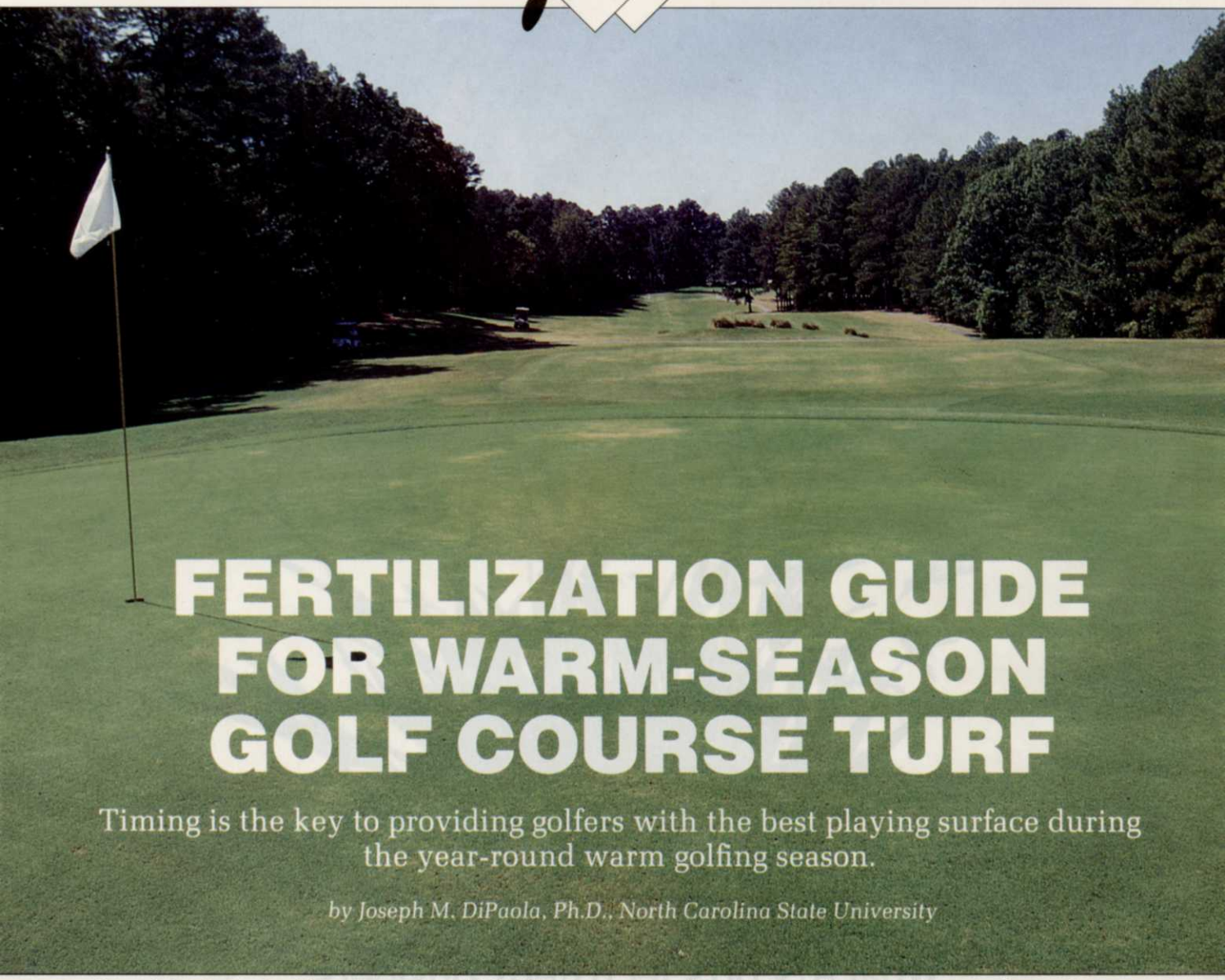

FERTILIZATION GUIDE FOR WARM-SEASON GOLF COURSE TURF

Timing is the key to providing golfers with the best playing surface during the year-round warm golfing season.

by Joseph M. DiPaola, Ph.D., North Carolina State University

Superintendents should implement a solid fertilization program in order to maintain good green color on the course.

As summer draws to a close and the cooler weather of fall approaches, golf course superintendents look forward to some annual activities like aerification, winter overseeding, lime applications, renovation and fertilization.

While fulfilling these management procedures, superintendents must also contend with the usual increase in the play of the course, including tournament events. Keys to playable turf are:

- balancing a fertility program to ensure adequate growth to withstand the wear of increased play;
- minimizing the very real risk of winter injury from excess fertilization of warm-season turf; and
- encouraging the germination and development of winter overseeded grasses with fertilization, which can also increase Bermudagrass growth and thus its competition with cool-season overseedings.

