January, August & Final Reports

Part 1 - Summary Project Details

REPORTS

Please use your TAB key to complete parts1,2,4 & 5

CRDC Project Number:
DAN146C

January Report:	☐	Due 29-Jan-01
August Report:	☐	Due 03-Aug-01
Final Report:	☒	Due within 3 months of project completion

Project Title:

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Part 3. Final Report

1. Background to the project.

Professor Joseph Kloepper, (Head of Plant Pathology Department, Auburn University, Alabama, USA) is a pioneer of plant-growth promoting rhizobacteria, and one of the leading scientists in biocontrol of plant diseases. The purpose of this travel grant was to invite him to visit the biological disease control program at the Australian Cotton Research Institute.

The cotton disease biocontrol project DAN 123 C has developed biocontrol agents for controlling seedling diseases and vascular wilts. Seedling disease biocontrol agents that we developed perform as well as the chemical fungicides. We have also developed a biocontrol method, using an endophytic bacterium belonging to a *Bacillus* sp., which has successfully reduced Fusarium wilt in field.

An understanding of the ecology of this biocontrol bacterium and an effective formulation are essential for further development of this biocontrol method.

General experience among scientists who work on endophytic bacteria is that the ecological studies of these bacteria are hard to conduct using conventional techniques.

Prof. Kloepper is one of the few biocontrol researchers who is working on endophytic biocontrol agents and has expertise in developing biocontrol agents which perform in the real world, ie in the field. His group developed a successful biocontrol seed formulation for cotton diseases. This formulation, which contains a strain of another *Bacillus* species, *Bacillus subtilis*, is marketed and used in America on crops including cotton. He has active research projects on biocontrol of cotton diseases, including Fusarium wilt.

2. Project objectives and to what extent they have been achieved.

The stated objectives/proposed outcomes in the grant application were:

- Testing of biocontrol agents in diverse geographical regions.
- Sharing of methodology to study endophytic biocontrol agents.
- Potential for faster development of biocontrol agents for use on commercial cotton farms.

- **Testing of biocontrol agents in diverse geographical regions.**

Prof. Kloepper expressed a strong interest in establishing a reciprocal strain testing program between NSW Agriculture and Auburn University (AU).

- Auburn University would test our stains in bioassays for cotton diseases, and we would test AU strains for *Fusarium.* From a practical point, some of the Auburn strains may be useful in Australia for control of Fusarium.

- Cotton growth promotion: This could be a collaborative effort—exchange of AU and NSW Agriculture strains, including AU's ISR strains. The goal is to determine if any of the strains can enhance root growth—first in the laboratory or growth chamber, and then in field.

- Induced resistance in cotton is another potential area for collaborative research. The idea is to test NSW and AU strains for induced systemic disease protection first and then for physiological changes to confirm induced systemic resistance. We discussed the possibility that Dr Putcha would do the bioassay, using angular leaf spot and Australian cultivars known to be susceptible. Professor Kloepper would then do tests for physiological changes, using Australian cultivars.

- **Sharing of methodology to study endophytic biocontrol agents.**

Professor Kloepper's group has used electron microscopy (EM) to study the colonisation of plants by endophytic bacteria. They have also shown that antibiotic marking of the endophytic biocontrol agents is not an effective tool for ecological studies, due to masking of antibiotic resistance.

It will be useful to conduct EM studies to further demonstrate the endophytic nature of our biocontrol agents in controlled conditions. This technique is not practicable for large ecological field studies. In our research project, we are currently working on incorporating genetic markers into our biocontrol agents. These markers work on the basis of a visual colour reaction and therefore could be a powerful tool in ecological studies of surface colonisers as well as endophytes.

- Potential for faster development of biocontrol agents for use on commercial cotton farms.

a. Link biocontrol program to cotton breeding program.

Conduct field tests combining early selections from the biocontrol program with breeding lines in their early stages. This would provide necessary data on interaction between host genotype and bicontrol agents three to five years before their release. From a practical view, it is possible that weak cultivar resistance could be enhanced by the biocontrol agent. Linking the two programs to test promising materials could reduce the time taken to develop a disease management package by three to five years.

b. Using mixtures of biocontrol agents

Test the hypothesis that two strains with different mechanisms can be used in combination without negative effects on each other. This approach could increase the robustness of biocontrol because while conditions are not favourable for the mechanism of one biocontrol agent to operate, under the same conditions the other biocontrol agent can be functional.

It is necessary to establish the mechanisms underlying the different biocontrol agents. Auburn University has established the mechanism of some of their biocontrol

agents already. We have preliminary evidence of the biocontrol mechanism of some of our strains. A collaborative study can be beneficial to both the groups in this area.

c. Reciprocal testing of biocontrol agents

A reciprocal testing program will be helpful in developing biocontrol agents for use on commercial cotton farms. Sharing the expertise of the two groups can reduce the costs and time involved. Testing the biocontrol agents under diverse conditions will not only help understand the performance consistency, but will also help in attracting interest from commercial companies with necessary expertise in developing formulations and marketing.

