

FACING THE CHALLENGES OF SOYBEAN RUST: A REVIEW OF SOUTH AFRICAN STRATEGIES

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Soybean rust (SBR) caused by *Phakopsora pachyrhizi* has affected soybean production practices in South Africa since detection 2001. Initial yield losses as a result of SBR were limited by applying strategies and fungicide programmes derived from neighbouring Zimbabwe and other SBR affected production regions around the world. Carefully directed local research optimised the strategies employed to face the challenge of SBR, ultimately securing the sustainability, and indeed growth, of soybeans as a crop in South Africa. Using long term weather data in a mathematical model, Van Niekerk developed a map of the soybean production area detailing climatic vulnerability to SBR. This map defined areas of low, moderate and high climatic risk to SBR infection and has assisted in refining the use of the sentinel plot system. The sentinel plot system was one of the first strategies employed to serve as an early warning mechanism for the commencement of fungicide programmes against SBR. Timely application of fungicides, along with effective spraying methodology has been established as important determinants the efficacy of on-farm SBR control. In high climatic risk areas, control of SBR follows a predetermined fungicide programme. In moderate risk areas, the sentinel plot network is used as an advanced warning system for the commencement of the first fungicide spray. In the low climatic risk areas, the use of tolerant cultivars is set to become a strategy to reduce vulnerability to sporadic SBR related yield losses. The potential mean yield loss ascribed to SBR in an area of moderate risk in South Africa is 25%, which adds significantly to the general production risk of soybean husbandry. Despite this increased production risk, the area planted to soybeans has increased consistently over the past 12 years, which reflects the confidence producers have that the challenge from SBR has been contained.

Facing the challenges of soybean rust: A review of South African strategies

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Introduction

- Soybean rust was detected in neighbouring Zimbabwe in 1998
- In 2001 the first outbreak of rust was reported in RSA
- Epidemics have occurred every year since
- Soybean production has grown significantly in the period 2001-2013
- The object of this presentation is to review the research we have conducted and the strategies that we have followed

PART1:Quantification of yield loss

PART2:Warning system

PART3:Control Strategies

PART4:The way forward

Significant references

Quantification of yield loss

Table 1 Mean effect of SBR on yield relative to a fungicide sprayed control at Greytown, meaned over two planting dates and 40 genotypes for three seasons (2002/03, 2003/04 and 2004/05)(Jarvie, 2009).

	Yield (kg ha ⁻¹)			Yield
Season	Sprayed	Unsprayed	Loss	Loss %
2002/03	1881	1686	195*	10.4
2003/04	3399	2407	993**	29.2
2004/05	3235	2299	937**	29.0
3yr Mean	2839	2130	708*	25.0

Treatment: Unsprayed; Sprayed = 2 x Punch C @ 400 ml ha⁻¹

%Yield Loss = (sprayed yield - unsprayed yield) / sprayed yield x 100

* = Significant ($P = 0.05$)

** = Highly significant ($P = 0.01$)

Quantification of yield loss

- Late planting sustained consistently high yield losses
- Early planting resulted in more variable yield losses, and escapes in some seasons. Similar trend found by Caldwell and McLaren (2004).

Warning system

Early warning system

- Network of sentinel plots
- Planted two weeks earlier than commercial crop
- Two cultivars representing maturity extremes
- Scouted by competent researchers
- Reported and announced centrally

