

# REGIONALIZING FERTILIZER RECOMMENDATIONS FOR NORTH DAKOTA, SOUTH DAKOTA AND WESTERN MINNESOTA

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## ABSTRACT

Fertilizer recommendations have varied between adjacent states. The inconsistencies at state lines made educational efforts in soil fertility more difficult for companies doing business across state lines. In an effort to alleviate these problems, the agronomists working with fertilizer calibration data and recommendations from the three states of North Dakota, South Dakota and Minnesota put together a recommendation system which could be used in a large part of all three states. The basic "core" set of recommendations is the same for all states with adjustments for special cases made by each state. The three states implemented the "Tri-State Recommendations" July 1, 1992.

## INTRODUCTION

Fertilizer recommendation systems have been developed by each states' Land Grant University. The core of these recommendations have been based on fertilizer calibration research in each state with some understanding and knowledge of neighboring state efforts. Due to variability in soils, climate, cropping systems, priorities from within each state and individual approaches, recommendation systems developed are usually different for each state. The result was a "different" fertilizer recommendation when someone stepped across the border between two states even though the soil, soil test level and crop are the same.

The differences in recommendations between states often were not large, however, it posed an educational problem for companies working across state lines and somewhat of a credibility problem for the states involved. To correct the problems, industry agronomists and others who worked across the North Dakota, South Dakota and Minnesota area urged the three states combine, where possible, fertilizer recommendation systems. The three states had a history of routinely meeting to discuss fertilizer recommendations for almost 20 years. Therefore, recommendations were very similar. The initial meetings to explore the possibility of actually joining the three state systems took place in the summer of 1990.

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## DISCUSSION

The initial goals of the North Dakota, South Dakota and Minnesota group were to: 1) Use boundaries other than state lines such as soil types and climate when making fertilizer recommendations 2) develop one core set of recommendations, and 3) develop a system that was easy to understand by everyone involved, including the general public. It was felt such a system would also aid in soil testing and fertilizer recommendation education.

It appeared some of the confusion and differences in fertilizer recommendations between states could be cleared up by specifically defining what low medium and high meant and by assigning the same soil test values to each "category" for the three states involved. The decision was to define soil test categories for most nutrients by expected probability of response (Table 1). Probabilities of response ranged from less than 20% for very high soil tests to more than 80% for very low soil tests.

**Table 1. TRI STATE FERTILIZER RECOMMENDATION SYSTEM DEFINITION OF SOIL TEST CATEGORIES.**

| <u>Category</u> | <u>Probability of Response</u><br>% |
|-----------------|-------------------------------------|
| Very Low        | > 80                                |
| Low             | 60-80                               |
| Medium          | 40-60                               |
| High            | 20-40                               |
| Very High       | < 20                                |

It was recognized that some crops do not respond as well as others in a particular category. For ease of use, however, and realizing that almost all crops are grown in a rotation, the group decided to use the same categories for all crops.

Specific soil test values for phosphorus potassium and the other nutrients were assigned to the soil test categories (Tables 2 and 3). Categories were not defined for manganese, iron, copper and boron because soil tests for these nutrients have not been calibrated in North or South Dakota and Western Minnesota. In addition, categories for nitrogen soil tests were not identified because calibration of the nitrate nitrogen test is dependent on yield goal and crop.

Most soil testing labs doing business in the three state area use both the Bray and Olsen soil tests for phosphorus. The decision was made to use a linear

relationship between these two tests (Table 2). It was also decided to use ppm for reporting all soil test levels except for the nitrate, chloride and sulfate sulfur soil tests. In addition, the three states agreed to use similar legume credits. (Table 4).

**Table 2. TRI-STATE SOIL TEST LEVELS FOR PHOSPHORUS AND POTASSIUM CATEGORIES**

| Test     | Soil Test Category |       |        |         |      |
|----------|--------------------|-------|--------|---------|------|
|          | VL                 | L     | M      | H       | VH   |
|          | -----ppm-----      |       |        |         |      |
| Bray-1-P | 0-5                | 6-10  | 11-15  | 16-20   | 21+  |
| Olsen P  | 0-3                | 4-7   | 8-11   | 12-15   | 16+  |
| NH4Ac K  | 0-40               | 41-80 | 81-120 | 121-160 | 161+ |

