TIPS FOR OPTIMUM WHEAT PRODUCTION

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Introduction

Winter wheat acreage in Wisconsin has been steadily increasing since the early 1970s indicating an interest by existing growers to either increase their present acreage or adding new growers willing to try winter wheat (Fig. 1).

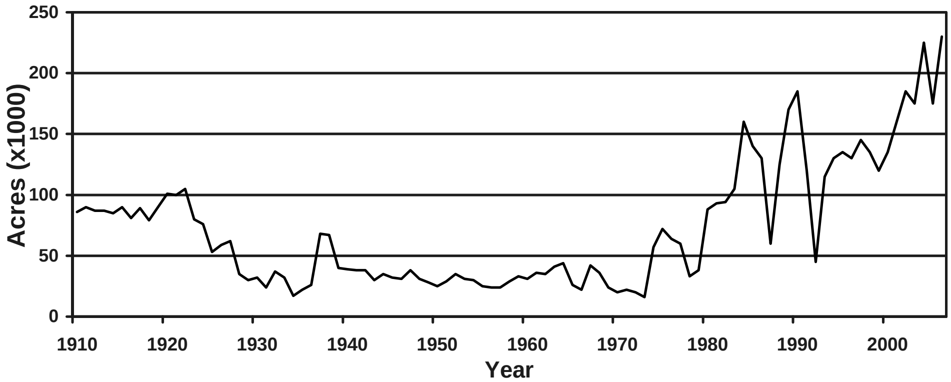

Fig. 1. Historical harvested acreage of winter wheat in Wisconsin. 1910 to 2006. (USDA-NASS, 2006).

Winter wheat yields in Wisconsin have been increasing at about 0.7 bu/a/yr since the early 1940s, indicating advancements in both wheat genetic yield potential and better management practices (Fig. 2).

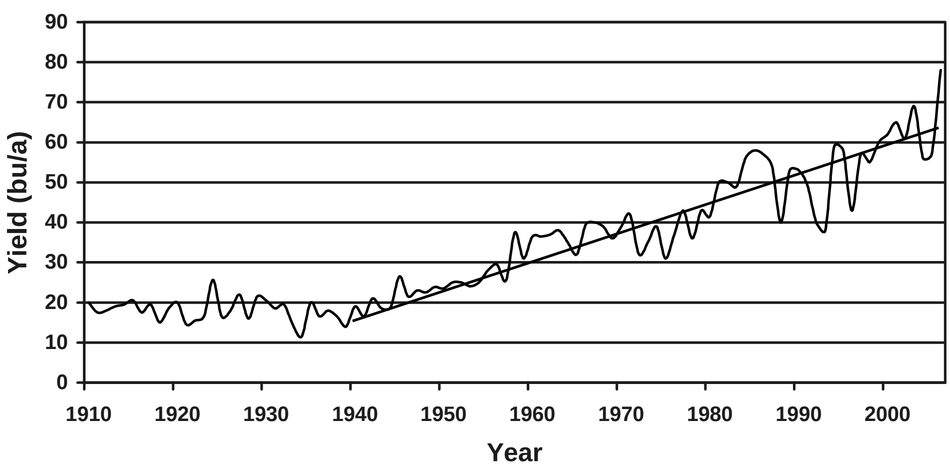

Fig. 2. Historical yield of winter wheat in Wisconsin. 1910 to 2006. (USDA-NASS, 2006).

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Separating any genetic advancements from environmental and management factors is often difficult. Wisconsin growers fortunately can select from a large list of varieties (Kaeppler et al., 2006) and manage them for high yields. Economic factors and the cropping system needs of Wisconsin farmers have led growers to choose wheat as a viable rotational crop. Winter wheat requires high management for optimum yields, similar to the management that growers invest in growing corn, soybean, or hay crops. Winter wheat is a good fit in Wisconsin with existing conservation tillage systems. It can be successfully planted and grown in existing crop residue, especially soybean. Wheat is a good competitor against weeds, keeping herbicide costs low. In addition, it has a high grain and straw yield potential, providing two sources of income from a single crop.

Intensive Wheat Management

Over the years, many authors have suggested techniques for improving wheat yields through so called "intensive wheat management" plans. Oplinger et al. (1985) outlined 15 steps for maximum wheat yields in Wisconsin. Bitzer and Herbek (1996) listed 18 steps for Kentucky growers to follow to increase their yields. Alley et al. (1993) outlined 8 steps to intensively manage soft red winter wheat in Virginia. Some grain merchandisers also offer suggestions for intensive wheat management to encourage and reward the production of high quality wheat with price premiums (Siemer, 2006).

