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Bacterial diseases of dry beans in South Africa with special reference to common bacterial blight and its control

by

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Submitted to the Faculty of Natural and Agricultural Sciences

Department of Microbiology and Plant Pathology

University of Pretoria

in partial fulfillment of the requirements

for the degree of

PhD

PRETORIA

NOVEMBER 2002

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This thesis is dedicated to the late Dr. Dermot P. Coyne for his valuable contribution to bean breeding especially with regard to bacterial diseases. His presence and expertise will be missed.

ACKNOWLEDGEMENTS

My sincere appreciation to the following persons and institutions who made this study possible:

Dr Schalk van Wyk and Prof Mike Wingfield for their support and critical appraisal of the draft manuscript

The ARC-Grain Crops Institute for providing funds and facilities to conduct this study

The Dry Bean Producer's Organization for funding this research

Ms Josephine Pholoholo for her excellent assistance throughout the study

Ms Liezel Herselman and Dr Charlotte Mienie for assistance with molecular studies

Dr Bradley Flett for assistance with statistical analyses and critical reading of the manuscript

Ms Atilda Swanepoel for IT support

Management at Soygro for time allocated to Dr Schalk van Wyk

Mark, for his encouragement and support during the study.

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BACTERIAL DISEASES OF DRY BEANS IN SOUTH AFRICA WITH SPECIAL REFERENCE TO COMMON BACTERIAL BLIGHT AND ITS CONTROL

by

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SUMMARY

Bacterial diseases, commonly associated with dry beans, often cause severe yield and seed quality loss. Disease surveys, as reported in chapter 2, indicated that common bacterial blight occurred in 83% and 85% of localities in seed and commercial dry bean production areas, respectively. Halo blight was restricted to cooler production areas and occurred in only 10% of seed production fields and 37% of commercial fields surveyed. Bacterial brown spot was the most widespread bacterial disease of dry bean, occurring in 93% of seed production fields and 100% commercial fields. Although incidences of bacterial diseases were high, severity was generally low. The widespread distribution of bacterial diseases in both seed and commercial production areas raises concern that the production of disease-free seed in South Africa might not represent an effective

control method.

In chapter 3 of this study, 255 *Pseudomonas savastanoi* pv. *phaseolicola* isolates, representative of all the localities and cultivars sampled, were categorized into different races according to their reaction on a set of differential cultivars. Seven races (1, 2, 4, 6, 7, 8 and 9) were identified with race 8, the most prevalent. Races 1, 2, 6 and 8 were widely distributed throughout the production area, while races 4, 7 and 9 were restricted to one or two localities.

In the study presented in Chapter 4, 143 *Xanthomonas axonopodis* pv. *phaseoli* (Xap) and *X. axonopodis* pv. *phaseoli* var. *fuscans* (Xapf) isolates from 44 localities in four countries, were inoculated onto eight *Phaseolus acutifolius* lines that differentiate between pathogenic races. Isolates varied in aggressiveness on cv. Teebus, however, pathogenic reaction on the set of differentials, indicated that all, but one isolate, grouped in what has been reported as race 2. Thus, results based on reaction of the majority isolates, suggest the absence of different races. However, the distinct differential reaction recorded for a single isolate, may prove to represent another, as yet unrecorded, race of this pathogen. Both RAPD and AFLP analyses revealed high frequency of DNA polymorphism among isolates and could distinguish between Xap, Xapf and a non-pathogenic isolate. Differences between Xap and Xapf isolates demonstrate that these are two distinct groups of bacteria. Information gained from this study has enabled us to select the most appropriate isolates to use in a resistance breeding programme.

