Understanding Wheat Growth and Development

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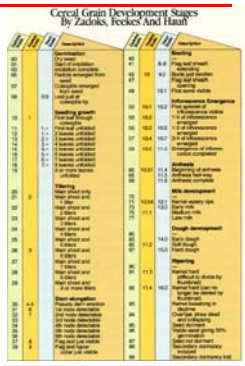
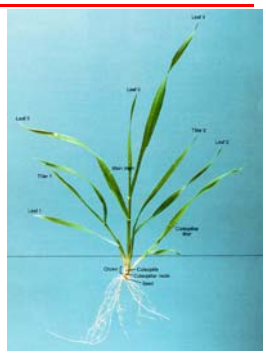
Cereal Grain Development Stages

- Feekes Scale
  - Eleven development stages
  - New leaves counted > 50% unfolded
  - Detailed heading & ripening
- Zadoks Scale
  - Ten development stages
  - New leaves counted > 50% unfolded
  - Two or more codes possible
- Haun Scale
  - Not commonly used



Positioning Wheat Plant for Growth Staging

- Find the first leaf
  - Lowest leaf with blunt tip
  - May have senesced
  - Sheath encloses all other leaves
  - Opposite of coleoptilar tiller



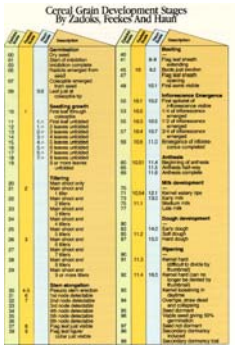
Count the Leaves on the Main Stem

- Opposite leaf arrangement
- Feekes and Zadoks Scale
  - Youngest leaf is ½ the length of the one below
- Left side: odd number of leaves
- Right side: even number of leaves
- Count dead or missing leaves

Count the Tillers

- Each tiller has its own sheath – prophyll
- Be aware of 2° or 3° tillers
- Tillers > 5th leaf will not produce heads and therefore, do not need to be counted

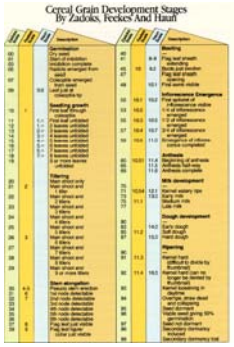
Four-leaf Wheat Plant with Two Tillers



Count the Nodes

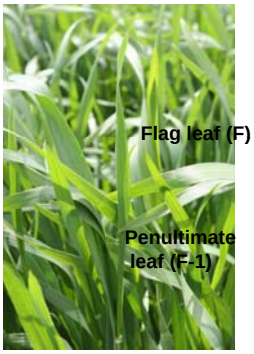
- Nodes can easily be seen or felt on the stem above the ground level

Pseudo-stem Erection (Hollow stem)



Has the Flag Leaf Emerged?

- Occurs when ≥ three nodes are present above the soil surface
- To confirm:
  - Split the leaf sheath above the highest node and search for additional leaves



Has Boot Stage Begun?

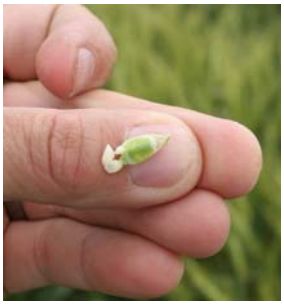
- Zadoks:
  - Follows emergence of the flag leaf collar and continues until heading
- Feekes and Haun:
  - Follows flat leaf extension and continues until heading

Has Head Emergence and Flowering Occurred?