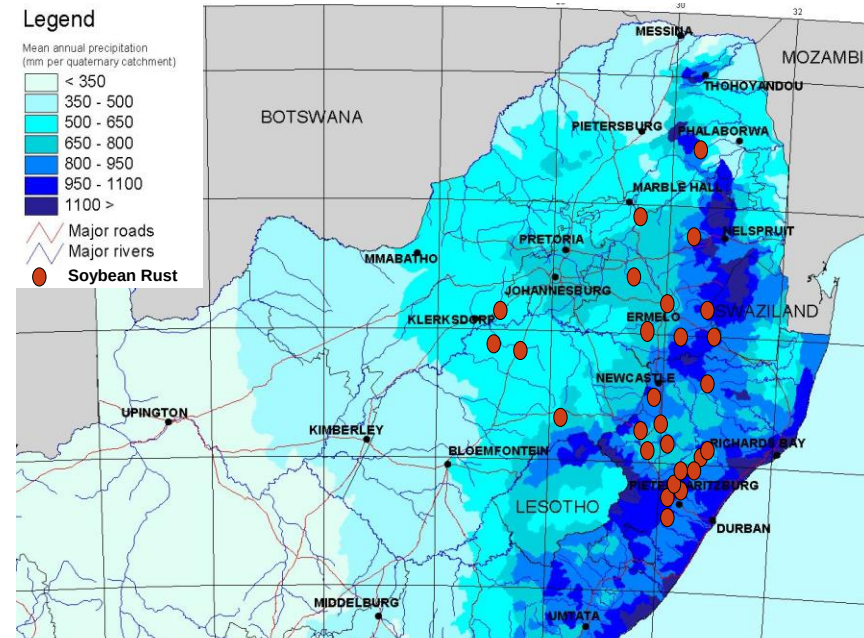


Figure 1. Distribution of locations with one or more reports of soybean rust superimposed on the annual rainfall map of South Africa (Source: Surface resources of South Africa, 1990)

SBR risk distribution

Van Niekerk's algorithm to predict the outbreak of SBR

- Minimum period of 6hr at correct temp and darkness for $I_R = 12$
- $I_R = 12$ sustained for two days, infection could occur and symptoms follow 10-14 days later if inoculum was present
- Model verified on sentinel plot data
- Historical weather data (1950-1999) was used to develop a climatic risk map for SBR
- The risk at any location changed throughout the season

