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## Spring Wheat production

Robert G. Hall

*Cooperative Extension Service, South Dakota State University*

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# Spring wheat production



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# Spring wheat production

**Robert G. Hall**  
Extension agronomist, crops  
South Dakota State University

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South Dakota is a major wheat producing state with a reputation for high quality, high protein spring wheat.

Flour milled from hard red spring (HRS) wheat is used in breads, rolls, and cereal foods. Durum spring wheat is milled into semolina flour for macaroni, spaghetti, and other pasta.

A bushel of wheat yields about 73 one-lb loaves of bread. A bushel of durum makes about 36 lb of pasta.

## WHEAT QUALITY

Growers, exporters, millers, bakers, and many others all handle wheat, and all have different definitions of wheat "quality."

Many growers think of quality in terms of Official U.S. Standards For Grain - Grades and Grade Requirements (Table 1) and protein content (in years when protein premiums are obtained). Commercial buyers evaluate wheat quality according to 22 tests that are conducted under complex laboratory conditions. In HRS wheat five of these tests receive critical examination by commercial buyers. They are percent protein content, protein quality, water absorption, flour extraction, and loaf volume.

Percent protein is important because flours differing in protein content are often blended to make various products. Protein quality is an indication of gluten content which gives strength and elasticity to the dough. Strength and elasticity greatly influence mixing time and mixing tolerance, important to millers and bakers.

Absorption tests indicate the amount of water needed in mixing flour into dough. Flour extraction tests show the percentage of bran-free flour obtained from the wheat. Loaf

volume indicates the volume obtained from a given amount of wheat flour. Generally, a high loaf volume value indicates a high quality wheat.

In durum wheat other tests receive critical examination by various commercial buyers. They include the percentage of vitreous (hard) kernels, clear amber color, noodle color, and noodle texture.

The amber color directly affects the desirable yellow color of pasta products. Vitreous kernels indicate the seed has developed and matured properly. Formation of vitreous kernels is adversely affected by moisture and by hot, dry weather during kernel maturation. Consequently, durum production is usually limited to northern regions of the state.

All of these factors can influence, through premiums or discounts, the price that growers receive.

Although affected by environmental factors, quality (for a grower) can be reasonably predicted on the basis of (1) variety, (2) protein content, (3) protein quality, (4) test weight, (5) area of origin, and (6) freedom from foreign matter.

## WHEAT MANAGEMENT CONSIDERATIONS

### Variety Selection

Variety selection means that a grower has matched a particular spring wheat variety with his local environmental conditions and his own crop management practices.

Specific variety characteristics are given in EC 774 (Variety Recommendations: Spring Grains and Flax, available from your county

Table 1. Official U.S. standards for grain - grades and grade requirements (HRS and durum wheat).

U.S. Grade	Minimum Test Weight per Bushel		Maximum Limits of—						
	Hard Red Spring	Other Classes	Heat-Damaged Kernels	Damaged Kernels (total) <sup>1</sup>	Foreign Material	Shrunken and Broken Kernels	Defects (total) <sup>2</sup>	Contrasting Classes	Other Classes (total) <sup>3</sup>
	lb	lb	%	%	%	%	%	%	%
No. 1	58.0	60.0	0.2	2.0	0.5	3.0	3.0	1.0	3.0
No. 2	57.0	58.0	0.2	4.0	1.0	5.0	5.0	2.0	5.0
No. 3	55.0	56.0	0.5	7.0	2.0	8.0	8.0	3.0	10.0
No. 4	53.0	54.0	1.0	10.0	3.0	12.0	12.0	10.0	10.0
No. 5	50.0	51.0	3.0	15.0	5.0	20.0	20.0	10.0	10.0

Sample

Grade U.S. Sample Grade shall be wheat which:

- (1) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4, or 5; or
- (2) Contains a quantity of smut so great that one or more of the grade requirements cannot be determined accurately; or
- (3) Contains 8 or more stones, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria spp.*), 3 or more castor beans (*Ricinus communis*), 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), or 2 or more rodent pellets, bird droppings, or an equivalent quantity of other animal filth per 1,000 grams of wheat or
- (4) Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or
- (5) Is heating or otherwise of distinctly low quality.

<sup>1</sup>Includes heat-damaged kernels.

<sup>2</sup>Defects (total) include damaged kernels (total), foreign material, and shrunken and broken kernels.

