The BMPs discussed here are organized under the categories of right form, right rate, right time, and right place.

**Right Form**

Fall applications. Use ammoniacal or ammonium forms of N. Many consider anhydrous ammonia to be the best form to minimize loss of nitrate ($\text{NO}_3^-$) because it has the slowest rate of nitrification. Good chances exist that a nitrification inhibitor will provide benefits on poorly drained soils and soils with higher moisture levels near the surface when N is not applied in excess. Fall applications with a nitrification inhibitor risk not being as effective as the same rate of N applied in the spring. Use of urea is acceptable in drier climates, such as parts of western Minnesota and South Dakota, if it is incorporated soon after application on soils with lower leaching and denitrification loss potentials. A urease inhibitor may provide benefits when incorporated or if 0.2 to 0.5 in. of rain does not occur within 2 to 3 days after application. Forms containing $\text{NO}_3^-$ are not recommended.

**Pre-plant or side-dress applications.** On sandy soils, anhydrous ammonia performs best and forms containing $\text{NO}_3^-$ should be avoided because of chances of leaching losses. On medium and fine textured soils, ammoniacal and ammonium forms, such as anhydrous ammonia and urea, reduce chances of $\text{NO}_3^-$ loss. A nitrification inhibitor will usually provide benefits with pre-plant and early side-dress applications on poorly drained soils when N is not applied in excess. Fair chances exist for silt loams and coarser textured soils. A urease inhibitor can provide benefits when incorporation of urea or urea ammonium nitrate (UAN) is not possible within 2 to 3 days after application.

**Right Rate**

Setting realistic yield goals. For recommendations using a yield goal approach, use the average yield of the previous 5 year production levels of a given crop, then add a small percentage increase to account for a possibly higher, future attainable yield potential. Abnormally low yields should be excluded from the average. Many states in the Northcentral Region have shifted N recommendations from a yield goal-based approach to methods that no longer consider yield levels. This change has occurred because of the lack of an observed relationship between economically optimum N rates and yield, analyzed across many site years of production.
available and either account for the NO3 changeable by the user. Making model parameters more explicit and making yield goal-based recommendations, making the approach application model. Other states are currently retaining data across several states. This approach avoids the need for the user to calibrate the model. The results are state-specific.

Fall applications. Fall applications. Fall applications. Fall applications. Fall applications. A p p l y ammoniacal and/or nitrate forms of N only when soil temperatures are sustained below the critical temperature for the crop grown. These assessments can be used to alter future management practices.

Post-season assessment. Post-season assessment. Post-season assessment. Post-season assessment. Post-season assessment. Measuring earleaf N concentrations and/or using the stalk nitrate test can provide indications of the sufficiency of N for the crop grown. These assessments can be used if a reference strip has been left in the field. Reference strips are those where N applications were made no later than about 6 weeks after planting. Post-season assessments are not recommended.

Accounting for all N sources. Accounting for all N sources. Accounting for all N sources. Accounting for all N sources. Accounting for all N sources. R e c o r d the effects of legumes on corn response to applications of ammonium forms on calcareous soils or ammonium forms on calcareous soils or ammonium forms on calcareous soils. Legumes should be credited or consideration given to the effects of legumes on corn response to applications of ammonium forms on calcareous soils or ammonium forms on calcareous soils. Legumes applied in other fertilizers and applied at other locations, rate, and nutrient concentration of applied N. Second year effects should be considered.

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Some N applied with or near the seed at planting provides a small supply of strategically-placed N early in the season. This can be especially important when the primary N application is banded between the rows. Plant root growth early in the season may not be extensive enough to reach this banded N, increasing the reliance on the N applied near the seed during planting. Placement in direct contact with seed limits the rates of N that can be applied (Table 1). It also carries higher risk of salt damage than placement a small distance from the seed, such as 2 in. to the side and 2 in. below (2x2).

Summary

The BMPs provided here for N use on corn represent general approaches used by many states in the Northcentral Region. Recommendations may vary for specific locations where more specialized BMPs exist.

For more detailed information and references pertaining to the BMPs described here, visit the Northcentral Region website at www.ppi-far.org/norg/northcentral. The website also has a similar summary of BMPs outlined for phosphorus and potassium in corn production in the Northcentral Region.

Table 1. Maximum recommended nutrient rates of starter fertilizer to be applied in direct contact with corn seed during planting at a row spacing of 30 in. Urea, UAN, and ammonium thiosulfate are not recommended for placement with the seed.

<table>
<thead>
<tr>
<th>State</th>
<th>Max. rate of N+K2O, lb/A</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa</td>
<td>10</td>
<td>Soils with adequate moisture, not sandy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 Sandy and/or dry soils.</td>
</tr>
<tr>
<td>Illinois</td>
<td>13-16</td>
<td>Rate range is for normal moisture conditions. In excessively dry spring conditions, these rates may be too high.</td>
</tr>
<tr>
<td>Indiana</td>
<td>8</td>
<td>Soils with CEC &gt; 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 Soils with CEC &lt; 7</td>
</tr>
<tr>
<td>Minnesota</td>
<td>12-16</td>
<td>Information calculated from data in Table 5 (in the reference) for the 10 gal/A rate, assuming 11.2, 10.3, and 11.65 lb/gal densities for 7-21-7, 4-10-10, and 10-34-0, respectively. Rates are based on adequate moisture. If soils are dry at planting, some seed damage can occur at these rates.</td>
</tr>
<tr>
<td>South Dakota</td>
<td>10</td>
<td>Medium and finer textured soils with adequate moisture. For dry and/or sandy soils.</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>10</td>
<td>For sources other than urea.</td>
</tr>
</tbody>
</table>

“Toolbox” is a feature on the PPI/PPIC website which holds free downloadable software tools for improved nutrient management. One useful tool is called PKalc (v.1.13), a simple balance calculator which helps users determine if phosphorus (P) and potassium (K) nutrient additions are keeping up with removal by crops. PKalc Software Checks Nutrient Balance users determine if phosphorus (P) and potassium (K) nutrient additions are keeping up with removal by crops. PKalc and other programs can be accessed for free at www.ppi-far.org/toolbox. Dr. Murrell is PPI Northcentral Director, located at Woodbury, Minnesota; e-mail: smurrell@ppi-far.org.