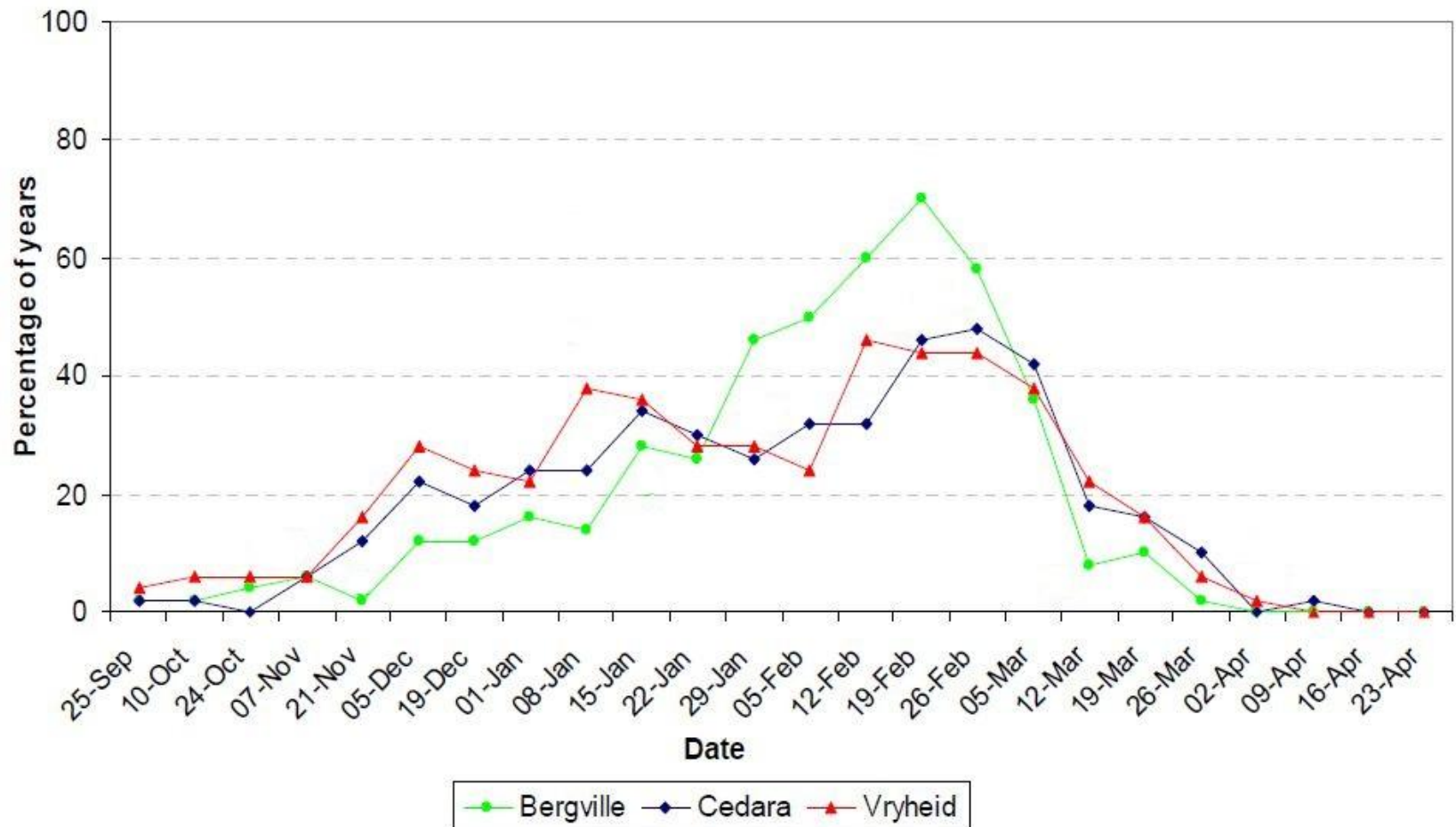


Figure 2. Frequency with which I_R exceeded a score of 12 for two successive days for 24 time periods during the soybean growing season for three locations over a 50 year period (Van Niekerk, 2009).

