Late-Season Nitrogen Fertilization: What We Do and Do Not Know

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LATE-SEASON NITROGEN FERTILIZATION

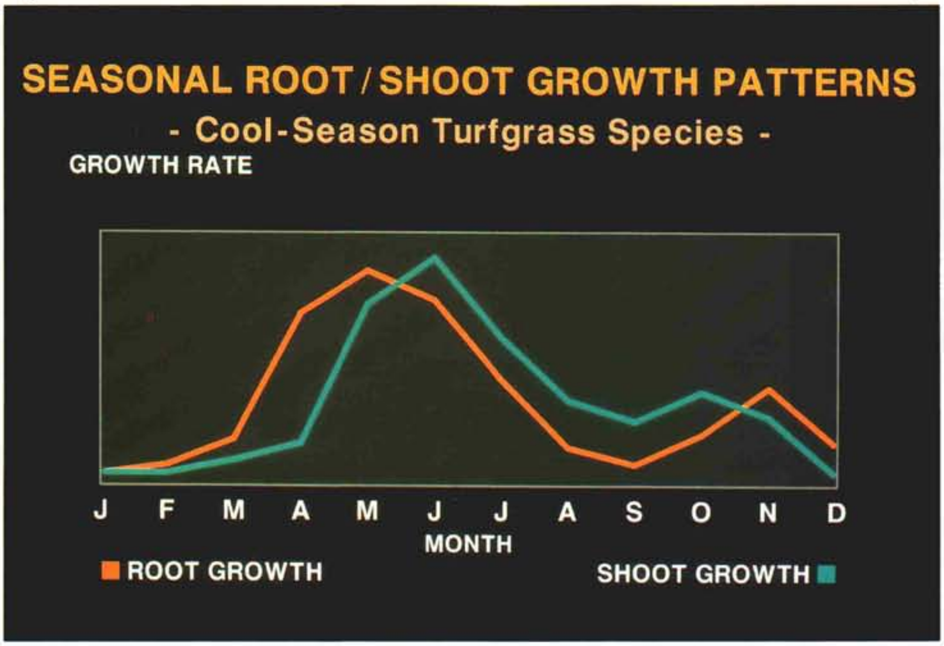
- Program recommendations* -

Timing	N Application Rate (lbs. N / 1000 sq. ft.)	Recommended N Sources
late March-April	1/2 - 3/4	IBDU, SCU, short-chain methylene ureas
late May-mid June	3/4 - 1	IBDU, methylene ureas, natural organics
late August-September	1	IBDU, methylene ureas, urea, SCU
late October-December	1-2	urea, IBDU, short-chain methylene ureas, SCU, ammonia sulfate

* For Kentucky bluegrass in Midwest & North-central U.S.

Figure 1.

Figure 2.



LATE-SEASON fertilization (LSF) of cool-season turfgrasses has been discussed often in recent years. This practice, sometimes referred to as fall fertilization, implies most nitrogen is applied from August through December. Many superintendents have long appreciated the advantages of using this fertilization philosophy in the management of roughs, fairways, tees, and possibly even greens. They have recognized the positive effects of LSF on some aspects of turf quality, including better fall and winter color, increased turf density, and enhanced spring green-up rate. These desirable effects generally can be experienced without noticeably increasing shoot growth during the fall or winter. Additionally, LSF can reduce the dependence on early spring applications (which often stimulate excessive shoot growth) to enhance the rate and degree of spring green-up.

For all of the talk about LSF, relatively little university research has been conducted on this subject. One purpose of this article is to discuss briefly what has been revealed about late-season fertilization from a research perspective, and to point to areas where further research should be directed. A second purpose is to define the how to's, when to's, and why's of late-season fertilization for those superintendents who are unfamiliar with the practice and wish to experiment with it, possibly with the intent of integrating it into their overall fertilization programs.

SINCE the early 1960s, research conducted at universities in Virginia, Rhode Island, Illinois, Michigan, Minnesota, and Ohio has provided substantial evidence to support the positive effects of LSF on turf quality. In order to achieve maximum benefits with regard to late-season color and early spring greening, follow a program similar to that outlined in Figure 1.

The program is most effective if it is begun with the August-September application of nitrogen described in that table. Proper fertilization at this time is important, because it greens up the turf following the stressful summer period, and prepares it to receive the late fall (October-December) application. It is important that the turf be green but not actively growing when this late fall application is made. The August-September application assures this. Proper timing of the late N application results in at least part of that N being taken up by the plant to enhance fall/winter color. It is not certain whether any N absorbed by the turf plant at this time plays a part in the enhanced greening the following spring, or if some of that N remains in the soil over the winter and becomes absorbed by roots during late winter/early spring. This uncertainty has important implications with regard to winter N leaching, especially on sandy soils, unfrozen soils, or in areas with high winter precipitation.

