# Some Considerations for Fertilizing Container Nursery Crops©

Youbin Zheng[1,2], Mary Jane Clark[1] and Erin Agro[1,2]
[1]Vineland Research and Innovation Centre, 4890 Victoria Avenue North, Box 4000, Vineland Station, Ontario, L0R 2E0, Canada
[2]School of Environmental Sciences, University of Guelph, 50 Stone Road E., Bovey Building, Guelph, Ontario, N1G 2W1, Canada

## INTRODUCTION

Ornamental horticulture is an economically important industry in Canada, with consumer retail spending tallied at nearly $6.3 billion for ornamental horticultural products and another $1.8 billion on landscaping services in 2007 nationwide (Deloitte, 2009). In addition, nursery operations have considerable input needs, for example 93.3% of the annual water usage by the Canadian ornamental horticulture sector is by nursery operations (Zheng et al., 2009). Excess fertilization and irrigation is not only costly, but can also injure plants and cause unnecessary water and nutrient runoff, resulting in environmental damage. However, insufficient fertilization can cause plant nutrient deficiencies, reduce crop productivity, and eventually reduce the efficiency of other resource inputs during nursery crop production. When optimal fertilizer application rates are used, nursery crops will perform at their best, and growers will be able to increase their profit margin, while minimizing environmental impacts. For different growing substrates, plants, and climate combinations, optimal fertilization rates will vary. As fertilizer companies continuously improve their products and release new products, research is needed to identify optimal fertilizer rates for nursery crop production. Conducting on-farm trials, with industry-standard cultural practices, is essential for understanding the response of crops to fertilizers, and the fate of the fertilizers (i.e., from application in the growing substrate to plant uptake or runoff to the environment). However, this type of on-farm research is rare, especially in temperate climate regions such as Ontario, Canada, and some states in northern USA.

To meet the research needs of the nursery industry, and provide growers with recommendations on optimal fertilization rates for container-grown nursery crops in temperate climate regions, we conducted extensive on-farm trials in 2012 and 2013. The trials were conducted at four commercial nurseries, located in different regions within Ontario, and at the Vineland Research and Innovation Centre. Four fertilizer types, two application methods (i.e., incorporation and topdressing), and 21 crop species were tested during production in both 1- and 2-gal containers. Based on the large amount of information obtained from these trials, the following results merit particular emphasis in order to increase fertilizer use efficiency and minimize negative environmental impacts during container-grown nursery crop production.

## DIFFERENT SPECIES HAVE DIFFERENT FERTILIZATION REQUIREMENTS

Results from different sites with both the 1- and 2-gal pot sizes showed that individual species responded differently to fertilizer application rates (Agro, 2014; Agro and Zheng, 2014; Clark and Zheng, 2014). For example, when plants were grown in 2-gal pots and fertilized with Polyon® 16-06-12, 5-6 month controlled-release fertilizer (CRF) at multiple rates, euonymus' response to increasing fertilizer application rates was not as positive as observed for hydrangea plants (Fig. 1). As a result, the optimal fertilization rate for euonymus was identified as 0.60 $kg \cdot m^{-3}$ N and 1.49 $kg \cdot m^{-3}$ N for hydrangea (Clark and Zheng, 2014).

