Technology Transfer

Fertilizer Management by Landscape Maintenance and Lawn Care Firms in Atlanta

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ADDITIONAL INDEX WORDS. runoff, nitrogen, phosphorus, water pollution, best management practices

SUMMARY. In response to a mail survey of the landscape maintenance and lawn care (LM-LC) industry in metropolitan Atlanta, we learned that 76% of respondents fertilized lawns and turf and 68% fertilized ornamental beds. Less than one-fourth of those who provided fertilization services offered an organic fertility option; for those who reported an organic option, an average of 25% of their residential customers used such a service. Complete fertilizers (N-P₂O₅-K₂O), ammonium nitrate, urea, and N solutions were the products applied by most respondents. Average amounts of N per application were ≈ 1.5 lb/1000 ft² on lawns and 1.1 lb/1000 ft² on ornamentals. Of firms that provide fertilization services, 88% use a predetermined application schedule, whereas 88% use visual observation and 69% use soil testing to guide fertilizer management. Only 5% reported using tissue analysis as a fertilizer management strategy. Nitrogen fertilizers were applied most frequently in the spring, with nearly equal amounts applied in summer and fall. Phosphorus was applied most commonly in the fall or spring. Relatively few firms

reported applying significant amounts of either N or P in winter. Most respondents indicated that they received adequate information about fertilizers, but few received information about organic fertilization. Commercial sales representatives and trade magazines were cited most often as sources of information; university specialists were the least-cited formal source of information concerning fertilization. We have suggested some research and educational issues to be addressed based on these results.

The issue of pollution and eutrophication of natural water bodies by nutrients applied to landscapes, especially turf areas, has been reviewed previously (Gold et al., 1990; Gold and Groffman, 1993; Gross et al., 1990; Harrison, 1992; Morton et al., 1988; Petrovic, 1990). Phosphorus rarely leaches into groundwater but may be washed into surface waters in association with eroded soil particles. Although runoff from turf areas may be greater due to compaction in high-traffic areas (Harrison et al., 1993), erosion from turf areas is negligible (Gross et al., 1990; Harrison, 1992; Harrison et al., 1993). Thus, P nonpoint-source pollution from landscapes, particularly turf sites, is minimal.

In contrast, N is more susceptible to leaching and potential water pollution because of the complex transformations of N in the soil (Petrovic, 1990) and its greater solubility. Several studies have indicated that little N leaches from well-managed turf sites (Gold et al., 1990; Gold and Groffman, 1993; Gross et al., 1990; Morton et al., 1988), although Petrovic (1990) pointed out that N is more likely to leach when applied as nitrate than as urea. In addition to the form of N applied, timing application to optimize plant recovery and minimize exposure to heavy rainfall should limit N loss from the landscape. Indeed, Morton et al. (1988) found that irrigation management could affect the amount of N leached from turf areas. Therefore, while nutrients applied to turf and landscape areas can become nonpoint-source pollutants under some circumstances, such pollution is minimal.

A survey was conducted of fertilizer and pest management practices used in the landscape maintenance and lawn care (LM-LC) industry in metropolitan Atlanta to 1) support a research program to identify potential sources of water pollution associated with the horticultural industry in urban and suburban areas and 2) design preventive or remedial strategies for any such potential pollution. Reviews of the issues to be addressed in this research program (Latimer et al., 1996a, 1996b) and a description of the survey approach and economic profile of the industry (Florkowski et al., 1996) have been published. Additional papers describing the major pests encountered, pesticide strategies used, and attitudes toward integrated pest management (IPM) are forthcoming. The present paper will summarize respondents' management of fertilizers in landscape maintenance and lawn care.

Materials and methods

The survey involved an extensive questionnaire mailed to commercial LM-LC companies in the 20-county Atlanta Statistical Reporting District. The mailing list was compiled from professional organizations and county business license records. We received 350 usable questionnaires for a gross return rate of 25.4%, adjusting for nonapplicable addresses and undeliverable mailings. In the survey, respondents were

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asked to indicate the amounts of N and P fertilizers (as percentages of total annual applications) they applied in each of four seasons: winter (December to February), spring (March to May), summer (June to August), and fall (September to November). Respondents were then asked to indicate what guided their fertilizer applications and if and where soil or tissue testing was performed. Next, respondents were asked to provide rates of nutritional treatments applied to lawns or ornamentals. The final issue addressed in this survey was the sources of information that operators used to guide fertilizer management and their attitudes about the adequacy of that information.

