Small Grain Growth and Development:
to Improve Management

Dr. Margaret Smith

Agronomist, Albert Lea Seed

March 2, 2023

Small Grain growth types

Winter	Spring	Facultative

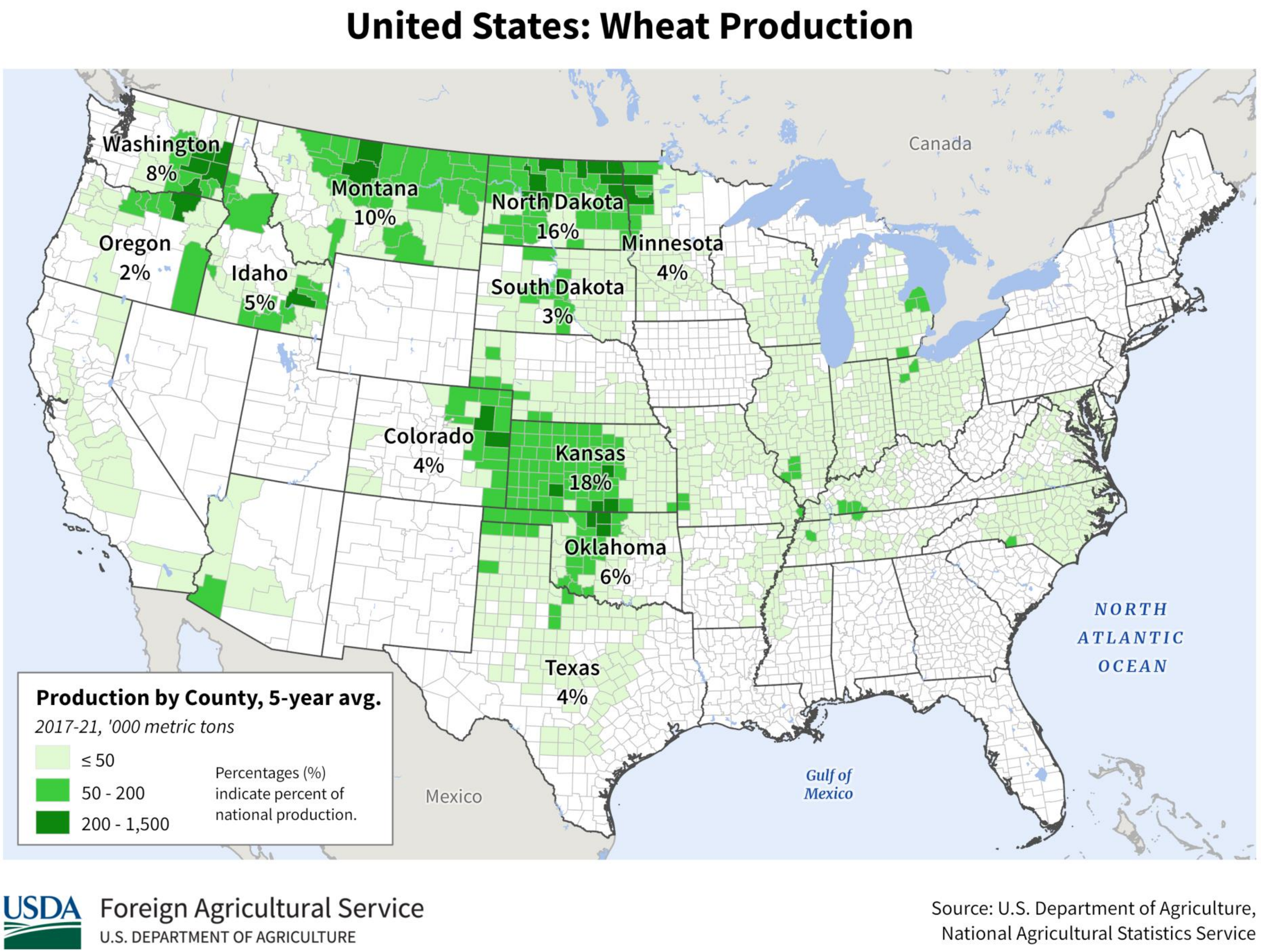
Small Grain growth types

Winter	Spring	Facultative
Wheat	Wheat	Wheat
(Oats)	Oats	
Barley	Barley	Barley
Rye	()	

ALBERT LEA SEED

VIKING & Blue River Organic Seed

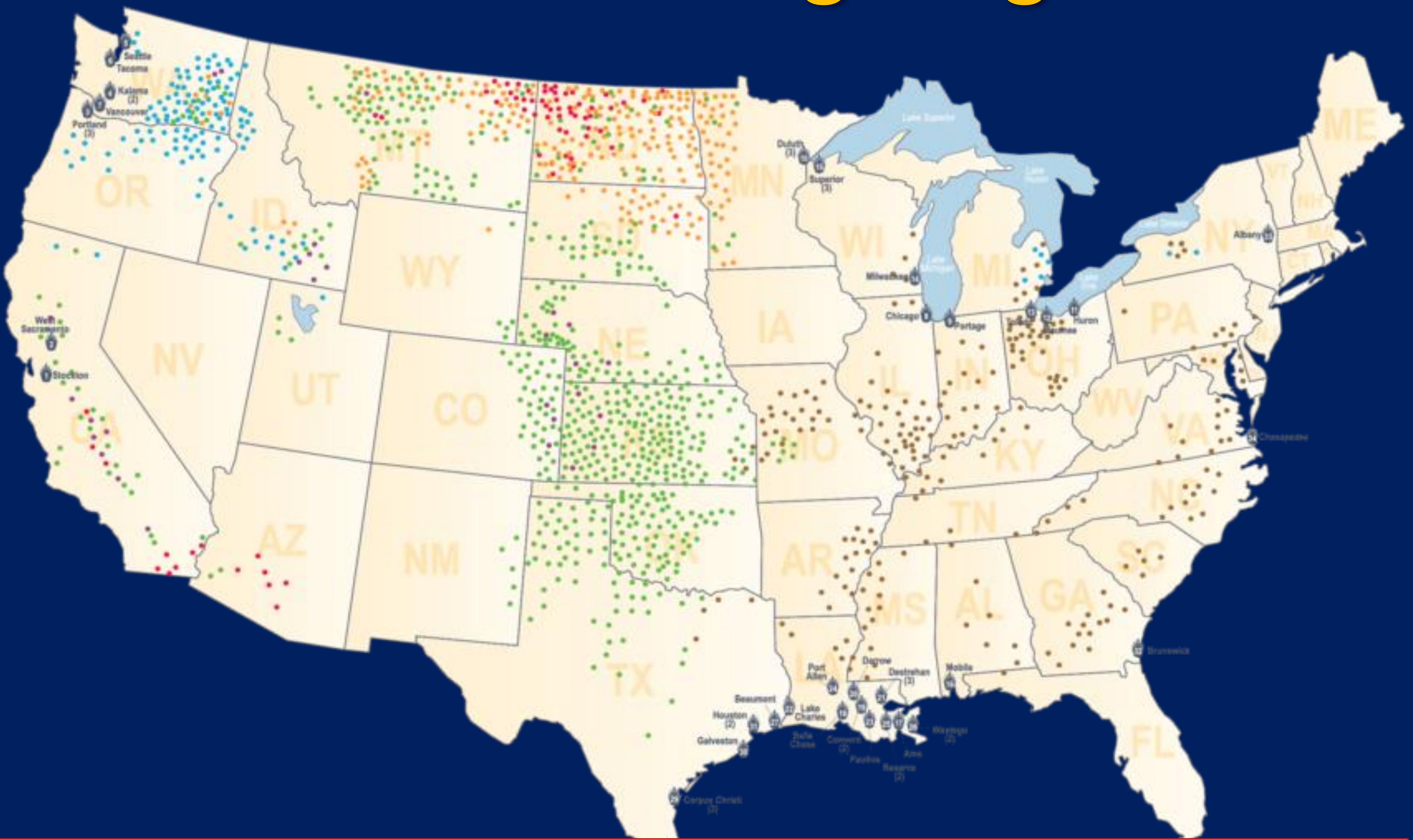
Wheat Growing Regions in the U.S.



ALBERT LEA SEED

VIKING & Blue River Organic Seed

Wheat Growing Regions in the U.S.

