SF1448

Fertilizing Winter Wheat

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Winter wheat fertilization recommendations in North Dakota previously were similar to spring wheat and durum.

As a larger research base was developed for spring wheat and durum, separating the winter wheat from other wheats became necessary due to their unique nutrient requirements.

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Nitrogen

Nitrogen timing

Winter wheat can be fertilized with the entire nitrogen amount in the fall, but studies in many winter wheat-growing areas show a consistently better yield response and greater nitrogen use efficiency when the bulk of N is applied in the spring at green-up. In addition, fertilizing on frozen soils that have a low chance of thaw before spring is a very poor fertilizing strategy. Frozen soil does not allow N to move into soil, so the N is free to move during snowmelt. Very large N losses are common when fertilizing onto frozen ground. A spring application is sometimes difficult due to uneven snowmelt and potentially wet soil conditions, but morning frosts once the snow melts usually enable a timely application.

Use of UAN (28-0-0) liquid fertilizer with stream bars is a preferred application method. Broadcast UAN applications should not be used due to leaf burn that will result. Stream bars should be monitored during application so that the stream pattern is not broken apart by wind. If the pattern is broken by wind, the stream-bar application will result in a broadcastlike application and severe leaf burning will result.

Urea granules may be used, but potential ammonia volatility is a concern if rain does not fall within a couple of days. No-till seedings are particularly at risk due to the high concentration of urease enzyme in residue compared with bare soil. Ammonia loss from urea breakdown due to urease activity is greatest when soil/residue is moist, temperatures are above freezing and the wind is blowing. The urease inhibitor Agrotain® (NBPT) may be used on urea to extend urea effectiveness through reduced ammonia volatilization for about 10 days. No other products have been shown to inhibit urease activity consistently to be recommended in North Dakota.

Nitrogen rates

Nitrogen rate cannot predict yield. Previous recommendation formulas forced a grower to predict a yield and then apply the yield prediction to a formula. This strategy often results in underfertilization in some years due to less than ideal growing conditions at the time of fertilization. Weather in the region is unpredictable, and often growing conditions improve and better yields are possible than those planned for initially. A better strategy is to rely on historical yield trends for a farm or soil than to try to predict the yield in the current year and then try to use a formula to come up with the “perfect” N rate. Therefore, consider the relative productivity of a farm or area within a farm as

- Low: yields below 40 bushels per acre
- Medium: yields between 40 and 70 bushels per acre
- High: yields greater than 70 bushels per acre

For areas of low productivity, total available N (fertilizer + soil test nitrate 2 feet) = 100 lb N/acre

For areas of medium productivity, total available N (fertilizer + soil test nitrate 2 feet) = 150 lb N/acre

For areas of high productivity, total available N (fertilizer + soil test nitrate 2 feet) = 200 lb N/acre

Table 1. Previous crop N credits.

Previous crop	Credit
Soybean	40 lb N/acre
Edible bean	40 lb N/acre
Pea and lentil	40 lb N/acre
Chickpea	40 lb N/acre
Sweet clover that was harvested	40 lb N/acre
Alfalfa that was harvested and unharvested sweet clover:	
>5 plants/sq. ft.	150 lb N/acre
34 plants/sq. ft.	100 lb N/acre
12 plants/sq. ft.	50 lb N/acre
<1 plant /sq. ft.	0 lb N/acre
Sugar beet	
Yellow leaves	0 lb N/acre
Yellow/green leaves	30 lb N/acre
Dark green leaves	80 lb N/acre

Adjustments to N rate

Previous crop N credits – see table 1.

Second-year N Credits

Half of credit given for the first year for sweet clover and alfalfa, none for other crops.

Reductions in N rate due to location within the Langdon region

See Figure 1 for the agri-climatology zone referred to as the Langdon region. If growing winter wheat in this region, reduce N rates by 40 lb/acre.

