BASIC CONCEPTS OF LATE-SEASON NITROGEN FERTILIZATION

Dr. Anthony J. Koski
The Ohio State University
Department of Agronomy
Columbus, Ohio USA

Late-season nitrogen fertilization, sometimes referred to as late-fall fertilization, has been utilized by turf managers for years. This type of fertility program involves the application of much of the season's nitrogen during the late season months of August through December (dependent on location). It is important that late-season fertilization NOT be confused with dormant (or winter) fertilization. The latter method implies that fertilizer applications are made after the turf has lost most or all of its green color during late fall or winter and is not actively-growing. This differs notably from the late-season concept, which requires that nitrogen be applied before the turf loses its green color in the late fall.

Late-season fertilization has become popular because many of the agronomic and aesthetic advantages attributed to its use supposedly are not realized when spring and/or summer fertilization is practiced. Purported advantages of the late-season concept include: better fall and winter color, earlier spring green-up, increased shoot density, improved fall, winter, and spring root growth, and enhanced storage of energy reserves (carbohydrates) within the turf plant. Some claimed disadvantages include: increased chance of snow mold injury and decreased cold tolerance.

Effects on Turf Quality

Turf fertilized in September and again during October, November, or December generally has better fall and winter color than a turf which was not fertilized at that time. In addition, signs of spring green-up often are apparent two to six weeks earlier if the turf has been fertilized during the previous fall. Most importantly, the enhanced rate of spring greening is realized without stimulating excessive shoot growth that accompanies the early-spring N applications called for in some turf fertility programs. The winter color of turf fertilized only during the previous spring and summer months is decidedly inferior to that turf which also receives nitrogen fertilizer during the fall. The rate of spring green-up of grasss that has not been fertilized the previous fall is often slow, with acceptable color being attained only after N is applied during March or April. Turf color may then become equal to that of turf which received late-season nitrogen applications, but the excessive shoot growth which accompanies spring fertilization is undesirable.

At Ohio State we have found the spring color of late-season-fertilized turf to remain quite good until late May or early June, when the effects of N applied the previous fall began to "wear off". A 0.75-1 lb./1000 ft.^{2} (0.4-0.5 kg/100 m.^{2}) application of N is recommended at this time (late May-June) to maintain an acceptable level of turf quality throughout the summer period. In Canada, the spring application might be made (depending on location) anywhere from mid-May to mid-June.

It is important to remember that the N source used for the fall applications be of the type that is not dependent on microbial activity to effect nitrogen release. This means that fertilizers containing urea, sulfer-coated urea (SCU), IBDU, shorter-chain methylene ureas, and ammonium sulfate are ideal N sources for the late season applications. Although SCU and IBDU are referred to as controlled-release fertilizers, the rate at which nitrogen is released from thse fertilizers is mainly dependent upon soil moisture level and not on the degree of microbial activity. The use of microbially-dependent N sources for late-season N applications may not elicit the desired fall/winter color response because they do not provide enough available N for plant uptake when temperatures are low. However, these slow-release N sources would be ideal for spring and summer use. Examples of these would be natural organic N sources and fertilizers consisting predominantly of longer-chain methylene ureas (i.e., low in cold-water soluble N).

Research at Ohio State, however, has revealed no noticeable stimulation of fall or winter root growth in response to late season nitrogen applications. The true advantage that late-season fertilization provides to turfgrass root growth is realized during the following spring. Apparently, the root growth of turf fertilized during late-winter/early-spring declines soon after N application. Conversely, turf fertilized using the late-season concept becomes green early and rapidly, without the need for an early-spring N application, and root growth continues at a maximum rate. It appears that the excessive shoot growth encouraged by early-spring N applications utilizes carbohydrates that may otherwise be used by growing roots. Thus, late-season nitrogen fertilization does not actually *stimulate* root growth. It simply allows spring root production to occur at a maximum rate, without being interrupted by the negative effects of early-spring nitrogen applications.

Disease and Winter Injury

There have been claims made that late-season fertilization reduces turfgrass cold hardiness and may increase the risk of winter damage by the snow mold diseases. However, researchers in Ohio, Virginia, and

Rhode Island reported that neither probllem occurred in their respective studies. Nevertheless, both types of injury could potentially occur if high rates (more than 2 lbs. N per 1000 ft.^{2}; 1 kg/100 m.^{2}) of a quickly-available N source are used at one application date and/or applictions are not timed properly.

Why Timing is Important

For the late-season concept to work successfully, it is essential that the turf be green when the late (October or November) N application is made. In central Ohio, this means that 0.75 - 1.0 lb. N/1000 ft.^{2} (0.4-0.5 kg/100 m.^{2}) of quickly-available N (such as urea) should be applied during the latter half of September. This will ensure that the grass will remain green late into the fall when the other application will be made. It is also important, however, that excessive shoot growth not be encouraged by over-application of N during September. The production of lush, succulent growth may decrease cold tolerance and increase the incidence of the snow mold diseases during the winter and following spring. For the same reasons, the late (October/November) application should be delayed if an extended period of unusually warm weather (average daily temperature greater than 50°F; 10°C) is being experienced, or is forecast to occur in the near future.

Trying the Program

The accompanying table illustrates, for three Canadian cities, nitrogen fertilization programs which emphasize the late-season concept. Note that these are suggested programs which those superintendents interested in (but unfamiliar with) late-season fertilization may begin experimenting with. The suggested application timings are based on timings developed through research performed in Columbus, Ohio, USA and adapted to reflect monthly differences in temperature between Ohio and the indicated Canadian cities. As with any new or unfamiliar turfgrass management practice, evaluate it carefully on a small scale basis as a beginning point. Evaluate it under different conditions (different timings, various N sources, on fairways, tees, and greens, etc.) and over 2-3 years to determine its effectiveness/potential benefits as compared to your current fertilization program. Confer with fellow turf managers, consultants, or university personnel who may be familiar with the practice in your area and could offer suggestions on its implementation.

