SOIL TEMPERATURE AND SOIL AERATION EFFECTS ON PROTEIN AND FREE AMINO ACID CONCENTRATIONS IN WHEAT GRAIN*

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SUMMARY

The root environment of wheat (*Triticum aestivum* L. em Thell) plants was modified with soil temperature and soil aeration treatments for 30 days during the grain filling stage to evaluate the effects of soil temperature and aeration treatments on the protein and free amino acids in the milk and mature stages of wheat grain.

The sum of the protein amino acids in the milk stage grain from plants grown at the 5°C soil temperature was significantly lower than that found in the seeds from plants grown at the 15°C soil temperature, but was not significantly different from the sum found in the seeds of plants grown at the 25°C temperature. Differential soil temperatures did not affect the free amino acids in the milk stage grain. The sums of protein and free amino acids in the mature grain were significantly higher in plants grown at the 25°C soil temperature than at 5 and 15°C. Free methionine only was lower in the grain from plants grown at the 25°C temperature than that found in the grain from plants grown at 5 and 15°C.

The soil aeration treatments had no significant influence on amino acids in the milk stage or mature grain. There were, however, several significant interactions between soil temperature and soil aeration on the individual protein and the sum of protein amino acid concentrations in the milk stage grain. At the 25°C soil temperature the protein proline and the sum of protein amino acids increased as soil aeration decreased. At 15°C soil temperature, the concentrations of protein proline and the sum of protein amino acids in the grain were increased with an increase in soil aeration.

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INTRODUCTION

Nitrate is the primary form of nitrogen absorbed by plant roots. The absorption and translocation of nitrogen in plants is affected by environmental soil temperature and oxygen supply. Utilization of nitrogen by higher plants requires that it be reduced before combining with keto-acids, then metabolically converted to various amino acids, and finally linked to form proteins. These various steps in the formation of amines, amides, and amino acids represent the main pool of nitrogenous compounds in plants.

Considerable interest has developed during the past decade in the relationship of soil environment and amounts of amino acids in plants. Guinn found that chilling roots of cotton (Gossypium hirsutum L.) seedlings at 10°C increased water- and acid-soluble nitrogen, but decreased nucleic acids. Rasmaev, working with wheat (Triticum aestivum L. em Thell) and corn (Zea mays L.), showed that protein decreased while the soluble nitrogen increased in plants sensitive to chilling. A study by Guinn and Brinkerhoff showed that poor root aeration increased alanine, serine, gamma-aminobutyric acid, glutamic acid, and glutamine contents in the roots and xylem sap in cotton. Studies on radish (Raphanus sativus L.) and turnip (Brassica rapa L.) leaves showed that near anaerobic soil conditions increased amounts of gamma-aminobutyric acid. Labanauskas and Handy reported that leaves from macadamia (Macadamia tetraphylla L.) plants grown in poorly aerated water culture solutions contained lower concentrations of total (free and protein) threonine, methionine, leucine, tyrosine, and phenylalanine than leaves from plants grown in well aerated sand cultures. In citrus (Citrus sinensis L.) seedlings, Labanauskas et al. found that leaves from plants supplied with low levels of soil oxygen contained significantly less of the protein amino acids: lysine, histidine, aspartic acid, threonine, serine, glutamic acid, glycine, alanine, valine, isoleucine, leucine, tyrosine, and phenylalanine – but more arginine – than analogous leaves of plants supplied with normal soil oxygen. Fulton et al. showed that flooding tomato (Lycopersicon esculentum L.) roots rapidly inhibited normal metabolic functions in all plant parts, but the most pronounced was the Krebs' citric acid cycle in roots. A unique feature of the flooded plant roots was their accumulation of gamma-aminobutyric acid. Lieberman and