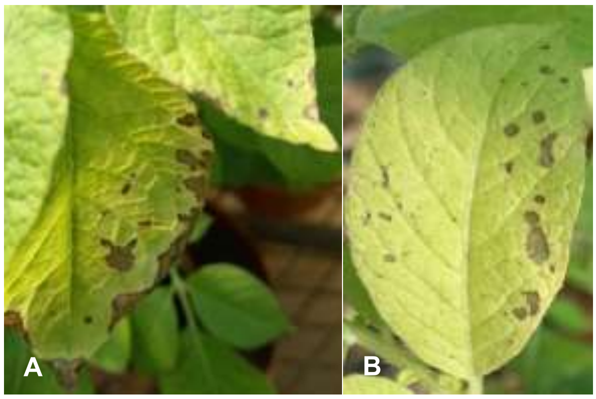

Figure 4. Symptoms caused by *Alternaria arborescens* (A) and *A. alternata* (B).

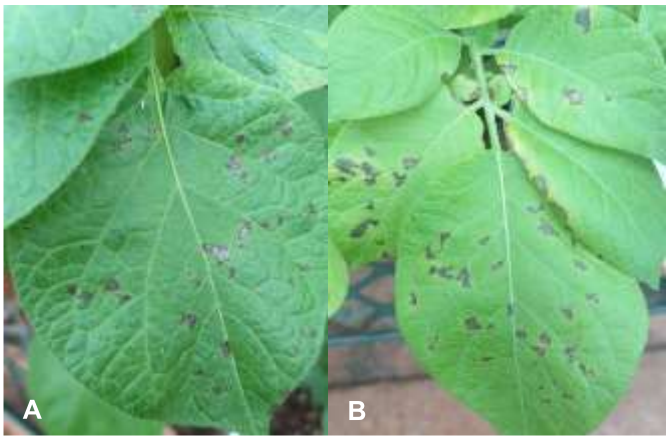

Figure 5. Symptoms caused by *Alternaria grandis* (A) and *A. solani* (B).

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Moringa value chain: seed and vegetative propagation

Compiled by Meshack Mofokeng[1], Salmina Mokgehle[2], Nadia Ibraimo[1], Mulalo Makhubele[1], and Nqobile Masondo[1,3]

Moringa (*Moringa oleifera*), commonly referred to as horseradish tree due to the taste of its roots, or drumstick tree, given the shape of its pods, is indigenous to South Asia. Moringa is increasingly becoming one of the most widely propagated species, particularly in developing countries due to its promising economic value. The multifaceted nature of Moringa benefits have intrigued South African researchers, farmers, and stakeholders, and this has led to the plant being introduced as a cultivated crop since 2006 in South Africa, with various projects focusing on the plant's morphology, growing conditions, production, chemistry, processing and utilization. The commercialization of several Moringa products has generated an interest in finding new and innovative propagation and cultivation practices for a sustainable supply of quality plant material without compromising the plant's nutritional, medicinal, and economic values.

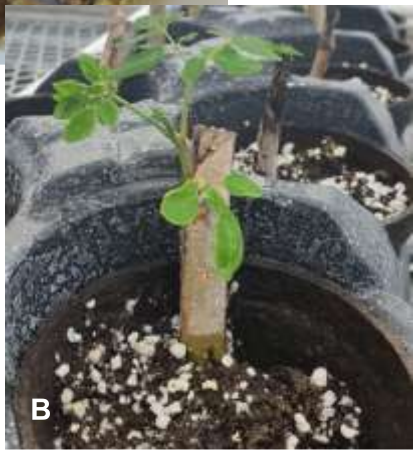

Figure 1. *Moringa oleifera* seeds (A) and cuttings (B).

