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Fertilizing Winter Wheat with Nitrogen for Yield and Protein

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Since winter wheat (particularly hard white wheat) is increasingly being purchased for multiple flour products, grain protein content and flour quality are becoming more important when marketing the wheat. Wheat with 11 and 14% protein contains approximately 1.2 and 1.5 pounds nitrogen (N) per bushel (bu), respectively. The trick is determining how much N is needed to produce winter wheat at a given protein level. Current N fertilizer guidelines for winter wheat do not consider specific grain protein goals or levels when suggesting N fertilizer rates. Thus, producers need N response information that predicts grain protein response as well as grain yield. To aid in making N fertilizer decisions with an emphasis on protein as well as yield, three winter wheat databases were constructed from fertilizer experiments located in South Central, Central, and Triangle areas of Montana from 1976 to 2000. The databases include grain yield and protein data associated with varying fertilizer N and soil nitrate N in three feet of soil. The three databases were segregated based on maximum location yields of less than 40 bu/a (14 locations), between 40 and 60 bu/a (22 locations), and greater than 60 bu/a (5 locations). Varieties included Centurk, NuWest, Tiber, and Rampart fertilized with varying rates of N and adequate phosphorus (P), potassium (K), and chloride (Cl). Nitrogen in the form of urea or ammonium nitrate was top dressed in the spring or applied while planting with rates ranging from 0 to 150 lbs N/acre. The experiments from the South Central area of Montana were conducted on conventional fallow (26), but the Central and Triangle area experiments were conducted on no-till recrop (following barley stubble) (2), chemical fallow (3), and conventional fallow (10).

Using the three databases, regression equations were calculated to predict grain yield, grain protein content, and protein yield as shown in Table 1 and Figures 1, 2, and 3, respectively. These equations were used to predict yield, protein, and protein yield, for a range of N rates (Table 2). The N rates could be used to predict yield, protein content, or protein yield in dollars utilizing different scenarios of the crop's value including protein premiums. Either actual or expected N fertilizer expenses could be tracked as well. Wheat growers can calculate N fertilizer needs by first selecting their expected yield level in Table 2, and then subtracting their soil nitrate N test values from the N rate at the desired protein level. The protein yield predictions shown in Table 1 are useful when producers want to fine- tune their N needs. Yield can be monitored throughout the growing season, and N increased to increase protein, if yields are predicted to be higher than the initial yield goal.

Fertilizer Facts:

- Nitrogen is an essential component of winter wheat production and grain quality.

- Available N (soil N plus fertilizer N) can have a profound impact on producing wheat with higher than normal protein.

- At a medium yield level, winter wheat requires about the same N as spring wheat (3.2 lb N/bu for 14% protein); however, more N (4.7 lb N/bu) is needed at low potential yield levels, and less (2.6 lb N/bu) is needed at high potential yield levels.

Table 1. Winter wheat regression equation summary.

No.	Equation	r^2
	Low Yield Potential (<40 bu/a)	
1	Yield (bu/a) = 18.0 + 0.25 N – 0.00086 N^2	0.64
2	Protein (%) = 9.5 + 0.027 N	0.45
3	Protein Yield (lb/a)= 90.5 + 2.13 N – 0.0053 N^2	0.82
	Medium Yield Potential (40 to 60 bu/a)	
4	Yield (bu/a)= 20.0 + 0.32 N – 0.00072 N^2	0.71
5	Protein (%)= 7.0 + 0.065 N – 0.00014 N^2	0.56
6	Protein Yield (lb/a) = 50.0 + 3.44 N – 0.0068 N^2	0.80
	High Yield Potential (>60 bu/a)	
7	Yield (bu/a)= 38.5 + 0.30 N – 0.00080 N^2	0.62
8	Protein (%)= 9.0 + 0.029 N	0.58
9	Protein Yield (lb/a)= 164.2 + 3.44 N – 0.0065 N^2	0.74

N = Fertilizer N + soil nitrate N (0-3 ft depth) in lb N/acre.

Table 2. Effect of N on winter wheat yield, protein content, protein yield, and N required per bushel for three yield levels.

	Yield Potential < 40 bu/a				Yield Potential 40 - 60 bu/a				Yield Potential > 60 bu/a			
N Rate (lb/acre)	Yield (bu/a)	Protein (%)	Protein Yield(lb/a)	N/bu (lb/bu)	Yield (bu/a)	Protein (%)	Protein Yield(lb/a)	N/bu (lb/bu)	Yield (bu/a)	Protein (%)	Protein Yield(lb/a)	N/bu (lb/bu)
0	18	9.5	91	0.0	20	7.0	50	0.0	39	9.0	164	0.0
20	23	10.0	131	0.9	26	8.2	116	0.8	44	9.6	230	0.5
40	27	10.5	167	1.5	32	9.4	177	1.3	49	10.1	291	0.8
60	30	11.1	199	2.0	36	10.4	232	1.6	54	10.7	347	1.1
80	32	11.6	227	2.5	41	11.3	282	2.0	58	11.3	398	1.4
100	34	12.2	250	2.9	45	12.1	326	2.2	61	11.9	443	1.6
120	35	12.7	269	3.4	48	12.8	365	2.5	63	12.4	483	1.9
140	36	13.3	284	3.9	50	13.4	399	2.8	65	13.0	518	2.2
160	36	13.8	295	4.5	52	13.9	427	3.1	66	13.6	547	2.4
180	35	14.4	301	5.1	54	14.2	450	3.3	67	14.2	572	2.7
200	33	14.9	303	6.0	55	14.5	467	3.7	67	14.7	591	3.0
220	31	15.4	301	7.1	55	14.6	479	4.0	66	15.3	604	3.3