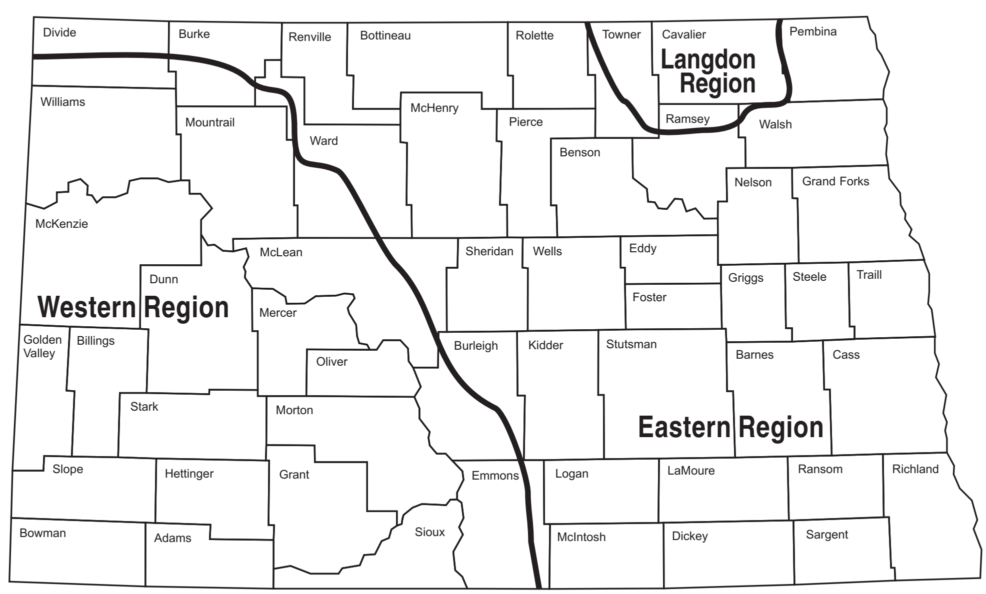

Figure 1. Agri-climatology zones in North Dakota for consideration of N rates.

This reduction is due to the unique climatic and soil conditions in this area that promote increased soil and residue mineralization and release of N to growing crops.

Phosphate

Applying banded phosphate (P) to winter wheat at seeding is extremely important. Phosphate helps the plants establish good root systems and crowns going into winter and helps winter survival. Broadcast P may be better than no P, but the difference in efficiency between the two applications in winter wheat is very pronounced.

Table 2. Banded fertilizer phosphate recommendations for North Dakota for winter wheat based on soil test (Olsen sodium bicarbonate) and productivity level.

	Soil Test Phosphorus, ppm				
Productivity level	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+
bu/acre	Pounds P_2O_5/acre				
<40	39	28	17	15	15*
40-70	60	40	25	15	15
>70	80	60	40	15	15

* Always include a small amount of starter P fertilizer in a band regardless of soil test results. If starter fertilizer banding is not used, rates in H and VH categories should be zero.

When banding granular or liquid fertilizer with the seed, do not exceed rates of N + K_2O as provided in Tables 3 and 4. If fertilizer must be applied at rates exceeding those in the tables, some change in fertilizer delivery must be made on the seeder so that the seed and fertilizer application is separated by at least 1 inch, preferably 2 inches.

Potassium

The potassium (K) recommendations have been changed. Finding responses to K when soil test K levels are greater than 100 parts per million (ppm) is difficult. Nearly all of the higher soil test K responses are related to a chloride response. Most soils in North Dakota have high enough potassium (K) levels to support excellent wheat production. Exceptions might be sandier soils or soils with a history of many years of continuous soybean. Current K fertilizer recommendations are displayed in Table 5. The recommendation in higher testing soils is provided to replace K that the crop will remove and to provide chloride if necessary. If chloride levels are adequate and other crops in the rotation regularly receive K fertilizer, then fertilizer rates in the high range of soil tests may not be needed.

Table 3. Maximum N + K_2O fertilizer rates with wheat seed at planting based on row spacing, planter opener type and seedbed utilization (from Deibert, 1986). SU = seedbed utilization.

		Row spacing, inches							
		6		7.5		10		12	
Planter opener type	Seed spread	SU	lb N+K_2O/ acre	SU	lb N+K_2O/ acre	SU	lb N+K_2O/ acre	SU	lb N+K_2O/ acre
	inches								
Double-disc	1	17%	20-30	13%	19-28	10%	17-23	8%	15-20
Hoe	2	33%	32-44	27%	27-38	20%	23-31	17%	20-27
	3	50%	44-58	40%	37-48	30%	30-40	25%	26-34
Sweep	4	66%	56-72	53%	46-58	40%	37-48	33%	32-42
	5	83%	68-86	68%	56-68	50%	44-57	44%	38-49
	6	100%	80-100	80%	66-79	60%	51-55	50%	44-56
	7			94%	76-90	70%	58-74	58%	50-64
	8					80%	66-83	67%	56-71
	9					90%	73-92	75%	62-78
	10					100%	80-100	83%	68-86
	11							92%	74-93
	12							100%	80-100

Table 4. Maximum N + K_2O fertilizer rates with wheat at planting based on soil texture and seedbed utilization. From Deibert, 1986.