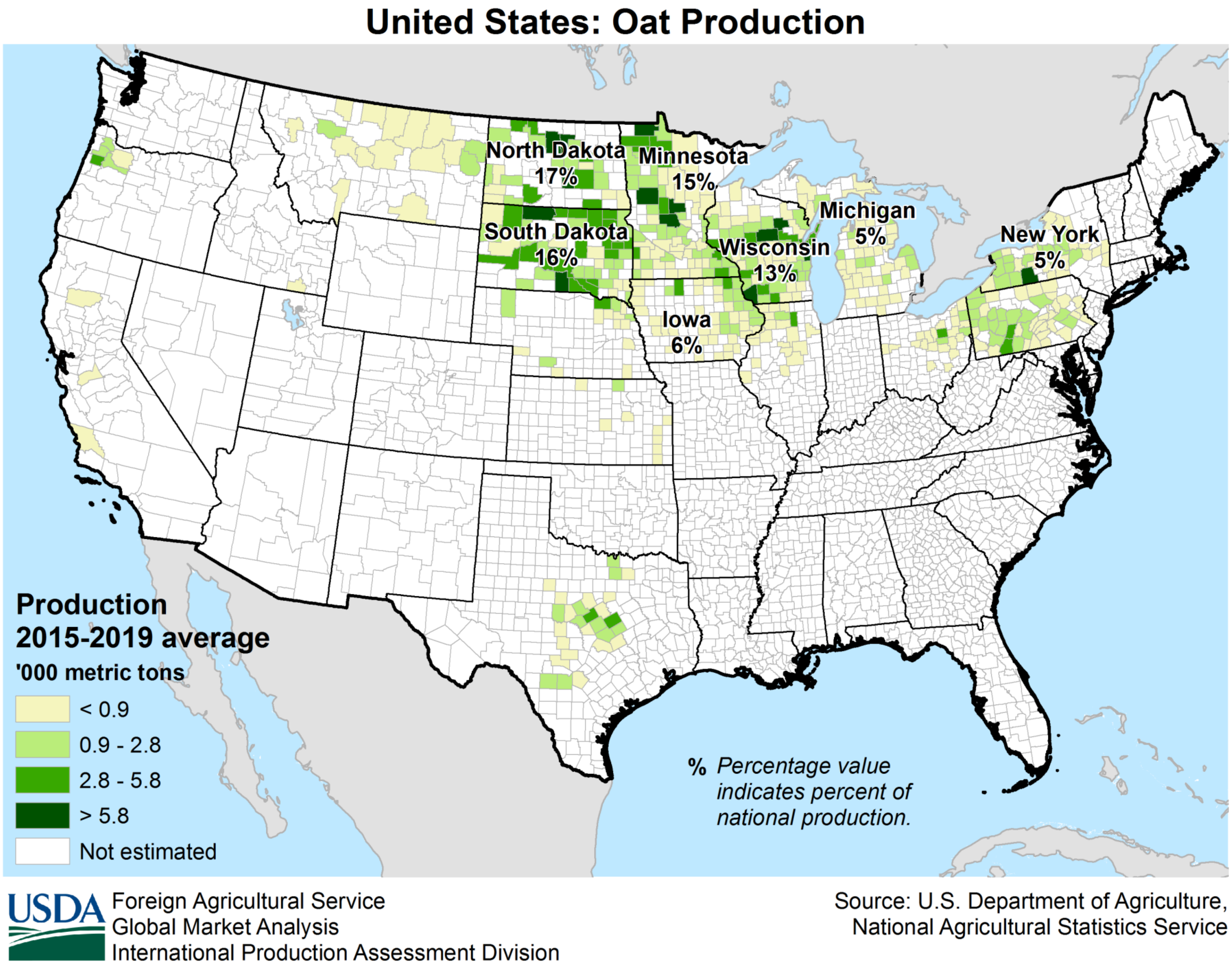


● HARD RED WINTER ● HARD RED SPRING ● SOFT RED WINTER ● SOFT WHITE ● HARD WHITE ● DURUM

ALBERT LEA SEED

VIKING & Blue River Organic Seed

Oat Growing Regions in the U.S.

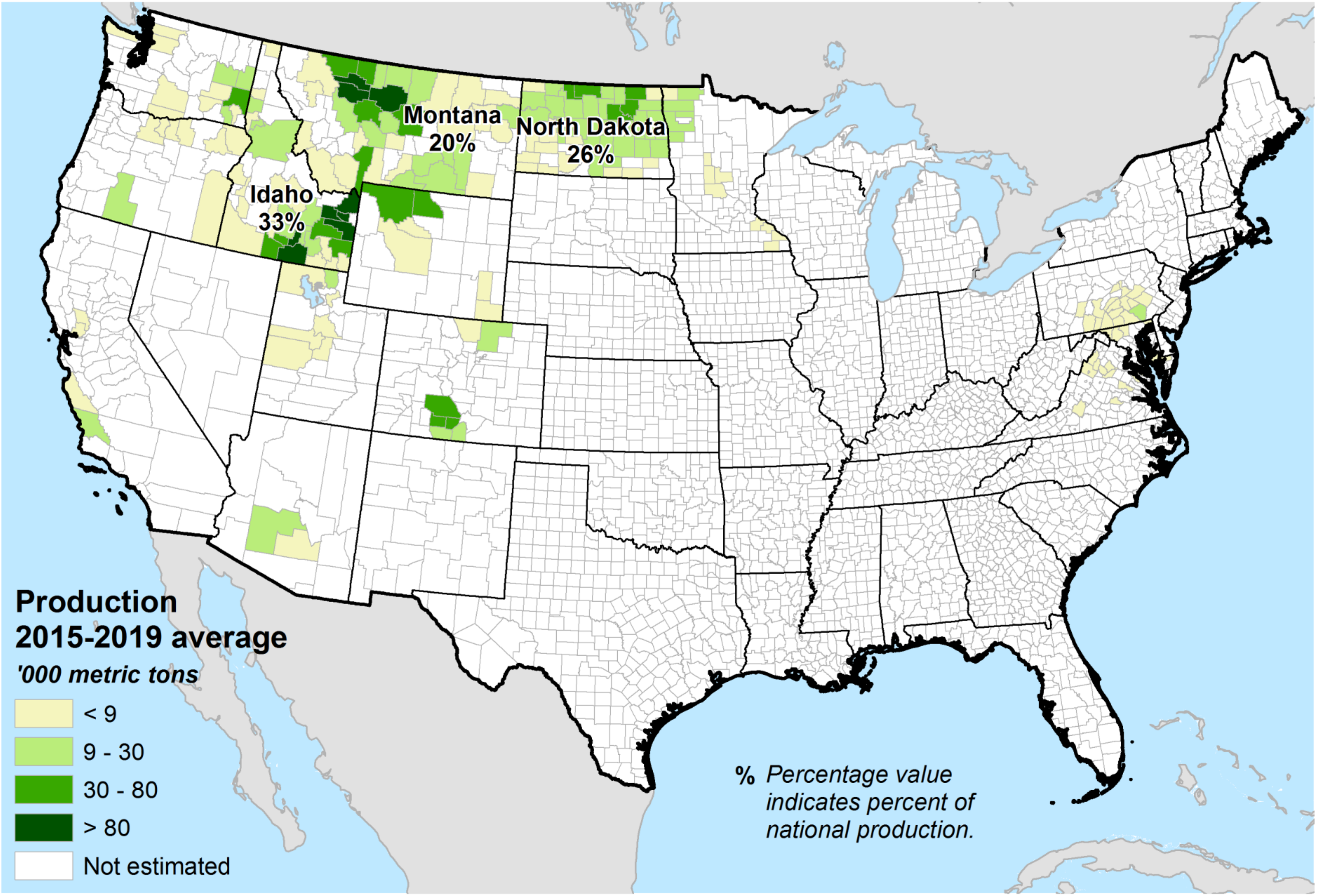


ALBERT LEA SEED

VIKING & Blue River Organic Seed

Barley Growing Regions in the U.S.

United States: Barley Production



USDA Foreign Agricultural Service
Global Market Analysis
International Production Assessment Division

Source: U.S. Department of Agriculture, National Agricultural Statistics Service

ALBERT LEA SEED
VIKING & Blue River Organic Seed

Cereal Rye Growing Regions in the U.S.

?????????????