Moringa can be propagated by direct seeding or vegetatively by cuttings (Figs 1A & B). Vegetative propagation, also called clonal propagation, gives true-to-type offsprings, meaning that the plantlets produced will carry the properties of the parent material. Propagation by seeds has possibilities of cross-pollination, resulting in genetic variation. Even so, a number of seed germination studies have been conducted on Moringa since seed germination is an easy and quick approach to growing plants. In a study by Jacob [1], Moringa seed germination was reported at 77.5% when seeds were not pre-soaked. Basically, pre-soaking did not provide any advantage. However, watering Moringa seeds twice a day improved the growth parameters of the seedlings [2], an indication that adequate watering plays an important role in seed germination. But then, Moringa trees cannot grow well in prolonged water-logged conditions. Temperature has also been shown to play a critical role in seed germination and seedling growth of Moringa. For example, low night/day temperatures (10/20°C) resulted in the highest germination percentage, while increasing temperature to 15/25°C and 20/30°C resulted in a slight, but not significant decline in germination percentages [3]. However, the higher temperature regimes (20/30°C) favoured germination rate, uniformity, and seedling growth in terms of seedling vigour [3].

The success of vegetative propagation by stem cuttings of Moringa seems to be influenced by the size of cuttings and plant growth stimulants. Cuttings with a stem diameter of 35-65 mm exhibited increased shoot development, leaf area, and leaf dry matter compared to 25-35 mm diameter cuttings [4]. Treatment of Moringa stem cuttings with auxins (500 mg/L IBA, NAA and IAA) improved sprouting (days to sprout) and development of buds into leaves [5]. When the stem cuttings were not treated with any plant growth hormones, they showed a low survival percentage due to poor root development [2]. On the other hand, a high concentration of auxins can significantly reduce the positive effect on root development and survival rates [4].

Overall, we have highlighted some of the research conducted on Moringa propagation. Based on the published work, factors that contribute to successful seed and vegetative propagation include seed priming, irrigation, temperature, size of stem cuttings and applied plant growth substances.

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Moringa value chain: cultivation strategies

Compiled by Nadia Ibraimo[1], Salmina Mokgehle[2], Meshack Mofokeng[1], Mulalo Makhubele[1], and Nqobile Masondo[1,3]

Moringa contributes as a functional crop in the agricultural system in different regions. The plant forms an essential part of an integral cropping system, attributed to its adaptability and a significant feature as a crop that grows in unfavourable soil and climatic conditions. Tropical or subtropical semi-arid climates, coupled with well-drained medium textured soils, are the most suitable growing conditions for Moringa. Due to the plant's diverse growth conditions, Moringa is one of the crops that has adapted well to South Africa's environmental conditions, with an increasing demand because of its high nutritious value. As such, a number of collaborative projects with several stakeholders [including the Department of Science and Innovation (DSI), the University of the Witwatersrand (WITS), the Agricultural Research Council (ARC), Phedisanang, Mo-Nutri, and the Makonde Indigenous Fruit Processing Association (MIPFA)] have focused on various aspects of the Moringa value chain such as its cultivation practices, processing, and product development.

Quality of the planting material, propagation techniques, irrigation, and management practices for increased production are crucial to developing a modern, sustainable, and profitable Moringa crop. Examples of climate-smart and sustainable production strategies, such as the adoption of drip irrigation and mulching, are showcased in Figs 1A & B. Applying sustainable production systems such as mulch contributes to soil moisture conservation, improves soil structure sustaining soil fertility, and increases plant growth and yield [1]. Productivity of Moringa is also highly dependent on field management practices, with optimum tree spacing and planting density adjusted based on the purpose of crop production. For instance, the production of leaves for human food consumption normally increases at higher planting densities or narrower plant spacing (0.75 – 1.0 m intra-row x 1.0 – 2.0 m inter-row) when compared to pod production (2.0 - 2.5 m x 2.5 – 5.0 m), while much higher planting densities, at considerably narrower plant spacing, are used for fodder production (0.15 – 0.2 m intra-row x 0.2 – 0.5 m inter-row) [2]. The purpose of production influences the targeted yield achieved. Dry leaf yield for human consumption ranges from 252 – 448 kg ha^{-1} [2], seed yield at 12% moisture content ranges from 50 – 100 kg ha^{-1} [3], while green fodder production ranges from 100 – 120 ton ha^{-1} (https://www.dairyknowledge.in/). High productivity of Moringa can bridge tradition and innovation, culture and health, as well as secure growth and economic development. Furthermore, the encouragement to cultivate Moringa trees in rural communities (Figs 1 & 2), coupled with the application of good agricultural practices for production of quality plant materials may benefit local health, create job opportunities and income, leading to poverty alleviation.