- Heading begins when the first awns appear
- Examine Florets
  - Flowering begins in the middle of the head
  - Generally 3-4 days following head emergence
  - Lasts ~7 days
  - Sensitive to stress

Determine Grain Development Stage

- Grain Development
  - Watery Ripe
  - Milk
  - Soft Dough
  - Hard Dough
    - Physiological maturity:
      - Glumes and peduncle are no longer green
      - Little green in plant
    - Water concentration:
      - 40-30%
  - Kernel Hard
  - Harvest Ripe



Components of Wheat Yield

- Tiller and head number
  - Nitrogen availability
  - Tillering
  - Feekes 6.0
- Head size
  - Maximum spikelet number
  - Winter wheat
    - Mid-to-late tillering
    - Feekes stage 2-3
- Kernel number per spikelet
  - Late jointing
  - Feekes 5-6
- Kernel size
  - Feekes 8
  - Keys to increase kernel size
    - Healthy flag leaf
    - Water
    - Nutrients

What about fall applied N?

- 3 year study at Arlington on fall applied urea on winter wheat.
- Risk of over winter nitrate loss of fall applied urea to winter wheat or residual soil nitrate appears minimal on this soil type (well drained Plano silt loam) unless above normal temperatures and precipitation occur resulting in minimal frost depth and greater leaching potential.
- The addition of a nitrification inhibitor did not result in reduced over winter soil nitrate losses when above normal temperature and precipitation occurred, however.

What about fall applied N?

- This research was not conducted on poorly or somewhat poorly drained soils and the results might differ in that there could be denitrification losses in the spring under warm wet conditions on poorly or somewhat poorly drained soils.
- The nutrient management regulations do have some restrictions on the application of fall N. These restrictions apply to soils with high permeability, soils with <20" to bedrock or soil with <12" to apparent water table, or within 1000' of a municipal well.
- On these soils the regulation soil no fall N except for the establishment of fall seeded crops and the N application rate is limited at 30 lb N/a.

Spring N Demand for Winter Wheat

- N fertilizer has two important functions:
  - Manipulate population
    - Effective population is tillers, not plants
  - Supply nutritional needs of crop for production of protein

What is the right time for N?

- Early spring if the crop looks thin < 70 tillers ft^{-2}
- If the crop looks good, wait until near jointing
  - Increase yield
  - Increase fertilizer efficiency
  - Avoid growth that is too lush (disease, lodging, water stress)
  - Allow better diagnosis of the right amount of N

N Recommendations for Wheat

	Soil organic matter content (%)			
Crop	< 2.0	2.0 – 9.9	10.0 – 20.0	> 20.0
Small grain silage	60	40	20	0
Small grain silage, Alfalfa underside	30	20	10	0
Small grain and legume silage	25	15	0	0
Small grain and legume silage u/a	15	10	0	0
Wheat for grain	90	70	40	0

Laboski et al. 2008; A2809

Response of N timing on WW Yield in 2008

P25R47	Grain yield (bu per acre)	
N rate	Arlington	Janesville
0	82.1	71.0
30	92.4	89.6
60	90.5	89.6
90	89.2	93.9
120	87.8	96.5
30+30	86.5	85.7
45+45	85.4	92.1
60+60	86.7	87.2
LSD: 0.10	2.7	3.5

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Optimum Economic Wheat Nitrogen Rate and Timing

Objective:

To compare the routine N management practices of several wheat growers with our research based recommendations

- 6 grower fields were identified
- Large plots are used
- 2 N treatments – PPNT determined and a grower selected rate
- Fall PPNT soil samples were taken
- Adjusted recommendations have come back from 0 to 70 lbs/a

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Winter Wheat P, K, and S Removal

- Sulfur for wheat mainly limited to sandy soils (0.25 pounds per bushel: 20 pounds for 80 bu)

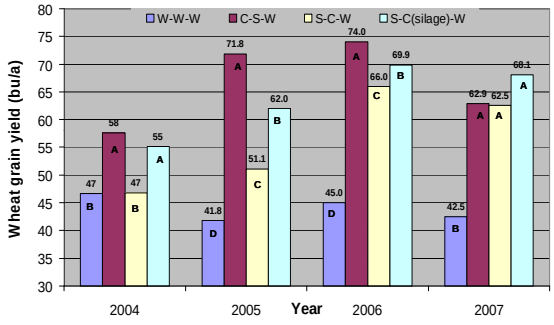
		----------Pounds per unit----------			
Crop	Unit	N	P_2O_5	K_2O	S
Wheat grain	bu	1.5	0.6	0.34	0.1
Wheat straw	ton	14	3.3	24	2.8

