Water and Nutrient Management Planning — Monitoring of Irrigation and Fertilization Practices©

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INTRODUCTION

Nutrient management regulations are a reality or on the horizon for agricultural operations in many states of the U.S.A. The federal Environmental Protection Agency (EPA) may soon enforce laws regarding non-point (diffuse) sources of nutrient loading to the nation's rivers and streams. These are the section 303(d) provisions of the Clean Water Act that have been law since 1972 (EPA, 2000a), which have not been enforced until now. Knowing the efficiency of irrigation water and nutrient applications in nursery and greenhouse operations is important, since it not only allows for a proactive environmental assessment of management practices, but it also can allow for cost savings in water and fertilizer inputs. A water and nutrient management planning process will help a grower assess the efficiency of these cultural practices, and gain the necessary information to write a plan. This information will allow a grower to evaluate changes that can improve his production efficiency, implement best management practices and reduce nutrient runoff without sacrificing plant quality or production time.

CURRENT MARYLAND NUTRIENT MANAGEMENT REGULATIONS

Water and nutrient management planning is a reality for nursery and greenhouse operators in Maryland and is looming for growers in other states, as there is concern throughout the U.S.A. about improving and maintaining the water quality of existing surface and groundwater resources. Water quality problems in rivers and surface water bodies are, in part, attributed to non-point nutrient runoff from agricultural operations. In 1998, the Maryland legislature passed the Maryland Water Quality Improvement Act of 1998, which requires agricultural producers to develop effective procedures to ensure that they do not pollute Maryland's water resources and to limit the runoff of nutrients into the Chesapeake Bay. The Maryland law requires virtually all agricultural operations to write and implement nitrogen (N) and phosphorus (P) based management plans by 31 Dec. 2002 (Maryland Department of Agriculture, MDA, 2000). Provisions of the Clean Water Act of 1972 are also influencing policy to ensure that all states formulate and document the impact of agricultural and other practices on watersheds (EPA, 2000b; Lea-Cox and Ross, 2001).

Further details of the Maryland law and the nutrient management regulations can be found at the MDA Office of Resource Conservation website at <http://www.mda.state.md.us>. All agricultural operations grossing more than $2,500 in annual sales have to write nutrient management plans. These plans must report the usage of the primary nutrients N, P_2O_5, and K_2O, but since soluble nutrients move in runoff, water management is included for out-of-ground (container) plant production. The legislation mandates the training of professionals who write these plans, so they are written effectively and meet the legislative requirements. To ensure that plans are effectively implemented, any person who applies nutrients to agricultural land must also receive “nutrient applicator” training.

While Maryland agronomic crop producers have had a voluntary nutrient management program underway since 1989, this new nutrient management legislation posed unique challenges for the nursery and greenhouse industry, because a wide range of production scenarios are used to produce a large number of different species and types of ornamental plants. Formulating an effective planning process that took both water and nutrient applications into account was particularly important for these types of operations, as cultural practices and site conditions may be conducive to nutrient leaching and runoff (Lea-Cox et al., 2001). Many nursery operations have already implemented improved management practices to conserve water and nutrients (Ross et al., 2001). Operations that do not already have such procedures in place will have to find cost-effective ways to comply with the regulations and document that they can effectively minimize the risk of nutrient movement from their operations (Lea-Cox et al., 2001). Specific information on the nursery and greenhouse nutrient management planning process in Maryland can be found on the Maryland Cooperative Extension nursery website at <http://www.nursery.umd.edu>.

DEVELOPING WATER AND NUTRIENT MANAGEMENT PLANS

A water and nutrient management plan must address three basic points:

1) An accounting of the total fertilizer applied to the growing area per year or crop cycle;
2) An assessment of the potential for nutrient runoff from growing areas; and
3) The measures to contain and/or abate any nutrients that do run off from production areas.

A water and nutrient management plan should order and systematically address the factors outlined above. The reason for having a plan is to demonstrate that water and nutrients are applied in an efficient way, and that the operation poses little danger to the environment. A number of approaches to developing a plan for a nursery or greenhouse are possible.

