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Inhibition of photosystem II activities in soybean (*Glycine max*) genotypes differing in chilling sensitivity

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ABSTRACT

Due to chilling sensitivity, minimum night temperatures represent the main constraint in soybean production in South Africa. In vivo quantification of photosystem II (PSII) function by direct chlorophyll fluorescence revealed that dark chilling (8°) inhibited PSII function in the extreme chill sensitive genotype, Java 29 (JAs) mainly by deactivating reaction centers and inhibiting the conversion of excitation energy to electron transport and electron transfer from reduced plastoquinone to the PSI end electron acceptors. Further analysis of the normalized fast fluorescence transients, revealed that in JAs, upon dark chilling, disengagement of the oxygen evolution complex (ΔV_K band) occurred which coincided with a concomitant decrease in O_2 evolution measured in vitro. The chilling resistant Maple Arrow (MAr), though one night cold stress lead to a decrease in fluorescence emission at 2 ms ($-\Delta V_J$ band) indicating a decrease in the Q_A^- concentration due to cold-induced slow-down of electron donation from P_{680}, however showed clear signs of recovery after the second and third cold nights. The moderate chill sensitive genotype, Fiskeby V (FBm) responded in a fashion intermediate to above-mentioned extremes. A second experiment showed that in JAs the inhibitory effect increased with increasing time of exposure to light following dark chilling. Our data demonstrated that significant differences exist in the cold tolerance of different soybean genotypes: (a) In respect to activity criteria, expressed by the quantum yields for primary photochemistry $\varphi_{Po} = TR_o/ABS$, for electron transport from photosystem II to photosystem I as $\varphi_{Eo} = ET_o/ABS$ and the efficiency, $\varphi_{Ro} = RE_o/ABS$, to reduce the end electron acceptors of photosystem I up to NADP; (b) In respect to stability criteria, dependent on structure and conformation, such as the capability of energetic cooperativity (grouping) among photosynthetic units quantified by the grouping probability for exciton movements within the energetically connected group of entire photosynthetic units. Therefore analyzing the O-J-I-P fluorescence transient according to the JIP-test offers a practical and sensitive in vivo screening test for dark chilling tolerance in soybean.