Relationship Between Internal CO_2 and Respiration in Selected Beta vulgaris L. Genotypes*

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INTRODUCTION

The relationship between internal CO_2 and respiration rates (evolved CO_2) is documented in fruits (Ben-Yehoshua et al. 1963, Blanpied 1975, Eaks 1980, Fidler and North 1971, Kidd and West 1949, Lyons et al. 1962, Marei and Crane 1971, William and Patterson 1962) and in sugarbeet (*Beta vulgaris* L.) roots (Cole 1980, Cole and Bugbee 1976, Wyse and Dilley 1973). Theurer et al. (1978) concluded that stroage losses of sucrose in sugarbeet roots could be reduced by selecting for low post-harvest respiration. Previous studies (Cole 1980, Cole and Bugbee 1976) suggested that low respiring genotypes could be selected by measuring internal CO_2 levels of individual sugarbeet roots. Cole (1980) demonstrated that internal CO_2 could be increased or decreased by selection, but did not show that internal CO_2 and respiration rate were associated in progeny of selected genotypes.

The objectives were to determine the relationship between internal CO_2 and respiration rates in progeny of selected genotypes of sugarbeets during the growing season and after post-harvest storage.

MATERIALS AND METHODS

Two sugarbeet genotypes were grown at Fargo, ND, on a fine-textured clay soil. The low internal CO_2 genotypes was F 1003 (Cole 1983). The high internal CO_2 genotype was a selection from FC 31068 (a synthetic population of five Rhizoctonia resistant lines). Seed were planted May 19, 1983, in a randomized complete block design of four-row-wide plots with three replications. Sub-plots were

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sampling dates (Sept. 9, Sept. 23, Oct. 12, Nov. 12, Dec. 12). Eighteen roots were manually harvested on each sampling date from a 3.6 m long section of the two center rows. The roots (18/plot) for the last two sampling dates were harvested on Oct. 12 and stored at 5 C for later analysis. Leaves were removed by trimming at the base of the petiole with a knife. Roots were washed and weighed.

After each harvest during the growing season, the roots from a plot were divided into three groups of six. The three groups were stored at 5, 10 and 15 C, respectively, for 3 to 4 days. Respiration rates and internal CO_2 were measured on individual roots at each temperature as previously described (Cole 1980). After 30 and 60 days storage at 5 C, subsamples (n = 6) of roots from the Oct. 12 harvest were transferred from 5 C to 10 and 15 C (one group left at 5 C) for 5 days prior to measuring respiration and internal CO_2.

Respiration and internal CO_2 were expressed relative to the high genotype at 15 C for each sampling date and averaged over the 5 sampling dates. Linear regression models between respiration rate and internal CO_2 were calculated for the high and low genotypes over all sampling dates and temperatures (n = 15).

RESULTS AND DISCUSSION

The low and high internal CO_2 genotypes differed significantly for both respiration and internal CO_2 at all sampling dates and temperatues (Figure 1). Both parameters were increased by increasing temperatures. The genotype x temperature interaction for respiration was non-significant for the fresh sugarbeets, but it was significant for sugarbeet roots stored for 30 and 60 days. The genotype x temperature interaction for internal CO_2 was significant at all sampling dates.

The highest rate of respiration and internal CO_2 was observed in sugarbeet roots stored for 60 days at 5 C prior to measurement at 15 C. Roots stored for 30 or 60 days at 5 C exhibited larger increases in respiration and internal CO_2 at 10 and 15 C compared to fresh sugarbeet

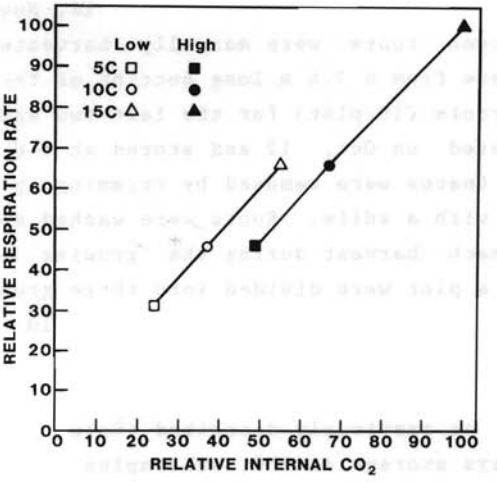

Figure 1. Relative respiration rate and internal CO_2 of sugarbeet roots averaged over 3 sampling dates during the growing seasons and 2 post-harvest sampling dates. Each data point represents 90 individual roots.

roots. The correlation coefficient (r) between respiration rate and internal CO_2 averaged over all sampling dates and temperatures was 0.90**.

The slopes of the linear regression models were equal; however, the intercepts were significantly different, which may indicate differences in diffusion resistance or premeability of the periderm tissue. Coefficients of determination of 0.83 and 0.81 were observed for the high and low internal CO_2 genotypes, respectively.

In another study, Cole (1983) showed that genotypes with low or higher levels of internal CO_2 could be identified under field conditions. The data reported in the present study indicate that respiration rates and internal CO_2 are significantly correlated in the progeny of parents selected for internal CO_2. Selection for internal CO_2 is a reliable and rapid method for identifying low or high respiring genotypes of sugarbeet roots. Selection can be made during the growing season or during post-harvest storage. The method may be reliable

in other species where internal CO_2 can be evaluated.

SUMMARY

Significant differences in internal CO_2 and respiration rate were observed between progeny of each genotype at all temperatures and sampling dates. A correlation coefficient of $r = 0.90^{**}$ ($n = 30$) was observed between respiration rate and internal CO_2 averaged over all sampling dates and temperatures. Linear regression analysis of the relationship between internal CO_2 and respiration rates for each genotype indicated that the slopes of the lines were equal and that the intercepts were significantly different. Selection for internal CO_2 is a reliable and rapid method for identifying low or high respiring genotypes of sugarbeet roots. Selection can be made during the growing season or during post-harvest storage.

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