Review of these and several other guides for intensive wheat management reveal many common recommendations, regardless of geographical location. Commonly, the first step in these guides to high wheat yields is the understanding of wheat growth and development. Following the understanding of wheat plant growth, most guides provide guidance with fertility, seedbed preparation, planting date and rate, weed and disease control, and optimal harvesting and marketing advice. We will pick out several of these and look closer at how Wisconsin growers can optimize wheat production.

Wheat Growth and Development

Growers planning for a successful wheat growing program need to understand how the plant grows and develops. Many management decisions are based on wheat growth stage and wheat, like corn and soybeans, responds to inputs applied at the correct stage of growth. The Feekes (Large, 1954) (Fig. 3) and the Zadoks (Zadoks et al., 1974) scales are commonly used to describe the growth of wheat. The Feekes scale uses a 1 to 11 scale while the Zadoks scale starts at 0 and ends at 100. The Feekes scale is more popular. However, either staging system will provide accurate growth stage information. The life cycle of wheat can be summarized by dividing it into two main stages, with anthesis marking the transition between the stages. In the first stage, vegetative growth is followed by seed initiation and development. This stage determines the final yield potential of the crop. The second stage is the grain filling period in which the potential yield developed in the first phase is realized. Optimum climatic conditions and proper management inputs during this period are very critical. Relevant growth stages will be indicated in the following discussion.

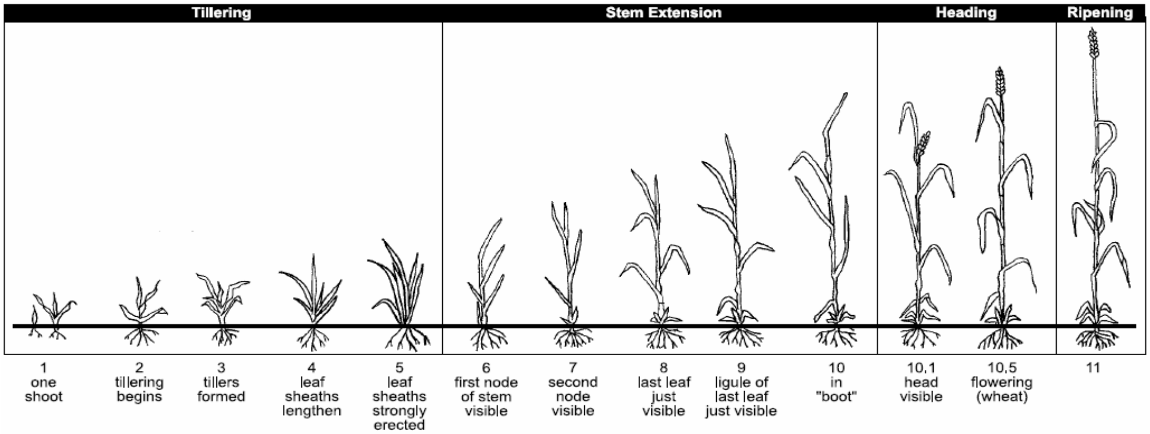

Fig. 3. The Feekes scale of wheat development.

Nitrogen Management

Nitrogen is the plant nutrient that usually limits wheat yields if it not present in the right amounts at the right time. Current nitrogen fertilizer recommendations for Wisconsin can be found in Laboski et al. (2006). Generally, 70 lb/a of N is adequate for soils with 2.0 to 9.9% organic matter. Applying too much N fertilizer can have detrimental effects on yield. Excessive N fertilization encourages excess vegetative growth, which increases the possibility of lodging, making harvest more difficult and also increases disease potential due to a dense canopy. Nitrogen credit for any applied manure needs to considered as well as an N credit of 40 lb/a for wheat following soybean.

Recent research (Lauer and Bundy, unpublished, 2006) at Arlington Ag Research Station focused on optimum N rates for wheat following three crop/management scenarios. Nitrogen rates of 0 to 125 lb/a were spring-applied to wheat in a no-tillage system. In 2005, wheat yields did not respond to N applications over 50 lb/a, and results from 2006 indicated no response over 25 lb/a (Table 1). Nitrogen applications to wheat should be made in early spring at Feekes GS3 to GS5. Applying N on slightly frozen ground in mid to late April in southern WI minimizes wheel traffic problems and meets the early season N needs of wheat. If stands are thin, tillering can be promoted with additional N applications.

Seeding Wheat

Winter wheat in Wisconsin is generally planted from mid-September to early October. Generally wheat yields are highest when it is planted the last 2 weeks of September and before the October 5 in southern Wisconsin. Too early (early September) planting exposes the wheat to possible infection from barley yellow dwarf virus which is carried by aphids. Too late planting does not allow the plant to establish roots and gain the winterhardiness necessary to survive the winter. Also, wheat needs a vernalization period to induce reproductive growth in the following spring and summer. Low temperature damage to the crown and suffocation of the plant are the two most common causes of wheat winterkill. Wheat is most susceptible to winter injury or death in early spring if the crown of the plant is smothered or not protected when wide temperature fluctuations occur and soil repeatedly freezes and thaws. The risk of winter injury or death is minimized when wheat is planted into standing stubble, in moist, weed free, fertile soils using a no-till drill within the recommending planting date range.