The sum of these three factors may not exceed the limit for defects.

<sup>3</sup>Unclassed wheat of any grade may contain not more than 10% of wheat of other classes.

<sup>4</sup>Includes contrasting classes.

Extension office). Background on how these characteristics affect variety selection follows.

**Maturity.** Maturity is based on heading date. In South Dakota, the difference in maturity between early and late maturing spring wheat is about 8 days for HRS and about 5 days for durum wheats.

At first glance, this may not seem like much. It is true that in some areas or years a variety will perform well regardless of maturity. For example, with adequate moisture and moderately cool temperatures, late maturing varieties thrive in areas where early maturing varieties are normally grown.

In other areas, or in a different year, hot, dry winds in early July can severely reduce test weight and yield. If that happens to you often, then select an earlier variety.

**Straw Strength.** This characteristic is often, but not always associated with plant height.

Semi-dwarf varieties (28 inches or less) tend to have better straw strength than standard height varieties (34 inches or taller). Under good fertility, especially high nitrogen and good moisture, straw strength will often determine if lodging will be a problem.

**Plant Height.** This greatly affects the amount of straw or residue left following harvest.

If you want straw for bedding or mulch, select a standard variety. If you don't need straw or if you are managing residue under no-till or reduced tillage, then consider a semi-dwarf.

**Disease Resistance.** HRS wheat varieties range from poor to good in resistance to leaf and stem rust. Durum varieties tend to have good resistance to both rusts.

Although either rust affects variety performance under severe infection, stem rust

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can go the final step and cause crop failure.

There are many varieties with good resistance to rusts, although you must be always alert. Rust resistance will change as new strains of the disease evolve over time. Current variety rust resistance ratings are given in EC 774.

**Protein.** Protein premiums are not offered every year. Presently, the marketing standard is 14%; premiums may (or may not) be paid for wheat containing 14% or more protein.

A major factor affecting protein premiums for HRS wheat is the average protein content of the hard red **winter** wheat crop. If it is low, then the chance for spring wheat protein premiums is greater, because millers usually blend the two classes to make bread flour.

A classification of varieties with high, medium, and low levels of protein is in EC 774.

You should note that a high protein variety may be a medium or low yielder while a low protein variety may be either a low, medium, or high yielder.

Therefore, to gain some marketing flexibility, consider planting two or more varieties. The high yielder will be good in years when protein premiums are not available. The second variety with a high protein potential allows you to collect premiums when they are offered.

**Test Weight.** This is an indication of how a variety reacts to the environment. Test weight indicates how densely the kernels have filled.

Test weight often differs among varieties because it is partly controlled by genetics. Crop testing results at SDSU indicate spring wheat varieties range from 54 to 61 lb test weight after cleaning. Test weights fluctuate up or down from one year or location to another; but varieties tend to maintain a relative rank to one another when grown under similar conditions.

**Yield.** Yield potential and stability are modified by environmental and management factors.

Evaluate as many variety yield records from as many sources as you possibly can. Use results from the SDSU Crop Performance Testing Program (EC 774), other land-grant colleges, seed companies, and agricultural publications.

A comparison between 3-year averages

obtained from replicated trials for varieties grown in **your** area is best when you are looking at yield.

Remember that yield differences among varieties are dependent on three major factors: (1) genetic potential, for yield and for adaptability to different growing conditions; (2) the environment; and (3) the management system or skills of the grower. Any time one or more of these factors is limiting, then yield will be reduced.

### Seeding Time

Spring wheat should be planted as soon as the soil can be properly worked. Seeding when soils are too wet often leads to poor seedling establishment and soil compaction. Yet you want to take advantage of early spring rains and moisture left from winter.

In South Dakota the best seeding time for HRS wheat is March 25 to April 20 and for durum wheat from April 1 to April 15.

When seeding is delayed past May 10, significant yield reductions usually occur, but if rainfall is plentiful and temperatures remain cool after a May 10 seeding, then you may see little or no drop in yield.

Research at Brookings has shown that a seeding delay of 16 days beyond the earliest possible planting date reduces yields. For 8 years, wheat was seeded at the earliest time each year that the soil could be worked (dates ranged from March 25 to April 22). Each year, a second seeding was made 16 days after the first. Yields from the early seeding dates averaged 24% higher.