Table 1. Forms of fertilizer materials used in lawn/turf and ornamental applications in Atlanta.

Fertilizer material	Fertilizer use (% of respondents)	
	Lawn/turf	Ornamentals
Synthetic fertilizers		
Complete fertilizer	51	52
Ammonium nitrate	13	7
Urea	13	5
Nitrogen solutions	9	11
Ammonium sulfate	3	3
Nitroform	1	3
Organic fertilizers		
Milorganite	3	1
Animal manure	<1	3
Animal manure compost	<1	5
Poultry manure	2	1
Poultry manure compost	0	3
Yard waste	1	3
Green manure-cover crop	<1	0
Biostimulants, etc.	1	2

Results and discussion

SUMMARY OF INDUSTRY PROFILE. The respondents represented predominately small, new (<10 years old), independently owned firms, with most reporting gross annual sales less than \$100,000 and value of equipment owned less than \$25,000. More than 60% of the firms reported a customer base of no more than 25 residential accounts. In contrast, a few major firms >20 years old reported gross annual sales in excess of \$1,000,000, equipment valued at greater than \$100,000, and a customer base of >500 clients (Florkowski et al., 1996). These data indicate a broad range of sophistication in the LM-LC industry: a few large, experienced, highly capitalized companies, and many small, inexperienced, low-capitalized operators. We might expect an equally diverse range in knowledge and sophistication in fertilizer and pesticide management. Furthermore, education and training to address such a diverse audience to prevent potential pollution might require radically different approaches for various operators.

SERVICES OFFERED. More than three-fourths (76%) of survey participants indicated they offered fertilization on lawns and other turf sites, whereas about two-thirds (68%) offered the service on ornamentals. Of those that offered a fertilizer application service, less than one-fourth (23%) offered an organic fertilizer option.

Among firms offering an organic fertilizer option, relatively few reported that their customers purchased this service: 23% (14 of 60) and 64% (25 of 39) respondents reported that none of their residential and commercial customers, respectively, purchased organic fertilizer management. More than half (55%) of respondents indicated that 10% or fewer of their commercial customers purchased organic fertilizer management and 87% reported that 50% or fewer of their residential customers purchased organic fertilizer management. This service accounted for 75% to 100% of the residential accounts for the remaining 13% of respondents. The organic fertilizer option was used less by commercial accounts: 82% of respondents indicated that organic fertilizer management accounted for 20% or less of

their commercial business, and 97% said it was half or less of their commercial accounts. On average, organic fertilizer management accounted for 25% and 11% of respondents' residential and commercial customers, respectively.

FERTILIZER FORMS AND AMOUNTS APPLIED. The rest of the discussion will be limited to those respondents indicating fertilizer application as a service. We determined the forms of fertilizer most commonly used in the LM-LC industry, and to estimate the rates applied in pounds per 1000 square feet (Table 1). The forms used were very similar for the two types of landscape, but certain differences emerged. Complete ($N-P_2O_5-K_2O$) fertilizers were the most common form reported, with more than half of respondents indicating their application to lawns and ornamentals. We did not determine whether complete fertilizers applied included rapid-release, slow-release, or a mixture of these forms. About 13% of respondents applied either ammonium nitrate or urea to lawns, but only 5% to 7% of operators used these materials on ornamentals. About 10% of the firms surveyed applied N solutions to lawns and ornamentals, but ammonium sulfate and nitroform were used by only 3% or less of respondents on either type of landscape.

In investigating use of organic nutrients, we discovered that 3% of operators reported the use of composted wastewater sludge (Milorganite) on turf, but only 1% on ornamentals (Table 1). Less than 1% of respondents applied animal manure or animal or poultry waste compost on turf, although 2% reported the use of poultry waste on turf. Animal wastes were more widely used in ornamentals, with 3% to 5% of respondents reporting the use of poultry and animal waste composts, respectively. Similarly, 3% of operators reported using yard wastes in ornamentals, but only 1% reported using yard wastes on lawns and turf.