**Table 3. TRI-STATE SOIL TEST LEVELS FOR SECONDARY AND MICRONUTRIENT CATEGORIES**

| Test  | Soil Test Category    |           |           |            |       |
|---|-----------------------|-----------|-----------|------------|-------|
|   | VL                    | L         | M         | H          | VH    |
|   | -----ppm-----         |           |           |            |       |
| Zn (DTPA) <sup>1</sup>                                  | 0 -.25                | .26 - .50 | .51 - .75 | .76 - 1.00 | 1.01+ |
| Fe (DTPA)   | - no categories       |           |           |            |       |
| Mn (DTPA)   |                       |           |           |            |       |
| Cu (DTPA)   |                       |           |           |            |       |
| B (Hot H <sub>2</sub> O)                                |                       |           |           |            |       |
| Mg (NH4Ac)  | 0 - 10                | 11 - 20   | 21 - 30   | 31 - 40    | 41+   |
| Ca (NH4Ac)  | 0 - 100               | 101-200   | 200-300   | 301 - 400  | 401+  |
|   | -----lb/A 2 feet----- |           |           |            |       |
| S (500 ppm P)   | 0 - 9                 | 10 - 19   | 20 - 29   | 30 - 39    | 40+   |
| C1 <sup>2</sup> (0.5 M K <sub>2</sub> SO <sub>4</sub> ) | 0 - 15                | 16 - 30   | 31 - 45   | 46 - 60    | 61+   |

<sup>1</sup> Corn, sorghum, flax, potatoes, edible beans only

<sup>2</sup> Wheat, barley, rye only.

**Table 4. TRI-STATE FERTILIZER RECOMMENDATION LEGUME N CREDITS<sup>1</sup>**

| Previous<br>Crop           | crop to be grown          |             |
|----------------------------|---------------------------|-------------|
|                            | Short Season <sup>2</sup> | Full Season |
|                            | lb N per acre (bu)        |             |
| Soybean (bu)               | 0.5                       | 1.0         |
| Alfalfa (harvested)        |                           |             |
| Sweet Clover (unharvested) |                           |             |
| Plants/sq. ft: > 5         | 75                        | 150         |
| 3-4                        | 50                        | 100         |
| 1-2                        | 25                        | 50          |
| < 1                        | 0                         | 0           |
| Sweet Clover (harvested)   | 10                        | 20          |
| Red Clover (harvested)     | 35                        | 70          |
| Edible bean, Field pea     | 10                        | 20          |

<sup>1</sup> 2nd year credits are half of 1st year

<sup>2</sup> Small grains

Fertilizer rate recommendations for the three state area were compared. For most nutrients with a given soil test and crop yield goal, recommendations were very similar. With that in mind, the core of the fertilizer rate recommendation system was developed for the three states by simply averaging most of the three state recommendations. The intent at that time was not to review all calibration data or make major changes in rate recommendations. In some situations, however, changes had to be made and current research was considered.

Equations were developed for the nitrogen phosphorus and potassium recommendations to eliminate numerous tables and aid in the computerization of the system (Table 5). Fertilizer recommendations for zinc, magnesium, calcium, sulfur and chloride were also consolidated (Table 6).

North Dakota, South Dakota and the western portion of Minnesota implemented the new system and recommendations July 1, 1992. Future plans are to review recommendations on a regular basis and make changes as indicated by past and current research.

Table 5. EQUATIONS FOR NITROGEN, PHOSPHORUS AND POTASSIUM TRI STATE FERTILIZER RECOMMENDATIONS.