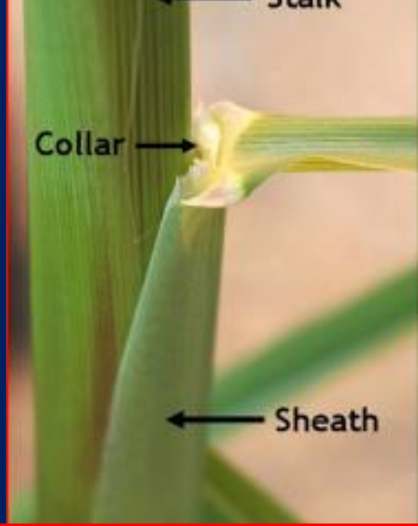
Small Grain Growth and Development

Why does it matter?

Driven by both daylength and temperature

How a Corn Plant Develops

J.J. Hanway, Iowa State University, 1966



Vegetative stages

- Vegetative Stages
  - VE: Shoot emerges from soil
  - V1: Collar is visible on lowest leaf
  - V2: Collar is visible on two lowest leaves
  - V(n): Each successive collar visible
  - VT: Lowest branch of tassel visible, before silks

Reproductive stages

- Reproductive Stages
  - R1 (silk): Any silk becomes visible outside the husk leaves
  - R2 (blister): Small, white kernels, and kernel fluid is clear
  - R3 (milk): Yellow kernels, milky white fluid in kernel
  - R4 (dough): Paste-like, or dough, kernel contents
  - R5 (dent): Kernels dent on the top due to starch accumulation
  - R6 (Physiological maturity): Physiological maturity with maximum dry matter accumulation. Black layer occurs after physiological maturity.

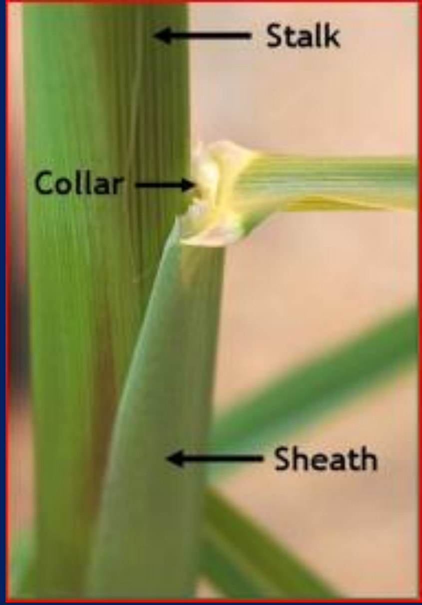
Small Grain Growth Stages

for all small grains

- Germination and emergence
- Seedling
- Tillering
- Stem elongation: Jointing
- Booting
- Heading
- Flowering: Anthesis
- Milk
- Dough
- Ripening

Key Production Operations with Small Grains

- Planting date and rate
- Optimizing tillering
- Nitrogen fertilization
- Grazing
- Early forage harvest
- Fungicide applications
- Rolling rye for mulching
- Later forage harvest
- Grain harvest



Small Grain Growth
---driven by both daylength and temperatures

Temperatures for Germination and Growing Degree Day ranges for Temperate Small Grains			
Wheat	**Oats**	**Barley**	**Rye**
37-40^{0}F	39-41^{0}F	38^{0}F	37-41^{0}F
Growing Degree Day Temperature ranges			
32^0 F-----70^0 F *32^0 F----95^0 F	Min 32^{0}F or 0^{0}C	Min 32^{0}F or 0^{0}C	Min 32^{0}F or 0^{0}C

Small Grain Staging Methods

- Feekes Growth Stage Scale---best known and most widely used
- Haun System---focused mainly on the leaf production stage of development
- Zadocks scale----provides more detailed information during early development stages than Feekes

Comparison of the Three Growth Staging Methods for Small Grains

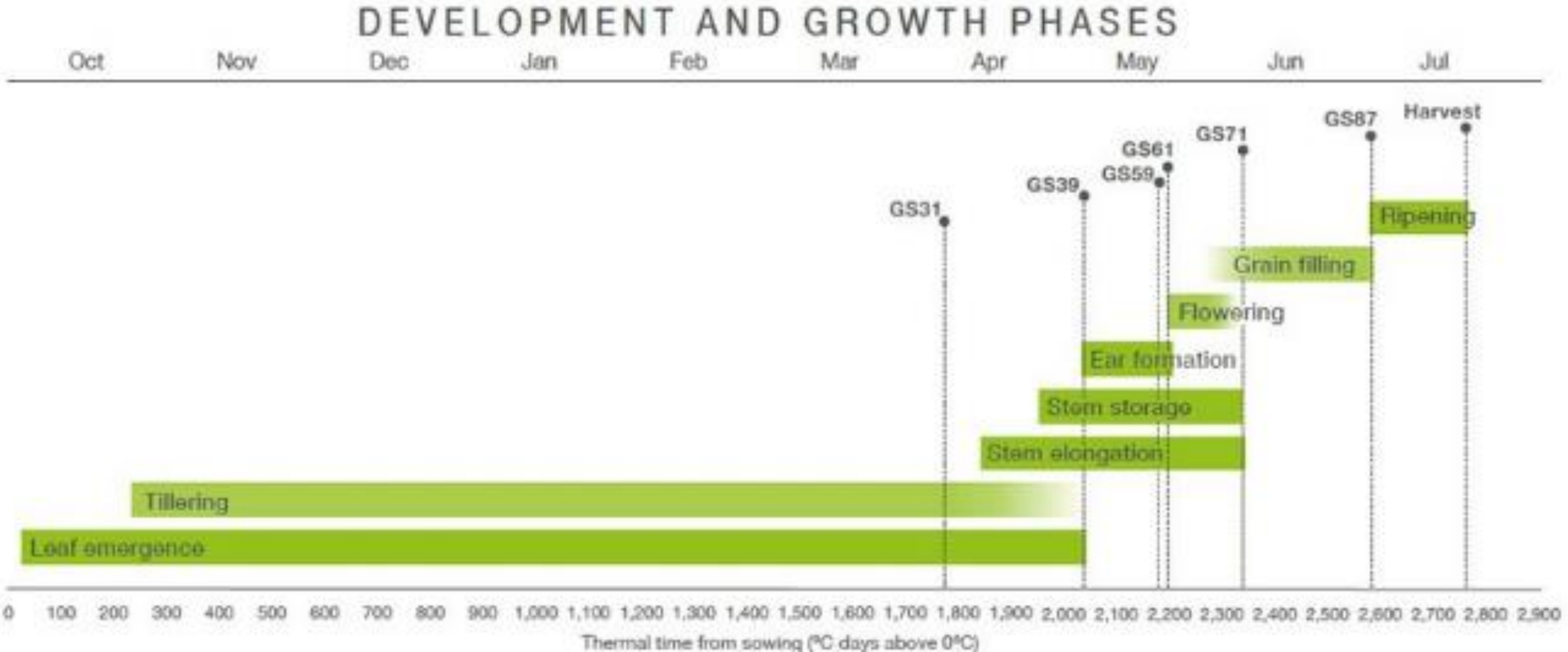
Table 1. Comparison of Zadoks, Feekes, and Haun growth scales for small grains

Growth stage	Scale		
	Zadoks	Feekes	Haun*
planting	00	—	—
emergence	10	1	0.0
first leaf	11	1	0.0–1.0
second leaf	12	1	1.1–2.0
third leaf	13	1	2.1–3.0
tillering	21–29	2–4	3.1–6.0
jointing	31	6	6.1–10.0
flag leaf	37–39	8	8.1–9.0
boot	40–47	9–10	9.1–10.0
heading	51–59	10.1–10.5	10.1–11.0
flowering	61–69	10.5.1–10.5.3	—
grain formation	71	10.5.4	—
milk	71–79	11.1	—
soft dough	85	11.2	—
hard dough	87	11.3	—
harvest ripe	92	11.4	—

Source: Flint 1990, p. 12.

