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THE FUTURE OF 4R NUTRIENT STEWARDSHIP

The 4Rs of nutrient stewardship – right source, right rate, right time, and right place – are factors that have been investigated by crop and soil scientists for decades. With such a rich history, does agriculture really have anything new to bring to these management practices?

Right source. Rather than producing only bulk commodities like MAP, DAP, urea, and anhydrous ammonia, fertilizer manufacturers are investing more and more resources into developing new technologies that improve the synchrony between nutrient release and crop uptake. Such advances may significantly increase future nutrient use efficiencies, reducing the risk of nutrient movement to unwanted places in the environment.

Right rate. The standard for past rate recommendations has been static look-up tables. The future is looking very different. Crop growth models are being integrated into nutrient rate algorithms, making it possible to estimate crop nutrient needs during the season as weather changes. Crop sensors also provide valuable in-season assessments of nutritional status, making it possible to alter rates within the season. Ongoing advances in GPS and GIS are making it easier and simpler to design and deploy on-farm nutrient rate experiments. Additionally, freely-available software tools can get rid of “bad” yield monitor data and statistically analyze studies to identify optimum rates. Models that estimate nutrient losses through a variety of pathways continue to develop and some of those algorithms are already finding their way into nutrient rate recommendation tools. All of these advances continue to make scientific methods and knowledge more accessible to farmers and advisers, allowing them to determine what rates work best under local conditions, not only to increase production but also to meet an ever expanding set of ecosystem services.

Right time. Changing weather patterns are making it difficult to rely on some past application timings to achieve the same results. The suite of tools available for on-farm research allows farmers and advisers to test different application timings to determine which ones produce the highest yields as well as have the best logistics. Equipment is constantly changing as well, increasing the time window in which applications can be made. Improved fertilizer technologies may also provide more options in the future.

Right place. Real-time kinematic (RTK) guidance systems have created unprecedented records of where bands are placed in the field, making it possible to create, over time, customized networks and configurations of sub-surface bands. In the future, these bands could be arranged to be in the best position for each crop in the rotation. Research continues as well into where to place nutrients in the landscape and how to combine that placement with other management practices, such as buffer strips, tillage, and cover crops, to reduce nutrient losses.

While the 4Rs have a rich history, they also have a promising and bright future. Improvements in nutrient management have always been a process rather than an end point. The journey ahead will bring many innovations that can improve our ability to achieve not only production and economic goals, but social and environmental targets as well.

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For more information, contact Dr. T. Scott Murrell, Northcentral Director, IPNI, Phone: (765) 413-3343. E-mail: smurrell@ipni.net.

Abbreviations: MAP = monoammonium phosphate; DAP = diammonium phosphate; GPS = global positioning system; GIS = geographic information system.

Note: *Plant Nutrition TODAY* articles are available online at the IPNI website: www.ipni.net/pnt