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Economic N rate and application timing for winter wheat for Wisconsin

University of Wisconsin Extension Recommendations

Nitrogen rates for winter wheat

	N to apply (lbs/acre)			
Yield Goal	Soil organic matter content			
	<2%	2–9.9	10-20	>20
40-90 bu/acre	80	60	40	0

Subtract legume and manure credits from these base recommendations;

No specific guidelines on application timing.

University of Minnesota Recommendations

Partial listing

Previous Crop	OM	Yield Goal – bu/ac 60-79	70-79	80-89
Non-legumes	<3%	130	155	170
	≥3%	110	135	150
Soybeans	<3%	110	135	150
	≥3%	90	115	130
Alfalfa 2-3 plants/sq ft	<3%	80	105	120
	≥3%	60	85	100

N to apply – lbs/acre

Michigan State wheat N recommendations

Wheat yield goal (bu/acre)	50	60	70	80	90+
Pounds N/acre	40	60	75	90	110

Apply no more than 25 lbs N in the fall, with balance applied early in the spring before ground thaws and stems begin elongation.

Indiana –Purdue University Recommendations

Regardless of soil type, 15 to 30 lbs N should be applied at seeding with the balance topdressed as regrowth begins.

CEC meq/100g	Topdress N fertilizer rates at various yield goals			
	55-64	**65-74**	**75-85**	**85+**
<6	70	80	90	100
6-10	60	70	80	100
11-30	50	60	70	90
>30	40	50	60	60

Iowa State University Recommendations – Winter wheat

Lbs N = bu/acre yield potential X 1.3

Eg., For a 90 bu/acre yield goal, recommendation would be 117 lbs N/acre.

University of Illinois
Nitrogen for winter wheat (lbs/acre)

Soil OM Content	Planted w/ alfalfa or clover	No alfalfa or clover seeding
<2%	70-90	90-110
2-3%	50-70	70-90
>3%	30-50	50-70

University of Illinois
Nitrogen for winter wheat

- Subtract nutrient credits
  - Soybeans = 10 lbs N/acre
  - Alfalfa = 30 lbs N/acre ($\geq$5 plants/sq ft.)
    = 10 lbs N/acre (2-4 plants/sq ft.)
- Excessive N applications can reduce yields through delayed maturity and lodging
- Apply some N and P before planting and the remainder in late winter or early spring.

Recent investigations

Nitrogen Rates and Application Timing for Winter Wheat

N rates for wheat – Boerboom and Gaska, 2001

Arlington Ag Research Station

Patriot HRWW	Yield bu/ac	Gross return $ per-acre*
60 lbs N per-acre	62.2	165.38
120 lbs N per-acre	67.4	165.46

*N cost = $.25/lb; Wheat price = $2.90/bu.

N rates for wheat – Boerboom and Gaska, 2002

Arlington Ag Research Station

Patriot HRWW

Pioneer 25R57 SRWW

Kaltenberg KW39 SRWW

	Yield (bu/acre)
60 lbs N per-acre	95.4
120 lbs N per-acre	92.6

N rates for Wheat – Bundy and Andraski, 2001

N rates compared in 21 trials 1996 – 1999

	lbs> N per-acre
Arlington	0, 30, 60, 90, 120
Lancaster Racine Chilton	0, 30, 60, 90, 120, 150, 180

Rec N rates = 60 lbs/ac for all sites except Chilton = 80 lbs/ac.

Previous crops = Corn silage (15), winter wheat (2), cabbage (2), Oats (1), Soybeans (1)

Varieties planted: Kaskaskia, Pioneer 25R26, Cardinal, Dynasty

N rates for Wheat – Bundy and Andraski, 2001

- Wheat yields @ economic optimum N rates (EONR) ranged from 43 – 86 Bu/ac.
- EONR ranged from 0 to 150 lbs N/ac.
  - 9 sites had EONR higher than recommendations
    - Ave = 16 lbs N/ac higher for soils ≥2% OM
    - Ave = 45 lbs N/ac higher for soils <2% OM
  - 12 sites had EONR lower than the recommendation

