THE IMPACT OF DARK CHILLING FOLLOWED BY EXPOSURE TO HIGH LIGHT INTENSITIES ON ULTRASTRUCTURE AND SELECTED BIOCHEMICAL REACTIONS OF PHOTOSYNTHESIS IN *GLYCINE MAX* (L.) MERRILL.

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PROJECT 3:

THE IMPACT OF DARK CHILLING FOLLOWED BY EXPOSURE TO HIGH LIGHT INTENSITIES ON ULTRA STRUCTURE AND SELECTED BIOCHEMICAL REACTIONS OF PHOTOSYNTHESIS IN SOYBEAN

The aim of this study was to increase the current understanding of the physiological, biochemical and ultra structural basis for the limitation of photosynthesis by dark chilling in soybean genotypes. The photosynthetic response to dark chilling in the presence or absence of root chilling was also compared. The impact of dark chilling on ultra structure and key reactions of photosynthesis was assessed in two soybean genotypes, 'Maple Arrow' and 'Fiskeby V'. Both these genotypes are regarded as chilling tolerant (albeit differentially tolerant). These genotypes were subjected to three nights of dark chilling followed by exposure to high light intensities. Half of the plants were subjected to whole plant chilling, while the other half were only shoot-chilled.

Non-intrusive analysis conducted to assess the physiological and biochemical impact of dark chilling included photosynthetic gas exchange measurements. Intrusive analysis included ultra structural and anatomical studies, measurement of the activities of key enzymes involved in photosynthesis and Western Blot analysis. Novel evidence is provided for the existence of an inverse relationship between loss of FBPase activity and loss of photosynthetic capacity in the two chilling tolerant soybean genotypes. The results presented suggest that 'Maple Arrow' is capable of "sensing" dark chilling stress much better than 'Fiskeby V'. The comparative investigation regarding the effects of dark chilling, in the presence or absence of root chilling, suggests that whole-plant dark chilling caused a greater decrease in photosynthetic capacity than shoot chilling alone.

In conclusion, the results presented strongly suggest a more dark chilling tolerant physiological and biochemical make-up in 'Maple Arrow' compared to 'Fiskeby V'. However, this effect was only visible in whole plant chilling. When roots remained at higher temperatures during chilling, the differential chilling sensitivity between the genotypes were not revealed, suggesting that 'Fiskeby V' is more sensitive to root chilling than 'Maple Arrow'.

Progress in terms of time frames

WE were able to complete all aspects of the research we have proposed and were funded for by the PRF and OPDT. All three our M.Sc. students completed their studies successfully. The data we have produced are even more than we have envisaged.

Main highlights from research undertaken during 2002

1. We have obtained new knowledge of the effect of dark chilling on the primary photochemistry of soybean, especially with regard to the inhibition/disengagement of the oxygen evolving complex (OEC). This information has been reported nationally (SAAB) and internationally (FESPP Congress, Crete, Greece, Sept. 2002). This data is presently being prepared for publication.

2. We have established the JIP-test as a sensitive indicator of dark chilling stress in soybean genotypes. As a consequence, we are currently using this technique to screen

30 South African soybean genotypes for dark chilling tolerance under controlled conditions (OPDT funded project: 2003-2005).

3. It was discovered that dark chilling appears to disrupt the internal time-keeping mechanisms in soybean that is required for the diurnal regulation of carbon metabolism. This disruption might be one of the main reasons for the difference in chilling tolerance between soybean genotypes.

4. The difference in chilling tolerance between genotypes is most prominent during whole plant chilling. When the roots are kept at normal temperatures during chilling, the differential chilling sensitivity between genotypes are often abolished, suggesting that certain genotypes are more sensitive to root chilling than others. This finding implicates the need for careful genotype selection, especially in areas that experience sub-optimal root zone temperatures.

5. Three M.Sc. students have successfully completed their studies. One of them will be awarded the degree *cum laude*. The degrees will be officially awarded at the graduation ceremony of the PU for CHE on the 15th of May 2003.

6. Three publications have appeared in 2002/2003 and two more are in press to appear in 2003. Eight papers have been presented (6 national and 2 international) at conferences.