### Seeding Rate and Depth

In the past, the HRS seeding rate recommendation was 1 bu (60 lb) in the central and western counties. Five pecks (75 lb) was standard in the higher rainfall eastern counties. A durum seeding rate of 6 pecks (90 lb) was suggested for northern counties; the higher durum seeding rate compensated for a larger seed size.

Research from South Dakota and Minnesota now indicates that seed size among HRS varieties may differ by 25 to 30% and among durum varieties by 20% in a given year. Durum seed size also averages about 15% larger than HRS wheat.

Keep these differences in mind as you plant.

You may need to recalibrate your seed drill when you switch varieties.

Recommended seeding rates (Table 2) are affected by seed size and seeding conditions. The number of seeds per pound indicated in the table is an average, which can range from about 12,000 to 20,000 for HRS wheat and about 10,000 to 18,000 for durum wheat. The numbers of 19,000, 16,000, and 13,000 were arbitrarily assigned to the small, medium, and large seed sizes, respectively.

Find the size of your seed by counting out 100 seeds. Have them weighed on a gram scale at your local elevator or seed dealer. The number of seeds per pound is equal to 45,400 divided by the **gram weight** of the 100 seeds.

As a minimum, 28 viable seeds per square foot or 1,200,000 viable seeds per acre should be planted. Upward adjustments of seeding rate may be needed if the seedbed is poor or the seeding is delayed beyond May 10.

A seeding depth of 1 to 3 inches, depending on moisture conditions, and a row spacing of 6 to 10 inches are recommended. Deeper seeding may lead to poor emergence. Seed 1 to 2 inches deep for semi-dwarf varieties.

Table 2. Seeding rate guide.

Seed Size	Seeds/lb	Seeding Conditions and Seed Density/Sq Ft		
		Good Seedbed 28	Poor Seedbed 32-35	Late Seeding 35
			<i>lb/acre</i>	
Small	19,000	*71	82-90	90
Medium	16,000	85	97-106	106
Large	13,000	104	119-131	131

\*Seeding rates assume 92% germination and 98% seed purity which equals 90% pure-live seed.

### Tillage and Seedbed Preparation

Conservation tillage in your wheat fields generally leads to better soil and moisture conservation.

North Dakota research indicates that type of tillage is not as important in yield results as the previous crop planted (Table 3). Tillage comparisons in South Dakota indicate there is no consistent yield advantage to either tillage system (conventional or conservation tillage) over a number of years.

For example, over 4 years a conventional black treatment yielded 2 bu less than the no-till treatment under fallow. In contrast, under continuous wheat, the black treatment yielded 3 bu more than either the reduced or no till tillage methods.

Conventional tillage has the advantage when moisture is above normal; conservation tillage has the advantage when moisture is limiting.

Table 3. Effects of previous crop and tillage on 7-year average wheat yields at Fargo, ND (S. Miller, NDSU).

Previous Crop	Tillage	
	Conventional	No-till
Wheat	33.7	33.3
Barley	37.0	35.3
Flax	38.0	37.5
Corn	38.6	36.6
Soybeans	45.3	44.9
Sunflowers	39.3	39.0
Tillage Average	38.7	37.8

Seedbed preparation, variety selection, and use of quality seed are probably the three management practices over which the grower has greatest control.

Double disking and harrowing are common conventional seedbed preparation methods on land previously row cropped. Moldboard plows or large heavy disks incorporate stubble left from sod or previous small grain crops. For conservation tillage, many growers use chisel plows to partially incorporate stubble or a noble blade, conserving moisture while leaving residues on the soil surface.

How much surface residue you leave is dependent on soil texture and slope. In sandy, loam, and clay soils, residue levels of 2,000, 1,500, and 750 pounds per acre, respectively, are needed.

The key is to leave sufficient residues to conserve moisture and soil but not enough to prevent the proper placement of seed during planting.

### Use Good Seed

Your expectations of a bumper crop will receive a jolt if you use poor seed.

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You can spread herbicides, pesticides, and fertilizers, but they may be wasted effort if you planted seed containing other varieties, other crop seed, weed seed, or seed-borne diseases.

The only guarantee of varietal purity and high quality seed is **certified** seed. If you are economizing by using bin-run seed, have the seed tested for germination and purity. If the tests indicate it is of questionable quality, don't use it.

Many studies indicate conditioned (cleaned) seed of high quality will out-yield typical bin-run seed by 3 bu per acre.