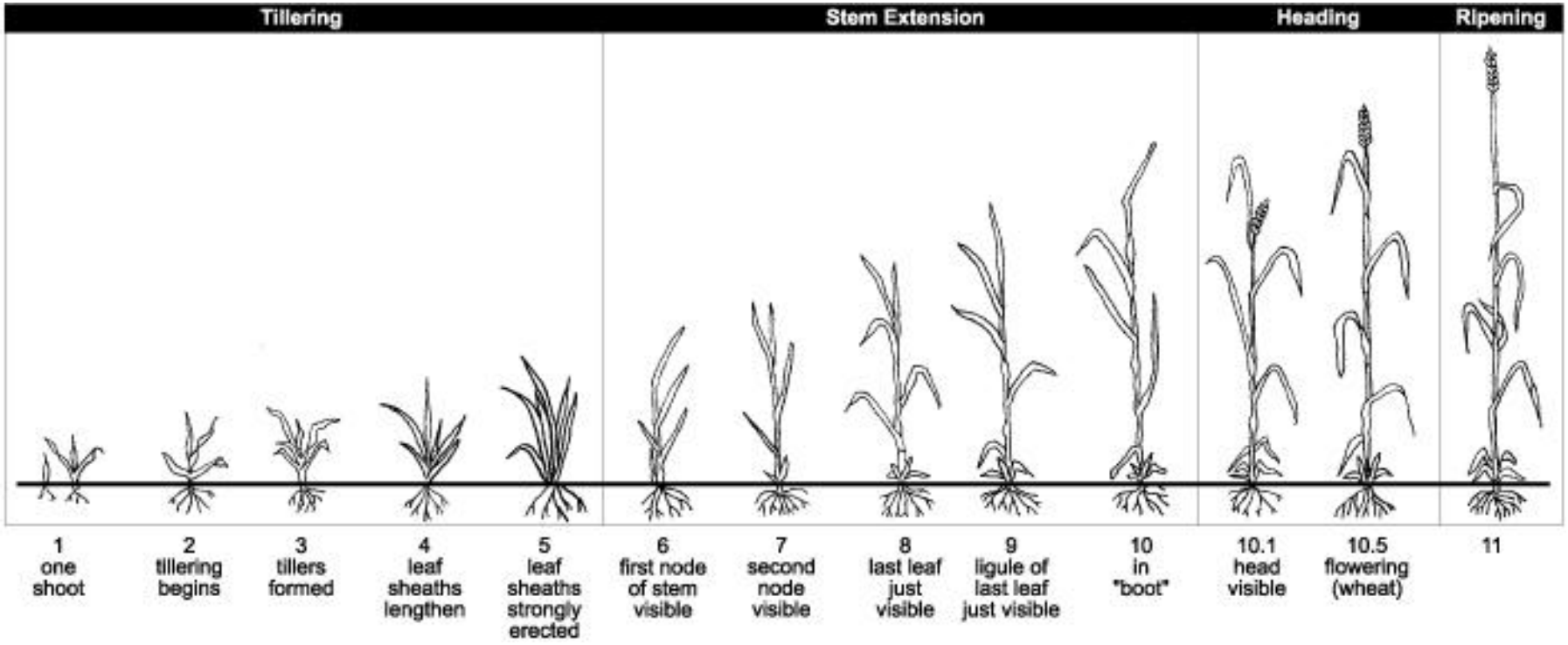
N rates for Wheat – Bundy and Andraski, 2001

- Yields were lower with high N rates compared to 0 lbs N/acre for 8/12 trials
  - Increased lodging and lower grain test weight
  - Excessive N resulting from fertilizer additions on soils with high residual $NO^{3-}N$
- Yields increased as soil NO^{3-}-N plus fertilizer N went from 10 to 150 lbs/acre
- Yields decreased as soil NO^{3-}-N plus fertilizer N exceeded 150 lbs N per-acre.

Adjusting N rates for wheat with the PPNT Bundy and Andraski, 2001

- Good evidence that wheat yield response to N is strongly effected by residual soil $NO^{3-}N$
- Preplant soil nitrate test (PPNT) appears to be an accurate predictor of N need.
- Current “proposed” N rate recommendations for winter wheat using the PPNT in WI where the previous crop is not alfalfa:

  N Rate = Base N rec – (PPNT NO^{3-}-N - 50)


Tillering
Stem Extension
Heading
Ripening
1 one shoot
2 tillering begins
3 tillers formed
4 leaf sheaths lengthen
5 leaf sheaths strongly erected
6 first node of stem visible
7 second node visible
8 last leaf just visible
9 ligule of last leaf just visible
10 in "boot"
10.1 head visible
10.5 flowering (wheat)
11

N Uptake by Winter Wheat
(Sullivan et. al., 1999)

- Field studies in Willamette Valley, OR.;
- Sampled above-ground plants through the growing season(s);
- Measured biomass accumulation and N concentration;
- N uptake = Biomass * N concentration

N Uptake by Winter Wheat
(Sullivan et. al., 1999)

- 20-40 lbs N uptake through tillering.
- Fall through early to mid-April in Wisconsin;
- Rapid N uptake during stem elongation (jointing).
  - Mid-April through early June, 2-3 lbs N/ac/day.
  - 60-100 lbs N accumulated.
  - Sufficient N availability is critical in this period;
- Thus, N should be applied during tillering, delaying a portion until onset of jointing only if early applied N losses are especially likely.

