Cotton
RESEARCH & DEVELOPMENT

Annual, Progress and Final Reports

REPORTS

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **CSP150C**

Annual Report: ☐ Due 30-September

Progress Report: ☐ Due 31-January

Final Report: ☒ Due 30-September
(or within 3 months of completion of project)

Project Title: Capital - Leaf chamber fluorometer

Project Commencement Date: 1/07/2002 **Project Completion Date:** 30/6/2003

Research Program: 2 Integrated Natural Resource Management

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Signature of Research Provider Representative: _____

Part 3.3 – Final Reports

1. Outline the background to the project.

Biotic (e.g. mites, aphids) and abiotic stresses (e.g. waterlogging, temperature) can have a significant effect on cotton growth and yield. Most of these stresses lead to a reduction in photosynthetic performance of leaves. Stress affected leaves often have low assimilation rates, reduced assimilate export, poor water use efficiency, and may suffer from photoinhibition (i.e. an inability to properly dissipate absorbed light energy). Currently photosynthetic performance of stressed and non-stressed leaves is measured using the LiCor 6400 photosynthesis system. However this instrument cannot partition the various processes involved in photosynthesis, i.e. in the absorption of light by pigments, in the transfer of electrons carrying the light energy, or in the utilisation of energy transferred to the site of CO_2 reduction. The Leaf Chamber Fluorometer (LCF) in combination with the LiCor 6400 will allow us to assess the performance of each of the above components.

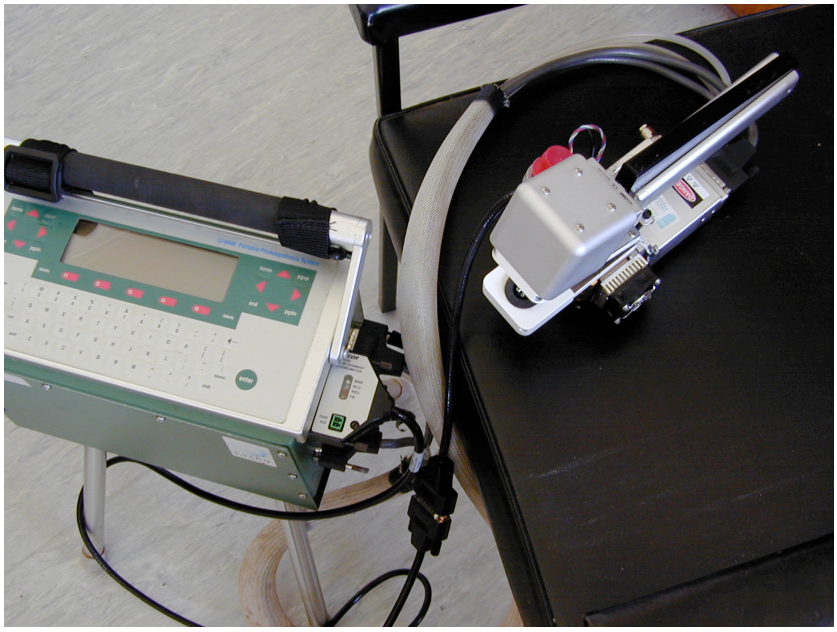

Figure 1. Measurement of leaf chlorophyll fluorescence enabled by the Leaf Chamber Fluorometer shown as an integrated component of the LiCor Photosynthetic System. The LCF consists of the light source/ fluorescence sensor at the top of the leaf chamber (right), the cable with indicator lights (center) and software in the console (left) that controls measurement operations and processes the incoming fluorescence data.

When light impinges on a leaf, most of the light energy is absorbed by chlorophyll pigments is used for photosynthesis. However, there is always a small amount of the absorbed light that is re-emitted as fluorescence. This fluorescence is detected and measured by the LCF. If the photosynthesis system is functioning properly, the amount of fluorescence will be small. But in a stressed leaf, absorbed light energy cannot be dissipated through the normal pathways of photosynthesis, resulting in an excess of photochemical energy which is expressed as an increase in fluorescence. In some cases, the onset of stress will cause small increases in fluorescence but not affecting the photosynthetic rate. In this situation, the LCF can be used as a diagnostic tool to detect early signs of stress.