Effects on Carbohydrate Relations

Plant carbohydrate levels during early fall do not appear to be greatly affected by timing of nitrogen application. From December to February, however, the carbohydrate content of late-season-fertilized turf may be slightly lower than that of turf fertilized only during the spring and summer. Regardless of the timing of nitrogen application, carbohydrates are accumulated by the slowly-growing turf plant during the fall and winter months, reaching a peak sometime during the December-February period.

The early-spring (March-April) carbohydrate content of turfgrass plants fertilized the previous fall is often higher than that those of plants which did not receive late-season N. The ability to store energy at this time is a result of the earlier greening realized through the use of late-season N fertilization. Photosynthesis occurs in the slowly-growing, late-season-fertilized turfgrass plant, thus allowing it to accumulate carbohydrates.

As root and shoot activity and plant respiration rates increase during the late winter and early spring, plant carbohydrate content generally decreases. This decline may be quite significant when the turf receives an early-season (February-April) nitrogen application, as compared to grass that has not been fertilized since the previous fall. The rapid decline occurs because carbohydrates are needed to support the increased shoot growth resulting from N appli-

Suggestions For Establishing a Late-Season N Fertility Program

	City / Timing		
Application	Calgary	Quebec	Toronto
Spring (1 lb. N/1000 ft.^{2}) (0.5 kg. N/100 m^2)	mid-June	early-June	late-May
Late Summer (1 lb. N/1000 ft.^{2}) (0.5 kg. N/100 m^2)	early/mid-August	mid-August	early/mid September
Fall (1-2 lbs. N/1000 ft.^{2}) (0.5-1.0 kg. N/100 m^2)	early/mid-October	early/mid-October	early-November

cations made early in the season. Conversely, the more slowly-growing, late-season-fertilized turfgrass plants may possess a larger carbohydrate pool during the spring period. As will be discussed later, the process of spring root production can benefit from this greater concentration of carbohydrates.

Another possible advantage resulting from late-season fertilization is that the levels of stored carbohydrates are higher than those found in spring-fertilized turf as summer approaches. The higher levels of carbohydrates are desirable at this time of year since greater stress tolerance and/or increased ability to recover from pest-, traffic-, or stress-induced damage may be realized.

Effects on Root Growth

For years, researchers have claimed that fall and winter root growth of cool-season turfgrass species should be stimulated by late-season and/or winter nitrogen applications. It had been hypothesized that this would occur as fall temperatures declined to the point where root growth is favored over shoot growth. Researchers have shown that root growth of cool-season turfgrass species does indeed occur during the fall after shoot growth has slowed or ceased. This situation develops because roots grow qyite well when soil temperatures are between 40 and 65°F (4-18°C), while shoot growth is favored when temperatures exceed 55°F (13°C). In fact, some root growth will occur as long as the soil remains unfrozen.

DROUGHT STRESSED TURF IN SOUTHERN ONTARIO

Turf and plants in general are normally stressed during the hot, dry months of July and August, however, as we write this report, Ontario lawns, athletic turf and golf courses have suffered unprecedented high temperatures with minimal rainfall since May 22nd. Recent rainfall has alleviated the situation but we are not out of the woods yet since hot, droughty periods can still occur.

Turf managers should rationalize their approach to providing fields for fall activities, those with irrigation systems will be able to cope. What do those with severe water restrictions such as the Waterloo region, or no irrigation, do?

Fortunately most grass species in lawns are capable of withstanding drought by going dormant until adequate rainfall, shorter days and cool nights arrive. This capability for many turf managers can be a plus, in that annual bluegrass common in turf cannot survive such severe drought conditions and will not easily compete with other grasses at this time.

The general approach would be to boost growth in time with ideal growth conditions, i.e. apply a slow release fertilizer of a 3-1-3 or 4-1-4 ratio at .75 kg (1.5 lb) per 100m^2 (1000 ft.^{2}) in mid-August to early September.

There has been speculation that many fields will have to be resodded; we feel that this is not necessarily so, waiting until regrowth appears would be the wiser policy at the moment. No doubt sod will thin out in areas oriented towards the hot afternoon sun (west), on steep slopes and berms and on gravels or thin topsoils.

Observation indicates that turf under shade trees did not suffer as much as that in open stands which means that heat stress was more of a problem than soil moisture deficiency. For instance, Creeping Red Fescue, normally considered a drought-tolerant grass suffered considerably from heat stress. Another side effect will be the proliferation of crab grass due to thinning out of turf swards.

To produce acceptable playing surfaces, turf managers should consider a low cost program of overseeding, a technique which has been used on the University of Guelph athletic fields since 1981. The program involves slit seeding mixtures of the turf type perennial ryes and/or with Kentucky Bluegrasses during the last two weeks of August.

Seeding should be done in two different directions for adequate coverage; one can also aerate or verticut and apply seed with a spinner type spreader.

Depending upon the type of overseeding mixtures used, rates of seeding will vary from 2.5 kg (5.0 lb.) to 3.5 kg (8.0 lb.) per 100 m^2 (1000 ft.^{2}). Ryegrasses should be applied at the higher rates and those mixtures containing Kentucky Bluegrass at the lower.

These timely techniques plus a winterizer application of nigrogen at .5 kg (1.0 lb) actual N per 100 m^2 (1000 ft.^{2}) in late fall should carry our athletic turf in fine shape through the coming winter.

Norman McCollum
Pat Tucker
Guelph Turfgrass Institute