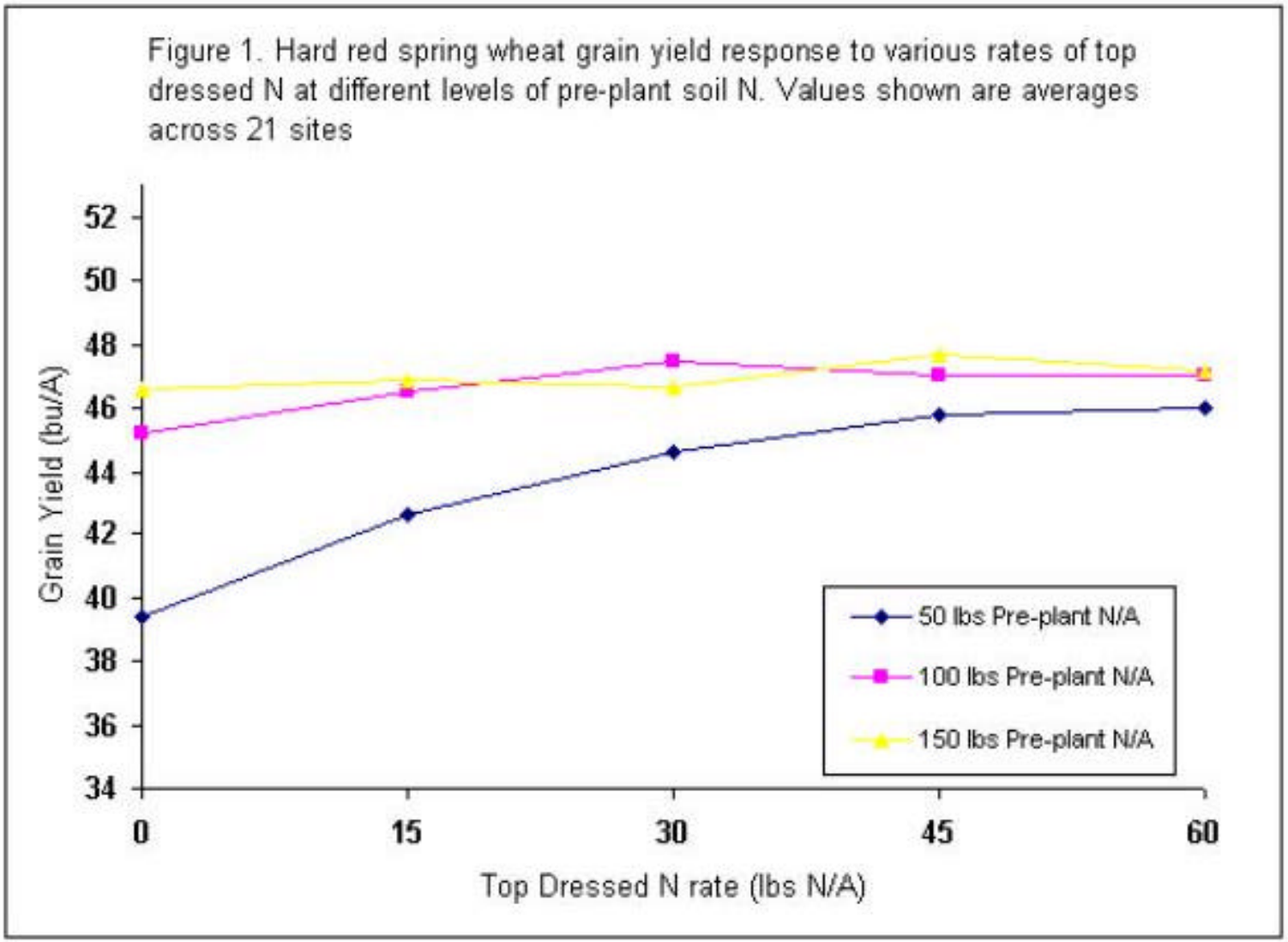
Effect of N application timing on yield (bu/acre) of winter wheat across 4 application rates (35-140 lbs/ac)

Kelling, Bundy and Oplinger, 1997

	Marshfield 1986	Chilton 1987	Racine 1987
All fall	60	60	66
All early spring	53	58	56
2/3 ES + 1/3 LS	61	57	56
1/3 fall + 2/3 ES	58	52	56
¼ fall + ½ ES + ¼ LS	59	55	61
2/3 fall + 1/3 LS	65	61	58

Fall = preplant; ES (early spring) = at green-up; LS (late spring) = early jointing.

Weirsma, Sims and Lamb, University of Minnesota, 2002



Summary and Conclusions

- Research behind N management recommendations for winter wheat in Wisconsin is somewhat limited;
- Wheat growers tend toward higher rates than recommended;
- Rate recommendations from neighboring universities tend to be significantly higher and timing recommendations vary;
- However, recent studies suggest those very high rates could reduce yields and result in economic loss in Wisconsin;

Summary and Conclusions

- Trials needed for N management on wheat following soybeans;
- Although indications are mixed, most research and recommendations suggest that fall and/or early spring N application is best;
- PPNT has good potential for predicting optimum N rate for winter wheat.