Green manures and cover crops were not used on ornamentals and were reported by only one respondent (<1%) for use on turf. Clearly, cover crops other than overseeding warm-season turf are unacceptable in a turf area, but winter cover crops such as clovers and vetches could be quite appropriate for annual ornamental beds

during winter, with the plant biomass returned to the soil to add organic matter and supply N to warm-season bedding plants. This approach might entail more labor for bed preparation than traditional clean beds and mulches and would interfere with cool-season bedding plants such as pansies. Still, this strategy could offer economic and environmental advantages where it could be applied, including providing refuge for beneficial insects as one aspect of integrated pest management.

Biostimulants, soil activators, and enzymes were used very little in the LM-LC industry (Table 1), with <2% of respondents reporting their use in turf and ornamentals, respectively.

Operators attempted to apply N at an average of 1.5 lb/1000 ft² to lawns and turf and 1.1 lb/1000 ft² to ornamental beds, per application. Frequency of application could not be determined from the survey.

FERTILIZER MANAGEMENT STRATEGIES. To schedule fertilizer applications, almost 88% of respondents indicated that they used visual evaluation, 69% indicated the use of soil testing, and <5% reported the use of tissue analysis as a guide to fertilizer management (data not shown). The use of subjective (visual appearance) and objective (soil testing) measures to guide fertilizer application might be encouraging, except that 88% of respondents also indicated that they applied fertilizer according to a regular schedule. This latter response is confirmed by a separate question elsewhere in the survey, in which 83% of respondents indicated that they applied fertilizers according to a predetermined schedule. Applying fertilizer according to determined need rather than predetermined schedule would be preferable from a pollution prevention standpoint. This might be an area for research and education for the industry.

Among respondents who indicated they used soil testing (151 operators), most (60%) used a state-supported laboratory for the service. Others used analytical services provided by either a fertilizer company (19%) or a commercial laboratory (20%). Only (13%) reported that their own company provided the analytical service. Based on the large number of operators using visual evaluations and the small percentage using tissue analysis, the use of diagnostic analytical services among the LM-LC industry could expand.

SEASONAL FERTILIZER APPLICATION. Given the predominance of predetermined schedules in guiding fertilizer application in the industry, application schedules must be technically correct. Furthermore, from the standpoint of preventing pollution by nutrients in runoff, applications should not coincide with possible erosion events.

Spring was the predominant season for N application (data not shown), which coincides with the resumption of warm-season turf growth and establishment of new ornamental beds. More than 75% of operators applied >20% of the total annual N in spring (data not shown). At the same time, however, few operators applied most of the annual N fertilizer in the spring: only 6% of respondents applied >50% in these 3 months. Summer and fall were very similar in the amounts of N operators reported applying. In summer or fall, ≈25% of respondents applied no N fertilizer, and 90% applied 40% or less of the annual allocation. Thus, about two-thirds of the respondents applied from 0% to 40% of their N in either the summer or fall. Winter N application was relatively infrequent, with more than half (55%) applying no N then and only 2% applying >30% of the N in winter.

In contrast, P application was less concentrated in any one season, but fall application predominated (data not shown). Only 29% of respondents reported applying no P in the fall, and 50% reported applying 20% to 50% of their annual P fertilization in fall. Spring was the next most common season for P application, followed by summer. Phosphorus application in winter was about as uncommon as N application. Sixty percent of respondents reported no P application in winter, and only 5% reported applying >30% then.

A major consideration in the timing of fertilizer application is whether the turf is warm season or cool season. This information was not included in the survey. Nonetheless, the survey results appear to be appropriate from horticultural and environmental viewpoints. Applying N in the winter is generally not acceptable in this climate due to the likelihood of loss by leaching, denitrification, or runoff during the mild but rainy winter. The seasonal application data indicated that N was distributed throughout the entire growing season, primarily but not exclusively in spring. Frequent, small N applications appear to be the most efficient strategy for optimizing plant uptake and minimizing losses from the landscape system. Fall P application should allow for soil infiltration and reaction before active plant growth in the spring. The main concern relative to nonpoint-source P pollution of surface waters is the movement of P associated with sediment washed into water bodies. Prevention amounts to incorporating P into the root zone to prevent its erosion with off-site soil movement. From this standpoint, applying most of the annual P fertilizer in the fall may increase the risk of loss during winter and spring rains, especially if soil is not protected.