- Presentation of a talk by Prof. Kloepper at the Australian Cotton Research Institute.

Prof. Kloepper's research on plant-microbe interactions is widely acclaimed. To take advantage of his visit to Australian cotton industry, and provide other cotton researchers with an opportunity to interact with Prof Kloepper, a one-day workshop entitled 'Micro-organisms and Cotton Productivity' was conducted on 7 September 1999, in Narrabri.

In the last decade, several new projects with significant microbiology component have been funded by the Cotton R&D Corporation and the Australian Cotton CRC. The Workshop brought the researchers of these projects together for a round-table discussion. and provided them with an opportunity for - (1) increased communication, consultation and collaboration among these projects, (2) increased awareness of the details of each project, (3) avoidance of duplication of research (4) identification of research areas that can complement one another and therefore increase efficiency and (5) sharing of information on methodologies.

The workshop, which focussed on microbiology, covered the following topics-
(1) Microorganisms and cotton productivity. The scope and potential (2) disease control, (3) insect control, (4) plant growth promotion (5) crop residue degradation, (6) breakdown of pesticides and herbicides, (7) microbial diversity (8) biofertilisers and crop nutrition, and (9) methods and tools.

The Workshop was attended by several researchers as well as a cross-section of the cotton industry including members of the Australian Cotton Growers Research Association, Cotton R&D Corporation, cotton seed companies, and some cotton growers. Dr Albert Rovira another prominent plant microbiologist and Dr. Rothrock, a visiting scientist from America were also in attendance.

The costs for the Workshop were covered by the Australian Cotton Cooperative Research Centre.

3. Other information

Prof. Kloepper held discussions with pathologists and microbiologists at the Australian Cotton Research Institute. He visited some cotton farms in NSW and

Part 4. Final Report Plain English Summary

Professor Joseph Kloepper of Auburn University, USA has conducted widely acclaimed research into plant-growth promoting rhizobacteria. He is one of the leading scientists in biocontrol of plant diseases. He visited the biological disease control program at the Australian Cotton Research Institute (ACRI) from 1 to 10 September, 1999. His visit was supported by the Cotton R& D Corporation through a travel grant (project DAN146C).

Prof. Kloepper's group and a group of scientists at the ACRI have strong common interests and collaborative links between the two research groups would be mutually beneficial. The cotton disease biocontrol project DAN 123 C has developed biocontrol agents for controlling seedling diseases and vascular wilts. Seedling disease biocontrol agents that have been developed at the ACRI perform as well as the chemical fungicides. A biocontrol method has also been developed using an endophytic bacterium (bacterium that colonises the plant internally) belonging to a *Bacillus* sp. This biological control agent has successfully reduced Fusarium wilt in field. An understanding of the ecology of this biocontrol bacterium and an effective formulation are essential for further development of this biocontrol method. General experience among scientists who work on endophytic bacteria is that the ecological studies of these bacteria are hard to conduct using conventional techniques. Prof. Kloepper is one of the few biocontrol researchers who is working on endophytic biocontrol agents and has expertise in developing biocontrol agents which perform in the field. His group developed a successful biocontrol seed formulation for cotton diseases. This formulation, which contains a strain of another *Bacillus* species, *Bacillus subtilis*, is marketed and used in America on crops including cotton. He has active research projects on biocontrol of cotton diseases, including Fusarium wilt.

Prof. Kloepper held discussions with pathologists and microbiologists at the ACRI. He visited some cotton farms in NSW and Queensland, and the seed processing facility at Cotton Seed Distributors in Wee Waa. To take advantage of his visit to Australian cotton industry, and provide other cotton researchers with an opportunity to interact with Prof Kloepper, a one-day workshop entitled 'Micro-organisms and Cotton Productivity' was conducted on 7 September, 1999, in Narrabri.

The Workshop was attended by several researchers as well as a cross-section of the cotton industry including members of the Australian Cotton Growers Research Association, Cotton R&D Corporation, cotton seed companies, and some cotton growers. Dr Albert Rovira another prominent plant microbiologist and Dr. Rothrock, a visiting scientist from America were also in attendance. The costs for the Workshop were covered by the Australian Cotton Cooperative Research Centre.

During Prof. Kloepper's visit, a number of areas were identified for collaborative research. A collaboration between the two research teams could result in faster development of biocontrol methods. These methods will reduce cotton yield losses from diseases. Bicontrol methods are perceived to be sustainable and environmentally acceptable methods by the community.