Continuing . . .

THE ECOLOGY OF NITROGEN ACTIVITY IN TURF SOILS

by

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Wilting and Nitrogen

Wilting injury or death of bentgrass is often a problem during warm, sunny days. Wilt is caused by a combination of factors—soil, climatic, and morphological and physiological condition of plants. Nitrogen has direct and indirect effects on wilting. Thatch encourages wilting in three ways : (1) shallow roots; (2) poor moisture infiltration; and (3) the inhibited gaseous exchange (consequent carbon dioxide gas accumulation) causes protoplasm to resist water intake; hence, plants wilt more rapidly.

Liberal nitrogen fertilisation influences the physiology and morphology of plants to encourage wilting in four ways. (1) Root to top ratios and root depths are reduced. (2) Fast growing leaves with high nitrogen fertilisation are thin walled and high in water content. These combined effects encourage water loss and make grasses vulnerable to wilting. (3) Temperatures of liberally nitrogen fertilised grasses may be increased because the darker green leaves absorb more heat and also because of higher rates of respiration. Water loss in leaves is positively related to leaf temperatures. (4) Liberal nitrogen decreases the osmotic concentration of cell sap because of lesser mineral uptake, such as potassium, per unit of tissue and lower sugar content. Water is lost faster from leaf cells with sap low in sugars and minerals as compared with higher concentrations.

Now we will look inside the plant to understand the principles just discussed.

Food Reserves and Respiration

The green chlorophyll in grass leaves fixes carbon dioxide into simple sugary substances that are then used for maintaining and forming new roots and tops. Thus plants manufacture energy products (sugars) that are re-utilised for making all other substances and tissues in growth processes. Plants must stay alive at night, during periods of dormancy, under snow, and any time when leaves are not making food. Thus, sugary substances not used for growth are condensed and stored as reserve carbohydrate energy foods. Such reserve carbohydrates are important in many ways : (a) When leaves and shoots are lost due to cold weather, wilting, diseases, insects, or due to heavy verticutting and leaf removal; new ones are made from reserve carbohydrates. (b) When leaves do not make enough food for root and top growth, the stored reserves supply the shortage. (c) New basal grass shoots form much faster with high as compared with low carbohydrate reserves. (d) With a shortage of reserve carbohydrates, the tops have first access to them; thus, a low root-top ratio and

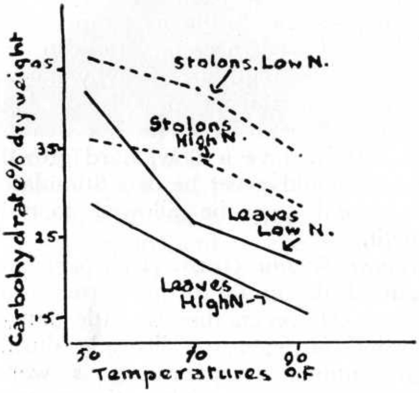

Figure 2.
Reserve carbohydrates in leaves and stolons of Cohansey bentgrass as influenced by temperatures and nitrogen fertilisation.

shallow roots. A simplified list of materials in plants is given below:

Organic Materials—19%
  Soluble carbohydrates
    Simple sugars
    Stored (fructosan or starch)
  Structural Materials
    Protoplasm (N-substances)
Water—80%
Minerals—1%

Fructosan is the main starch-like storage reserve carbohydrate in northern turf-grasses like bluegrass, bentgrass, and others. Fructosan accumulates in grasses in the stubble, underground in roots and rhizomes and also in leaves. Alternately it breaks down into simple sugar for growth and is stored again. The amount of fructosan reserves in grass tissue is influenced drastically by closeness of clipping (leaf removal), available nitrogen in soils and by the temperature (season of application). The combined effects of very close clipping, and high soil nitrogen during the hot summer season would cause very low frustosan reserves.

