THE UNIVERSITY OF ARIZONA
Cooperative Extension

Small Grain Growth and Development

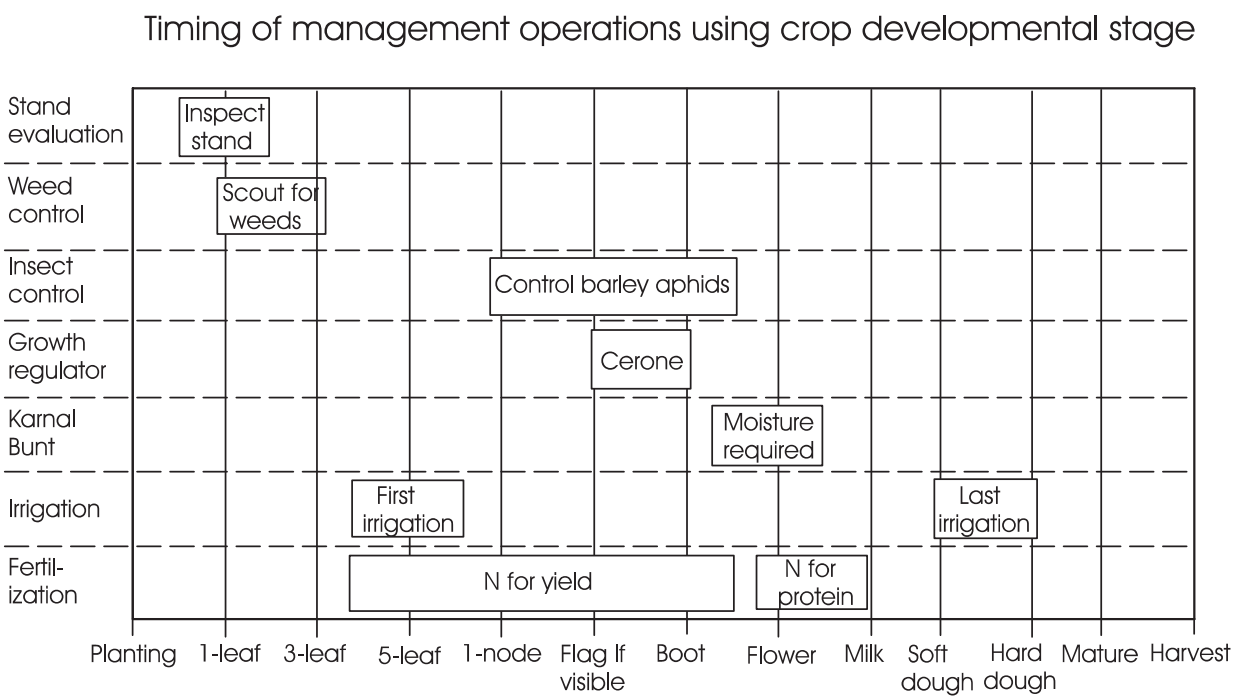

Fig 1. Timing of management operations using crop growth stage.

Small grain growth and development can be divided into several major and minor stages. Progression from one stage to the next can be described by growing degree days (GDD), commonly referred to as heat units (Table 1). Crop development is dependent on temperature as calculated by GDD, but other factors may affect crop development such as location, planting date, variety, photoperiod, and crop stress. Identification of crop growth stages is important for various management practices (Fig. 1). Publications related to various aspects of small grain management can be found at http://cals.arizona.edu/forageandgrain/small.html#extpubs.

Seedling Growth

Emergence can be defined as when the first leaf reaches half its length. The time required for emergence depends on seeding depth as well as temperature. The **1-leaf** stage is reached when the first leaf is fully developed. A leaf is considered fully developed when the next leaf is visible in the whorl. The first leaf is actually a seed leaf (cotyledon) and can be identified by its rounded tip compared to the sharp tip of all other leaves. The **2-leaf** stage occurs when the second leaf has reached its final length and the third leaf is visible in the whorl.

Management: **Stands** and soil conditions should be evaluated between emergence and the 2-leaf stage. If soil crusting is hindering emergence, a light irrigation may be warranted. An adequate stand is approximately 20 plants per square foot. The yield difference associated with a later planting should be considered before replanting. **Weed control** failures are often associated with applying a herbicide too late. Therefore, scout for weeds between the 1- and 3-leaf stage, and apply a herbicide at the proper developmental stage of the crop and weed.

9/04 **AZ1347**

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This information has been reviewed by university faculty.

cals.arizona.edu/pubs/crops/az1346.pdf

Table 1. Growing degree days (86/45 °F) required for small grains to reach various growth stages at Maricopa, AZ .