Table 1. Effect of previous crop and N rate on no-till wheat grain yield. Arlington, WI. 2005 and 2006.

Year	N rate	Previous Crop Soybean	Corn silage	Corn grain	Mean
	lb/a	---------------- bu/a ----------------			
2005	0	65	48	40	51 c
	25	72	56	52	60 b
	50	74	66	52	64 ab
	75	71	67	57	65 a
	100	77	67	53	66 a
	125	73	68	53	65 a
	2005 mean	72 a	62 b	51 c	
2006	0	70	61	65	65 c
	25	74	74	64	70 ab
	50	76	73	63	71 ab
	75	77	72	74	74 a
	100	77	74	68	73 a
	125	71	65	62	66 bc
	2006 mean	74 a	70 ab	66 b	

Seeding depth of wheat is an important consideration. Seeding too deep results in delayed emergence, which increases the potential for winterkill. Deep seeded wheat does not benefit from soil surface warming during the day, and is further delayed by cool night temperatures. Optimal seeding depth for wheat is 1 inch.

Wheat seeding rates recommendations have varied widely both in amount to seed and in units for measuring seed planted per area. We are recommending a change from using pounds of seed per acre or seeds per square foot to seeds per acre, similar to corn and soybean seeding rate recommendations. Because winter wheat seed size is highly variable, just using a unit like pounds per acre can result in highly variable seeding rates in terms of seeds per acre. Table 2 shows recommended seeding rates for a range of planting dates in Wisconsin. Also shown are spring plant density targets for growers assessing spring stands and over-winter survival.

Tillage and Rotation Considerations

Winter wheat can be established in no-till systems. No-till is especially well suited for planting wheat after soybeans. Accumulations of residue on the soil in a no-till system help protect small seedlings by trapping snow and serving as an insulating blanket. Pay particular attention to spreading residue evenly across the field so that it does not interfere with good seed to soil contact and burn down any existing weeds, especially dandelions and winter annuals prior to planting. Planting winter wheat after corn taken for grain or silage is generally not recommended unless the corn residue is incorporated into the soil. This is because of the risk for head scab, *Fusarium graminearum*, which also causes *Giberella* stalk and ear rot in corn.

Pest Management

Careful observation of the crop through the season will enable you to apply timely pest control when it is necessary. Seed-applied fungicides are typically applied to control seedling blight, loose smut, or bunt. Several fungicide products are currently available to Wisconsin growers (Boerboom et al., 2006). The addition of seed-applied insecticides is primarily used to plants have emerged by vectoring the barley yellow dwarf virus. Winged, infected aphids fly to

Table 2. Winter wheat seeding recommendations and spring plant density targets.

Seeds/acre Million	Seeds/sq ft	Row Width 6	7	7.5		
		Plants per foot row				
0.3	6.9	3	4	4		
0.4	9.2	5	5	6	Minimum spring densities	
0.5	11.5	6	7	7		
0.6	13.8	7	8	9		
0.7	16.1	8	9	10		
0.8	18.4	9	11	11		
0.9	20.7	10	12	13		Seeding Rate for Sept 1 to Sept 15
1.0	23.0	11	13	14	Good spring densities	
1.1	25.3	13	15	16		
1.2	27.5	14	16	17		
1.3	29.8	15	17	19		
1.4	32.1	16	19	20		Seeding Rate for Sept 15 to Oct. 1
1.5	34.4	17	20	22		
1.6	36.7	18	21	23	Excellent spring densities	
1.7	39.0	20	23	24		
1.8	41.3	21	24	26		
1.9	43.6	22	25	27		Seeding Rate for Oct. 1 to Oct 10
2.0	45.9	23	27	29		
2.1	48.2	24	28	30		
2.2	50.5	25	29	32		
2.3	52.8	26	31	33		
2.4	55.1	28	32	34		
2.5	57.4	29	33	36		
2.6	59.7	30	35	37		

these fields and transmit the virus as they feed. Delaying wheat planting into later September control aphids. Aphids, such as the bird cherry-oat aphid, infect winter wheat in the fall after the reduces the opportunity for aphids to feed and transmit the virus. Gaucho 480F (imidacloprid, Gustafson) seed treatment is labeled for the early season control of aphids. Fig. 4 shows results for a seed treatment study at two locations in Indiana during the 2005-2006 growing season. Data from one location indicated no effect from either the fungicide or insecticide seed treatments. At the second location, there was a significant yield increase for a Raxil-Thiram (tebuconazole + thiram, Gustafson) + Gaucho combination treatment. This may indicate that aphids were a significant problem. Data from local sources should also be used in determining whether to use a particular product. Other factors to consider in choosing whether to use a seed pesticide treatment include planting date, seed quality, and cost of the pesticide.