	Fructosan reserves in grass tissue	
Influencing factors	*Low*	*High*
1. Closeness of clipping	Very close	Lax
2. Available nitrogen	High	Low
3. Temperature (season of application)	Very warm	Cool

Data are now available to point out these inter-relationships. In our laboratories, Cohansey bentgrass was grown at temperatures of 50°, 70°, and 90° F. with low and high nitrogen, Figure 2. The stubble stems (stolons) were higher in carbohydrate reserves than the leaves. Note that stolons and leaves grown with low nitrogen were much higher in carbohydrate than those with high nitrogen. There was a drastic drop in carbohydrate in all tissue as temperatures were increased from 50 to 90° F. The lowest carbohydrate occurred with high nitrogen and high temperature; on the other hand the highest carbohydrates occurred with the lowest temperatures and low nitrogen. The carbohydrate content was much higher than would occur on a putting green because the grasses were not clipped for several weeks.

Liberal nitrogen fertilisation stimulates respiration (increased release of carbon dioxide and "burning up" food reserves apparently associated with fast growth),

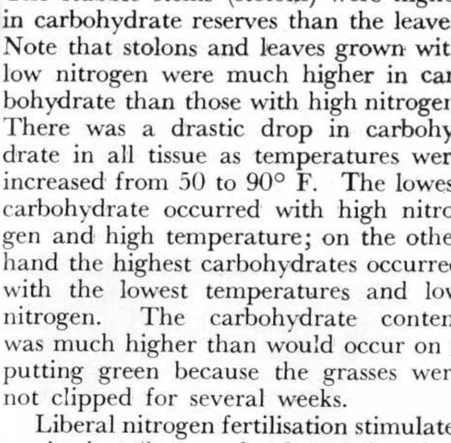

Figure 3.
The respiration rate of Cohansey bentgrass leaves with low and high nitrogen fertiliser at three temperatures. The rate of photosynthesis, carbon dioxide fixed is also with low nitrogen fertilisation is also given.

Figure 3. The highest rate of respiration occurred with the highest temperature and high available nitrogen. Thus, during high temperatures, liberal nitrogen fertilisation reduces food reserves due to fast growth and high respiration. Here reserve foods are made into protein-like compounds and plant tissue, especially top growth. When temperatures are too low for grass to grow

rapidly, high nitrogen does not stimulate respiration and food reserves remain high.

Figure 3 also shows that carbon dioxide fixation (rate of making sugary substances) increased as temperatures were raised from 50° to 70° F.; there was a rapid drop in food fixation with temperatures. Because food is fixed at a low rate and respiration is high during high summer temperatures, nitrogen should be applied at low rates during the summer for cool season grasses.

A summary on some of the effects of nitrogen on grass growth is given in Figure 4.

Timing Nitrogen Applications

Cool season grasses (bent, blue, and others) should have liberal amounts of

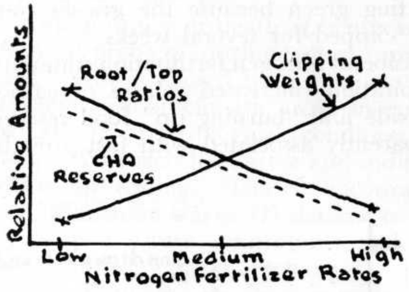

Figure 4.
The influence of nitrogen fertiliser on yield of clippings, root/top ratios and carbohydrate reserves of grass.

available soil nitrogen during the cool spring and late summer season. This is the season when such grasses are best adapted and make most of their growth. There is little danger of applying too much nitrogen in late summer as growth and respiration will be inhibited as temperatures keep getting cooler. Thus, carbohydrate reserves build up during autumn even with liberal nitrogen. Available soil nitrogen should be decreasing in late spring as temperatures get higher. It is necessary to keep cool season grasses slightly to heavily starved for nitrogen during periods of high summer temperature. With hot weather it is best to have a slow, hard growth. Grasses should never be over stimulated nor should they be allowed to stop growth.

Warm Season Grass: The principles discussed also apply to the warm season grasses. However, there is little danger in using nitrogen too liberally during high summer temperatures as warm season grasses have high optimum temperatures for growth. Warm season grasses do not usually have adverse respiration effects at high temperatures and photosynthesis is efficient at high temperatures. Thus, food reserves remain high at usual summer temperatures.

Nitrogen fertilisation should not be excessive during late summer when growth of warm season grasses is slowed up because of low temperatures. Over stimulated and actively growing non-hardy grasses are injured readily by rapid temperature declines. Likewise, excess nitrogen fertilisation and competition from overseeded winter grasses can seriously retard bermudagrass regrowth.

Nitrogen fertiliser is a most important mineral nutrient for growth control of turf.