Temperature and Its Interaction With Light and Moisture in Nitrogen Metabolism of Corn (Zea mays L.) Seedlings

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GROWTH of plants is a function of the rate of their metabolic processes. An important effect of temperature on plants is associated with biochemical functions. Plant responses to temperature have long been studied but only limited information is available on relationships between temperature and nitrogen metabolism.

Many plants accumulate nitrate to levels toxic to animals under certain conditions. The accumulation has been associated with many environmental factors including moisture stress, high temperatures, and reduced light intensity. From an ecological standpoint, it is difficult to separate effects of such individual factors. Therefore, a study of possible interactions of these factors in their physiological effects is important in understanding the physiological ecology of the corn plant.

This investigation was conducted to obtain information on effects of temperature and its interaction with moisture stress and light intensity on nitrogen metabolism of corn seedlings.

REVIEW OF LITERATURE

Hanway and Englehorn (9) found that corn accumulated nitrate under drought conditions unless the soil was extremely low in available nitrogen and that nitrate accumulation occurred in highly fertile soil even when moisture conditions were favorable. Mattas and Pauli (13) showed that accumulation of nitrate in corn seedlings under artificial drought conditions was associated with reduced nitrate reductase activity. Hageman and co-workers (7, 8) reported that reduced light intensity caused nitrate accumulation and reduced nitrate reductase activity in corn seedlings and plants.

Burr (4) found that increases in air temperature caused decreases in total nitrogen of leaves of sugar cane at any of three different soil temperatures. He noted that these effects of temperature contributed to the difficulty of setting exact values for tissue diagnosis of sugar cane nutrition.

Steward et al. (19) concluded that night temperature and its interaction with photoperiod were important in determining the quantity and composition of soluble nitrogen of the mint plant. Effects of temperature during growth of Tulipa gesneriana were found to produce noticeable differences in the free amino acid composition of the leaves and these effects of temperature were not due to differences in stage of maturity of plants growing at different temperatures (6). Decreasing night temperature from 65° to 50° F. caused a slight increase in alcohol-soluble nitrogen free amino acids of strawberry plants grown at 70° F. (12). Dickson and Lords (5) detected a temperature influence on the soluble leaf protein of an inbred line of corn.

Ritenour and Huffaker (17) reported that nitrate reductase activity decreased with age when 1-week-old grown barley seedlings were allowed to grow dark at 25° C., but activity of the enzyme at 2 weeks of age when the seedlings were placed in the dark.

Molybdenum is known to be the metal constituent of nitrate reductase (14). However, only minimal amounts of molybdenum are required by plants. Johnson et al. (10), for example, found that tops of corn plants grown for 8 weeks on a molybdenum-deficient soil contained 0.07 ppm of molybdenum (on dry weight basis) and yet showed no evidence of molybdenum deficiency. There was no increase in growth or change in appearance when molybdenum was added to 1 ppm, although the addition increased molybdenum concentration in tops to 1.03 ppm.

EXPERIMENTAL PROCEDURE

Three experiments were conducted to evaluate temperature, temperature X moisture, and temperature X photoperiod interactions, respectively. Seedlings of a double-cross inbred line K1859 [(WF9 X N6) (K148 X K150)], were grown in plastic pots in small growth chambers. Pots were filled with a mixture of bentonite and micromulite and nutrients were supplied by water containing strength Hoagland No. 1 solution. The number of plants varied from 4 to 8, depending upon the experiment intensity of 1500 ft.-c. (0.92 Langley) and a photoperiod of 16 hours were used except for a part of the temperature experiment.

Tops of 4 seedlings taken at random from 4 pots were used to obtain 1 sample. Four samples were analyzed and duplicate determinations, whenever run on each sample. Averages of the duplicates were used for statistical analyses of the data in a randomized design. Seedlings were sampled always at the same time and were obtained on all samples immediately after cutting tops. Weight samples were dried for 24 hours in an oven at 70° C. and weighed. Dry matter contents of samples were used to calculate nitrogen fractions and total nitrogen. A preparation containing three nitrogen fractions according to soluble nitrogen, insoluble nitrogen, soluble protein nitrogen, and nonprotein nitrogen was used in the preparation of the standard for the analyses.