The difference between success and failure often depends on a superintendent's timing of agronomic practices, particularly in relation to environmental conditions.

A good beginning point for planning a late-summer and fall fertility program is to review nutrient and soil pH status record. It is also advisable to double-check the area of the greens, tees and fairways. Inaccurate judge of their size, which has a tendency to change over time, can result in significant over- or under-applications of nutrients. Soil sample collection at this time also avoids delays in receiving laboratory results typically experienced in the spring.

After adequate soil phosphorus, potassium and pH levels have been attained, greens should be sampled annually, tees every one to two years and fairways every two to three years.

Minimizing winter injury

Centipedegrass, bahiagrass and St.

Augustinegrass have only poor to moderate resistance to cold damage; Bermudagrass has intermediate cold tolerance; zoysiagrass is the most low-temperature hardy of the warm-season turfgrasses. Advantageously, Bermudagrass and zoysiagrass have deep rhizomes which typically avoid exposure to low temperature because of their below-ground location. Warm-season turfgrasses without these underground lateral stems cannot fully benefit from protective insulation offered by the soil.

A healthy turf tolerates more types of stresses. Fertilizing under-nourished turf before stress exposure will typically enhance performance. However, once an adequate nitrogen level has been established, undesirable turf responses to additional fertilization are likely. Nitrogen, phosphorus and potassium fertility ratios of 3-1-2 or 4-1-2 should be sought; however, a specific application may need to vary, to compensate for actual soil nutrient levels.

Unlike cool-season grasses, increasing nitrogen fertilization during the fall increases the risk of winter injury to warm-season turf. Nitrogen applications to warm-season turfgrasses at or above 1 lb. N/1000 sq. ft. after October promote leaf development from the crown when the metabolism of this structure should be hardening.

This new flush of growth has resulted in turf winter injury by increasing the temperature at which the turf is injured during the winter. However, like cool-season grasses, fall nitrogen applications will prolong the fall color retention and speed the turf's spring greenup.

Many fertilizer sources including sulfur-coated ureas, ureaformaldehyde reaction products, IBDU, etc., have yet to be evaluated for their impact on winter injury of warm-season turf following fall applications.

Potassium deficiency can result in a weak stand of turf because this nutrient is critical for maximization of cold hardiness, disease resistance and drought tolerance of the turf. Adequate levels of potassium encourage the development of a deep and extensive root system.

Winter injury is a problem for all warm-season turfgrasses, but is of particular concern for northern regions of the transition zone of turf adaptation. Maximizing winter survival will minimize weed infestation and reduce the turf's spring renovation requirements. Potassium applications at 1-2 lbs./1000 sq. ft. have enhanced cold hardiness, but do not alter fall color retention. Late summer potassium applications will increase the availability of this nutrient at the beginning of the hardening process.

While phosphorus applications have not been found to influence the cold hardiness of warm-season turfgrasses, a high P-to-K ratio has been observed to increase the winterkill of centipedegrass. This response demonstrates that the balance between nitrogen, phosphorus and potassium is important for turf quality and winter survival.

Cold hardiness following fall nitrogen fertilization can be enhanced by including phosphorus and potassium.

Foliar application of iron has been used to improve turf color without the shoot growth stimulation that follows nitrogen fertilization. This color enhancement can occur even in the absence of iron deficiency symptoms (eg. interveinally chlorotic younger leaves). Iron salts (eg. ferrous sulfate) and chelated sources (eg. Agri-Plex, Extra-Iron, Ferriplex 138, Rayplex, Sequestrene 330) are typically applied at 2-8 lbs. of elemental iron per acre (0.75 to 2 oz. of iron per 1000 sq. ft.).

Iron salts are usually a less expensive treatment. Exercise care however, when applying iron near sidewalks, cartpaths, markers or other objects to avoid staining. Washing immediately after application will minimize staining.

Nitrogen fertilizer applications to warm-season greens, tees and fairways should be gradually diminished at about 60 days prior to the first normal frost. The fertilization requirement of greens exceeds that of tees and that of tees exceeds that of fairways, largely because of the increased demand for greater recuperative rate, clipping removal, more intensive irrigation and sandy soil profiles.

Overseeded turf requires fertilizer applications from fall through spring if optimum turf quality and color is to be maintained. Fertilization rates generally should not exceed 0.5 lb. N/1000 sq. ft. and be repeated every four weeks. Applications should be delayed until the overseeded cool-season grasses have germinated and have been clipped in order to minimize Bermudagrass competition.