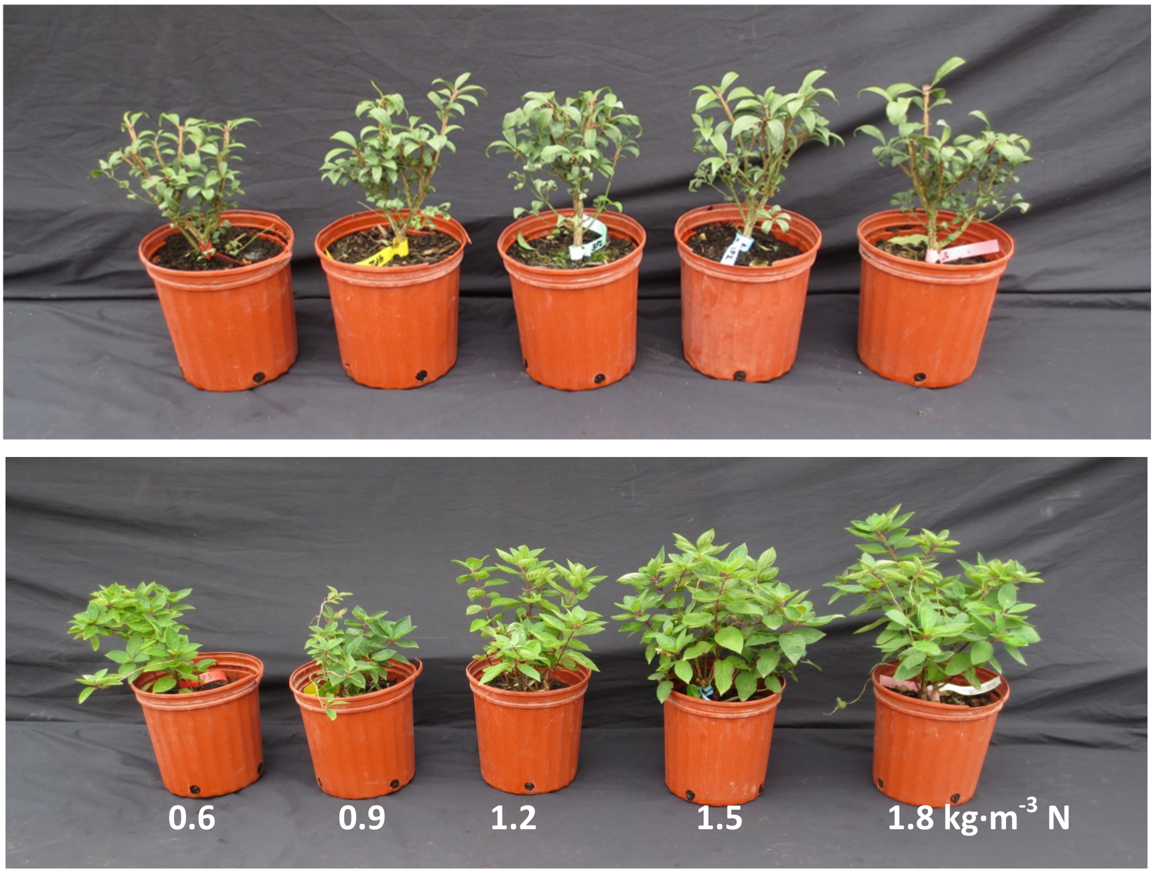


Fig. 1. Response of euonymus (*Euonymus alatus* ‘Compactus’; above) and hydrangea (*Hydrangea paniculata* ‘Grandiflora’; below) plants to five fertilization rates. Plants were transplanted on 5 June 2013 into 2-gal containers having incorporated Polyon® 16-06-12, 5-6 month controlled-release fertilizer at five rates. Photos were taken in September 2013.

By understanding species-specific responses to fertilization and unique optimal fertilizer rates for individual nursery crops, growers can divide crops into fertilizer requirement groups (i.e., low, medium, and high groups). Groups of crops with different fertilizer requirements can be potted with their optimal fertilizer rates at different times, to ensure planting efficiency. By doing so, growers can easily optimize plant growth and minimize excessive nutrient loss from over-fertilization. Based on our observations and discussions with growers, many Ontario nursery operations are currently applying one fertilizer rate for all plant species on the same farm, and some operations are grouping their plants according to water demand, which is a good practice. Growers may like to use these species-specific optimal fertilization rate results (Zheng et al., 2013), and information from other sources, to determine appropriate nursery crop grouping during production.

**FERTILIZER CAN BE USED TO ACCELERATE OR SLOW PLANT GROWTH**

Our research showed that increasing the application rate of incorporated CRF can significantly shorten the time for some crop species to reach marketable size. For example, when growing ninebark (*Physocarpus opulifolius* ‘Nugget’) plants in 2-gal containers from June to September, the acceptable CRF application range is from 1.2 to 1.5 kg nitrogen per $m^3$ of growing substrate (kg·$m^{-3}$ N); however, when CRF rate increased to 1.8 kg·$m^{-3}$ N, production time was reduced by at least 14 days (Clark and Zheng, 2014). Applying an appropriate high fertilizer rate is able to shorten production time, compared to lower rates, thereby saving water and labour costs. However, fertilization rates should be selected to finish crops based on the anticipated shipping schedule, otherwise over-fertilization may cause excess plant growth and resulting labour costs associated with maintaining and pruning plants.