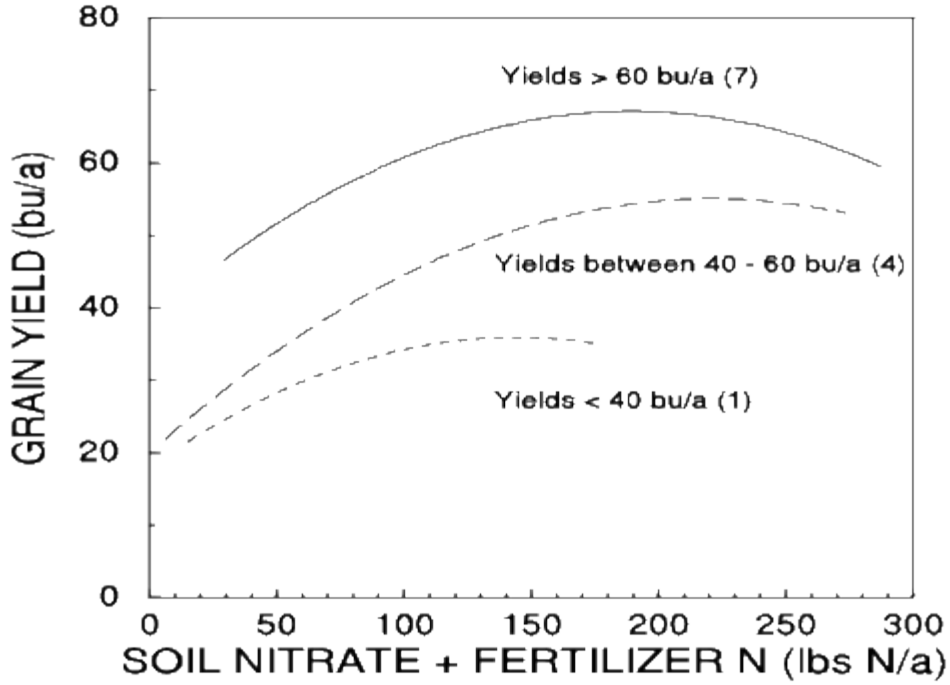

Figure 1. Effect of available N on winter wheat yield.

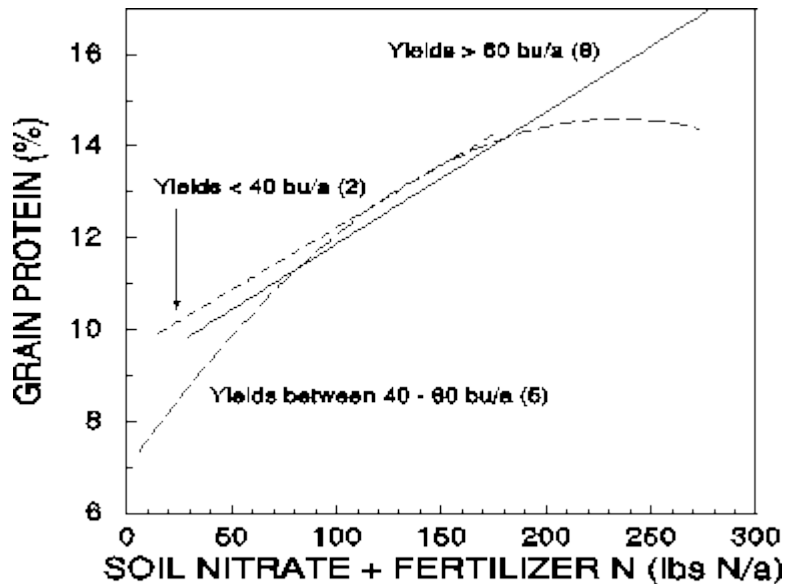

Figure 2. Effect of available N on winter wheat protein.

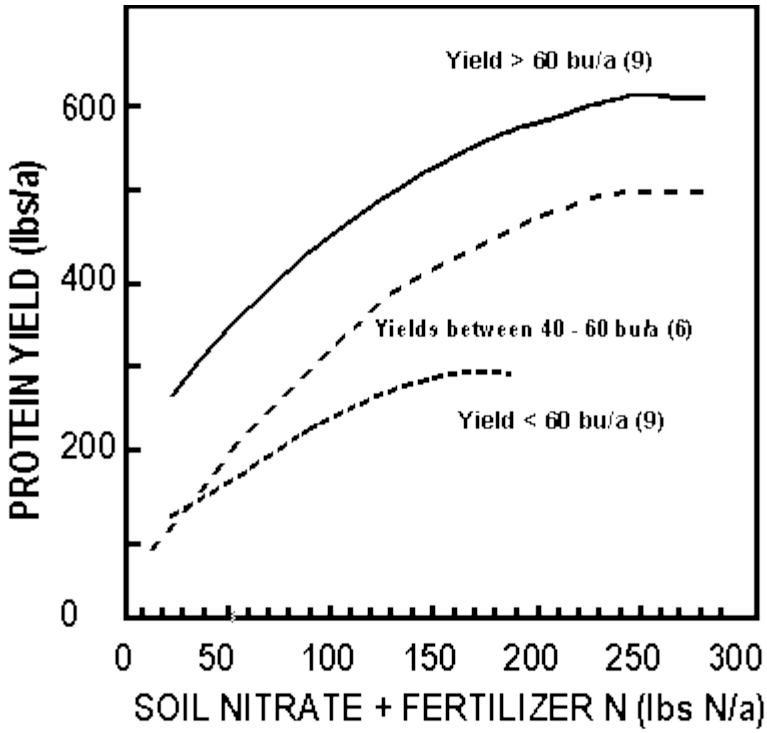

Figure 3. Effect of available N on winter wheat protein yield.

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