| Code, Crop, Yield unit        | N<br>Recommendation <sup>1</sup> | P <sub>2</sub> O <sub>5</sub><br>Recommendation | K <sub>2</sub> O<br>Recommendation |
|-------------------------------|----------------------------------|---|------------------------------------|
| 01, Alfalfa, ton              | none                             | =18.57YG-0.93STP*YG                             | =55.71xYG-0.38STK*YG               |
| 02, Alfalfa-Grass, ton        | none                             | "   | "                                  |
| 03, Alfalfa(new seeding), ton | none                             | "   | "                                  |
| 04, Grass, ton                | =25YG                            | =45.0-2.5STP                                    | =80.0-0.53STK                      |
| 08, Sudangrass, ton           | =25YG-STM                        | =11.0YG-0.533STP*YG                             | =43.0YG-0.3STK*YG                  |
| 09, Grass(new seeding), ton   | =25YG                            | =45.0-2.5STP                                    | =80.0-0.53STK                      |
| 10, Corn(grain), bu           | =1.2YG-STM                       | =0.7YG-0.035STP*YG                              | =1.166YG-0.0073STK*YG              |
| 11, Corn(silage), ton         | =10.4YG-STM                      | =5.62YG-0.28STP*YG                              | =9.5YG-0.06STK*YG                  |
| 12, Sorghum, bu               | =1.1YG-STM                       | =0.666YG-0.033STP*YG                            | =0.875YG-0.0058STK*YG              |
| 14, Soybean, bu               | -----                            | =1.55YG-0.10STP*YG                              | =2.20YG-0.0183STK*YG               |
| 15, Edible Beans, lb          | =0.0875YG-122.5-STM              | =0.0231YG-0.0011STP*YG                          | =0.03460YG-0.00021STK*YG           |
| 16, Barley(feed), bu          | =1.7YG-STM                       | =0.785YG-0.039STP*YG                            | =1.286YG-0.0085STK*YG              |
| 17, Barley(malting), bu       | =1.5YG-STM                       | =0.785YG-0.039STP*YG                            | =1.286YG-0.0085STK*YG              |
| 18, Wheat(winter), bu         | =2.5YG-STM                       | =1.071YG-0.054STP*YG                            | =2.71YG-0.017STK*YG                |
| 19, Wheat(spring), bu         | "                                | "   | "                                  |
| 20, Rye, bu                   | "                                | "   | "                                  |
| 21, Oats, bu                  | =1.3YG-STM                       | =0.644YG-0.032STP*YG                            | =1.2777YG-0.0086STK*YG             |
| 22, Flax, bu                  | =3.0YG-STM                       | =1.170YG-0.058STP*YG                            | =2.2YG-0.014STK*YG                 |
| 23, Rape Seed, Canola, cwt    | =6.5YG-STM                       | =3.6YG-0.17STP*YG                               | =5.4YG-0.034STK*YG                 |
| 24, Mustard, cwt              | "                                | "   | "                                  |
| 25, Millet, lb                | =0.035YG-STM                     | =0.0171YG-0.00085STP*YG                         | =0.03YG-0.00018STK*YG              |
| 26, Potatoes, cwt             | =0.4YG-STM                       | =0.5YG-0.026STP*YG                              | =0.85YG-0.0057STK*YG               |
| 27, Sunflowers, lb            | =0.05YG-STM                      | =0.0225YG-0.0011STP*YG                          | =0.041YG-0.00027STK*YG             |
| 28, Garden                    | =3.5-0.03STM                     | =3.6-0.18STP                                    | =5.4-0.03STK                       |
| 29, Fallow                    | -----                            | -----   | -----                              |
| 30, Buckwheat, bu             | =2.2YG-STM                       | =1.32YG-0.066STP*YG                             | =1.86YG-0.0116STK*YG               |
| 31, Lawn                      | =4.0-0.04STM                     | =2.5-0.125STP                                   | =5.0-0.0286STK                     |
| 32, Lawn(new seeding)         | =2.0-0.025STM                    | =5.0-0.25STP                                    | =5.0-0.0286STK                     |
| 33, Safflower, lb             | =0.05YG-STM                      | =0.027YG-0.0014STP*YG                           | =0.048YG-0.0003STK*YG              |

Abbreviations: YG = yield goal; STM = soil test nitrogen, lb/A; STP = soil test Bray #1 Phosphorus (ppm); STK = soil test potassium (ppm).

<sup>1</sup>A sampling date adjustment and previous crop N credit should be subtracted from the N recommendation when appropriate.

**Table 6. TRI-STATE SECONDARY AND MICRONUTRIENT FERTILIZER RECOMMENDATIONS.**

| Nutrient        | Soil Test                        |       |                    |       |    |
|-----------------|----------------------------------|-------|--------------------|-------|----|
|                 | VL                               | L     | M                  | H     | VH |
|                 | -----lb/A-----                   |       |                    |       |    |
| Zn <sup>1</sup> | 10                               | 10    | 5                  | 0     | 0  |
| Mg              | 50                               | 50    | 25                 | 0     | 0  |
| Ca              | Lime                             | Lime  | 0                  | 0     | 0  |
| S-coarse        | 25                               | 25    | trial <sup>3</sup> | trial | 0  |
| S-med, fine     | trial                            | trial | 0                  | 0     | 0  |
| C1 <sup>2</sup> | -----60 minus soil chloride----- |       |                    |       | 0  |

<sup>1</sup> Corn, sorghum, flax, potatoes, edible beans only.

<sup>2</sup> Wheat, barley, rye only.

<sup>3</sup> Trial basis only

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