Nematode pests threatening soybean production in South Africa, with reference to *Meloidogyne*

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The area planted to soybean in South Africa has increased by 54% since the 2009 growing season, mainly as a result of the increasing demand for protein-rich food and fodder sources. Moreover, the introduction of advanced technology, namely the availability of genetically modified herbicide tolerant soybean cultivars also contributed towards increased soybean production. The omnipresence of plant-parasitic nematodes in local agricultural soils, however, poses a threat to the sustainable expansion and production of soybean and other rotation crops. *Meloidogyne incognita* and *M. javanica* are the predominant nematode pests in local soybean production areas and those where other grain-, legume- and/or vegetable crops are grown. The lack of registered nematicides for soybean locally, crop production systems that are conducive to nematode pest build-ups as well as the limited availability of genetic host plant resistance to root-knot nematode pests, complicate their management. Research aimed at various aspects related to soybean-nematode research, namely, audits of nematode assemblages associated with the crop, identification of genetic host plant resistance in soybean germplasm to *M. incognita* and *M. javanica*, the use of molecular markers that are linked to such genetic resistance traits as well as agronomic performance of pre-released cultivars that can be valuable to producers and the industry are accentuated in this review. Evaluation of synthetically-derived as well as biological-control agents are also discussed as complementary management tactics. It is important that lessons learned through extensive research on soybean-nematode interactions in South Africa be shared with researchers and industries in other countries as they might experience or expect similar problems and/or challenges.

Introduction

Soybean (*Glycine max* (L.) Merr) is a major source of protein and oil, both for local human and animal consumption.[1,2] During the 2012/2013 growing season, sunflower ranked first in terms of its production (860 000 t)[1], followed by soybean (710 000 t) and dry bean (60 200 t)[3]. These three are the main oilseed- and protein crops being produced in South Africa. Locally, the hectares planted to soybean have increased by 54% from 2008/2009 to the 2013/2014 growing seasons.[1] Furthermore, the introduction of advanced technology in the form of genetically-modified, herbicide-tolerant, Roundup® Ready (RR) soybean material, was experienced in 2004 when such cultivars were released for commercial production in South Africa.[4] These trends reflect the increasing and urgent need for oil and protein sources to feed a fast growing nation as well as its cattle industry.[2]

Although soybean was traditionally cultivated in the Free State, KwaZulu-Natal, Mpumalanga and Gauteng Provinces,[1] its production was and still is extended to areas where predominantly maize and crops such as groundnut, sunflower, potato and others were traditionally grown. The initiative to expand and stimulate local soybean production resulted in exposure of the crop to new pests and diseases that have the potential to seriously reduce local soybean production.[2] For example, the soybean leaf miner, *Aproaerema modicella* (Deventer) that was introduced into South Africa and reported as a pest of groundnut during the early 2000s also attacks soybean in certain areas of the country.[5] A similar scenario was experienced in 2001 when the economically important soybean rust disease, caused by the newly-introduced fungus *Phakopsora pachyrhizi* Sydow, was first recorded as a major pathogen of soybean crops in traditional local production areas.[6] Not only should soybean cultivars be adapted to local environmental conditions to optimise crop performance, it should also exhibit resistance to diseases and pests such as plant-parasitic nematodes, bacteria, fungi and insect pests.[2]

Although not always perceived as pests of soybean and other crops, plant-parasitic nematodes are economically one of the most important production constraints in crop production areas of sub-Saharan Africa.[7] The latter include current and potential soybean production areas in South Africa.[8-10] Towards the end of the 1980s, the estimated annual soybean yield losses resulting from plant-parasitic nematode parasitism amounted to approximately 9%.[11] The 9%, however, referred to damage caused by various plant-parasitic nematode communities and did not distinguish between the contribution by particular nematode species. More recent assessments of the pest status of root-knot nematodes on soybean revealed yield losses that ranged from 25–70%.[8,12,13] In addition, two of the national soybean cultivar trials that are annually conducted by the Agricultural Research Council's Grain Crops Institute (ARC-GCI) were terminated during 1999 as a result of high root-knot nematode infections causing total crop failure.[14] Distinct root-galling (Figure 1a and b) represents below-ground symptoms and is caused by feeding of female root-knot nematodes (Figure 2). On the other hand, above-ground symptoms in fields where high population levels of these pests occur can include stunted plants with yellowing leaves (Figure 3).