If a stress factor has already affected photosynthetic rate, the LCF will serve to locate the site of impairment within the leaf. Such information is useful because if we know that the impairment resides in the light-processing region, remedial measures to bolster the CO_2 fixation function, such as applying nitrogen, will not be effective.

2. List the project objectives and the extent to which these have been achieved.

The fluorometer with its capacity to reveal details in photosynthetic malfunctions has been made available to CSIRO cotton researchers. It is currently being used in a chilling injury experiment (CSP140C, "The impact of temperature extremes on cotton performance").

3. Detail the methodology and justify the methodology used.

The LiCor Leaf Chamber Fluorometer (LCF) has been tested and its operational procedures described prior to research use. The following gives some main points aimed at intended users

The LCF is an integrated component of the LiCor 6400 Portable Photosynthesis System. On the whole, the installing and the running of the LCF are relatively straightforward. However, it is critical that some caution be taken in operating the LCF. The LCF comes in 3 parts: the upper and the lower portions of the leaf chamber, and the dedicated 35-pin cable. Installing the LCF requires removing the existing leaf chamber (upper and lower portions) and adding the fluorometer cable. Book 5 of the operating manual shows how this is done. After changing to the LCF, the Configuration must be reset to "Default fluorometer". In the LCD display window, there are about 12 new operational parameters, and about 20 new monitoring and output parameters associated with the LCF. The meaning of these parameters are given in the manual. The LCF can be used as a straight photosynthesis meter (without collecting fluorescence data). It is important to remember that the leaf area measured by the LCF is 2 cm^2, and not the 6 cm^2 of the standard LiCor 6400 chamber. This may be handy in situations where the leaf area to be measured is less than 6 cm^2. The hand piece will become heavier with the LCF attached and the integrated unit tends to draw slightly more power. So unless fluorescence measurements are specifically required or having the smaller leaf chamber is critically important, it is advisable that either the standard LED light source or the clear top chamber be used.

4. Detail and discuss the results including the statistical analysis of results.

Currently, fluorescence data are being collected as a part of an ongoing project.

5. Detail a plan for the activities or other steps that may be taken.

Current and future projects that can benefit directly from the LCF include those on pest damage to leaf functions (such as that by aphids and jassids), on abiotic stresses in cotton performance (such as chilling injury, heat stress, waterlogging and drought stress. At present the instrument is being used to detect sites of photosynthetic dysfunction following cold shock in an effort to understand the physiological mechanism of chilling stress in cotton.We anticipate that there will be an ongoing demand for the fluorometer as projects aiming to describe the underlying physiology of various perturbations on cotton growth.

6. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.

The LCF constitutes an important addition to the analytical capabilities of the cotton researcher team. It will assist researchers in quantifying physiological consequences of biotic and abiotic stresses which lead to a reduction in photosynthetic performance. Knowedge gained from this instrument will both enhance the fundamental understanding of cotton

performance under stress and identify management strategies best suited to mediate the specific site of photosynthetic dysfunction in cotton.

Part 4 – Final Report Executive Summary

Provide a one page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

The Leaf Chamber Fluorometer is an exciting new addtion to the physiological instrumentation available to the scientists at ACRI. The LCF has raised the investigative capabilities of the cotton research team and made it possible to study in greater depth stress related physiological responses in cotton. Its application will be broad encompassing stresses induced by pests and environmental extremes such as temperature and available water. Current and future projects will be measuring gas exchange and chlorophyll fluorescence concurrently, exploring and revealing the physiological origins of stresses in cotton that could result in declining yield and fibre quality. Significant findings using the LCF are expected over the next few years which will maintain research of an innovative standard in areas of cotton physiology for the team at ACRI.