### Other Management Considerations

Specific weed control, soil fertility, and seed treatment information is available at your county Extension office. The following is general background information that growers should know.

**Weed Control.** More often than not, weeds reduce yield. Weeds show no mercy to a wheat crop, so carry out a planned cultural weed control program, along with a supplemental herbicide program when needed. A number of chemical control measures are outlined in FS 525A (Chemical Weed Control in Small Grains)

**Insect Control.** The same can be said for insects: more often than not, they limit wheat yields. Again, a planned cultural insect control program along with a supplemental pesticide program may be needed. Pesticide recommendations change rapidly; check with your Extension office for the latest information.

**Soil Fertility.** Wheat is no different from other crops, it is greatly affected by soil fertility.

Nitrogen is used most. Approximately 2.4 lb of nitrogen (N) are needed to produce each bushel of wheat. When growers set their yield goal for 40-bu wheat, 96 lb N must be supplied to the crop through a combination of commercial fertilizer and residual carried over in the soil.

Soil testing is a cheap way to assure that neither too little nor too much fertilizer is applied. Specific soil fertility recommendations are given when you send your soil samples to the SDSU Soil Testing Laboratory. Additional

fertility recommendations are also outlined in FS 677 (Fertilizing Wheat).

**Seed Treatment.** Seed treatment with a recommended chemical is often a good practice when seeding in cold soils in early spring. Under such conditions, germination is delayed. While the seed sits there, it is vulnerable to attack by soil-borne diseases. A seed-treatment coating protects it from such disease organisms. Check with your local Extension office for current information on seed treatment.

### Crop Rotation

Rotating spring wheat with other crops is a good idea. It helps control the almost certain buildup of crop pests when the same crop is planted year after year. There are pitfalls in rotations, however.

For example, it is not recommended that you follow corn with wheat. In such a case, corn residues left on the surface are an ideal environment for continuing the life cycle of the *Fusarium* disease that causes headscab in wheat. Rotating also increases chances for (1) chemical carry-over from previous crops and (2) volunteering of the previous crop.

Results of a long-term North Dakota wheat rotation study with several other crops indicates that, regardless of tillage system, wheat benefited from the rotation (Table 3). This benefit was especially evident when wheat followed soybeans, but be aware of potential herbicide carry-over problems from the previous crop.

Wheat following wheat had the most adverse effect on wheat yields.

### Harvest and Storage

Windrowing followed by combining is the most common method of harvesting spring wheat in South Dakota. In most cases, this eliminates weeds, uneven ripening, shattering, and high moisture grain problems.

Swathing may start at the hard-dough stage; but combining should be delayed until the kernels dry to a moisture content of 13% or less. Supplemental drying allows you to start harvest earlier, at a higher moisture content, if many acres are involved. A combination of early, medium, and late maturing varieties will also spread the work load.



Direct combining is becoming a more common method of harvesting; it is feasible if the crop is relatively free of weeds and is uniform in maturity. Direct combining should be done before the grain reaches 13% or less moisture. Shatter losses may be reduced by direct combining at 18 to 20% moisture. At such a high moisture content the harvested grain must be dried artificially for safe storage.

Proper moisture content and sanitation of the storage bin and surrounding areas are cost effective in preventing grain storage problems.

New crop grain should be dried to a moisture content of 12% or less before storage. Old crop grain should be removed from storage bins prior to filling with the new crop. Any old grain infested with mold or live insects and their eggs can contaminate the new crop.

Get the discarded grain out of the vicinity of storage bins to prevent recontamination. Clean and spray the bin floors and walls with an approved pesticide to rid cracks and seams of live insects. If the stored grain becomes infested with molds or insects, spray with an approved pesticide. Current information on pesticides can be obtained at your local Extension office.

Storage bins should also be weather, bird, and rodent proof before filling. **Spring wheat is marketed primarily as a human food crop; keep it clean.**

Preventive measures are much more cost effective in minimizing storage losses than chemical control after the stored grain has become infested with mold or insects.

## Wheat Diseases

In South Dakota 20 or more diseases can affect wheat, but not all are important in any given year. Following are those that are most common and cause considerable loss.

**Rust.** The most devastating is stem rust, which affects both the stem and the leaves. Elongated, brick red pustules on the stem or leaves are symptoms.

Leaf rust, in contrast, attacks only the leaves. Symptoms are distinct circular orange-red pustules.