Nozzle types

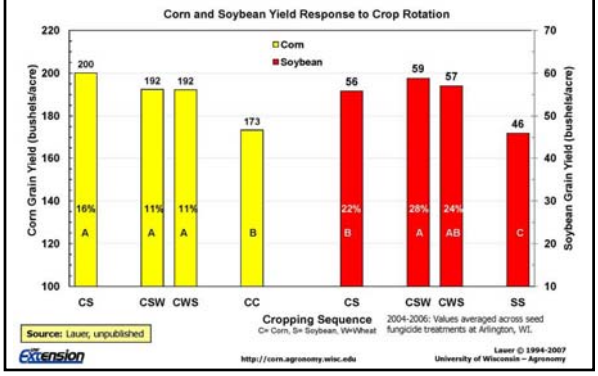
- Streamer bar once popular is loosing ground
- Tank mixing herbicides and nitrogen is a tricky compromise

Nozzle types

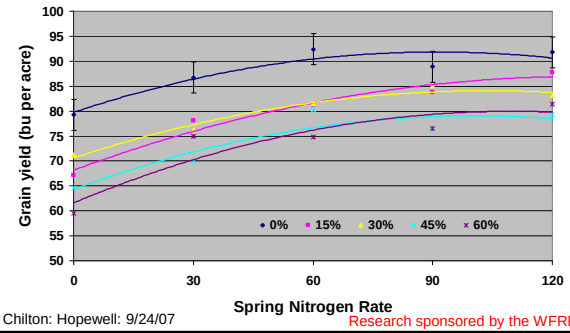
Impact of Rotation on Wheat Yield



Adding a third crop does not increase corn grain yield, but does improve soybean grain yield ...



Effect of % Winterkill and Spring N on Wheat Yield



Chilton: Hopewell: 9/24/07

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Effect of Spring N on Wheat Yield Components

Seeding rate	% WK	N rate	Grain Yield	Lodging (1-5)	1000 KWT	Tillers sq ft	Heads SM
1.75	0		87.8	2.1	41.3	182	710
1.50	15		79.6	2.1	41.5	150	640
1.25	30		79.4	1.6	40.9	112	576
1.00	45		74.0	1.5	40.5	95	623
0.75	60		73.4	1.3	41.0	95	533
LSD (0.10)			5.9	0.3	NS	16.9	60.8
		0	68.4	1.0	42.4	124	572
		30	77.2	1.3	42.4	127	630
		60	82.0	1.7	40.6	128	580
		90	82.1	2.2	40.3	135	679
		120	84.7	2.3	39.4	120	622
LSD (0.10)			3.1	0.2	0.8	NS	53.0

Figure 5-1. Herbicide application periods at various growth stages of small grains (using Feeke's scale) *Adapted and used with permission from Michigan State University Extension publication* Weed Control Guide for Field Crops (E-434)

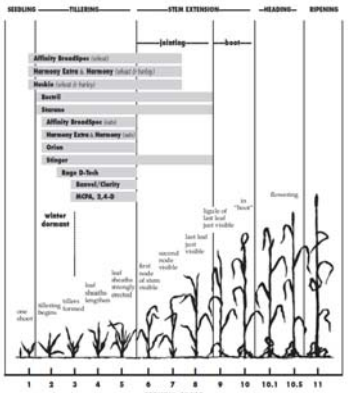

Image Courtesy of A3646

Table 5-1. Crop registration, tolerance, and herbicide effectiveness on weeds commonly found in small grains