				Percent seedbed utilization		
Soil texture	— Particle size — sand	silt	clay	10-20 Double-disc 1 inch	30-50 Hoe 2-3 inches	60-100 Sweep 4-12 inches
	Percent			lb N + K_2O /acre		
Loamy sand	80	10	10	5	10-20	25-40
Sandy loam	60	35	15	10	15-25	30-45
Sandy clay loam	55	15	30	15	20-30	35-50
Loam	40	40	20	20	25-35	40-55
Silt loam	20	65	15	25	30-40	45-60
Silty clay loam	10	55	35	30	35-45	50-70
Clay loam	30	30	40	35	40-50	55-80
Clay	20	20	60	40	45-55	60-100

Table 5. Potassium recommendations for winter wheat.

Soil test K > 100 ppm, no additional K required.
KCl (0-0-60-50Cl) may be applied if Cl levels are low.
Soil test K 100 ppm or less, apply 50 lb/acre KCl (30 lb/acre K_2O)

Sulfur

Sulfur is becoming more important than potassium or chloride in the state as a third major nutrient. Environmental regulations on fossil fuel emissions have put more stringent restrictions on sulfur emissions in recent years. This has resulted in less sulfur through rainfall than in past years.

The sulfur soil test is not a good predictor of possible sulfur deficiency. A more useful method to determine whether soils within a field likely will be S deficient is to consider which soils are sandy loam or coarser textured with less than 3 percent organic matter on higher landscape positions. If soils with these properties are present, review fall and spring rainfall conditions.

If the fall and/or early spring seasons received normal to greater than normal rainfall or greater than normal winter snow, then the stage is set for possible sulfur deficiency and a pre-emptive spring fertilizer application should include a soluble sulfur fertilizer.

Ammonium sulfate at rates of about 10 lb S/acre or gypsum at 20 lb S/acre would be excellent sources of sulfur. Elemental sulfur, even premium bentonite-blended forms, would not be nearly as useful in correcting a deficiency. The new granules of phosphate fertilizers that include sulfur could be used, but rates would need to be high enough to supply the 10 lb S/acre needed as the ammonium sulfate portion of the fertilizer, or the application should be supplemented with a sulfate containing fertilizer.

Sulfur application is best done in the spring. Gypsum or ammonium sulfate may be blended with a urea top-dress application, while ammonium sulfate solutions or ammonium thiosulfate may be applied with stream bars (not broadcast nozzles) along with 28-0-0.

Copper

Increases in yield and decreases in fusarium head blight (scab) have been documented in North Dakota with the application of copper (Franzen et al., 2008). The responses to copper were seen mostly on low organic matter, sandy soils. However, only about 15 percent of the sites that fit these criteria in the study responded. Predicting whether wheat grown on these soils would respond to copper would be difficult.

Copper application is a site-specific nutrient at best. Wheat would not benefit from its application on loam soils or heavier, or in soils with between 3 percent and 8 percent organic matter. An application of copper sulfate at a rate of 5 lb Cu/acre would last many years.

Chloride

Chloride responses are well-documented in wheat. In studies in the state and the region, wheat tends to respond positively to chloride about half the time, with yield increases in the 2- to 5-bu/acre range. Studies in consecutive years that investigated varietal responses to chloride provided inconsistent results. Yield increases from chloride arise from increased resistance to certain root and leaf diseases and an increase in kernel size. The critical level of chloride is 40 lb/acre in the surface 2 feet of soil. If the soil test is less than 40 lb Cl/acre, fertilizing with 5 to 10 lb Cl/acre with or near the seed at planting should supply the crop sufficiently for the year. The most common source of Cl is KCl (potash, 0-0-60). When adding Cl to fertilizer, refer to Tables 3 and 4 so critical levels of N + K_2O are not exceeded.

Other nutrients

No evidence is available to indicate that supplemental zinc, iron, manganese and boron are needed in North Dakota. Although numerous reports in the U.S. and around the world show these nutrients are required as fertilizer, our soils apparently supply enough and our wheat is adapted sufficiently to our soils that these nutrients do not need to be supplied artificially.

References

Deibert, E.J. 1994. Fertilizer application with small-grain seed at planting. NDSU Ext. Publication EB-62. NDSU Extension Serv., Fargo, N.D.

Franzen, D.W., M. McMullen and D.S. Mossett. 2008. Spring wheat and durum yield and disease responses to copper fertilization of mineral soils. Agronomy Journal 100:371-375.

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