TISSUE TESTING: A TOOL FOR TURF FERTILIZATION

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Assessment of Fertility Status

Various methods can be used to assess the fertility status of turf. Visual assessment of turf color and growth can be used to determine the need for some nutrients or the diagnosis of elemental toxicities. For example, nitrogen fertilization rate and timing for turf are typically based on subjective criteria such as visual estimation of turf color, density, and growth. In come cases visual symptoms do not provide the complete answer to a problem. Therefore, it is a good idea to confirm visual observations with more quantitative methods such as soil and tissue testing. Periodic evaluation of the fertility status of a turf using soil and tissue testing may reveal hidden problems and provide a guide for developing fertilizer programs that will prevent nutritional problems.

There are four important components to any soil or tissue testing program:

1) sampling,
2) laboratory analysis,
3) interpretation, and
4) recommendations.

Specific procedures need to be followed to collect and prepare a representative sample for analysis, thus ensuring that results and recommendations will be meaningful. Soil and tissue testing laboratories should be consulted for information on how to properly collect, handle, and ship samples. The procedures of a soil or tissue analysis must be valid, therefore, the choice of a reputable lab is important. Interpretation of laboratory results should be based on available research data and the practical experience of soil and plant scientists. Research that correlates laboratory results with field response data is required for the best interpretation. Unfortunately, very little research has been conducted on turfgrass to provide the information needed for precise interpretation. Recommendations are based on the interpretation of test results. Therefore, recommendations based on research that correlates lab results with field responses will provide the most dependable testing programs.

Tissue Testing

Tissue testing can be used to monitor the nutrient status of turf and relate those levels to the response from fertilizer. Tissue analysis can also be used to diagnose nutrient deficiencies, identify hidden problems, and verify a diagnosis based on visual symptoms.

Plant tissue can be tested by two methods: 1) total analysis of the elemental content of tissue and plant sap, and 2) rapid test of the soluble nutrients in plant sap. The total analysis is more quantitative and the preferred method for precision work, although both methods can produce useful results.

Care should be taken when collecting tissue samples. Leaf blades are usually collected and precautions must be taken to avoid contamination from soil or other foreign matter such as weeds and other debris. Hand clipping is the preferred collection method, however, a thoroughly cleaned mower can be effectively used. Tissue sampling from both good and bad areas can often provide more easily interpreted results than comparisons with standards. Avoid sampling soon after a fertilization or other chemical applications. Clippings should be dried immediately at 60°C before shipping to a lab. One should consult with the testing laboratory to be used, so that any special sample collection, processing, and shipping requirements can be followed.

To interpret tissue test results, some standards should be available. In crop production, critical nutrient levels have been defined as the level below which a yield reduction will occur due to low nutrient availability. For most cases in turf systems, maximum yield is not a useful goal. Critical nutrient levels for turf need to be based on density, color, and other components of turf quality as well as growth.

Research on Nitrogen Tissue Testing of Bentgrass

The development of a more quantitative measurement of the nitrogen status of turfgrasses has received limited study. Objective criteria for determining the nitrogen status of turf during the growing season would likely increase the effectiveness of recommendations for nitrogen fertilization.

Nitrogen present in plant tissue is largely incorporated in protein. Near infrared reflectance spectroscopy (NIRS) can accurately quantify the amount of protein nitrogen present in forages and subsequently can determine total tissue nitrogen concentration. Isaac and Johnson were able to accurately determine the nitrogen content of creeping bentgrass and bermudagrass using a monochromator style NIRS instrument. Near infrared reflectance spectroscopy has also been used successfully to measure the protein content of forage crops. Minimal sample preparation and speed/ease of measurement make NIRS useful in situations where samples need to be processed quickly for turfgrass management decisions.

A significant limitation to the use of tissue analysis for nitrogen status monitoring is that the interpretation of results suffers from limited quantitative nitrogen response data. Fertility response studies for crop production systems benefit from a quantitative harvest index with a readily identifiable goal of maximum yield. Turfgrass systems lack such an easily defined goal since the desired response in fertility studies would be optimum yield, not maximum yield. Optimum yield is more subjective than maximum yield, but could be defined as sufficient growth to tolerate and recovery from various stresses affecting a turf. Dollar spot disease is one stress of turfgrass responsive to the nitrogen fertility status, and thus could be a parameter useful for defining critical or optimal levels of tissue nitrogen content.

The objective of our research was to evaluate the relationship between dollar spot disease severity of creeping bentgrass and clipping nitrogen content as a basis for defining sufficient and deficient levels of nitrogen.