A simple and effective planning approach is to evaluate the cultural practices that affect water and nutrient runoff. These cultural factors include substrate physical and chemical properties, fertilizer application methods and rates, irrigation water application methods, rates and duration (Lea-Cox et al., 2001). However, a wide range of production scenarios are used to produce a large number of different species and types of ornamental plants in nursery and greenhouse operations. Crop cycles also range from 4 to 6 weeks in greenhouse production to multi-year cycles in field nursery production — all which complicate the planning process. In addition, unique site characteristics and infrastructure contribute to water and nutrient runoff. Most importantly, there is inadequate scientific knowledge of optimal nutrient requirements for most ornamental species.

Table 1. Example management unit and production data for a hypothetical container nursery.

Management unit (Crop type and/or container size)	Number of plants	Growing area (sq. ft)	Area under production (%)	Production time / goal
Annuals -Plugs	500,000	2000	0.4	Feb - June (2 cycles)
Herbaceous perennials < 1 gallon	75,000	75,000	13.0	Mar - Oct (1 cycle)
Woody perennials 1 - 3 gallon	175,000	200,000	34.6	6-15 months (1 cycle)
Woody perennials 4 - 7 gallon	150,000	300,000	52.0	12-24 months (1 cycle)

The challenge was thus to formulate a strategy that would permit a grower or his planner to capture the necessary information and enable them to write a nutrient management plan that accurately assesses the efficiency of the various cultural practices. The resulting process (Lea-Cox et al., 2001) not only documents the quantities of nutrients that are used, but also looks at the physical aspects of nutrient movement, capturing data (e.g. irrigation interception efficiency and leaching fraction) that influence nutrient leaching and potential runoff from nursery or greenhouse production sites. In brief, the water and nutrient management process evaluates the physical and management factors that can contribute to nutrient runoff, and measures key variables which assess the contribution of these factors to N and P runoff from any production site. An assessment of the risk of nutrient runoff can then be derived from this data.

ORGANIZING PLANT PRODUCTION — MANAGEMENT UNITS

A means of organizing the production of the various plant species and production methods is necessary to define a minimum number of management categories. The concept of “management units” is therefore defined in general terms. The goal is to group plant species and/or plant sizes that are produced in a similar fashion into the least number of units, to make the documentation process easier. In a container nursery or greenhouse operation, we favor management units based on container size (Lea-Cox et al., 2001), since most producers can easily track this. More importantly, container size often dictates how plants are grouped and spaced in production areas in the nursery, and this spacing dictates the efficiency of overhead water applications. Nutrient applications are also often based on container size and species. From experience, most nurseries can group their entire production into three to six management units. Production data can then be compiled and reported in a table, an example of which is provided in Table 1.

DOCUMENTING NUTRIENT APPLICATIONS

All sources of nutrients applied to the various growing areas need to be documented on an annual or crop cycle basis. The first attempt in putting records together can merely be collecting the purchase receipts showing the quantity of fertilizer used for the production year, divided by the total growing area. A more detailed approach is to keep records of nutrient applications by "management unit", or by species if large numbers of the same plant are grown. Records of applications of incorporated nutrients, seasonal slow-release fertilizer applications and additional soluble applications (if used) should be kept for each production area. This facilitates the risk assessment process (Lea-Cox et al., 2001). An example of a summary table showing nutrient applications by "management unit" is shown in Table 2.

Documenting Irrigation Water Management. Container-grown crops are usually produced on compacted sites, and excess irrigation water drains from production areas as runoff. Container size and spacing, type of substrate, crop maturity, crop architecture, and irrigation duration are all factors that affect irrigation water interception, leaching, and runoff. Since the amount of water running off is a primary concern, procedures to estimate the interception efficiency, leaching fraction and potential runoff (Ross et al., 2001) can be used to check the efficiency of irrigation water applications. Overhead sprinklers are usually used on smaller-sized containers; larger container sizes may have drip or microsprinkler irrigation, which places the water directly into the container with maximum application efficiency.

Assessing the Risk of Nutrient Runoff.

Site Risk Assessment. A site risk assessment involves looking at several factors, including the topography, surface conditions, irrigation practices that contribute to water movement, and those factors that mitigate the effects of surface water runoff. Irrigation water and stormwater contribute to the total water that may contribute to nutrient runoff from production areas. On-site grass waterways, structures to manage storm water, devices to slow water velocity, and other erosion control measures can reduce this runoff to a minimum. Two methods of managing water as

Table 2. Example of annual nutrient application totals for various management units.

