CHAPTER 4
SUMMARY AND CONCLUSIONS

The concept of recommending a single N-program for all cool-season turfgrass species is not appropriate due to substantial differences in growth habit and N use. An appropriate lawn N-program should take into consideration environmental growing conditions, desired appearance, management intensity, namely mowing needs, and use. The purpose of this study was to generate data that aid in recommending N fertilization programs for cool-season lawns that maximize above-ground turfgrass responses (turfgrass color and quality), minimize soil N loss while protecting water quality. Seven nitrogen (N) fertility programs and an unfertilized control were studied in detail for two and one-half growing seasons to define the minimum N requirements of the three principal cool-season lawn species: Kentucky bluegrass (*Poa pratensis* L.) (KBG), perennial ryegrass (*Lolium perenne* L.) (PRG) and turf-type tall fescue (*Festuca arundinacea* Schreb.) (TTTF) grown throughout the cool-humid region. Traditionally, Purdue University has recommended that a minimally acceptable lawn should receive N once annually at 49 kg N ha\(^{-1}\), applied in early September. This practice may or may not be appropriate to maximize visual quality and growth for all species. Where higher quality expectations are desired additional N applications are often applied in November and May. There is increasing concern that the widely recommended practice of applying late-season N (e.g. early-November) may result in leaching losses and negatively affect water quality.

This study demonstrated that there were significant differences among species and N-programs. The data generated in this study indicates that a single N application (74 kg N ha\(^{-1}\)) from urea in early-November resulted in faster spring green-up, superior seasonal
canopy greenness, overall turfgrass quality (TQ), and to some extent less disease incidence than a single September (49 kg N ha\(^{-1}\)) application and the unfertilized control.

Among species across N-programs and study years, TTTF produced greater dry matter yield (DMY) than KBG and PRG. For TTTF, all three medium (123 kg N ha\(^{-1}\) yr\(^{-1}\)) N-programs and the two high (196 kg N ha\(^{-1}\) yr\(^{-1}\)) N-programs provided similar DMYs. The low November N-program did occasionally provide similar DMYs as the medium and high N-programs in 2004 but did not provide equivalent canopy greenness, leaf tissue N content or TQ. The most noticeable decline in color and appearance occurred in late-summer as N became depleted. Among the medium N-programs, the Apr., May, and July (AMJ) N-program was better in regards to leaf tissue N content, canopy greenness, and TQ where it was similar to the two high N-programs. Disease incidence and severity was most severe for the two low N-programs and unfertilized treatment due to a lack of plant vigor during summer months. Overall blight averaged 12 and 19 % for the low N and unfertilized treatment, respectively. Therefore, where a general purpose TTTF lawn is desired, the N requirement appears to be 73-123 kg N ha\(^{-1}\) yr\(^{-1}\).

For KBG, the two high N-programs consistently resulted in the greatest DMY, canopy greenness, TQ, and least disease incidence. The results for the medium N-programs were less consistent. The medium AMJ and September and November (SN) N-programs produced similar DMY to the high N-treatments during the first study year (2004). The medium Sept., Oct., and May (SOM) N-program resulted in greater canopy greenness and annual TQ in 2004 than the other medium N-programs. The medium AMJ N-program did provide superior canopy greenness values in 2005, but also had greater disease. Regardless of N-program, the KBG seed blend used in this study required a November N application to encourage rapid spring green-up. The medium SN N-program did improve spring canopy greenness, however, it did not provide equivalent canopy greenness throughout the entire growing season like the medium SOM and the two high N-programs. Among the low N-treatments, the November N-program resulted in greater spring canopy greenness and TQ than the low September N-program. Compared to Purdue’s current N recommendation, SNMJ, the SONAM program resulted in superior spring canopy greenness and TQ values due to its additional fall N application. For a
moderate quality KBG lawn the minimum N requirement appears to be $\geq 123$ kg N ha$^{-1}$ yr$^{-1}$, however, where N leaching is of concern $< 195$ kg N ha$^{-1}$ yr$^{-1}$ should be applied especially as the lawn matures and greater N mineralization occurs.

For PRG, few differences among N-programs were observed for DMY, leaf tissue N content, and canopy greenness. Two medium N-programs, AMJ and SOM were similar to the high N-treatments, however, the medium SN N-treatment was not. A PRG lawn appears to require $> 123$ kg N ha$^{-1}$ yr$^{-1}$ to promote turf vigor, resist disease and maintain stand density. Among the high N-programs, stand blight was 41\% on 19 July 2005, whereas for the medium N-programs 31 - 78\% blight occurred. Since PRG is a bunch-type grass, turf recovery from disease may be a slow process without sufficient available N and large damaged areas may require reseeding to maintain stand density, TQ and prevent undesirable weed encroachment. The two high N-programs were better than the medium and low N-programs, however, there were no significant differences between the SONAM and Purdue’s high N recommendations (SNMJ) for DMY, leaf tissue N content, canopy greenness, TQ, and disease severity. The minimum N requirement to produce a consistent PRG lawn appears to be $\geq 123$ kg N ha$^{-1}$. Regardless of N application, however, it appears that PRG will not completely resist summer diseases and some loss in summer stand density in the cool-humid region should be expected.

In terms of seasonal nitrate (NO$_3^-$-N) in soil solution, concentrations for TTTF were generally low $< 0.5$ mg L$^{-1}$ throughout the study and likely have little negative impact on water quality. Among the three species, KBG appears to be most at risk for soil NO$_3^-$-N losses, especially during spring and late-fall. During the first study year, Nov. 2003 and the spring of 2004, NO$_3^-$-N concentrations in soil solution were comparatively high $\leq 6.6$ mg L$^{-1}$. On one date in Nov. 2003 NO$_3^-$-N concentrations were very high $> 17$ mg L$^{-1}$ and exceeded the EPA minimum drinking water standard 10 mg L$^{-1}$. In general, soil NO$_3^-$-N concentrations for PRG were low, $< 3.4$ mg L$^{-1}$. Elevated NO$_3^-$-N levels were observed in the fall of 2005, which could be due to the lack of stand density caused by disease.

If the goal is to plant and maintain a healthy, attractive, persistent lawn with the fewest N inputs, this study demonstrates that planting TTTF and providing 73-123 kg N
ha\(^{-1}\) yr\(^{-1}\) with some of this N applied during late-fall would meet these objectives. Although TTTF provides a moderate quality lawn, a well fertilized, \(\geq 123\) kg N ha\(^{-1}\) yr\(^{-1}\), KBG lawn provided superior TQ during the active growth months and may be more appealing to some property owners. A medium to high quality KBG lawn requires, 123-195 kg N ha\(^{-1}\) yr\(^{-1}\), but appeared to be most prone to soil N losses during periods of slow growth (e.g. spring). For a moderate quality PRG lawn, 123-195 kg N ha\(^{-1}\) yr\(^{-1}\) appears necessary, property owners must realize that even with ample N fertilizer, visual quality and stand density may decline during the late spring and summer due to disease.