Turfgrass fertilization remains as much an art as a science. Decisions on application rates and sources of nutrient carriers are made based on subjective color assessments by the superintendent, budgets and the club schedule as much as they are on the turf's agronomic requirements. How-

FALL NITROGEN GUIDE FOR WARM-SEASON GOLF TURF

	August	September	October	November	December
	---------- lbs nitrogen/1000 sq. ft. ----------				
Greens	0.75-1.5	0.25-0.5	—	—	—
Hybrid Bermudagrass	0.75-1.25	0.25-0.5	0.25-0.5	0.25-0.5	0.25-0.5
Overseeded Bermuda					
Tees	0.75-1.25	0.25-0.5	—	—	—
Hybrid Bermudagrass	0.5-1.0	0-0.5	—	—	—
Common Bermudagrass	0.5-1.0	0-0.5	—	—	—
Vamont Bermudagrass	0.75-1.0	0.25-0.5	0.25-0.5	0.25-0.5	0.25-0.5
Overseeded Bermuda					
Fairways	0.3-0.5	0-0.3	—	—	—
Hybrid Bermudagrass	0.25-0.3	0-0.25	—	—	—
Common Bermudagrass	0.25-0.3	0-0.25	—	—	—
Vamont Bermudagrass	0.3-0.5	0.25-0.3	0.25-0.3	0.25-0.3	0.25-0.3
Overseeded Bermuda					
Roughs	0-0.3	—	—	—	—
Common Bermudagrass	0-0.25	—	—	—	—
Bahiagrass	0-0.1	—	—	—	—
Centipedegrass					

The higher application rates are suggested for irrigated areas that have clippings removed, particularly for turf on sandy soils. These suggestions are only offered as a guide. Courses located where the first normal frost occurs before or after the first week in October should shift the calendar to the left or right, respectively.

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ever, the many nitrogen fertilizer carriers now available, particularly slow-release sources, have enhanced program flexibility. Fall fertilization programs are largely driven by the need to prepare the warm-season turf for overseeding or for maximum winter survival while dormant.

Southern bentgrass

The growing season for bentgrass greens in the South is shorter than the time between killing frosts. Bentgrass golf greens grow very little during the hot, humid summer months typical of the southern United States. The bentgrass root system will usually become increasingly shallow throughout the summer, so it is critical that root system development be maximized by late-spring.

Supplemental spring applications of potassium at 1 lb. K/1000 sq. ft. can substantially improve bentgrass rooting.

During the course of a year, bentgrass greens may receive between 5-10 lbs. of nitrogen per 1000 sq. ft. depending upon many factors. Newly-constructed greens typically need nitrogen applications at the upper end of this range. Slow-release fertilizers used during the late-summer and fall should not exclusively contain nitrogen sources that need microbial activity for nutrient release (eg. ureaformaldehyde, activated sewage sludge). Declining soil temperatures during the fall and winter will limit nutrient availability from these sources. Also, nutrient release may occur the following summer when the superintendent wishes to minimize nitrogen levels for reason of heat stress and disease.

Late summer and early fall in much of the southern United States can include many very warm days interspersed with cool spells. Superintendents should resist the urge to quickly aerate, top-dress and fertilize bentgrass greens until cool weather is assured. Waiting until soil temperatures have dropped to near 70 degrees F. is a more reliable guide than air temperatures.

Aerating the greens accelerates soil drying which can increase the water stress experienced by bentgrass during late summer.

Fertilizer applications should not accompany top dressing and drag matting at this time of the year. Placing fertilizer salts on bentgrass leaves during late summer—while this turf's root system is most shallow—will further aggravate water stress should warm weather return. So, if tournament schedules and other factors necessitate an earlier-than-desirable aerfication, fertilizer applications should be conducted in a separate operation.

LANDSCAPE *Guide* MANAGEMENT

FERTILIZATION GUIDE FOR COOL-SEASON GOLF COURSE TURF

Golf course superintendents must rely on their powers of observation, and experiment with different fertilization practices.

by David Wehner, Ph.D., University of Illinois

Turfed areas are unique. They must withstand traffic, repeated mowing, attack by disease and insect pests and, at the same time, provide a dense, dark-green covering of the soil surface. One of the most important management practices that helps ensure that the turfgrass plant is able to do its job is proper fertilization.

Because each turfgrass area is different, and each turfgrass manager has a different idea of what is considered acceptable, a single program cannot be written for all areas.

Instead, turfgrass managers should rely on their powers of observation to determine the desired results and experiment with modifications to discover better ways of producing those results.

Nitrogen fertilization

Turfgrasses require 16 elements for adequate plant growth. Of these, nitrogen (N) is supplied by fertilization in the largest quantities, followed by potassium and phosphorus. Nitrogen sources are characterized by their rate of nutrient release.

Water soluble N sources such as urea, ammonium nitrate and ammonium sulfate provide a short, quick response. Slow-release N sources such as ureaformaldehyde, sulfur-coated urea, IBDU and Milorganite will last longer because they are re-

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