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Increased soybean yields through control of soybean mosaic virus by identification of resistant sources

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Introduction

During PRT funded surveys (1994-1995) to identify viruses of soybeans in South Africa and to determine their importance, soybean mosaic virus (SMV) and a previously unreported rhabdovirus were identified as the only two viruses of any economic consequence on soybeans in South Africa (Pietersen *et al.*, 1994; 1995; 1996). SMV was identified from 134 samples (19.3% of all samples) collected throughout the various soybean production areas surveyed. While the incidence of SMV was generally below 1% in most commercial fields visited, some exceptions occurred, where the virus was present at levels of 10-15%. The virus however was present in the National Soybean Cultivar Trials and National Germplasm Collection during this period at incidences of up to 20% of the whole trial, varying between 0% to 50% infected plants in single cultivar plots.

Worldwide, SMV is considered a major virus problem. It is amongst the top ten most important filamentous viruses in North America, South America, Africa, the Indian Subcontinent, China, and South East Asia (Milne, 1988). Soybean fields with 100% infection have been observed, and yield losses of 10-50% are common in Japan (Inouye *et al.*, 1988). Elsewhere rates of up to 32% have been observed in fields, and losses of 25-83% have been recorded (Almeida & Silveira, 1983, cited by Salazar,1988; Dhingra & Chinulu, 1980; Ross, 1977).

SMV consists of a number of strains worldwide (Cho & Goodman, 1979; Roane *et al.*, 1986, Lucas & Hill, 1980, Hill *et al.*, 1989). In South Africa only strain G1 was detected in the former Transvaal (Pietersen & Garnett, 1992) in limited studies. In South Africa, resistance to the G1 strain of SMV has been identified in Ibis and PNR 565, amongst commonly planted cultivars or those being evaluated in the National Cultivar Trails (Pietersen, 1995) . At least three genes, *Rsv1, Rsv_2, and Rsv_3,* confer resistance to various strains of SMV (Buzzel & Tu, 1984; Kihl & Hartwig, 1979; Lim, 1985; Chen et al., 1991). However, the resistance conferred by each gene can be overcome by different strains of SMV. For example, strain G7 overcomes resistance conferred by the *Rsv1* gene in the soybean line PI 96983 which is resistant to strains G1 to G6 (Lim, 1984). It is therefore essential that the natural strain variation is established, when using resistant cultivars as a virus control method. This information is also essential for a breeding program, as selection pressures may result in the predominance of specific strains locally, as suggested by strain differentiation studies in which only strain G1 was detected in the former Transvaal (Pietersen & Garnett, 1992).

Aim

The initial aim of this study was to identify the strains of SMV present in South Africa and to identify local soybean cultivars resistant to these SMV strains, in order to allow breeders to make knowledgeable decisions regarding SMV in their breeding programs. It was envisaged that this would be achieved as follows over a four year period:

1) Determine local strains of SMV in South Africa

a) Use archived SMV infected material (over 350 sources), and supplement this by collecting new SMV material. Isolate SMV from these and determine the strain by bioassay (only possible on limited numbers, c.30).

b) Develop a method for rapid, large scale detection and strain identification (use known strains), in order to test larger numbers of isolates than by bioassay. This method must differentiate strains in a manner which correlates with the bioassay, ie. Must target a portion of the virus genome involved in the resistance mechanism (look for resistance markers). Achieve this by sequencing the whole genome of known isolates G1, G3, G5 & G6, target nucleotide differences and note their correlation with resistance, and then screen up to 300 local sources of SMV.

2) Identify soybean cultivars & lines resistant to local & international strains by the inoculation of plants by aphids, monitoring the infection rate, virus levels, soybean yield (in comparison with healthy plants) re. herbage & seed, and measuring the rate of seed transmission.

Based on this to recommend cultivars with one or combinations of resistance/tolerance to industry.

Due to financial and temporal constraints imposed on the project by the PRT these aims were amended after the first year, with the PRT's approval, to be completed one year later, at the end of 1999, to the following:

1) Determine local strains of SMV in South Africa

a) Use archived SMV infected material, but do not supplement this further with new SMV material. Isolate SMV and determine the strain by bioassay on limited numbers, c.30.

b) Attempt to develop a method of rapid, large scale detection (use known strains), in order to test larger numbers of isolates than by bioassay. Achieve this by focusing on only two regions of the genome of known isolates G1, G3, G5 & G6. Confirm the identity of the SMV sources.

2) Identify soybean cultivars & lines resistant to the only two identified local strains (G1 and G3) by the inoculation of plants by aphids, monitoring the infection rate, virus levels, soybean yield (in comparison with uninoculated plants) w.r.t.. herbage & seed, and measuring the rate of seed transmission. Then based on this, to recommend cultivars with one or more combinations of resistance/tolerance to the industry.