Genetic Variability in Carbon Fixation, Sucrose-P-Synthase and ADP Glucose Pyrophosphorylase in Maize Plants of Differing Growth Rate

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ABSTRACT

The net photosynthetic rate and the activities of ribulose 1,5 bisphosphate carboxylase (RubisCo), phosphoenolpyruvate carboxylase, sucrose-P-synthase, and ADP glucose-pyrophosphorylase, key enzymes of the leaf carbohydrate metabolism were compared in eight maize (Zea mays L.) genotypes presenting large differences in growth rate. The sucrose-P-synthase activity varied in the ratio 1 to 3 from the less active to the more active genotype and this variation was highly correlated with those in growth rate. ADPglucose pyrophosphorylase activity was not significantly different from one genotype to another whatever the basis for expression, leaf area, or soluble protein. The photosynthetic rate at June-August was significantly correlated with the fourth leaf earliness index. In the present paper, we have examined the possible biochemical basis of these differences. Four key regulatory-enzymes were considered: RubisCo1 and PEPcase for carbon fixation, SPS and ADPG-PPase for sucrose and starch synthesis, respectively. RubisCo is often thought to be limiting photosynthesis in vivo because of its low specific activity (12). PEPcase in maize was recently reported to be better correlated with photosynthetic rate than RubisCo (2). ADPG-PPase is the main regulatory point on the starch synthesis pathway (14). SPS activity is apparently just sufficient to account for the in vivo rate of sucrose synthesis. Interspecific variation in SPS has been observed and activity was shown to be inversely

0032-0889/89/0416/05/$01.00/0

Received for publication May 13, 1988
and in revised form August 25, 1988
growth rate was determined and correlated with the enzyme activity measured on the same plants. From one experiment to another the ranking of the genotypes was rather similar; however, some interchanges occurred in the more rapidly growing genotypes.
Fig. 3.

Figure 3 shows the growth rate of maize leaves (expressed as area per leaf disc) at 25°C. The data is plotted against several variables, with the growth rate (RUBISCO QUANTITY) and sucrose-P-SYTHASE activity (SUCROSE-P-SYTHASE) being the main variables of interest. The correlation coefficients (r) for these variables are 0.65 and 0.82, respectively, indicating a strong positive correlation.

The graph on the left illustrates the relationship between RUBISCO QUANTITY and the growth rate, with points indicating the values for different genotypes. The graph on the right shows the relationship between sucrose-P-SYTHASE activity and the growth rate, again with points indicating the values for the same genotypes.

The results suggest that higher RUBISCO QUANTITY and sucrose-P-SYTHASE activity are associated with faster growth rates, as evidenced by the positive correlation coefficients.
genotypes were grown at 1 month interval, F7 × F2 being in common so that it could be used as internal standard. Good repeatability was noted for this genotype (cf. points 7 and 7' Fig. 5). The magnitude of variations in SPS and growth rate
reported a high correlation between RubisCo or PEPcase activities and CO₂ assimilation in maize leaves of different ages. A correlation was also observed with dry matter accumulation but PEPcase paralleled more tightly biomass than RubisCo in maize seedling grown with different nitrate levels (21) or in senescing source-leaves during kernel growth (2). The presently observed variation in RubisCo is of the same magnitude as that in net photosynthesis but the higher intra-genotype variability tends to obscure the correlation with growth rate. PEPcase activity varied similarly but the corre-

c of leaf sucrose phosphate synthase. Z Pflanzenphysiol 102: 443–450