A nitrogen fertility study was initiated on a 'Penncross' creeping bentgrass turf grown on a sandy loam and mowed at 1-cm. Fertility treatments were arranged in a 4 x 2 factorial combination of annual N rate and application interval, respectively. Treatments during 1992 and 1993 included weekly applications of NH_4NO_3 at rates of 3.0, 6.1, 9.2, and 12.2 kg N ha^{-1}, and biweekly applications at rates of 6.1, 12.2, 18.3, and 24.4 kg N ha^{-1}. The two application intervals resulted in cumulative (annual) nitrogen rates of 73, 147, 220, and 293 kg ha^{-1}. Fertilization treatments during each year of the study were initiated in June and the last application was made in October. An unfertilized control was included in the trial. Plot size was 0.9- by 3.7-m, and the experimental design was a randomized complete block design with five replications.

Clipping samples were taken periodically from a 1.67 m^2 area of each plot when dollar spot disease damage was evident. The amount of dollar spot damage was assessed by counting the number of infection sites, or estimating the percent area damaged with a line-intersect count. Line-intersect counting was done with a grid of intersections spaced 76- by 76-mm that covered the center 0.8- by 3.4-m of the plot. Clippings were dried at 60 °C, sifted to separate soil and debris, and ground with a Udy Cyclone Mill fitted with a 1-mm screen. Clipping nitrogen content was determined by NIRS analysis. The NIRS nitrogen analysis was made with a Model 591 NIRS monochromometer using the equation provided with the InfraSoft International software (Version 3.0). Sample cells for NIRS analysis were filled with approximately 2.5 g dry weight of ground tissue. (Karsten Turf Inc., Phoenix AZ)[1]

Results for Nitrogen Testing of Bentgrass Tissue

As expected, N concentration in bentgrass clippings increased with increasing N fertilizer rate. Generally, as clipping N content increased damage from dollar spot disease decreased. We expressed disease damage on a normalized scale so that we can compare disease response over many dates. Normalization of disease damage expresses maximum dollar spot disease on a given date as 1. No disease is represented as 0. On several dates a non-linear response was observed indicating that higher levels of clipping N were providing smaller reductions in disease severity.

When the data was combined for all observation dates there was no apparent trend in the data. However, we observed that the response data was grouped according to the period of the growing season. Further

[1] Trade names are mentioned for the convenience of the reader and does not imply endorsement by Rutgers over similar products.

examination of the data found that these observed groupings of response data were associated with the progress of disease. When response data were grouped according to increasing and decreasing periods of disease activity there was more consistency in the data.

The type of response found during the increasing phase of disease was different from the response found during the decreasing, or recovery, phase. During an increasing phase, suppression of dollar spot disease was not observed until the N content of creeping bentgrass clippings had reached approximately 5%. However, increased clipping nitrogen content during a decreasing phase of disease activity decreased dollar spot damage; maximum recovery from disease was observed as clipping N content exceeded 5%.

We have also evaluated growth (clipping yield) response to clipping N content. Clipping yield of creeping bentgrass generally increased in a linear fashion as clipping nitrogen content increased. It should be noted that fertilization rates in this study were low to moderate. Therefore, it is possible that higher nitrogen fertilization rates may have produced non-linear growth responses.

A plot of both clipping yield and dollar spot damage responses against clipping nitrogen content indicated that these two response lines intersected at a clipping nitrogen content of approximately 4.5%. This intersection point of the two response lines at 4.5% clipping nitrogen has been observed on a number of dates in our study. Further evaluation of this data will indicate whether or not this value (4.5%) changes over the growing season.

Conclusions

Our data indicated that it is possible to identify optimal and critical levels of nutrients in turfgrass clippings using a criterion such as dollar spot disease severity. Additional studies are needed to define critical and optimal levels of nutrients for other criteria that relate to turfgrass performance to determine if these critical and optimum levels will be the same or differ across a number of criteria. Furthermore, these critical and optimal levels need to evaluated for other varieties of creeping bentgrass as well as other turfgrass species.

Based on our field trials, tissue nitrogen content in creeping bentgrass clippings should be approximately 4.5% for good recovery potential from dollar spot disease damage. This level of clipping nitrogen content will stimulate a moderate level of growth (clipping yield).

Suppression of dollar spot disease during an increasing phase of disease activity on bentgrass will require a clipping nitrogen content of approximately 5%. This level of N is not recommended as a long-term maintenance level due to high growth rates (clipping yield). Extended periods of high clipping yield could reduce carbohydrate reserves and limited root development necessary for good stress tolerance.