An outbreak of rust comes after reproductive spores are blown northward

from southern states where they overwinter. Wheat varieties differ in tolerance (see EC 774).

**Headscab.** Symptoms include a bleached or prematurely ripened appearance soon after the heads flower. This disease affects individual spikelets, a portion of the head, or the entire head.

When the whole head is infected, growers often confuse headscab with insect damage from stem maggot. The difference is easily determined by pulling on the wheat head. Since stem maggots feed at the base of the stem, the head can easily be pulled out of the plant. In headscab the head resists an easy pull.

Headscab infection may occur any time it rains or high moisture conditions prevail while the crop is flowering. The risk of infection is higher if wheat follows corn. If you find headscab, increase fan speeds during combining to blow out the lighter, shriveled seeds. Grain infected with this disease contains toxins which are harmful to both man and livestock.

Since headscab results in blank or shriveled kernels, the percentage of infected area in the head (and consequently in the field) is directly associated with the percentage of yield reduction. Chemical treatment is not economically feasible, and there are no resistant varieties.

**Leaf-Spot Disease, Tanspot.** Tanspot, a fungus disease, occurs on the upper and lower leaf surfaces. It starts as tan-brown flecks which eventually join and form larger tannish lesions with a brown colored center.

Brome grass, wheat grass, and wheat residues on the soil surface serve as major hosts; barley and rye are infrequent hosts. These crops or their residues can serve as overwintering or alternative environments for tanspot.

Some fungicides and cultural practices are used to control this disease. Current chemical control information can be obtained from your local Extension office. Cultural methods include crop rotation and some partial incorporation of previous crop residues so that you still have enough "trash" on the soil surface to retard soil erosion.

**Septoria Leaf Spot.** Initial symptoms include pale green flecks on lower leaves, especially near the soil surface. Later the flecks join and form lesions with a water-soaked appearance, which eventually appear dry, yellow, and finally reddish-brown.

Straw, seed, and overwintering or volunteer wheat appear to be the major means by which the disease carries over from year to year. Control measures include the use of disease-free seed and some incorporation of residues.

## WHEAT GROWTH

Knowing the growth stages of the wheat plant helps you understand the management practices you will be carrying out.

Refer to the drawings in Figure 2, "Wheat growth stages," as you read the following.

### Emergence

The wheat seed needs a minimum soil temperature range of 34 to 36°F for germination, but an optimum range of 59 to 65°F is best for rapid germination and growth. During the next 6 to 8 days after germination the primary root and main shoot develop and the main shoot elongates above the soil surface.

During emergence the main shoot is protected by a leaf sheath called the coleoptile (C). This protective sheath encases the growing point as the main shoot advances upward.

The growing point is still below the soil surface and protected from frost and hail.

**Management.** A seeding depth of 1 to 3 inches is suggested. Don't seed semi-dwarf varieties more than 2 inches deep. If crusting should occur, you can lightly harrow or rotary hoe so the coleoptile can emerge.

### 1st to 3rd Leaf Stages

Successive leaves ( $L_1$  to  $L_2$ ) continue to emerge until the growing point develops to form the head. During this period the plant's growth stage is defined by the number of fully emerged leaves. A leaf is fully emerged once the collar (that area at the junction of the leaf blade and sheath) becomes visible (see back view, Figure 1). For example, at the 3rd leaf

stage there are three emerged leaves plus a partially visible 4th leaf.

### 4th to 5th Leaf Stage

During growth from the 3rd leaf to the 4th leaf stages, tillering or stooling starts to occur.

At the 4th and 5th leaf stages the number of tillers lags behind the number of leaves by three. For example, by the time the 4th and 5th leaves have fully emerged, the 1st ( $T_1$ ) and 2nd ( $T_2$ ) tillers are visible. Up to four or five tillers emerge, depending on plant population.

Tillering differs among varieties but can be affected by moisture and temperature. Adequate moisture and cool temperatures will result in the maximum number of tillers. Hot and dry weather tends to suppress the number of tillers.