**INCREASING FERTILIZER APPLICATION RATE CAN INCREASE NUTRIENT LOSS TO THE ENVIRONMENT**

By measuring the differences between total nitrogen (N) and phosphorus (P) inputs, and the N and P remaining in the growing substrate and plant tissues, we observed nutrient losses to the environment. For all plant species grown in 1-gal pots at all production sites, increasing fertilizer application rate increased N and P loss to the environment (Agro, 2014). For example, the amount of N and P lost per container increased linearly with increasing fertilizer application rate (Fig. 2). To reduce nutrient loss to the environment, these results suggest that it is a good practice to apply the lowest possible fertilizer rate. However, the rate should provide adequate nutrition for plant growth, since nutrient deficiencies can cause crop failure or prolonged production time, potentially resulting in wasted resources or environmental damage.

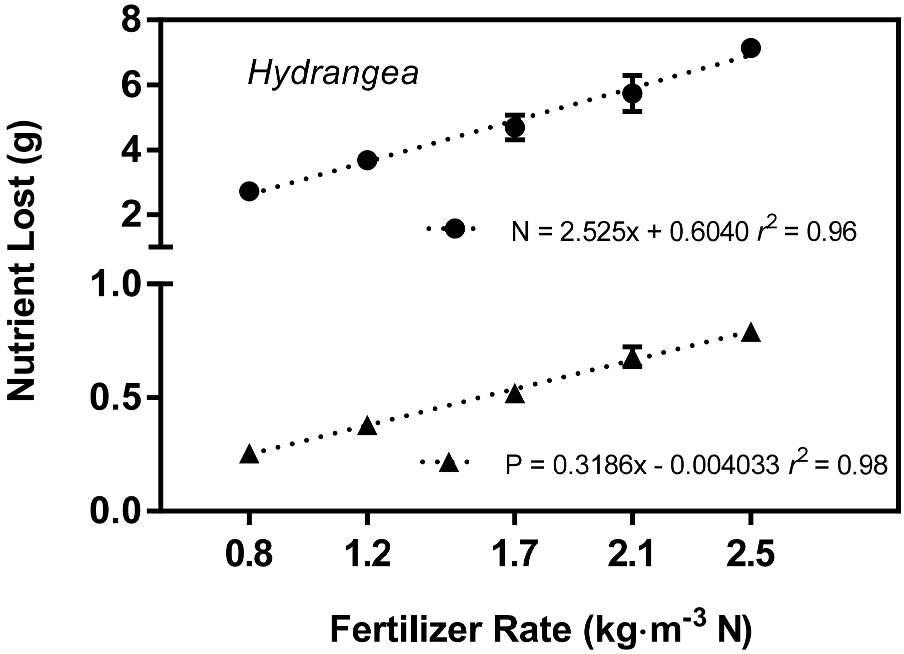


Fig. 2. The nitrogen (N, ●) and phosphorus (P, ▲) lost to the environment ($g{\cdot}pot^{-1}$) from *Hydrangea paniculata* 'Bombshell' grown with five rates of Polyon® 16-06-12, 5-6 month controlled-release fertilizer (Adapted from Agro and Zheng, 2014).

**TIMING AND METHODS OF FERTILIZATION**

Determining when and how to apply CRF is critical in container nursery crop production. For example, CRFs are manufactured to release nutrients at different rates following application, with the expected nutrient release duration ranging from a few weeks to more than a year. An industry practice of applying a high rate of long-duration CRF in the first production year has been considered to avoid labour costs of topdressing in the second year; however, our research showed that this may not be a good practice. For example, when western red cedar (*Thuja plicata* 'Whipcord') liners were potted in 1-gal containers, and an 8–9 month CRF fertilizer was incorporated at multiple rates, the highest rate resulted in a high early-season substrate EC, but the EC quickly decreased during the first 2 months after transplanting (i.e., EC change of $>8\ mS{\cdot}cm^{-1}$ to $<1\ mS{\cdot}cm^{-1}$; Agro, 2014). Therefore, these results suggest applying less fertilizer more frequently to increase fertilizer use efficiency.