The March-April application is necessary only if 1) no late-season N applications were made the previous year, or 2) late-season N applied the previous year has not provided the desired rate/degree of spring greening. Late-season fertilization may produce poor results if N applications are not timed properly, or if rapid or unexpected changes in temperature and/or moisture occur during the fall or winter. Proper timing and normal temperatures and moisture are especially important to those nitrogen sources highly dependent on temperature and/or moisture to effect N release.

Research at Ohio State University has shown that fertilizer sources containing higher percentages of quickly available N may be somewhat easier to use for the late fall treatment in the LSF program. One reason is that the quickly available N source can cause a rapid greening response (seven days), thus widening the window during which these fertilizer sources can be used successfully. The temperature- or moisture-dependent N sources may require as much as two to three weeks lead time to generate the same degree of greening as a quick-release source. An unexpected or rapid decrease in temperature or moisture availability may reduce N release from these sources at a crucial point in the program. Secondly, a general dependence upon adequate moisture to trigger N release from certain fertilizer sources may limit their use to irrigated areas of the golf course. The fertilizer source used may even dictate how far into the fall the irrigation system must remain operational.

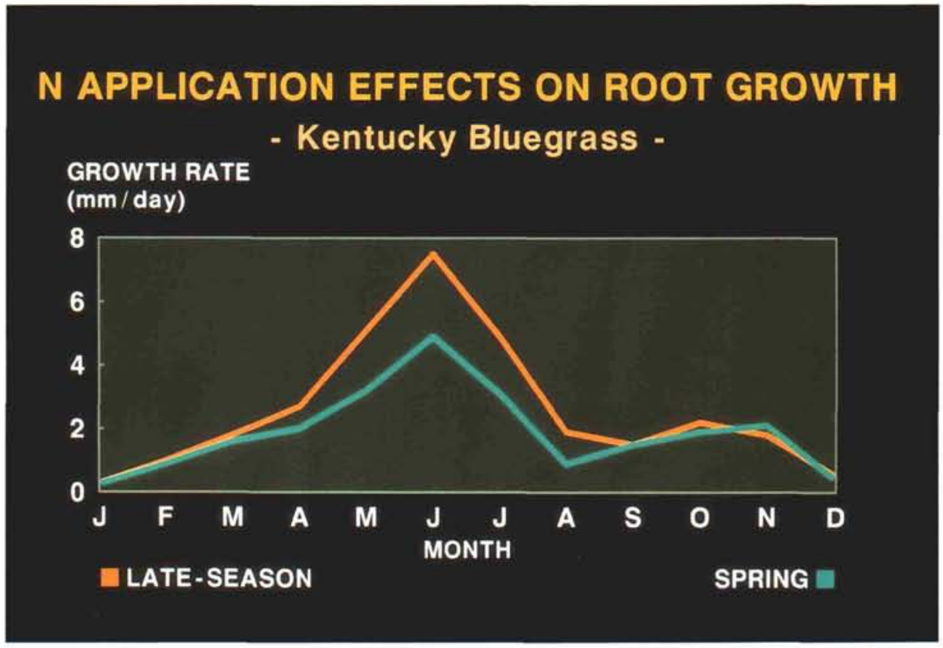
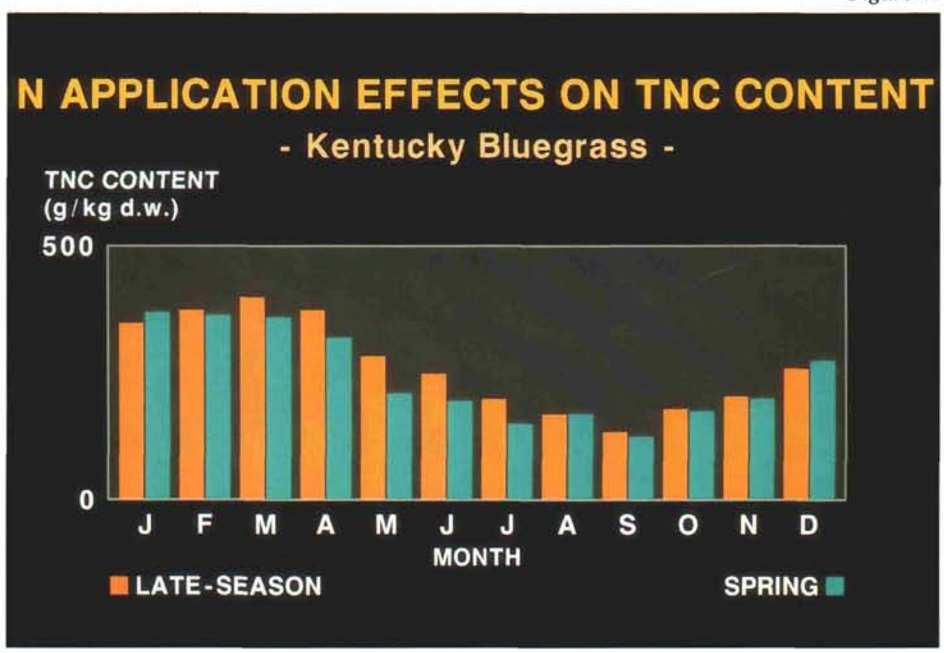


Figure 3.