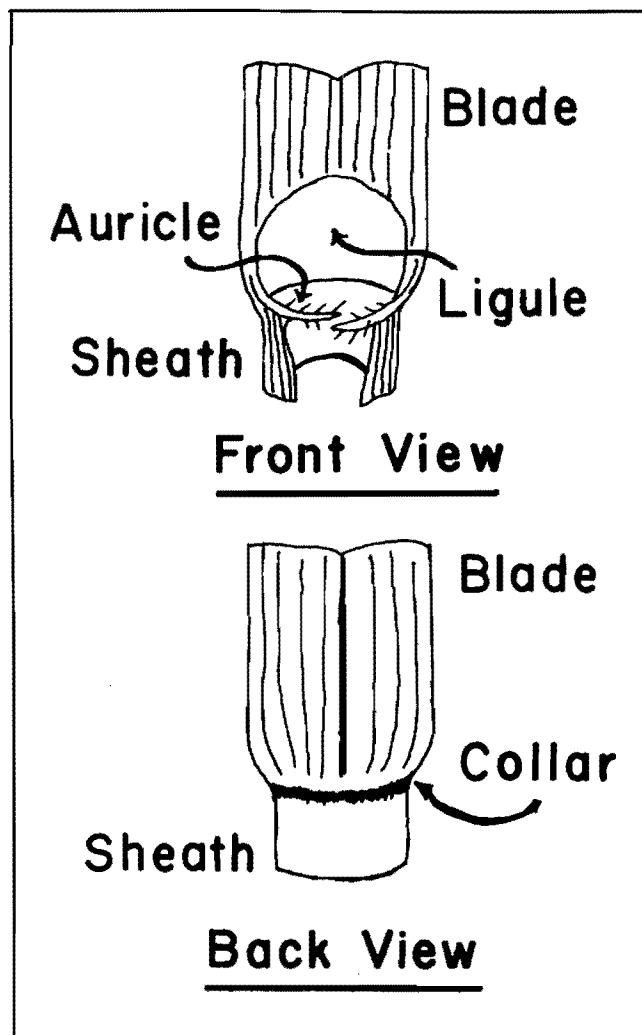


Fig 1. Parts of a wheat leaf.