To investigate different fertilizer application methods on the growth of container-grown forsythia (*Forsythia* × *intermedia* 'Spring Glory') and nutrient leaching to the environment, Alam et al. (2009) found that a dibble fertilizer placement is superior to both incorporation and topdress for plant growth, under drip irrigation. Greater concentrations of $NO_3$-N generally leached from containers with incorporated fertilizer, followed by dibbled fertilization, than from a topdressed application. In addition, splitting the CRF application into two application times greatly reduced $NO_3$-N in leachate.

There are many different CRFs available to growers, differing in nutrient release mechanisms, durations, and patterns, as influenced by climactic conditions. In addition, nursery production management practices, such as irrigation, influence nutrient release from CRFs. Recent research has shown that both timing and methods of CRF application are important to maximize nutrient use efficiency and minimizing nutrient loss to the environment; however, few research studies have addressed these topics (Alam et al., 2009; Agro and Zheng, 2014; Clark and Zheng, 2014) and more research is needed to best serve the nursery industry.

## LEAF TISSUE ANALYSIS ALONE MAY NOT BE ABLE TO IDENTIFY NUTRIENT DEFICIENCIES

Some extension publications suggest the best way of diagnosing nutrient disorders is by evaluating plant leaf nutrient content by conducting a tissue analysis (e.g., OMAFRA, 2014). This general practice may help to identify nutrient deficiencies for certain species under certain conditions. However, for some species leaf tissue analysis alone may not be able to identify nutrient deficiencies. For example, the overall appearance (Fig. 3) and the measured growth attributes of 'Nugget' ninebark clearly showed that plants fertilized with CRF at 0.6 $kg \cdot m^{-3}$ N were inferior to plants fertilized at higher rates; however the leaf tissue nutrient analysis showed no differences in N, P, K, Mg, or Ca content among plants grown at different CRF rates (Clark and Zheng, 2014).

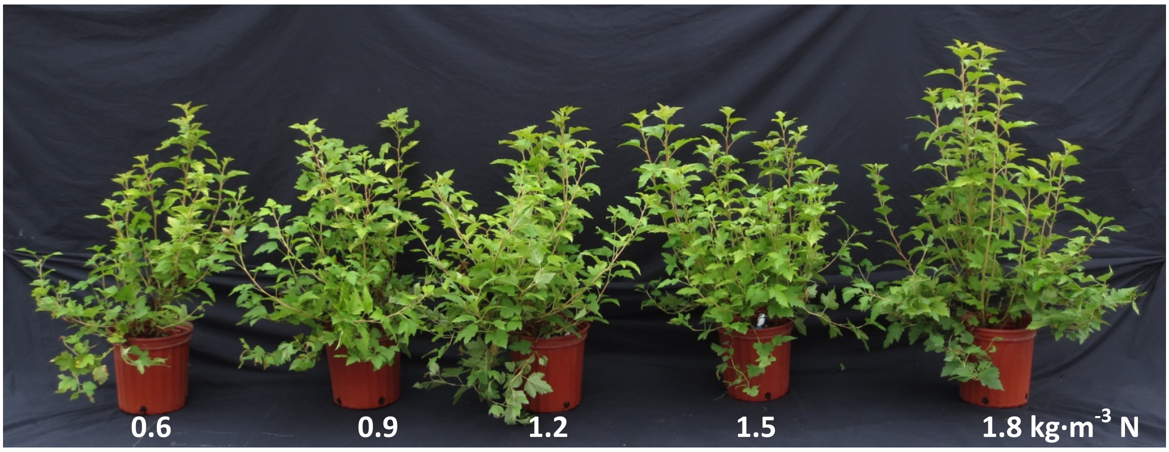


Fig. 3. Plant growth response of *Physocarpus opulifolius* 'Nugget' to a range of controlled-release fertilizer application rates. Plants were transplanted on 5 June 2013 into 2-gal containers having incorporated Polyon® 16-06-12, 5-6 month controlled-release fertilizer at five rates. Photos were taken in September 2013.

