IMPORTANCE OF CARBOHYDRATES IN SUMMER SURVIVAL OF MERION AND NUGGET KENTUCKY BLUEGRASS

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Growth of cool season turfgrasses is often inhibited during midsummer by supraoptimal temperatures, or those temperatures above the optimum for growth. During this period turfgrass stress is increased due to excessive wear and lack of water which can often lead to a deterioration of turfgrass quality. In intensively managed areas, improving irrigation practices such as syringing, can assist in turf grass survival. But this is not always feasible on extensive areas such as golf fairways, roadsides and parklands.

To assist in the development of new cultivars for these situations it is necessary to understand the mechanism of high temperature growth inhibition. Several theories have been proposed, the most widely accepted involves the rapid utilization of energy (carbohydrates) at these high temperatures, resulting in an energy level too low to support growth (11). A more recent theory has suggested that the exhaustion of carbohydrate reserves does not limit growth, but rather growth is the major sink for the soluble carbohydrate, and that its concentration is inversely related to growth. Supraoptimal air temperatures have resulted in higher carbohydrate levels both in the roots (4) and shoots (6) than would normally occur at optimum temperatures.

Further, the perception site that induces high temperature injury has yet to be determined. Some have speculated it may be in the crown region (7, 8), others the roots (3) or the shoots (10). In turfgrasses it is known that supraoptimal soil temperatures can retard growth to a much greater extent than air temperatures (5). Such temperatures are known to influence carbohydrate levels (9) and amide and protein changes (2).

This investigation was designed to study the effects of controlled soil temperature on the dry weight and carbohydrate levels in the shoots, crowns and roots of a heat tolerant (Nugget) and a heat susceptible (Merion) Kentucky bluegrass. The soil temperature was controlled at 22 C by placing the pots containing the cultivars into a modified freezer unit (1), which in turn was placed into a walk-in growth chamber. In this way, air temperatures could be varied from 22 to 38 C (equal to 70-100 F) in 4 C increments while soil temperatures would remain constant. In an adjacent investigation soil temperatures were allowed to equilibrate with the air temperatures within the chamber.

Results indicated that in both cultivars, shoot growth declined when temperatures were above the optima for growth (26 C in this investigation), but at the higher temperatures of 34 and 38 C, this decline in shoot growth was reduced if soil temperatures were cooled. Nugget survived the heat stress better than Merion as measured by a larger ratio verdure (living green tissue) to thatch (dead brown tissue).

Analysis of turfgrass parts for water soluble carbohydrates showed that at cool soil temperatures, shoot carbohydrates levels did not fluctuate by increasing the air temperature. At the warmer soil temperatures, Merion exhibited very low shoot carbohydrates during peak growth, but at supraoptimal temperatures, high shoot levels and very low root levels were measured. Nugget maintained high carbohydrate levels throughout the 10 week period. This emphasized the importance of choosing a cultivar and cultural practises which allow for moderate rather than rapid spring shoot growth as this appears to be important in summer survival.

This study suggests that the root may perceive the supraoptimal temperature and eventually cause a decline in shoot growth. In those cultivars where shoot carbohydrates are depleted at periods of maximum growth, root carbohydrates may be translocated to the shoots. The loss of these carbohydrates may be involved in the perception of supraoptimal temperatures.

BIBLIOGRAPHY

1. Aldous, D. E. and J. E. Kaufmann. 1977. Method of soil temperature control for turfgrass research. Agron. J. Jan-Feb (accepted for publication).

2. Beard, J. B. and W. H. Daniel. 1966. Relationship of creeping bentgrass (Agrostis palustris Huds) root growth to environmental factors in the field. Agron. J. 58:337-339.

3. Cole, F. D. and P. L. Steponkus. 1968. Some effects of high temperature on plant growth. Plant Physiol. Abstr. p. 43.

4. Davidson, R. L. 1969. Effects of edaphic factors on the soil carbohydrate content of roots of Lolium perenne and Trifolium repens L. Ann. Bot. 33:579-589.

5. Ketellapper, D. J. 1960. The effect of soil temperature on the growth of Phalaris tuberosa L. Physiol. Plant. 13:641-647.

6. Martin, D. P. 1972. The influence of temperature, cultural factors, and analytical techniques on carbohydrate levels in turfgrasses. Ph.D. Thesis. M.S.U. pp. 1-89.

7. Matsushima, S., T. Tanaka, and T. Hoshino. 1966. Analysis of yield determining process and its application to yield-prediction and culture improvement of lowland rice. IXXV. Temperature effects on tillering in case of leaves and culm, culm-bases, and roots being independently treated. Proc. of Crop Soc. Japan 75:479-483.

8. Peacock, J. M. 1975. Temperature and leaf growth in Lolium perenne. II. The site of temperature perception. J. Appl. Ecol. 12:115-123.

9. Seitz, G. L. 1974. Effects of soil temperatures gradient in growth and carbohydrate nutrient levels in three warm season grasses. Proc. of Flor. Turfgrass Manag. Conf. Vol. XXII. pp. 114-114.

10. Voldeng, H. D. and G. E. Blackman. 1973. The influence of seasonal changes in solar radiation and air temperature on the growth in the early vegetative phase of Zea mays. Ann. Bot. 37:553-563.

11. Younger, V. B. and F. T. Nudge. 1968. Growth and carbohydrate storage of three Poa pratensis L. strains as influenced by temperature. Crop Sci. i:455-457.