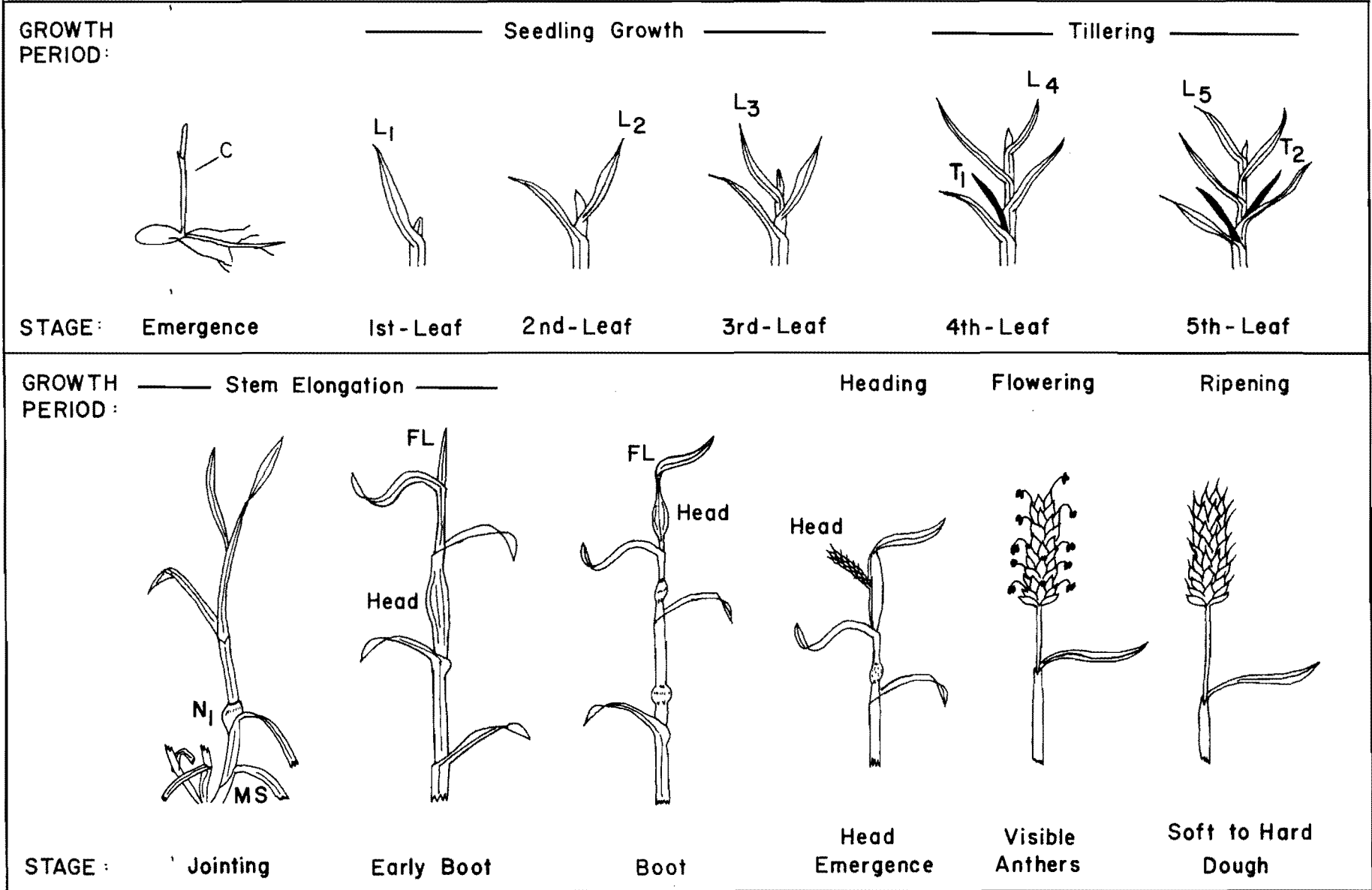


Fig 2. Wheat growth stages

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Even though the main shoot or some tillers may not survive the growing season, any remaining tillers have the potential to produce grain.

**Management.** Herbicide application may be necessary during this growth period (see FS 525A). This is the optimum growth stage for topdressing with nitrogen.

### 1st Node

During this period, jointing or stem elongation starts to occur. Jointing is first indicated by the appearance of the 1st node (N<sub>1</sub>) or joint near the base of the main shoot (MS). Thereafter, periods of elongation are evident as successively higher internodes elevate the growing point, now changed into a head.

During jointing, the head is exposed to hazards such as frost, hail, or pests.

**Management.** Application of herbicides during this period may be detrimental to normal growth. This is the latest growth stage for topdressing with nitrogen.

### Early Boot

The transition from jointing to the early boot stage is indicated by the appearance of the terminal leaf, called the flag-leaf (FL), and by the advance of the head up the main shoot.

**Management.** In some cases this may be the only stage in which some growth regulator chemicals may be applied. Growth regulators restrain the height of the plant, thereby reducing the chance of lodging under lush growing conditions. For dryland wheat, growth chemicals may not be cost effective. Even for irrigated wheat, you should be relatively sure of economic benefit before applying. Follow label directions in regard to rate and growth stage at which to apply.

### Late Boot

At this stage the flag-leaf is fully expanded and the head is enclosed within its sheath.

The flag-leaf, the stem, and the head above it manufacture more than 75% of the photosynthetic products needed during grain filling. Flag-leaf damage from hail during this period may severely limit yields.

**Management.** From late boot through final ripening it is important that the flag-leaf be protected. The use of pesticides to guard the flag-leaf from disease or insect pests may be justified. Herbicide applications at this stage may be detrimental. Follow label directions.

### Heading

This stage is indicated by the emergence of the head from within the sheath formed by the flag-leaf. Thereafter, the stem below the head elongates and the head attains its final height.

**Management.** At heading or after emergence some chemicals such as herbicides or growth regulators may adversely affect head development. It depends on the chemical used. Follow label directions.

### Flowering

This stage is indicated by the presence of open florets with visible anthers or male organs. The main stem flowers first, followed by the tillers in the same sequence in which they developed.

Once a head flowers, pollination is complete within 2 to 3 days. Severe moisture stress and/or high temperatures may inhibit self pollination and kernel development. During flowering, rainfall or irrigation in combination with the *Fusarium* fungus disease headscab may severely limit yields.

**Management.** Plant early or choose early maturing varieties so flowering will not occur during hot, dry weather. Reduce the risk of headscab by (1) not irrigating during the flowering stage or by (2) using two or more varieties that differ in maturity so the entire crop is not in flower and exposed to rainfall at any one time. Presently, there are no headscab resistant varieties.

### Ripening

During final ripening, the developing kernels advance from the milk stage to the soft and hard dough stages, and finally the hard kernel stage.

**Management.** Normal planting dates and proper variety selection can avoid reductions in yield and test weight during grain ripening caused by hot, dry weather in July.