Also, leaf tissue nutrient sufficiency ranges are currently unknown for the majority of container nursery species (Plank and Kissel, 2006; Bryson et al., 2014), which limits the ability of growers to clearly determine tissue nutrient deficiencies from tissue nutrient analysis results. In our trials, even when tissue nutrient content values were within the published sufficiency range, poor plant growth and performance were observed at low fertilization rates (i.e., *Spiraea*); conversely, when nutrient contents were below the sufficiency range, no negative impacts were observed for plant growth or performance (i.e., *Cornus*; Clark and Zheng, 2014). In addition, some commonly-grown nursery crops are not included in current nutrient sufficiency recommendations. Therefore, to determine nutrient deficiencies, nursery growers are limited to comparing tissue nutrient content data to generalized survey averages or ranges (Plank and Kissel, 2006; Bryson et al., 2014), or to tissue nutrient analysis results from other plants in their own nursery. Further research is needed to determine nutrient sufficiency standards for prominent nursery crop species, to develop standard tissue nutrient content benchmarks, and to investigate consistent, reliable nutrient disorder diagnostic methods.

## CONCLUSION

In conclusion, fertilizer can be used as a management tool in container nursery production to maximize profit margin and minimize negative environmental impacts. For example, fertilizer can be used to regulate production timing, either to slow plant growth and reduce pruning, or to accelerate growth and shorten production time. To effectively use CRF in container nursery crop production, several aspects need to be taken into consideration, such as fertilizer type, as well as application timing, method, and rate for individual species. During nursery crop production, leaf tissue nutrient analysis alone may not be sufficient to identify nutrient deficiencies. More research is needed on the topics discussed in this publication in order to provide reliable recommendations for improving fertilization practices in container nursery crop production.

## ACKNOWLEDGEMENT

This work was financially supported by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP), Landscape Ontario, and Agrium Advanced Technologies. Thanks to our southwestern Ontario nursery partners and Gro-Bark (Ontario) Ltd. for providing materials, time and expertise.

## Literature Cited

Agro, E.E. 2014. Determination of Optimal Controlled Release Fertilizer Rates for Container Nursery Crop Production in Cold Climates. MSc. Thesis. University of Guelph, Guelph, Ontairo.

Agro, E. and Zheng, Y. 2014. Controlled-release fertilizer application rates for one-gallon container nursery crop production in southwestern Ontario, Canada. HortSci. 49:1414-1423.

Alam, M.Z., Chong, C., Llewellyn, J. and Lumis, G.P. 2009. Evaluating fertilization and water practices to minimize $NO_3$-N leachate from container-grown *Forsythia*. HortSci. 44:1833-1837.

Bryson, G.M., Mills, H.A., Sasseville, D.N., Jones, J.B., Jr. and Barker, A.B. 2014. Plant Analysis Handbook III: A Guide to Sampling, Preparation, Analysis, Interpretation and Use of Results of Agronomic and Horticultural Crop Plant Tissue. Macro-Micro Publishing, Inc., Athens, Georgia.

Clark, M.J. and Zheng, Y. 2014. Species-specific fertilization can benefit container nursery crop production. Can. J. Plant Sci. (in press; ubs.aic.ca/doi/abs/10.4141/CJPS-2014-340).

Deloitte®. 2009. The impact of ornamental horticulture on Canada's economy. <http://www.canadanursery.com/Storage/29/2219_COHA_Deloitte_Report_FINAL_-__January_2009.pdf>.

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). 2014. Nursery & Landscape Plant Production and IPM. URL: <http://www.omafra.gov.on.ca/english/crops/pub841/p841order.htm>.

Plank, C.O. and Kissel, D.E. 2006. Plant Analysis Handbook—Commonly Found Nutrient Concentration Ranges. <http://aesl.ces.uga.edu/publications/plant/contable.asp>.

Zheng, Y., Clark, M.J., Agro, E. and Vinson, K. 2013. Fertilizer can be used as a management tool in container nursery production. <http://vinelandresearch.

com/sites/default/files/2013_nursery_fertilizer_report.pdf>.
Zheng, Y. and Dixon, M. 2009. An economic and environmental competitive impact and market assessment for the Canadian Ornamental Horticulture Alliance—Irrigation, runoff and nutrient management. Report for COHA, Oct., 2008.