Note: * Values are for Yecora Rojo wheat

Winter Barley Growth and Development Phases



Vernalization----'to make springlike'

A combination of:

- low temperatures and
- duration

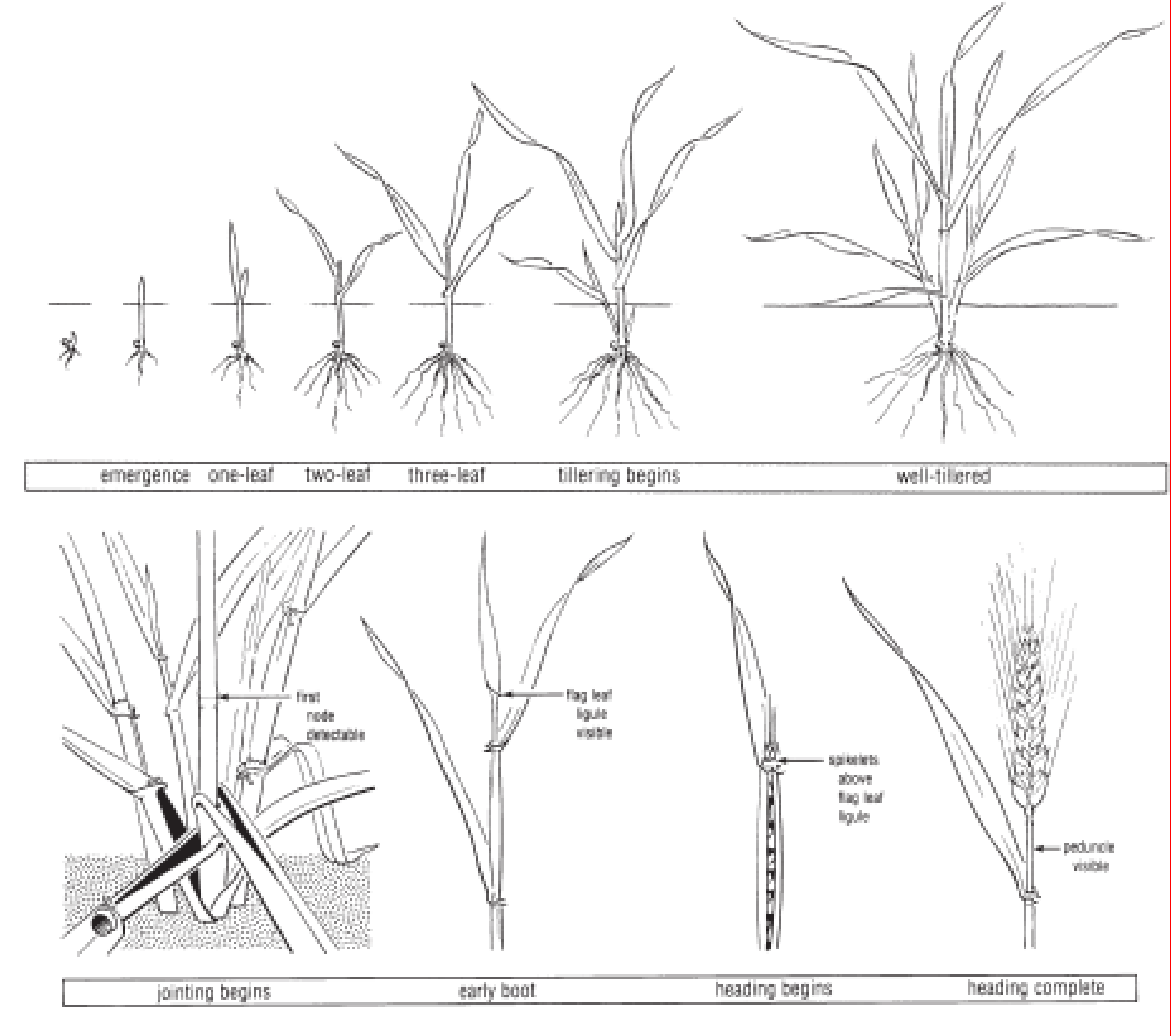
that influences *active meristems* to become sensitized to day length.

Vernalized plants can respond to lengthening days and increasing temperatures in the spring following the vernal equinox and switch to reproductive mode of growth.

Winter Small Grain
---requirements for vernalization

Wheat	Barley	Rye
30-52^{0} F	34^{0}F	$<45^{0}$F
50 days (Ohio has reported vernalization at higher temps and longer periods)	Lowest number of days required of the small grains---30-45 days Plants with only 15 days at temps remain vegetative	30 or more days(?)

Growth Stages of Wheat, Barley, and Rye



Wheat Leaf Structure

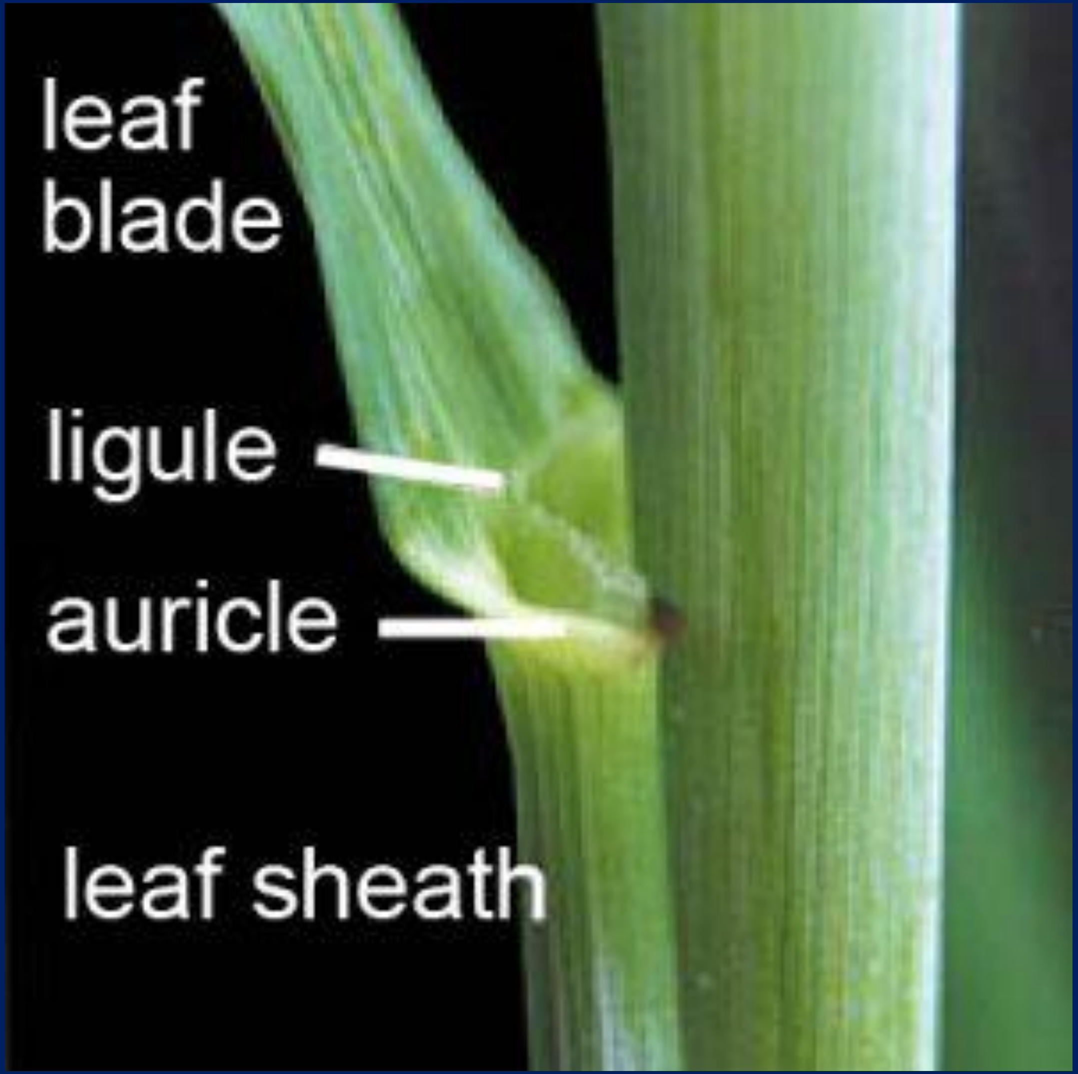
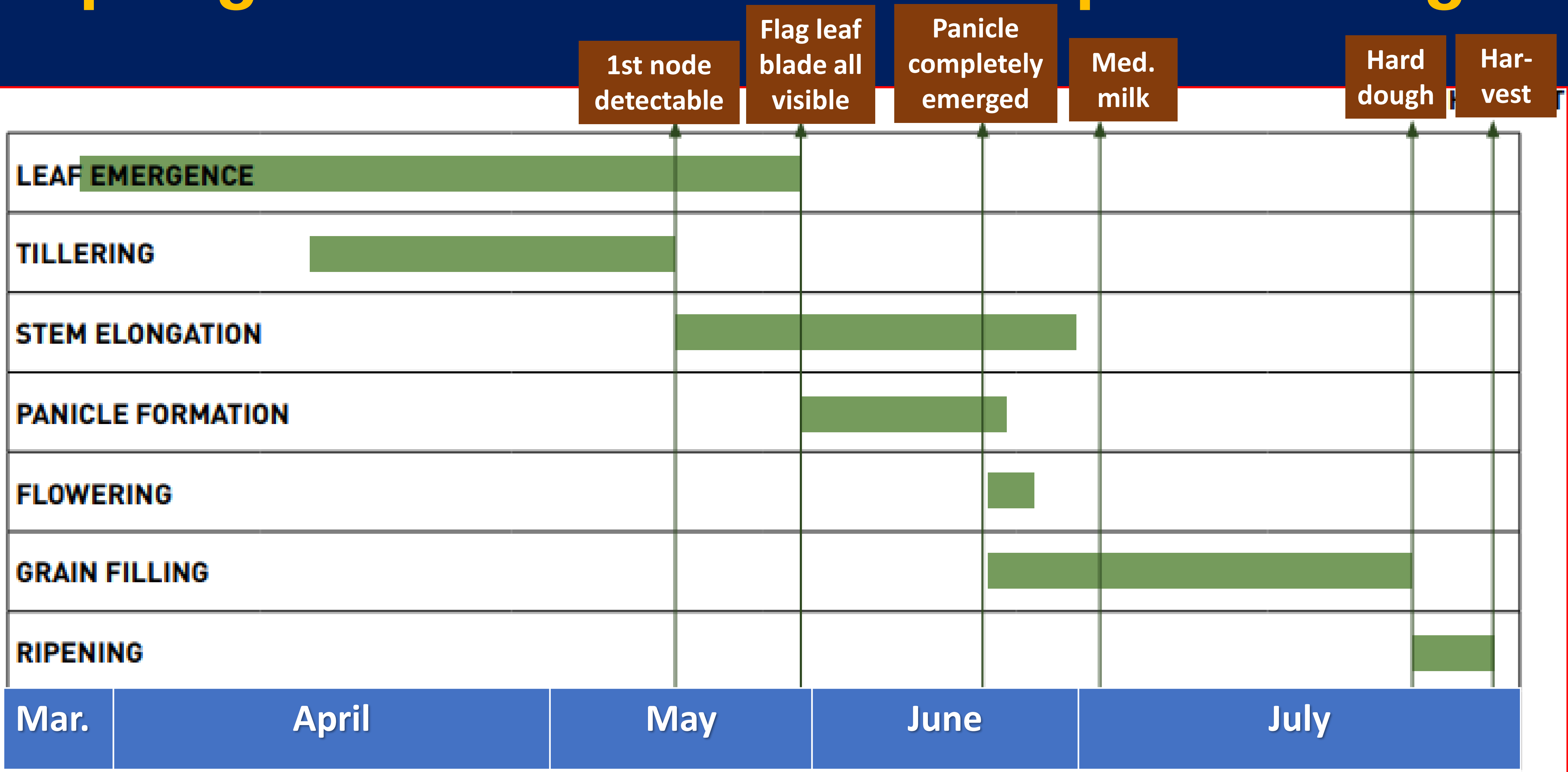