South African cultivars differed significantly in their susceptibility to bacterial diseases as shown in Chapter 5. Cultivars Teebus, Cerillos, PAN 146 and PAN 159 were the most susceptible to common bacterial blight with Monati and OPS-RS2 exhibiting significantly lower susceptibility. Negative correlations were obtained between disease ratings and yields obtained in the common bacterial blight trial. Cultivars exhibited some levels of resistance to halo blight, with small seeded cultivars generally more resistant than large seeded types. A negative correlation was obtained between halo blight rating and yield. Cultivars differed significantly in their susceptibility to bacterial brown spot. Teebus, Cerillos, Bonus and PAN 159 were the most susceptible cultivars, with Mkuzi exhibiting the highest levels of resistance. The majority of cultivars exhibited acceptable levels of resistance to bacterial brown spot. No significant correlation was obtained between disease rating and yield. Although a number of cultivars exhibited field resistance to halo blight and bacterial brown spot, all cultivars were susceptible to common bacterial blight. This disease is, therefore, considered the most important bean bacterial disease in South Africa. Improvement of common bacterial blight resistance in South African cultivars is thus important to obtain stable yields.

In chapter 7 of this study, backcross breeding was used to improve common bacterial blight resistance in the small white canning bean, cv. Teebus, using resistance in XAN 159 and Wilk 2 sources, respectively. High resistance levels in near-isogenic lines, developed in two independent breeding programmes, indicated successful transfer of resistance from both sources. Presence of SCAR-markers, SU91 and BC420, in 35 of 39 XAN 159 derived Teebus lines and all lines derived from Wilk 2, confirmed successful resistance transfer. AFLP studies conducted to determine genetic relatedness of two near-isogenic Teebus lines, showed a similarity of 96.2% with the maximum similarity between these lines and Teebus being 93.1%. Material developed in this study has been included a bean breeding programme and seed will be made available to farmers after extensive field testing.

Sequence characterized amplified region (SCAR) markers, linked to four independent quantitative trait loci (QTL) in XAN 159 and GN #1 Nebr. sel. 27, are available for indirect selection of resistance to common bacterial blight in *Phaseolus vulgaris*. In chapter 8, existing SCAR-markers, SU91, BC420, BC409 and SAP6, were evaluated for potential use in the local breeding programme. Segregating populations of progenies developed through backcross breeding with cultivars Teebus and Kranskop as susceptible recurrent parents and XAN 159 and Vax 4 as resistant donor parents were evaluated for presence of existing markers. Presence of all four markers in improved Teebus lines (XAN 159 derived), confirmed successful transfer of resistance in these lines. Marker BC420 was absent in XAN 159 derived Kranskop-lines. These lines were only moderately resistant when tested in the greenhouse, indicating that the QTL linked to this marker is important in order to obtain high levels of resistance. Progenies from first backcrosses with Kranskop as recurrent parent using Vax 4 have exhibited high levels of resistance when tested in the greenhouse and presence of all markers found in Vax 4 confirms transfer of resistance. Results gained from this study indicate that marker assisted selection can successfully be implemented in breeding for common bacterial blight resistance in South Africa.

In chapter 9, I assessed yield losses in South African genotypes, caused by common bacterial blight. This was determined using one susceptible cultivar (Teebus) and two resistant near-isogenic Teebus-lines (TCBR1 and TCBR2). Different parameters (disease ratings, % leaf area loss and % infection) were used to evaluate disease. Disease incidence was high in plots containing the susceptible cultivar Teebus. Genotypes differed significantly in their susceptibility to common bacterial blight. Copper sprays reduced the percentage leaf area loss and enhanced seed size. Disease free plots, however, were not achieved using copper sprays. Common bacterial blight significantly reduced yield and seed size in the susceptible cultivar, Teebus. Yield losses of 43.5% were observed in diseased Teebus plots after artificial inoculation with common bacterial blight. The resistance introduced, into the near-isogenic lines, upon release in the industry, will contribute to common bacterial blight control in future productions of the small white canning bean.

In the series of studies presented in this thesis, I have clarified a number of issues regarding bacterial diseases of dry beans in South Africa. Information was gained on the incidence and severity of bacterial diseases, pathogenic variation that occurs in two of the three respective pathogen populations, susceptibility of cultivars to bacterial pathogens and deployment of resistance as long term control strategy to the most important disease. Progress that was made in this study, especially with regard to the development of resistant cultivars, will make a significant contribution towards the South African dry bean industry.