CYTOPLASMIC EFFECTS ON PHOTOSYNTHESIS AND CHLOROPHYLL CONTENT

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Abstract

Chloroplasts, which contain their own circular DNA genome, are the organelles responsible for photosynthesis. Through evolutionary divergence different *Gossypium* species differ in their chloroplast genome and possibly in photosynthetic rate. Transfer of exotic cytoplasms containing these divergent chloroplast genomes into the cotton nuclear background could affect photosynthetic efficacy. This study was conducted to test this hypothesis.

Cytoplasms from A_2, B_1, C_1, $D_{2\text{-}2}$, $D_{3\text{-}d}$, D_8, E_1, F_1, AD_1, AD_3, AD_4 and AD_5 were transferred into cotton (*G. barbadense* L.) by repeatedly backcrossing with 57-4 and Sev7 (with virescent leaves) as the recurrent parents. The alloplasmic lines with the different cytoplasms on 57-4 and/or Sev7 backgrounds and the two recurrent parents were tested in consecutive years during 1996-1998. Each experiment was arranged in a randomized complete block design with three replications in which each plot was a single 50 ft row. Seeds were planted in the greenhouse in late April or early May and transplanted into the field ca one month later. Normal production practices were followed. During the boll-filling stage (from late July to mid-August), the fourth main-stem leaf from the top of 1-2 diploid plants per replication was sampled with a Licor-6200 portable photosynthesis system to measure net photosynthetic rate, stomatal conductance and transpiration rate. Measurements were taken on four dates in 1996 and two dates each in 1997 and 1998. On each date the measurements were conducted and completed between 10:00-12:00am during sunny days. The chlorophyll content was determined only in mid-August, 1998. Fourth main-stem leaves were selected from which to take 2 leaf disks per leaf with a total of 6 disks per plot. Chlorophyll in each of the leaf disk plot samples was extracted with 10 ml of 80% acetone at $4^{O}C$ for 24 to 72 hrs. The chlorophyll contents of the extracts were determined by absorbency at 663nm and 645nm measured on a spectrophotometer. All data were subjected to analysis of variance, and the means of the traits from the alloplasmic lines were compared with their recurrent parents as the standards.

In the normal green-leaf background (57-4), cytoplasms from A, B, C, D, E and other AD genome species had no significant effect on leaf chlorophyll a, b content and their ratio. However, in the virescent background (Sev7), cytoplasms from A_2, B_1, D_8 and F_1 significantly increased chlorophyll a, b, content and reduced the chlorophyll a/b ratio. In the normal green-leaf background, exotic cytoplasms increased net photosynthetic rate, and this was correlated with increased stomatal conductance. Exotic cytoplasms also consistently increased water transpiration rate in the normal green-leaf background. The A_2, B_1 and F_1 cytoplasms in the virescent background, consistently increased net photosynthetic rate and stomatal conductance, while water transpiration rate remained unchanged. Most exotic cytoplasms tended to increase dark respiration rate, but additional tests are needed for verification.

Through breeding, photosynthetic efficacy possibly can be improved via introduction of exotic cytoplasms into cultivated tetraploid cotton. Although only small differences exist among the cytoplasms of the tetraploid species (AD_1 to AD_5), utilization of other tetraploids will increase the cytoplasmic diversity of the cultivated cottons and reduce vulnerability to biotic and abiotic stress conditions. We have found that some exotic cytoplasms increase chlorophyll content due to the interaction between the specific cytoplasms and the specific *G. barbadense* background (virescent leaves, v7v7). The results should be tested in other of the several known virescent genes. These alloplasmic lines provide a promising system to study the mechanisms of cytoplasmic-nuclear interactions at the biochemical and molecular level.

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