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SIMULTANEOUS MEASUREMENTS OF PHOTOSYNTHESIS AND CHLOROPHYLL A FLUORESCENCE IN NS SUNFLOWER GENOTYPES (Helianthus annuus L.)

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Crop yield depends on photosynthetic efficiency and the extent of photosnthetic area. Photosynthetic efficiency can be estimated either at the level of plant or at the level of photochemical apparatus. Photosynthetic capacity of each leaf depends on leaf and its maximum rate of photosynthesis (English et al., 1979). By estimating these parameters in the course of plant development it is possible to deduce which leaves are particulary important in certain phases of plant development, especially in phases of seed development.

It has been shown that photosynthetic rate varies with both leaf age and position on the plant (Rawson and Constable, 1980; English et al., 1979). As chlorophyll fluorescence yield is complementary to photosynthetic O_2 evolution variations in chlorophyll fluorescence yield with leaf age and position on the plant can be expected. There are two components that are involved in fluorescence quenching: "photochemical" component (q_Q) and "nonphotochemical" component (q_E). The first one represents the decreasing of fluorescence yield by photochemical mechanisms, and the second one represents the decreasing of fluorescence yield by the energetic status of the leaf. By the use of Modulated Fluorescence System with pulses of saturating light it is possible to distinguish the contribution of these two components, which are influenced by CO_2 assimilation (Schreiber et al. 1986).

We have investigated three NS sunflower genotypes: hybrid NS-H-43 and its parental lines OCMS-22 and RHA-SNRF, during their ontogenesis. Photosynthetic O_2 evolution and chlorophyll fluorescence by leaf discs were simultaneously measured at 25°C, at saturating CO_2 in gas-phase polarographic O_2 electrode system. Light response curves were measured after 3-4 cycles of reillumination, by the application of partially computerized procedure as described by D.A.Walker (1987). Thus quantum yield (efficiency of photosynthetic apparaturs) and maximum rates of photosynthesis, under saturating CO_2 and saturating light, were determined. Responses of photosynthesis to photon flux density changed but quantum yield did not change as leaves of the studied genotypes expanded and aged. These results are in agreement with results of Rawson and Constable (1980). Figure 1. shows leaf area and maximum rates of photosynthesis at different leaf positions on plant in 4 phases: flower bud, first and last anthesis and seed filling. In the stage of flower bud maximum rates of photosynthesis follow the leaf area profile. The leaf which is near to its own maximum area has the highest maximum rate of photosynthesis. (In later stages upper leaves, which are then mature, ecquire the highest maximum rates of photosynthesis too). It has also been shown that these leaves are also responsible for supplying most of the photosynthate required by the developing seed (McWilliam et al., 1974). Although the hybrid did not always have the highest maximum rates of photosynthesis, it had the highest photosynthetic capacity among the examined genotypes.

Differences in chlorophyll fluorescence quenching between different leaf positions in two phases (flower bud and last anthesis) are shown in Figure 2. The same pattern can be observed for all genotypes: older leaves which do not grow rapidly (leaf area is near the maximum) have faster fluorescence quenching. The younger leaves have a slower fluorescence quenching.

Further analysis of q_Q and q_E components of fluorescence quenching should show possible differences among the genotypes.

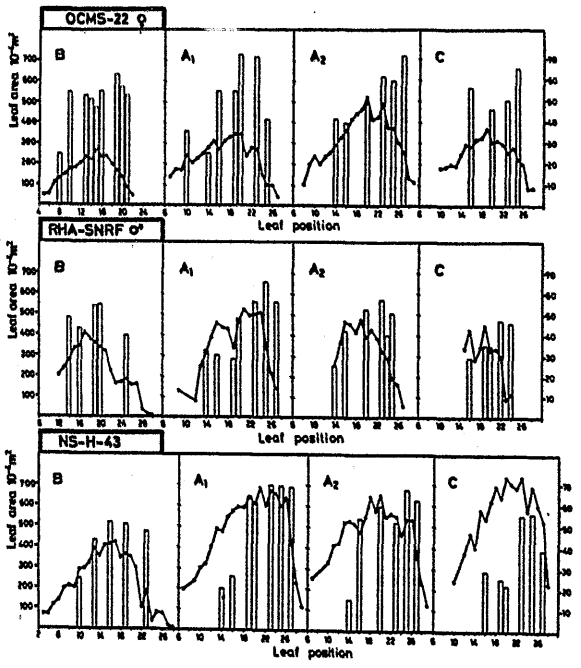

Fig. 1 Leaf area profile and values for maximum rates of photosynthesis O_2 evolution at indicated leaf positions on the stem of sunflower plants (NS-H-43, RHA-SNRF, OCMS-22) in the stage of flower bud (B), first anthesis (A_1), last anthesis (A_2) and seed filling (C).

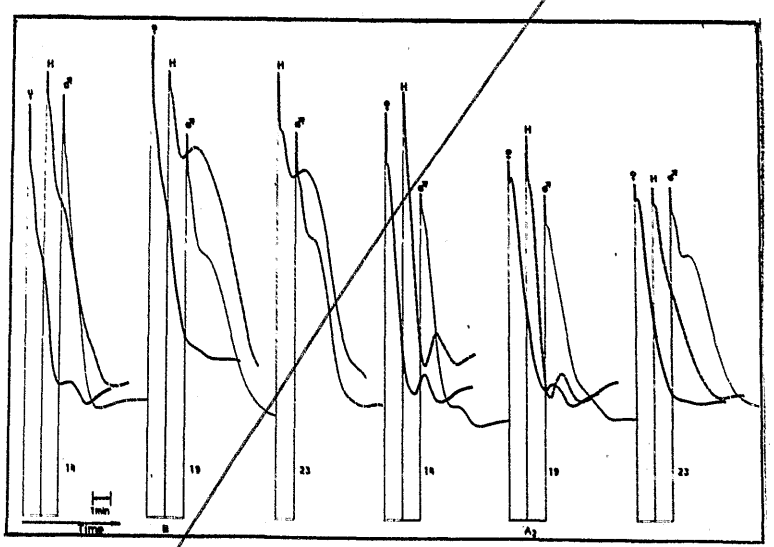

Fig. 2 Chlorophyll fluorescence yield for indicated leaf position in the phase of flower bud (B) and last anthesis (A_2) for hybrid NS-H-43 (H) and parental lines OCMS-22 (♀) and RHA-SNRF (♂).

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