Photo from Alabama A & M & Auburn Universities

Tillering in Oats

Spring Oat Growth and Development Stages

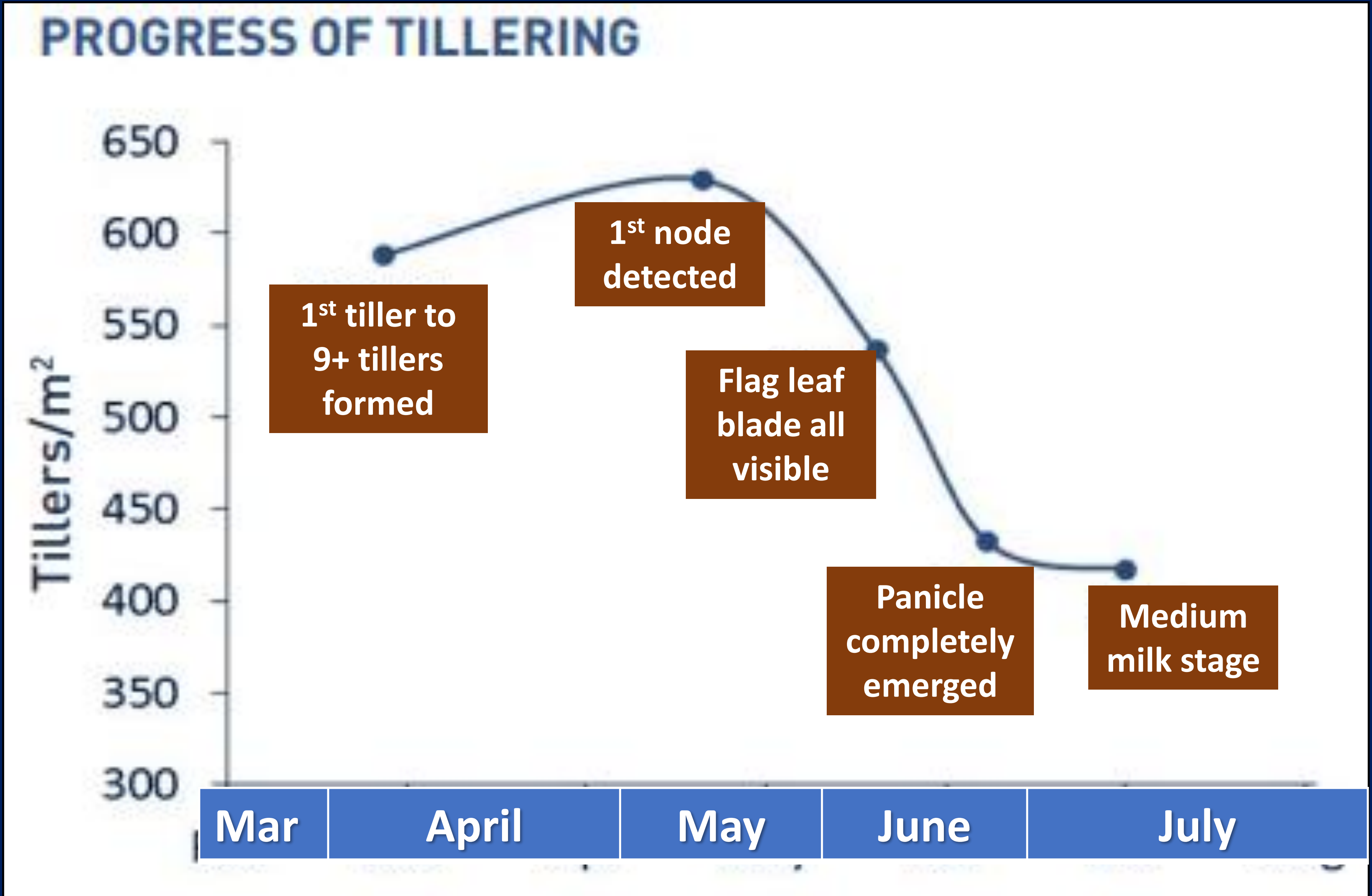


Tillering in Oats

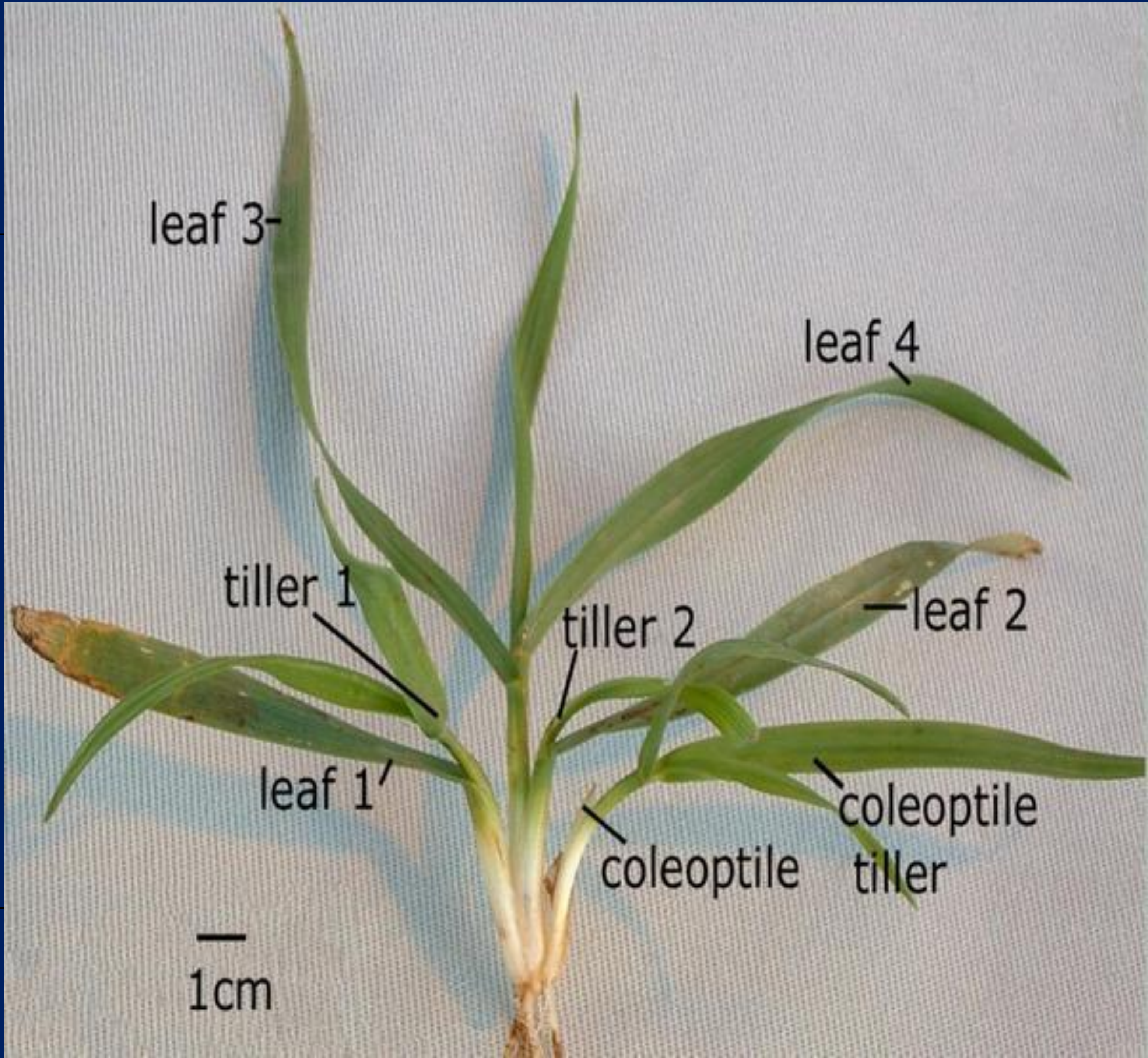
- **TILLERING** Tillering starts when a number of leaves have emerged, and continues until the start of stem extension. Tillering is affected by seed rate, temperature and the availability of water and nutrients. *Applying N before stem extension can increase tiller numbers.*

- **FINAL SHOOT NUMBERS** Maximum shoot number almost always exceeds final shoot number. *Smaller, later-formed tillers die off as competition for light and nitrogen increases throughout the season.*

Tillering in Oats



Tillering in Wheat



Tillering in Winter Wheat (and Rye)

- Optimum seeding dates (varies by latitude) result in more tillers produced in the fall than spring
- With later planting dates, a higher percentage of spring tillers produced grain (because there were fewer fall tillers)
- Weight of both grain and straw for productive fall tillers was greater than for productive spring tillers
- Kernel numbers per spike were always higher for fall tillers