SOURCES AND ADEQUACY OF INFORMATION. Commercial sales representatives and trade magazines were listed as the two most important sources of information about fertilizers and were cited by 62% and 49% of respondents, respectively. County extension personnel were listed as fertilizer information sources by 46% of respondents, and 35% listed peers. Only 28% listed University of Georgia specialists (i.e., extension, research, and teaching faculty) as sources of information about fertilizer. Although university specialists deliver information to the industry via county extension personnel, popular publications, and industry educational programs, they were not primary sources of information.

With respect to information about organic fertilizers, the same relative ranking of information sources emerged. Only about one-third (34%) indicated that they received information about organic fertilizer from commercial sales representatives, and 19% to 27% cited trade magazines, county extension offices, and peers as sources. University specialists again ranked last (13%) among formal sources of information concerning organic fertilizers.

The respondents in our survey apparently feel satisfied with the amount of information they receive concerning fertilizers application: 91% indicated that they received adequate amounts of information "almost always" or "often." In contrast, concerning organic fertilizer management, only 45% indicated that they "almost always" or "often" received adequate amounts of information, an equal percentage indicated that they received adequate information "not so often" or "rarely," and 9% indicated that they did not know whether they received adequate amounts of information about organic fertilizers.

Conclusions

These survey results suggest a number of factors to consider in designing research and educational programs to prevent or reduce the potential for pollution of surface water and groundwater by fertilizers applied to lawns and ornamental landscapes. Communicating via commercial sales representatives and popular trade magazines is currently the most efficient way to reach maintenance firms. The forms and amounts of fertilizers typically used by the industry appear appropriate. The best approach to prevent P pollution from landscapes is to ensure that soil particles with associated nutrients do not wash off of the site. It would be interesting to determine how operators reconcile their scheduling, observation, and soil test information to determine when and how much to fertilize and to test the appropriateness of the derived fertilizer application schedule. Most operators apply the bulk of N in the spring, with additional N applied in summer and fall; most of the P is applied in the fall and spring. Finally, relatively few operators offered an organic fertilizer option and even fewer customers purchased such an option. This may be due to availability, aesthetic problems, high transportation and application costs of organic fertilizers, or a lack of information. In contrast, operators and customers indicated that information concerning conventional fertilization was adequate.

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Utah's Vegetable Growers: Assessing Sustainable Agriculture

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ADDITIONAL INDEX WORDS. survey

SUMMARY. Without a clear understanding of individual farms and farming practice, progression toward more sustainable vegetable production cannot occur. Seventy randomly selected vegetable farmers in Utah were surveyed by telephone and mail to gather baseline data on their agricultural practices. The Utah vegetable farmers profile generated by this survey included a measure of each respondent's attitude toward sustainable agricultural practices and his or her interest in further cooperation with research and extension. A farming index to measure practices used and a perceptual index measuring farmer's views regarding sustainable practices were developed, pilot tested, and refined during the project. Although the perceptual index did not serve as a proxy for actual farm practice, it identified farmers who had an appreciation for sustainable agriculture. Together with the farming index, we now have detailed information on actual farm practices for a variety of different vegetable farmer groups. The use of these two indices will help measure the effectiveness of future research and extension efforts as farmers progress toward more sustainable vegetable production.

Traditional research and extension efforts have not met the needs of Utah's vegetable industry. Extension programs have historically focused on the progressive farmer with the expectation that adopted technology will diffuse to other farmers. This, however, assumes that there is a homogeneous population of farmers. A previous study of sustainable farmers in Utah demonstrated that small part-time farmers outnumber large influential, progressive farmers (Drost et al., 1996). While some diffusion occurs from the progressive farmers to small part-time farmers, targeting extension to representatives of homogeneous subgroups increases the speed of the diffusion process regardless of farm size (Roling, 1988). Since different commodities have different cultural practices, it is important that the farming system of each be understood before corrections or changes can be implemented. At the same time, agricultural extension needs to balance traditional

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