Figure 1. Irrigation set-up for Moringa at Tooseng in Limpopo Province (A) and the application of mulching at Phedisanang farm in the Gauteng Province (B)

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Figure 2. *Moringa oleifera* trees growing in a semi-arid area of South Africa under dryland conditions.

Moringa value chain: product development

Compiled by Nqobile Masondo[1,2], Salmina Mokgehle[3], Meshack Mofokeng[1], Mulalo Makhubele[1], and Nadia Ibraimo[1]

Globally, Moringa has a significant economic importance as it plays a crucial role in nutritional, industrial and medicinal application (Fig. 1). A number of Moringa products have been commercialized in different parts of the world. Due to its functional properties, Moringa leaves are commonly included in ready-to-eat food products or snacks (Fig. 2). Examples include supplementation of white maize soft porridge with Moringa powder [1], durum wheat fresh pasta fortified with Moringa leaf powder [2], incorporating defatted soy flour, carrot powder, mango peel powder, and Moringa leaf powder in wheat semolina-pearl millet pasta [3], and bread fortified with Moringa seed powder [4]. Researchers have shown the promising economic value of Moringa in baked products and other food-based products [5, 6]. Fortification of stable food products with Moringa can be beneficial, particularly in poor communities, as the plant is rich in protein, vitamins, and minerals, amongst others.

The Agricultural Research Council-Vegetable, Industrial and Medicinal Plants (ARC-VIMP), through its agro-processing and product development programme is involved in Moringa product development in collaborations with Indigenous Knowledge System (IKS) holders and different stakeholders including Phedisanang PTY LTD (Hamanskraal, Gauteng Province), Makonde Indigenous Fruit Processing Association (Makonde, Limpopo Province), Mo-Nutri (Tooseng, Limpopo), Mothong trust (Mamelodi, Gauteng Province), the University of Pretoria and the Department of Science and Inno-

