FUGATE, KAREN KLOTZ* and ABBAS M. LAFTA, USDA-ARS, Northern Crop Science Laboratory, 1307 - 18th Street North, Fargo, ND 58105. **What controls respiration rate in stored sugarbeet roots?**

ABSTRACT

Respiration is the process in which plants degrade stored compounds to generate metabolic energy. For stored sugarbeet roots, respiration is essential to sustain life, maintain healthy tissues, and heal wounds incurred during harvest and piling. Respiration, however, occurs at the expense of sucrose and is estimated to be responsible for 60 to 80% of the sucrose lost during storage. In plants, respiration is regulated by the availability of respiratory substrates, cellular energy status, or total respiratory capacity. It is unknown, however, which of these mechanisms regulate respiration rate in stored sugarbeet roots.

Research conducted to date suggests that postharvest sugarbeet respiration is not regulated by total respiratory capacity or cellular energy status. No relationship between respiration rate, respiratory capacity (due to the combined capacity of the terminal oxidases of the electron transport pathway), and cellular energy status (measured as ATP concentration or the ratio of ATP to ADP concentrations) was found in roots whose respiration rate was altered by abiotic stress. In addition, determination of tissue respiration rates in response to potential effectors of respiration demonstrated that respiratory capacity was 2.4-fold greater than that utilized by respiring root tissues and that respiration rate did not increase when respiration was uncoupled from energy production.

Evidence indicating a lack of respiratory control by total respiratory capacity or cellular energy status suggests that sugarbeet root respiration is regulated by the availability of respiratory substrates. Respiratory substrates in sugarbeet root are synthesized from sucrose by the action of sucrose-degrading enzymes and the enzymes of glycolysis, the oxidative pentose phosphate pathway and the tricarboxylic acid cycle. To identify possible restrictions in these pathways that may limit the availability of respiratory substrates, the concentrations of compounds that are substrates, intermediates or cofactors of these pathways were determined in stored roots and in harvested roots whose respiration was altered by abiotic stresses. Sucrose, glucose, fructose, citrate, succinate and malate were abundant in stored roots. The high concentrations of these compounds suggest that they are unlikely to be limiting. Compounds present at low concentrations included the phosphorylated sugars of glycolysis, α-ketoglutarate and fumarate of the TCA cycle, and the energy-related compounds, ATP, ADP, NAD^+ and NADH. Alterations in respiration rate in response to injury were associated with changes in many of the substrates, intermediates and cofactors of the respiratory metabolic pathway. Concentration changes, however, were greatest for the early glycolytic intermediates including fructose, fructose 6-phosphate, glucose 6-phosphate, fructose 1,6-diphosphate, and the triose phosphates, dihydroxyacetone phosphate and glyceraldehyde 3-phosphate, and the TCA cycle intermediates, citrate, α-ketoglutarate, and succinate.