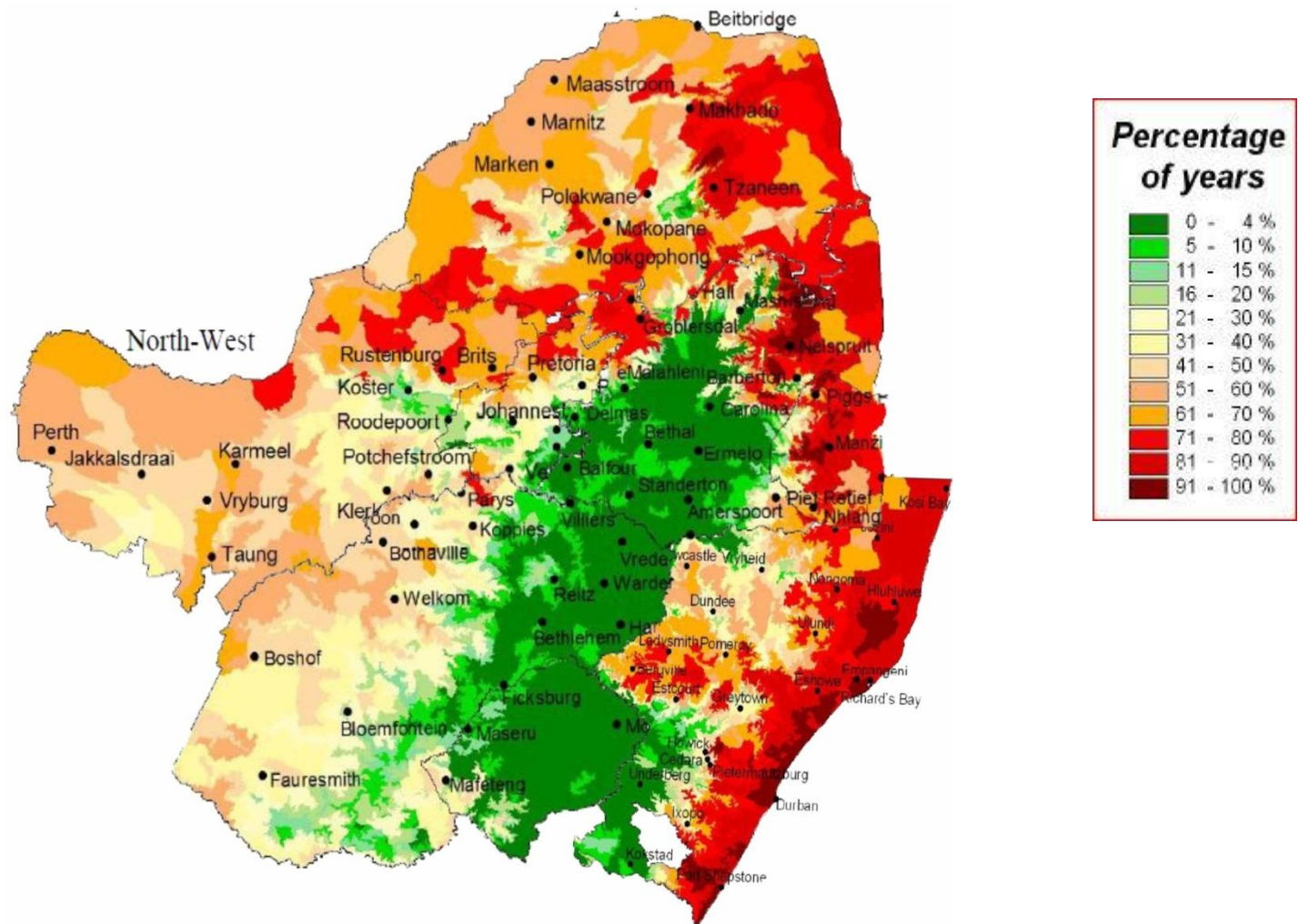


Figure 3. Long term climatic vulnerability of South African soybean production area to SBR, as calculated for the interval 19 to 25 February (after Van Niekerk, 2009).

Fungicide Control Strategies

- Du Preez and Caldwell evaluated fungicides, effective dosage rates and frequency of applications
- General conclusions
 - Limited curative, primarily preventative action
 - 1 to 3 sprays required
 - Sub optimum doses / repeated use of similar action chemicals represented a risk to a build up of pathogen resistance

On farm strategies

- First spray within 10 days of the Sentinel plot warning in the area
- Second spray followed at 21-28days later.
- Documented differences between registered chemicals exist, however, principal determinant of on-farm control is
 - Timing
 - Effectiveness of delivery



Photo courtesy of FJ Kloppers



Photo courtesy of FJ Kloppers



Photo courtesy of FJ Kloppers



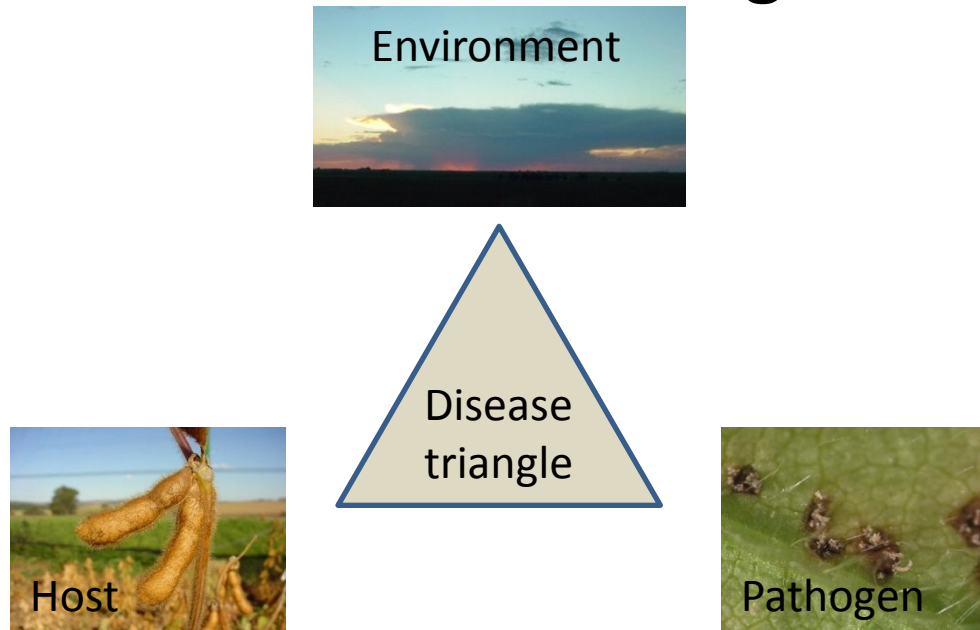
Photo courtesy of FJ Kloppers

Breeding for tolerance

- Select segregating populations for yield under rust stress conditions
- Conventional methodology of expressing tolerance as a yield loss percentage inadequate.
- Use the W_iP_i statistic to simultaneously select genotypes for general performance and yield stability under a range of rust stress conditions

The way forward

- The sentinel plot warning system cannot be replaced by a live update of Van Niekerk's prediction model because it represents only one side of the disease triangle



The way forward

- In the areas that have been identified as moderate and high risk, chemical control of SBR must continue



The way forward

- In the areas categorised as low risk, tolerant varieties could be deployed to reduce yield losses where preventative spraying is not practiced.



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Thank you