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Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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MANAGING PLANT NUTRITION FOR MULTIPLE GOALS

Managing plant nutrition sustainably requires that multiple goals be addressed at the same time. Plant nutrition research focuses on many diverse goals. They include maximum crop yields, maximum economic yields, lower emissions of ammonia and nitrous oxide to the air, and smaller losses of nitrate and phosphate to water. Scientists also seek to manage plant nutrition for the quality and healthfulness of the foods harvested.

In some cases, there are trade-offs. Practices that maximize yields don't always minimize nutrient losses. Nutrient sources that minimize ammonia loss may not minimize nitrate loss. Rates of N that maximize corn yields don't always minimize nitrate losses. Application timing for P in the fall may maximize economic yield but may not minimize risk of phosphate loss. Placement of phosphate in the soil may decrease loss of dissolved phosphate in runoff, but the soil disturbance may increase total phosphate loss through erosion. **So how do we reach all these goals at once?**

The first step is to look for what these goals have in common. They are all related to, and impacted by, choices for source, rate, time and place of nutrient applications. These choices are all site-specific; they change with soil properties like texture and drainage, and with changes in weather and climate. And there's a tendency that whenever nutrient use efficiency is improved, opportunity for nutrient losses goes down. This tendency is most obvious for the larger potential losses, like ammonia volatilization and nitrate leaching, but it holds true even for the small losses that cause big impacts such as nitrous oxide emissions warming the atmosphere.

The second step is to embrace the 4Rs. It means choosing the right source, right rate, right time and right place for each nutrient application. That means looking for things the key nutrients have in common, with respect to how they behave in site-specific interactions of the weather with the soil. Nitrogen and P are the two nutrients that have the most significant impacts on air and water. The similarities in the way they respond to the 4Rs are numerous.

Source. The most economic sources of P—manure, commercial ammoniated phosphate fertilizers—contain N. Right time and place minimizes losses of both nutrients.

Rate. Since N is mobile in soils in more humid climates, its optimum rate depends mostly on weather and crop yield potential. The optimum rate of P depends more directly on soil test level, but the rate to maintain that soil test level is proportional to yield too. Right rate considers crop demand.

Time. In climates with excess rainfall, the optimum time to apply N is as close before crop uptake begins as is practical, since excess rain can cause either nitrate leaching or denitrification losses. While the optimum time to apply P is more flexible, P losses, too, are driven by rain. It's important to minimize the risk of water running off the field after any source of P has been broadcast on the soil surface. An eye on the weather forecast is important for both nutrients. Applying before a gentle rain that can move the nutrients into the soil yields much different results than before a hard rain that drives losses through runoff, leaching and denitrification.

Place. Loss risks of both N and P are minimized by placement in the soil. Ammonia escapes to the air much less when fertilizers containing urea or ammonium are mixed into the soil. Risk of phosphate loss in runoff is reduced when fresh fertilizer applications aren't lying on the soil surface when runoff events occur.

The weather is not a controllable factor. So you need to tailor the 4Rs to the weather. To manage for multiple goals, focus on the similarities of how your key nutrients respond to the weather.

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Abbreviations: N = nitrogen; P = phosphorus.

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