Thiry, et al, KSU, 2002

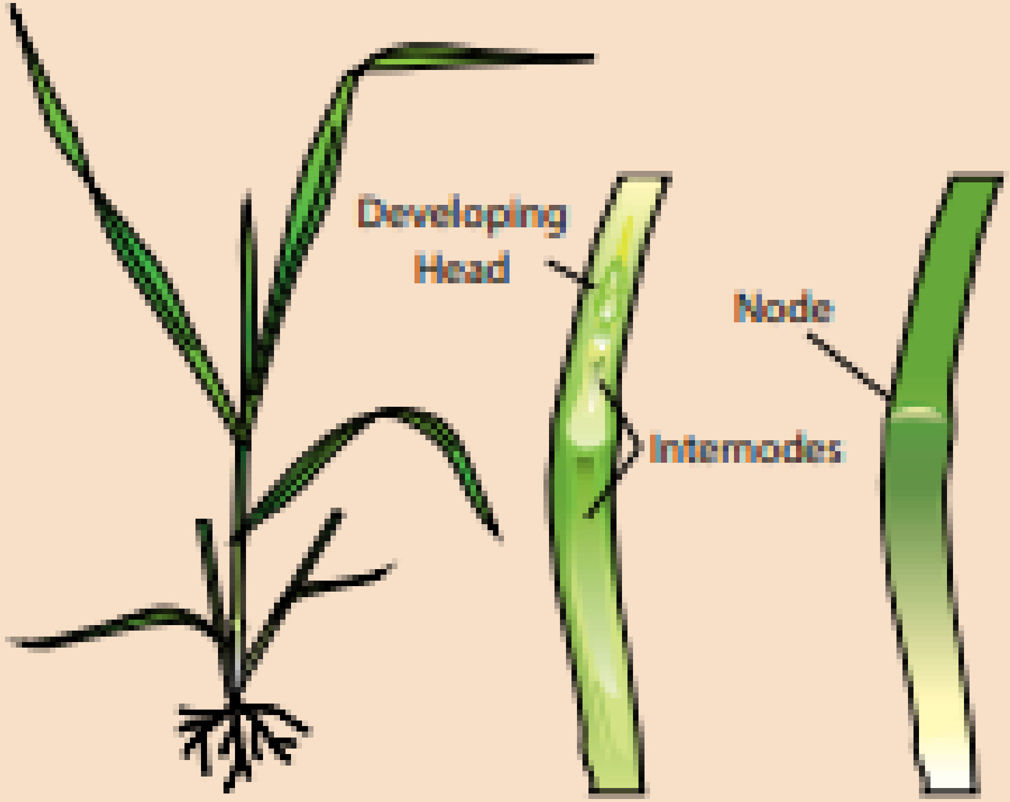
Enhancing Tillering

- Plant at the early range of optimum
- Assure adequate N fertility early, before jointing
- Physical disturbance: grazing, tine weeding *before the end of tillering stage-----*
  - *get cows off BEFORE you see the fist node of jointing stem*

Small Grain Growth Stages

- Germination and emergence
- Seedling
- Tillering
- Stem elongation: Jointing
- Booting
- Heading
- Flowering: Anthesis
- Milk
- Dough
- Ripening

Jointing stage: elongation of stems



Feekes 6

First node of stem visible (jointing). The first node of the stem becomes visible as a result of internode elongation. Nodes are stacked and move up as the internodes elongate much like a telescope. Sensitivity to low temperatures increases as the developing head is pushed up by the expanding stem. Crop water demand increases to about 0.25 inch per day. Approximately 25 percent of the total dry matter is accumulated by this stage.

Management. Consider a first fungicide application under significant disease pressure. Do not apply dicamba or 2,4-D after wheat reaches jointing, and avoid equipment with wide tires.

