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64. © The "4R" nutrient stewardship framework for horticulture. Mikkelsen, R. L. HortTechnology 21(6):658-662. 2011.

Workshop

The "4R" Nutrient Stewardship Framework for Horticulture

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Summary. Improving plant nutrient management is important for environmental, economic, and social considerations. The adoption of the "4R" nutrient stewardship framework (right source, right rate, right time, and right place) provides a basis for examination of the underlying scientific principles behind fertilizer use. These 4R concepts are based in global principles related to chemistry, biology, physics, and economics, but the selection of specific practices is adjusted to individual field conditions, relying on local expertise and data. Various stakeholders have input in the selection of nutrient management practices, and their objectives may not always coincide. The development of performance indicators to measure the progress made by adoption of the 4R management techniques needs to be decided by stakeholders.

Nutrient management for horticultural crops is complex, requiring the integration of biological, chemical, and economic factors. The global food requirement continues to grow, and fertilizer is presently estimated to be responsible for at least half of the current food supply (Erisman et al., 2008; Stewart et al., 2005). Responsible nutrient management and sustainable horticultural production must include consideration of environmental, economical, and social components (Fig. 1). While successful production systems address all three of these components, the focus and attention that each individual component receives depends on stakeholder expectations and may change with improvements in knowledge and practice.

Appropriate management of plant nutrients varies widely depending on the specific objectives of the stakeholders. These groups may include farmers, local organizations, government regulators, and the general public. All of these groups have an interest in food production and can give input on how plant nutrients are used. There is considerable effort to develop "best" management practices (BMP), but there is not always consensus on what is best and these different groups often have competing interests. Management decisions on what is best or right are not only based on scientific data, but include ethical considerations and value judgments that change depending on the objectives of the stakeholders.

With varied expectations of what nutrient management means to different stakeholders, the path to achieve economic, environment, and social goals may sometimes be in conflict. For example, in some areas, environmental targets may be the highest priority. In other regions, specific social goals or economic objectives may be most important. Additionally, these priorities continue to change as society, technology, and scientific knowledge advances.

General fertilizer recommendations are a useful start to guide nutrient application, but they often fail to consider complex crop rotations common in horticultural production. They also cannot predict differences that regularly occur in external factors, such as rainfall, pest pressures, and temperature. Additionally, forecasts of global climate change predict that the occurrence of erratic weather patterns will become more common, requiring additional flexibility to respond to changing conditions.

Plant nutrient management is fundamental to many current global sustainability issues. The direct link of soil management to food production must be addressed to achieve acceptable progress on these challenges. As a comprehensive framework to guide nutrient management decisions, it is universally recognized that it is in our best interests to use the right source of nutrients, in the right rate, at the right time, and in the right place—termed the four rights or 4R. A systematic review of these four factors will greatly assist in selecting the best combination of on-farm practices to meet the desired outcomes.

What are the performance goals?

A method for tracking improvement in nutrient use and successful adoption of management practices requires selection of performance indicators and deciding what to measure. The most common measurements have traditionally been profitability

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
1.1209	lb/acre	kg·ha^{-1}	0.8922