Management unit (Crop type and/or	Pre-incorporated			Topdressed + soluble applications			Total nutrients (lb/acre/year)		
container size)	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Annuals									
Plugs (2 cycles)	-	-	-	125	54	104	125	54	104
Herb. perennials									
<1 gal.	300	43	165	-	-	-	300	43	165
Woody perennials									
1-3 gal.	450	65	250	150	32	125	600	97	375
Woody perennials									
4-7 gal.	650	94	360	150	32	125	800	126	485

it leaves the property are containment basins and buffer strips; the presence and effectiveness of these or other nutrient loss control methods should be assessed and documented in the plan.

Containment Systems. When containment basins are used, the goal is to capture the runoff and recycle or treat the water before it exits the property. Containment means the runoff is captured and nutrient loads are mitigated or recycled back onto plant-production areas. Constructed wetlands or buffer areas can also be used to treat the water before it is released into public surface waters. Provisions should be included for handling stormwater overflow situations. Risk assessment guidelines are given in the Maryland regulations (MDA, 2000) and further discussed by Lea-Cox et al. (2001).

Buffer Strips. Another alternative to containment basins for those nurseries not able to contain or recycle water is the establishment of grass or grass and tree buffer areas, which slow sediment and nutrients leaving the property. The effectiveness of these buffer areas is currently a subject of debate, particularly where large water flows and/or nutrient loads frequently occur. However, these structures are particularly appropriate for those nurseries that use low inputs of water and nutrients (slow-release fertilizers and low-volume irrigation), since nutrient leaching and runoff volumes are typically low from these operations. Sediment basins that slow the flow of water and trap soil or substrate particles before a buffer area may also provide significant nutrient reductions in nitrogen (by denitrification) and phosphorus (by adsorption).

Best Management Practices and Implementing a Water and Nutrient Management Plan.

Ultimately, the effectiveness of any water and nutrient management plan depends upon adopting suitable best management practices and implementing cost-effective changes in management or infrastructure. By gathering some basic information on fertilizer and water efficiency, a grower can assess the risk of a particular practice (Lea-Cox et al., 2001) and modify or adopt best management practices (Yeager et al., 1997). The focus of the process should not be on regulating nutrient applications, but adopting practices that improve the efficiency of water and nutrient applications, and the profitability of the business. It may not be economical or even necessary to lower the risk of all individual factors, since a matrix of management and site factors is being measured, and a single factor may have a disproportionate effect on the overall risk. This particular factor should therefore be the target of a recommended best management practice.

By implementing a strategy of best management practices, combined with routine monitoring and the bioremediation or recycling of runoff, nursery and greenhouse operations should have minimal impact on the environment.

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The Art and Science of Plant Introduction©

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The Southern Plant Conference last seek in Athens opened a Pandora's Box of questions and concerns. The plant world is changing from one of universal sharing to a more protectionist mode. The USPTO (U.S. Patent and Trademark Office) is becoming more stringent about the prior handling and exposure of plants. In the minutes available today, I plan to share accumulated information based on phone calls, literature, and the internet.

A selected palette of woody plants with commercial potential are:

- *Hydrangea quercifolia* 'Amethyst', 'Vaughn's Lillie'
- *Hydrangea macrophylla* reblooming selections: 'Penny-Mac', 'David Ramsey', 'Decatur Blue', 'Oak Hill', and 'Endless Summer' (will be patented); preliminary DNA "finger printing" indicates the above five are very similar.
- *Ceanothus americanus*
- *Ceanothus delileanus* 'Gloire de Versailles', 'Henri Desfossé'
- *Ceanothus pallidus* 'Roseus', 'Marie Simon'
- *Spiraea japonica* 'Snowball', 'White Gold'
- *Cercis chinensis* 'Don Egolf' (fruitless)
- ×*Cupressocyparis leylandii* 'Gold Rider'; has yellow foliage in heat of Georgia's summers.
- *Thuja plicata* 'Canadian Gold'; has yellow foliage in heat of Georgia's summers.
- *Deutzia gracilis* 'Elaine's Gold'–cream-yellow leaf margin.
- *Indigofera decora* (syn. *I. incarnata*) 'Rosea'
- *Agarista populifolia* (syn. *Leucothoe populifolia*) dwarf form (Leprechaun™)
- *Osmanthus* ×*fortunei* 'Fruitlandii'
- *Pieris phillyreifolia* has possibilities
- *Prunus incisa* – Fuji Cherry; one of the best small cherries; parent of 'Okame'. Two new cultivars are 'Fair Elaine' (pink) and 'Snowcloud' (white)