		Growing degree days (86/45) °F*			
Growth stage	Description	Barley (Short-season)	Barley (Full-season)	Durum	Wheat
Emergence	½ leaf expanded	93	95	100	98
1 leaf	1 leaf expanded	127	130	137	134
2 leaf	2 leaves expanded	196	201	212	206
3 leaf	3 leaves expanded	264	271	286	279
4 leaf	4 leaves expanded	333	342	360	351
5 leaf	5 leaves expanded	401	412	434	424
6 leaf	6 leaves expanded	470	483	509	496
1 node	1 node above ground	528	602	564	522
2 node	2 nodes above ground	631	707	675	631
Flag leaf visible	Flag leaf visible	653	780	813	768
Flag leaf collar	Flag leaf collar visible	708	836	873	826
Boot	Swelling of flag leaf sheath	763	893	933	885
Heading	Head emerges	799	930	971	923
Flowering	Pollen shed	821	952	1142	1051
Water	Kernel watery	952	1117	1306	1197
Milk	Kernel milky	1083	1282	1470	1342
Soft dough	Kernel mealy	1280	1529	1716	1559
Hard dough	Kernel hardening, losing color	1358	1628	1814	1646
Maturity	Kernel mature, heads tan	1476	1777	1962	1777
Harvest	Kernel dry, brittle, hard	1820	2121	2306	2121

* The growth stages in this table represent the main stem, except at maturity and harvest where all stems are represented. Growing degree days were obtained from the Arizona Meteorological Network, AZMET (http://cals.arizona.edu/azmet). Growing degree days (GDD) are based on Barcott and Mucho for short season barley; Baretta, Commander, Max, and Nebula for full season barley; the average of current commercial varieties for durum; and Yecora Rojo for wheat. The GDD to required to reach various growth stages may vary according to the year, location, and variety. For a listing of the current varieties and their relative heading and maturity dates see http://cals.arizona.edu/pubs/crops/az1265.pdf) .

Tillering

A tiller is a shoot that arises from the base of the plant. Tillering begins at about the **3-leaf** stage and continues until stem extension. Cool weather, moist soil, and high nitrogen fertility status promote tillering. Tiller death occurs between stem extension and flowering, and as many as half of the tillers produced may either die or not produce a grain head. The grain head is initiated at the **4-leaf** stage, but can only be seen clearly using a microscope. At the **5-leaf** stage, a pseudo-stem formed by the leaf sheaths becomes apparent. The stem begins to elongate after the **6-leaf** stage in most varieties.

Management: The **first irrigation** is usually needed by the 5-leaf stage, although it may be applied early in cracking soils or to encourage tillering. **Nitrogen fertilizer** may be applied at this time to encourage tillering, and is usually applied in every irrigation until flowering, or slightly thereafter.

Stem Extension

Stem extension, or jointing, begins when the first node is visible above the soil surface. Leaves continue to develop during this stage, although they may be difficult to count accurately due to death of the lower leaves. Most durum varieties in Arizona develop about 8-10 leaves, while barley develops 8-12 leaves. Stem extension is the time of most rapid growth and nutrient uptake. The **1-node** stage begins after the development of 6 leaves, or 7 leaves in the case of full season barley. Nodes can be identified by cutting the stem in half, stripping the leaf sheath away from the stem, or by running your thumb and forefinger along the stem. The growing point is often mistaken for a node, but is identified easily when the stem is cut open. At the **2-node** stage, 2 nodes are visible above ground, and plant height is increasing rapidly. On most varieties except for full-season barley, the **flag leaf is visible** when 3 nodes are visible above ground. This stage is difficult to identify unless the leaf sheaths are removed exposing the emerging

head. When the flag leaf is fully developed, the **flag leaf collar** becomes visible and the portion of the stem below the flag leaf elongates elevating the flag leaf above the previous leaf. **Booting** occurs when the stem swells due to the passage of the emerging head, and begins near the end of flag leaf elongation and ends when awns become visible at the flag leaf collar. **Heading** begins when the tip of the head is visible at the flag leaf collar and ends when the base of the head clears the flag leaf collar. The stem continues to grow and raise the head above the flag leaf collar. Head extension is usually complete by flowering, except for barley which may flower near head emergence.

***Management*:** The crop is most sensitive to water and nitrogen stress during this stage, so timely **irrigations** and application of **nitrogen fertilizer** are more critcal during this time period than any other. The only **insect** that normally is a problem on small grains in Arizona is aphids on barley. These insects usually do not appear until stem extension, and if they appear after heading, chemical control is not necessary. Natural enemies are often effective in reducing aphid populations. **Cerone** is a plant growth regulator used to control height and reduce lodging in small grains. This chemical should be applied between the flag leaf visible stage and boot to be most effective. Wet conditions between awn emergence and the end of flowering are critical for the development of **Karnal bunt**, but chemical control measures are not currently recommended

Grain Development

Flowering is identified when the anthers are yellow and shedding pollen. The anthers are usually externally visible during flowering, but may not extrude under water stress. The **kernel watery** stage begins after pollination. During this stage, the kernel will develop in size and will have a water consistency. Once the kernel obtains its final length and width, it will accumulate dry weight more rapidly and the kernel contents will have a **milky** consistency. As more dry weight is deposited and the kernel loses moisture content, the kernel will have a mealy consistency referred to as **soft dough**. At the **hard dough** stage, it is difficult to squeeze contents out of the kernel and the kernel loses its green color. Dry weight accumulation ceases at **physiological maturity** indicating grain yield has been made. This stage occurs when the heads have completely turned color from green to tan and grain moisture content at this time is about 38%. Small grains in Arizona are ready for **harvest** when the grain moisture content is less than 10%. The amount of time required between physiological maturity and harvest is usually a minimum of 10-12 days, but this period can be extended if drying conditions are not favorable or the soil is moist.

***Management*:** **Nitrogen fertilizer** applied before heading affects yield primarily, and that applied between heading and about 2 weeks after flowering is most effective in increasing grain protein content. The soonest the **last irrigation** should be applied on most soils is the soft dough stage, and any irrigation applied after physiological maturity will have no effect on grain yield.