	Affinity BroadSpec	Banvel/Clarity	Buctril	Callisto	Harmony Extra	Harmony	Huskie	MCPA amine	Orion	Rage D-Tech	Starane	Stinger	2,4-D amine
Cereals registered	B,W	B,O,W	All	O	B,O,W	B,O,W	B,W	All	B,O,W	All	B,O,W	All	All	All
Mode of action group	2	4	6	27	2	2	6, 27	4	2, 4	4, 14	4	4	4
Can be underseeded?	No	No	Alfalfa	No	No	No	No	Alfalfa, red clover	No	No	No	No	No/Yes*
Cereal crop tolerance	G/E	F/G	G	G/E	G/E	G/E	G/E	G	G	G	G/E	E	G
Annual grass weeds	N	N	N	N	N	N	N	N	N	N	N	N	N
Annual broadleaf weeds													
Common chickweed	G	G	P	G	G	F	G/E	F	G	P	G	P	F
Common ragweed	G	G	G	F/G	P	F	G	G	G	F	G/E	G/E	G/E
Giant ragweed	P	G	F/G	F/G	P	P	G	G	F	F	—	G/E	G
Lambsquarters	G/E	G/E	G/E	E	G/E	E	E	G	G	G/E	P	N	E
Pennycress	E	F	G	E	E	E	E	E	G	E	F/G	P	E
Pigweed	E	G/E	F/G	E	E	E	G/E	G	G	E	P	N	E
Prickly lettuce	G	G	F	—	G	F	G/E	G/E	F	G	G	G/E	G/E
Shepherd's purse	E	F	E	E	E	E	G/E	E	G	G	—	P	E
Smartweeds	G	G/E	G	E	G	G	G/E	P	G	F	—	F	P
Wild buckwheat	G	G/E	G/E	P	G	F	G/E	F	G	F	F/G	F/G	F
Wild mustard	E	F	G	G	E	E	G/E	G/E	G	G	F/G	N	G/E
Wild radish	F/G	F	G	—	F/G	F	G/E	G/E	—	G	—	N	G/E
Perennial broadleaf weeds													
Canada thistle	G	F	P	P	G	P	F	F	P	P	P	G/E	F
Field bindweed	P	F	P	P	P	P	F	F	P	F	F/G	P	F
Perennial sow thistle	F	F/G	N	—	F	P	G	F	F	F	P	F	F

Abbreviations
Cereals registered: B=barley, O=oats, W=wheat
Control ratings: E=excellent, G=good, F=fair, P=poor, N=none, — = no information
**Some brands of 2,4-D amine allow application in underseeded small grains. We do not recommend it because the risk of legume injury is very high.*

Image Courtesy of A3646

Table 5-2. Harvest and/or grazing restrictions for herbicides registered for use in small grains[a]

Herbicide	Use(s)	Type of animal	Interval between application and grazing or harvest	Comments
Affinity BroadSpec	wheat, barley	all	45 days	Do not graze or feed wheat or barley as forage or silage
Buctril	small grains	all	45 days	Do not harvest summer-seeded alfalfa treated with Buctril until following spring.
Callisto	oats	all	30 days for grazing or forage; 50 days before harvest	
Dicamba	small grains	non-lactating lactating	0 days 7 days	Do not harvest hay within 37 days after treatment.
Glyphosate[b]	small grains, preharvest	—	7 days	Apply only when grain is in hard dough stage (30% moisture or less)
Harmony Extra / Harmony SG	wheat, barley	all	45 days	Do not graze or feed wheat or barley as forage or silage.
Huskie	wheat, barley	all	25 days for grazing or forage; 60 days for grain or straw	
MCPA	small grains	all	—	Do not allow livestock to graze treated fields within 7 days of slaughter.
Orion	small grains	all	7 days for grazing; 60 days before harvest	
Rage D-Tech	small grains	dairy or meat	14 days for grazing	Do not feed straw to livestock.
Starane	small grains	all	7 days for grazing; 40 days before harvest	
Stinger	small grains	all	7 days	Do not harvest hay from treated grain fields.
2,4-D	small grains	all	2-week grazing restriction	
	small grains, preharvest	all	7 days before harvest	Do not feed straw to livestock.

[a]Labels may have changed after this table was prepared. Consult current labels to verify the information.
[b]These are the restrictions on the Roundup and Touchdown labels and several other glyphosate products. Differences exist on some brands of glyphosate. Verify what restrictions apply to your brand before using it.

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