Foliar applied fungicides fit into intensive wheat management systems that use practices such as high N rates, high seeding rates, and high yielding varieties. The primary purpose of applying foliar fungicides is to protect the health of the flag leaf. The flag leaf is the largest leaf on a wheat plant and is the first leaf below the head. The flag leaf contributes up to 85% of the final grain yield due to its size and location on the plant and in the canopy. Grain yield reductions can occur if only 5 to 10% of the area of the flag leaf surface is diseased. Foliar-applied fungicides may provide economical yield increases if:

- Disease is present on the lower leaves
- Humid weather with moderate temperatures are forecast for longer periods
- High yield management practices are employed
- Wheat is planted following wheat
- Varieties planted are susceptible to common leaf diseases

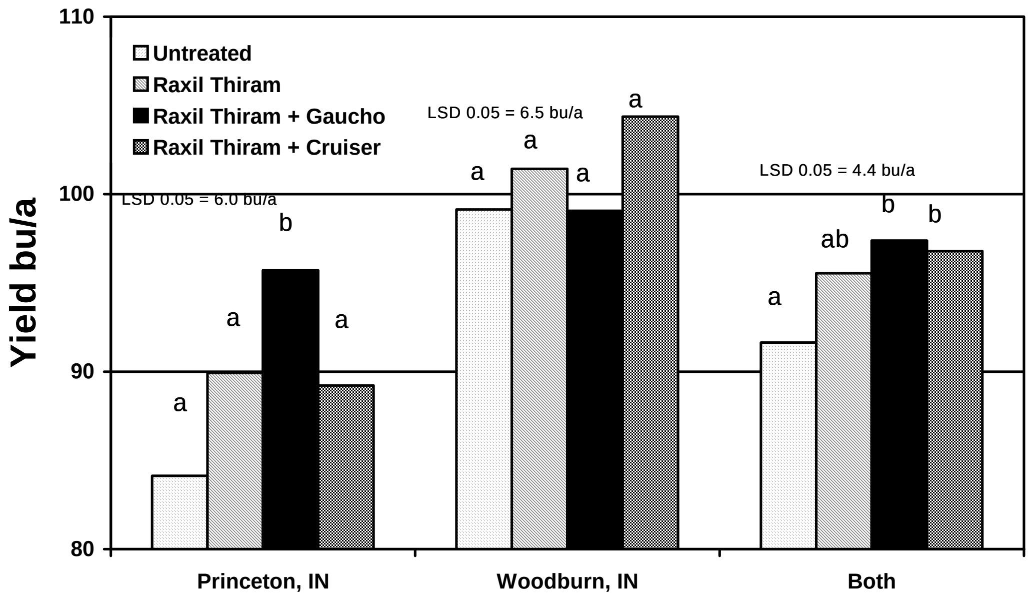

Fig. 4. Effect of fungicide and insecticide seed treatments on winter wheat yields in Indiana. 2006. (Tryon, unpublished data, 2006).

A sound weed control program combines cultural, mechanical and chemical control. Post emergence applied herbicides need to be applied at the correct stage of weed and crop growth and the herbicide should match the weed spectrum present in the field. Growers should be especially careful of applications of 2,4-D and dicamba after jointing because these herbicides can reduce yield or cause blank heads. Certain herbicides can also be applied in liquid fertilizer, but this should only be done if recommended on the herbicide label.

References

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USDA-National Agricultural Statistics Service. 2006. Wisconsin reports and statistics [Online]. Available at http://www.nass.usda.gov/Statistics_by_State/Wisconsin/index.asp#.html (accessed 12 Dec 2006). USDA-NASS, Washington, DC.

Zadoks, J.C., T.T. Chang, and C.F. Konzak. 1974. A decimal code for growth stages of cereals. Weed Res. 14:415-21.

Additional Sources of Information on Winter Wheat Production

Illinois Agronomy Handbook
iah.aces.uiuc.edu/index.php

University of Missouri Extension
muextension.missouri.edu/explore/agguides/pests/ipm1022.htm

Winter wheat production in North Dakota
www.ag.ndsu.edu/pubs/plantsci/smgrains/eb33w.htm

The Ohio State University Extension
ohioline.osu.edu/iwy/index.html

Purdue University Agronomy Extension
www.agry.purdue.edu/ext/smgrain/index.html

University of Saskatchewan, Saskatoon, Canada
www.usask.ca/agriculture/plantsci/winter_cereals/index.php

University of Wisconsin
soybean.uwex.edu