Nitrogen Uptake by Oat Crop at Various Growth Stages

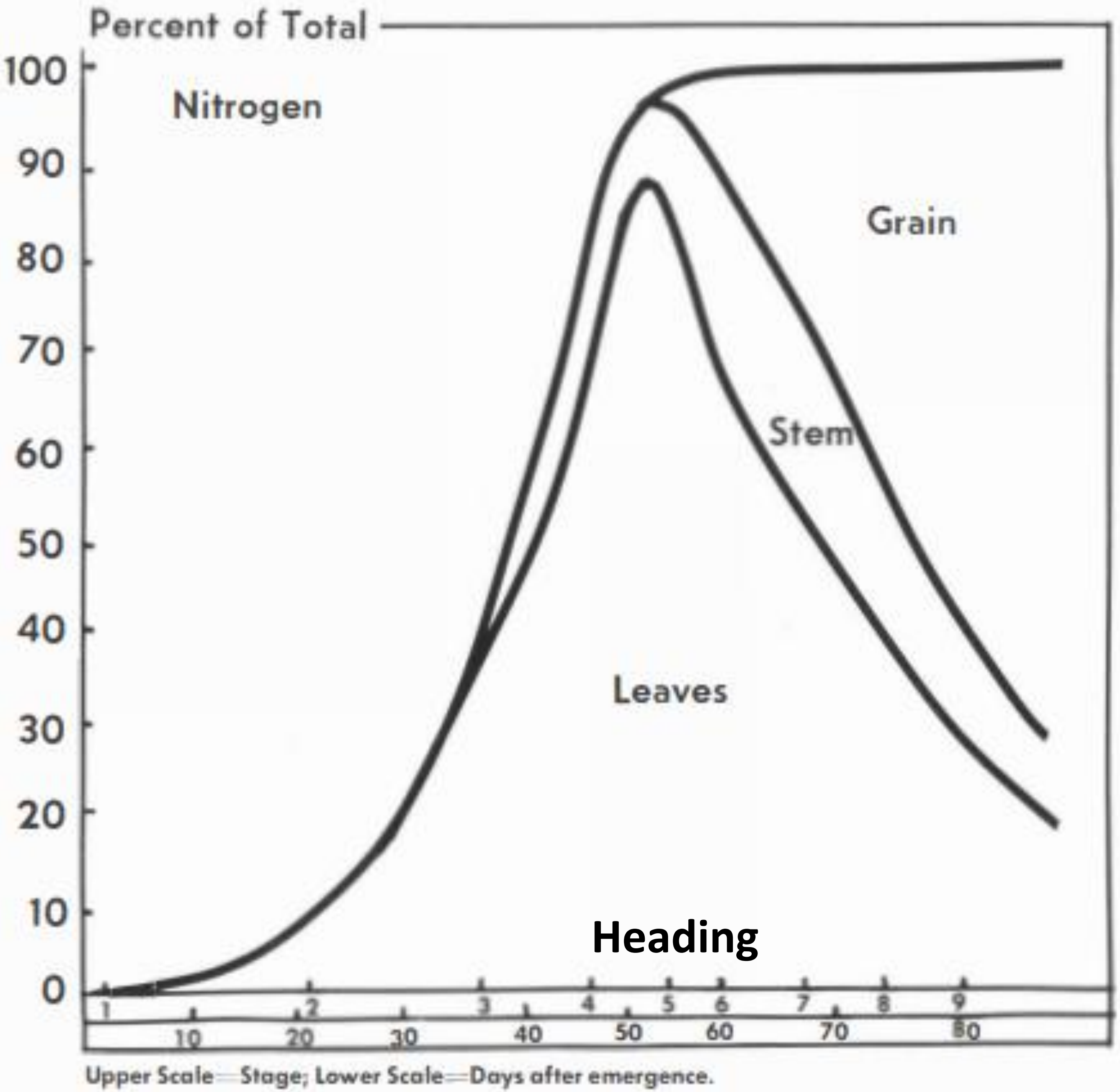
Rate = 1.1 lb/A/day
Total = 67 lbs/A by first node detectable

= 0.9 lbs/A/day
= 79 lbs/A by flag leaf blade all visible

= 1.2 lbs/A/day
= 101 lbs/A by panicle completely emerged

From: Oat Growth Guide----Opti Oat

Nitrogen uptake by the oat plant and its distribution into leaf, stem, and grain fractions.



From: How an Oat Plant Develops, SDSU, 1976

Jointing stage: elongation of stems

Complete spring topdress N by this stage

Early jointing stage and same stage dissected.

Jointing stage : elongation of stems

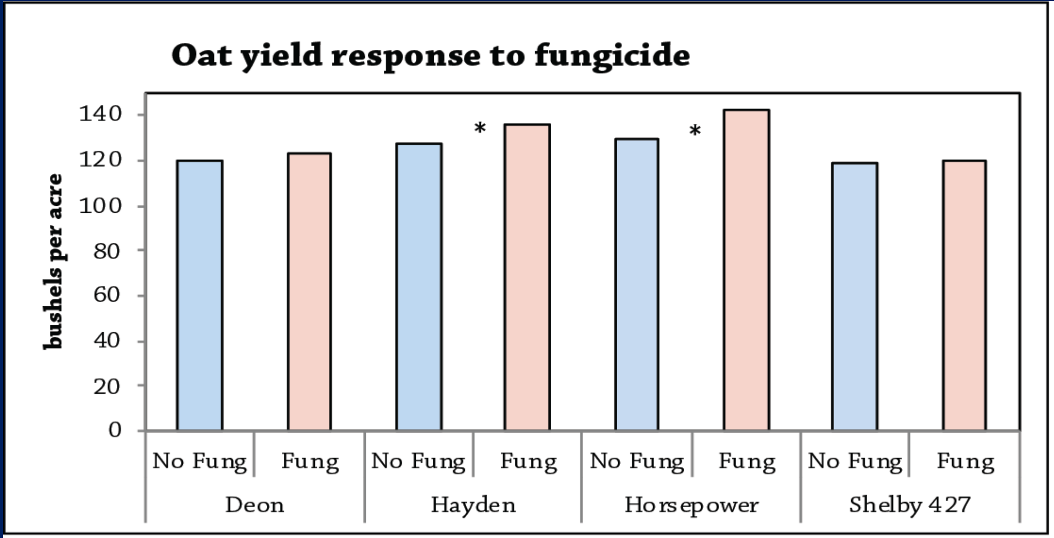
- Complete spring topdress N by this stage

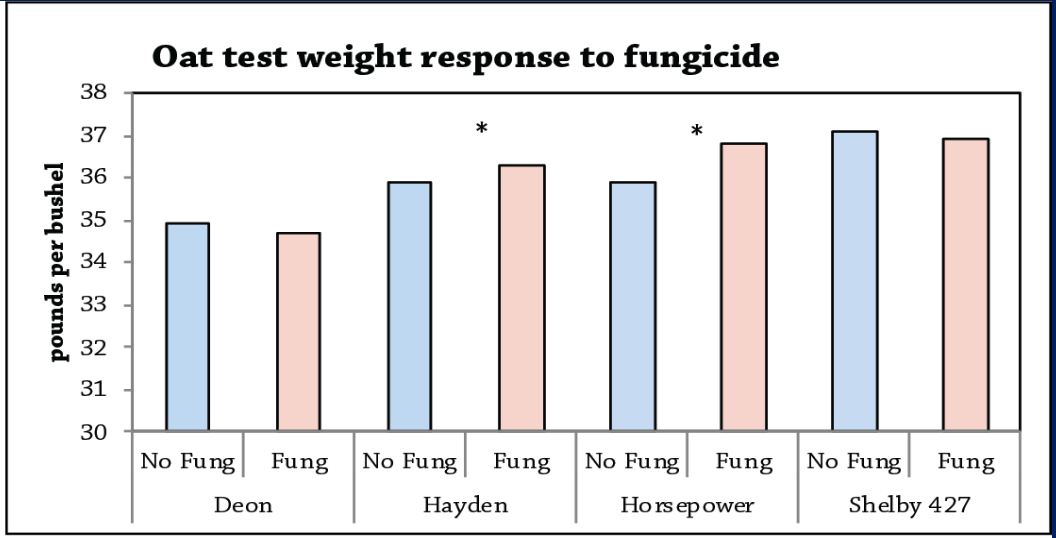
Flag Leaf stage (preboot)