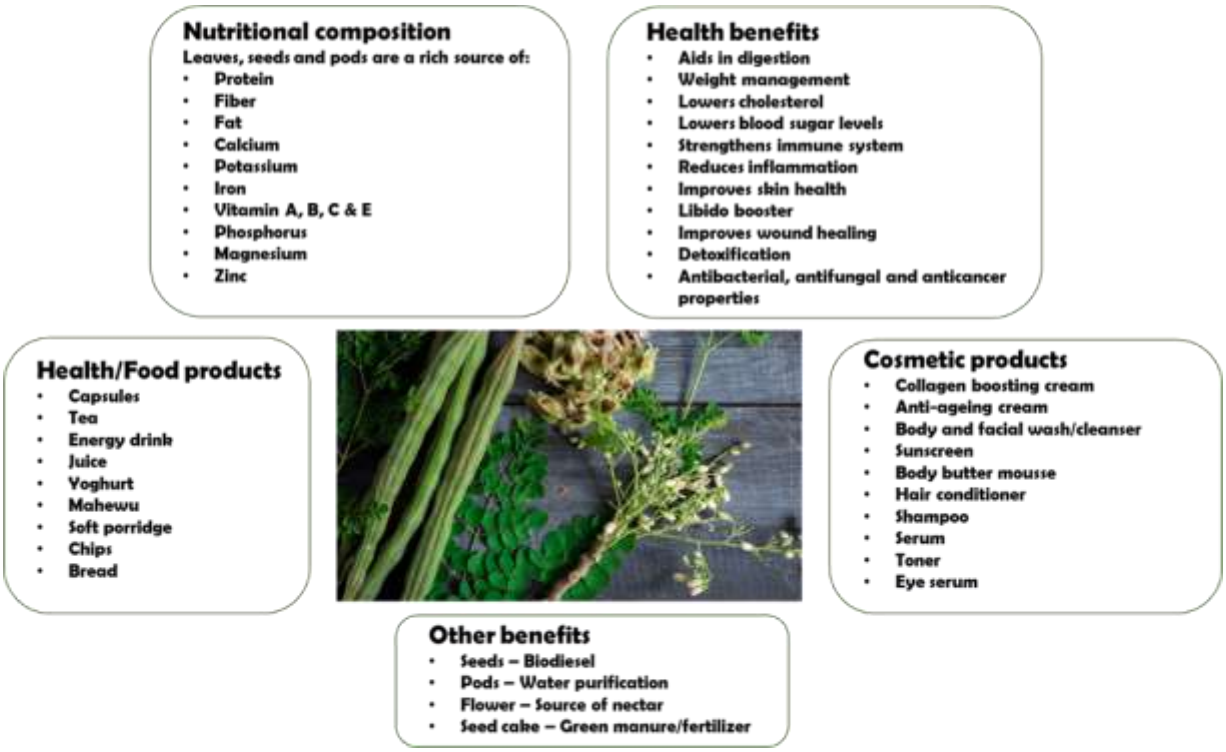

Figure 1. Nutraceutical, cosmeceutical, therapeutics and other benefits of Moringa.

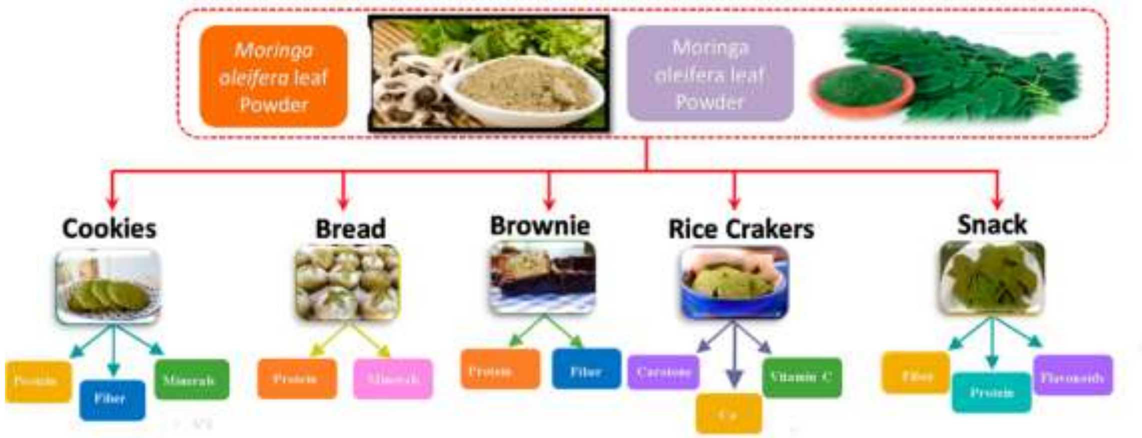

Figure 2. Different Moringa food products in bakery industry [7].

vation (DSI). The ARC-VIMP is also involved in enterprise development through assisting Small, Medium and Micro Enterprises (SMMEs) in the production of teabags, capsules, and other plant-based products (Fig. 3). The innovative food-based products developed from Moringa leaf powder opens up opportunities for IKS-holders, communities and SMMEs to be involved in the formulation of new products from Moringa or other indigenous South African plants. Product development from underutilized indigenous plants, based on their historical traditional usages, can complement the use of Moringa and diversify the food and dietary supplement (nutraceutical) industry as several indigenous plants have valuable nutritional and medicinal benefits that remain untapped.

Figure 3. Different products developed from several projects involving ARC-VIMP team, IKS-holders and other stakeholders.

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Empowerment of farmers with knowledge on disease control and plant growth rhizobacteria

Compiled by Dr Rene Sutherland, Leguminous, Leafy and Fruit Vegetables Division, Crop Protection Unit

Various farmer's days were held across the Gauteng Province regarding plant disease control and the use of plant growth promoting rhizobacteria (PGPRs). The theme was "Farming for a greener future". The training started off with an introduction of what bacteria are and their role in our lives. This was followed by information on plant diseases and their control strategies. The last part of the training focused on PGPRs and their benefit to agriculture. The application of PGPRs has large potential to improve crop production, as it enhances the natural control of soil-borne diseases. This decreases the use of chemical control, thus reducing input costs. There was a total of 86 participants. The information provided to the farmers will enable farmers to apply control measures, including the use of PGPRs, to prevent the impact of plant diseases. This will result in reduced input costs, increased yields, improved health and nutrition, and possible income generation through the sales of excess produce.

Farmers being trained on the control of plant diseases, what PGPRs are, and the advantages of using PGPRs.

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