Figure 4.



The May-June application is necessary to maintain adequate quality during the summer. The positive effects of N applied the previous fall begin to wear off at this time.

It is important to recognize that optimal N application dates will vary with location in the country. For example, the proper timing for the spring application in Ohio is from mid to late May, while in Michigan, Wisconsin, or Minnesota it might be in mid to late June. Similarly, Ohio locations may receive N in early to mid September and again in early to mid November. In the more northern states, these application dates may translate into August and mid to late October, respectively. Consideration must also be given to the type of N source for each application.

IT HAS LONG been hypothesized that LSF would promote fall/winter root growth because it occurs during the fall and winter at temperatures below which shoots are inactive (Figure 2). Nitrogen fertilization during the fall or winter, it was reasoned, would stimulate root growth without affecting shoot growth.

Research at Ohio State, however, has detected no such stimulation of late-season root growth by LSF (Figure 3). Root growth benefits significantly during the spring with LSF. This benefit is derived from the fact that spring greening takes place without requiring stimulation from early spring N applications. Nitrogen applied during March and/or April appears to depress root growth. This probably occurs because N-stimulated shoot activity (growth and respiration) effectively outcompetes growing roots for energy produced and stored in the plant in the form of carbohydrates (Figure 4). Thus, LSF does not actually stimulate winter or spring root growth, but instead allows spring root production to occur at a maximum by forgoing the dependence on spring fertilization to promote spring green-up.

Although LSF may slightly lower the total non-structural carbohydrate (TNC) levels during fall and early winter, the enhancement of winter color and earlier spring greening allow the plant to accumulate more carbohydrate (via photosynthesis) than turfgrass plants that are not under an LSF program. This small but detectable surplus in TNC is carried into the summer. It has not been proven that the higher TNC content confers any advantage to turfgrass plants managed using LSF, but it certainly cannot be considered disadvantageous, either.

For many years it has been suggested that LSF would lower a turfgrass plant's resistance to low-temperature injury. The previously mentioned decrease in fall/winter TNC content with LSF was considered to support this contention, since concentration of carbohydrate in plants during the hardening-off process is considered of importance in conferring resistance to low-temperature injury. However, there is little research evidence to support this contention where LSF is properly implemented.

Similarly, there is little evidence to suggest that LSF increases the occurrence of cold-weather diseases, such as the snow molds. In fact, published findings from Minnesota, Virginia, and Rhode Island indicate that LSF may even *reduce* the incidence and/or severity of some winter diseases, and may help heal turf damaged by disease.

Low-temperature injury and disease may become problems where LSF is not practiced properly, either as a result of

Figure 5. LSF study on perennial ryegrass at Ohio State showing response to 41-0-0 and SCU (left) compared to unfertilized check plots (right) at 30 days after application of 2 lbs. N/1000 sq. ft.

over-application of N, or where applications are not timed to allow for natural hardening-off. Recent (November) observations of an LSF study at Ohio State on mixed bentgrass/*Poa annua* putting green turf showed that *Poa annua* in plots fertilized in September and/or October continued to grow and remain succulent. At the same time, the bentgrass in those plots retained excellent color, and appeared to harden-off and cease growing. This would suggest that the effects of LSF on resistance to low-temperature injury and disease incidence may pose more of a concern on annual bluegrass turf. It is difficult to find information regarding the effects of LSF on annual bluegrass. This deficiency points to just one area where knowledge of certain aspects of late-season fertilization is lacking, and research should be pursued.

A number of other questions remain unanswered regarding the response of some of the cool-season turfgrass species and cultivars to late-season fertilization. Late-season fertilization studies currently under way at Ohio State are evaluating the effects of various N sources, N rates, and application timings on the quality of tall fescue, perennial ryegrass (Figure 5), and putting green height creeping bentgrass (Figure 6). Other research should examine the relationship between LSF and the quality of Kentucky bluegrass cultivars. The cultivars of this species tend to vary greatly in fall/winter color and rate of spring greening.

As new fertilizer technologies are developed, the suitability of these products for use in LSF programming must be evaluated. Another project recently initiated at Ohio State on Kentucky bluegrass is comparing new and experimental fertilizers to some of the standard N sources. These fertilizers should be evaluated for their ability to perform well in situations where water from either irrigation or precipitation is limited or unpredictable in availability.

While university research and the practical experiences of professional turfgrass managers both have revealed the advantages of late-season fertilization, it is obvious many questions remain about this concept. While continued research is important, it is just as essential to encourage the exchange of results, ideas, and concerns between researchers and superintendents. These exchanges will help stimulate productive investigations by the university researcher. They will also allow superintendents to refine LSF programs already in use, and better inform superintendents interested in incorporating the LSF concept into their current turf management programs.

Figure 6. LSF study on putting-green-height creeping bentgrass at Ohio State.