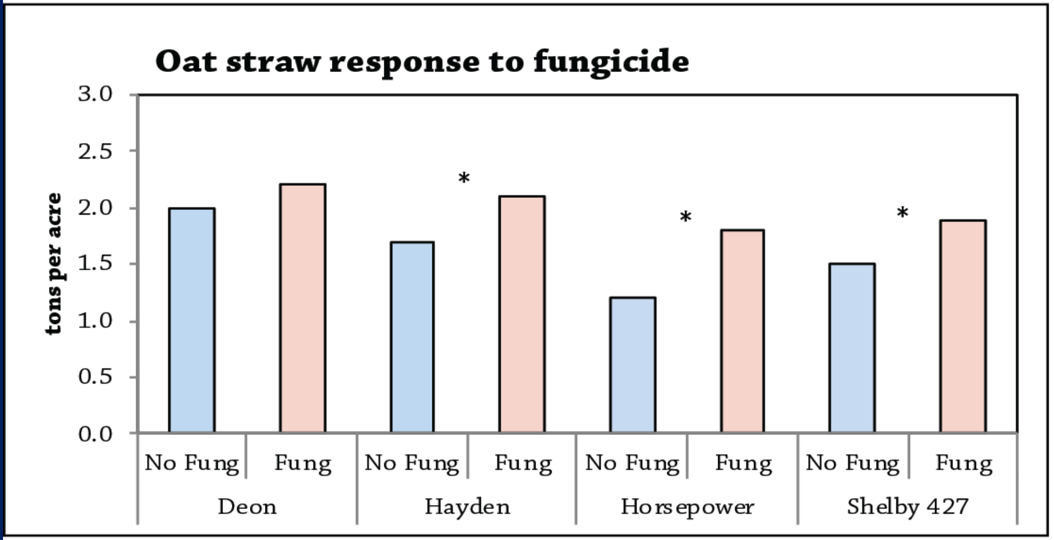
- Scout for crown rust on oats
- Fungicide treatments at this stage if present (better by ground, but can be done aerially)

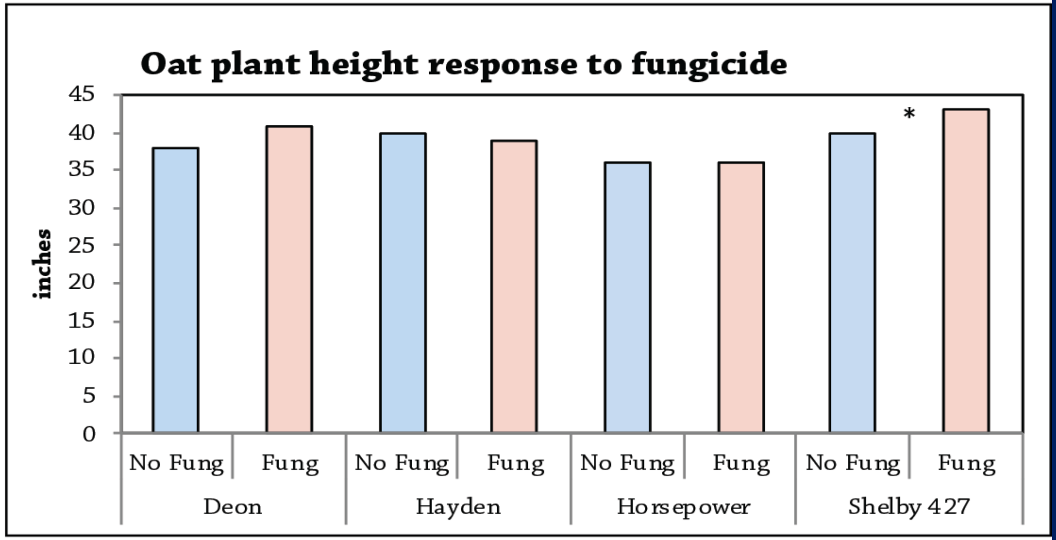
Photo from: A Field Guide to Cereal Staging

Fungicides on Oats---2019 NE Iowa ISU Research Farm









Boot stage

- Ideal harvest time for high-quality forage
  ----20-23% protein
  ----76-81% digestible DM
  ----allows for following
  crop of soybeans or
  warm-season grasses
  for hay or silage

Photo from Alabama A & M & Auburn Universities

Wheat Heading stage

Photo from Alabama A & M & Auburn Universities

Consider treating to prevent fusarium head blight: scab

- Heading---early flowering stage
- Check Scabsmart for potential

Scabsmart.org---tracking and tools for FHB

scabsmart.org

ScabSmart

Home | Fungicide Timing | Grain Class Management | Best Management Practices | Collaborations | Services

Welcome to ScabSmart

ScabSmart provides key management information for each small grain class affected by this disease in the U.S. **ScabSmart** is intended as a **quick guide** to the integrated strategies that result in optimum reduction in Fusarium Head Blight (FHB=Scab) and the primary associated mycotoxin (DON). Through the use of this website, we hope you will find information on the best management strategies for Fusarium Head Blight in your region. Overall, the integration of management strategies (e.g. fungicide applications, genetic resistance, crop rotation, and residue management) provides the best control of scab and DON. Specifically, planting moderately resistant varieties along with the application of recommended fungicides at anthesis when the weather favors scab development offers a higher DON reduction and the best opportunity for improvement of grain quality (e.g. test weight).

Welcome to the new and improved ScabSmart website! Click here for an overview of new features and services.

Quick Steps:

Feekes Growth Stages

Table 1. Comparison of Zadoks, Feekes, and Haun growth scales for small grains

Growth stage	Scale		
	Zadoks	Feekes	Haun*
planting	00	—	—
emergence	10	1	0.0
first leaf	11	1	0.0–1.0
second leaf	12	1	1.1–2.0
third leaf	13	1	2.1–3.0
tillering	21–29	2–4	3.1–6.0
jointing	31	6	6.1–10.0
flag leaf	37–39	8	8.1–9.0
boot	40–47	9–10	9.1–10.0
heading	51–59	10.1–10.5	10.1–11.0
flowering	61–69	10.5.1–10.5.3	—
grain formation	71	10.5.4	—
milk	71–79	11.1	—
soft dough	85	11.2	—
hard dough	87	11.3	—
harvest ripe	92	11.4	—

Source: Flint 1990, p. 12.

Note: * Values are for Yecora Rojo wheat

Wheat Management Considerations by Feekes growth stages

Feekes Growth Stage	Management Considerations
1.0	Check stands for emergence and uniformity. Check for weeds and apply herbicides if necessary[1]. Begin monitoring for various aphid species (continue through season)[2]. Check seedlings for Hessian fly feeding damage[3].
2.0 3.0	Make early nitrogen applications to enhance tillering in thin stands. Avoid excess nitrogen.
4.0	Scout for insect and disease problems. Check stands for heaving caused by freezing/thawing cycles. Decide whether post-emergence weed control is warranted.
5.0	Make spring topdress nitrogen applications. Apply herbicides as needed for weed control[1].
6.0	Cutoff for nitrogen applications to avoid leaf injury. Cutoff for some growth regulator herbicides, like 2, 4-D and dicamba[4].
7.0	Scout for insect and disease problems.
8.0 9.0	Apply fungicides to protect flag leaf from foliar diseases if necessary. Cutoff for any further herbicide applications unless harvest aid treatments are needed.
10.0	Determine if fungicide applications for glume blotch management are needed. Check risk for Fusarium head blight (scab) at www.wheatscab.psu.edu. Check for armyworm feeding. Consider control measures if armyworm feeding is clipping heads.
10.5.1	Apply fungicides to suppress Fusarium head blight if necessary

Wise, et al, Purdue Univ. 2011

Management Strategies for Diseases

Oats		Barley	
Crown rust	*Variety selection, fungicides*	Fusarium	*Variety selection* *Crop rotation* *Fungicides*
Barley Yellow dwarf	*Variety selection*	Barley yellow dwarf	*Variety selection* *Aphid vector management(?)*
Fusarium	*Not a common or big problem, fungicides*	Septoria P. Mildew Rusts	*Avoid high humidity areas.* *Fungicides*

Management Strategies for Diseases

Wheat		Rye	
Fusarium (Biggest economic losses in wheat)	*Variety selection* *crop rotation* *fungicides*	**Ergot**	*Variety selection* *Crop rotation* *Fungicides* *avoid traffic after jointing begins*
Leaf and stem rusts	*Variety selection* *crop rotation* *fungicides*		
Bacterial Leaf Streak	*Variety selection* *crop rotation* *fungicides*		

Small Grain Growth Stages

Quick Review

- Germination and emergence
- Seedling
- Tillering
- Stem elongation: Jointing
- Booting
- Heading
- Flowering: Anthesis
- Milk
- Dough
- Ripening

Small Grain Growth & Development: Resources

How an Oat Plant Develops	South Dakota State U.
Identifying Wheat Growth Stages	University of Kentucky
Managing Wheat by Growth Stage	Purdue Extension
Oat Growth Guide	Opti-Oat Project
A Field Guide to Cereal Staging	Ontario Ministry of Ag. & Guelph University

Small Grain Growth and Development:
Knowledge to Improve Management

Dr. Margaret Smith

Agronomist, Albert Lea Seed

March 2, 2023

Email: margaret@alseed.com

Tel: 800-352-5247