Small Grain Growth Stages and Management

Aaron Gabriel
Cornell Cooperative Extension
Yield =

# of tillers X
kernels per head X
kernel weight
Zadok Development & Growth Stages

- 00 – 09  germination
- 10 – 15  seedling development
- 20 – 25  tillering
- 30 – 39  stem elongation
- 40 – 49  boot
- 50 – 59  head emergence
- 60 – 69  flowering
- 70 – 77  milk
- 80 – 89  dough
- 90 – 92  ripening
<table>
<thead>
<tr>
<th>Stage</th>
<th>General Description</th>
<th>Scale</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germination</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry seed</td>
<td>00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start of imbibition</td>
<td>01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imbibition complete</td>
<td>03</td>
<td>Seed typically at 35 to 40% moisture.</td>
</tr>
<tr>
<td></td>
<td>Radicle emerged from seed (caryopsis)</td>
<td>05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coleoptile emerged from seed (caryopsis)</td>
<td>07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leaf just at coleoptile tip</td>
<td>09</td>
<td></td>
</tr>
<tr>
<td><strong>Seedling Growth</strong></td>
<td>First leaf through coleoptile</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First leaf unfolded</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 leaves unfolded</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 leaves unfolded</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 leaves unfolded</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 leaves unfolded</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 leaves unfolded</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 leaves unfolded</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 leaves unfolded</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 or more leaves unfolded</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td><strong>Tillering</strong></td>
<td>Main shoot only</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 1 tiller</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 2 tillers</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 3 tillers</td>
<td>23</td>
<td>Many plants will only have 2 or 3 tillers per plant at recommended populations.</td>
</tr>
<tr>
<td></td>
<td>Main shoot and 4 tillers</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 5 tillers</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 6 tillers</td>
<td>26</td>
<td>Leaves often twisting spirally.</td>
</tr>
<tr>
<td></td>
<td>Main shoot and 7 tillers</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 8 tillers</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main shoot and 9 tillers</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>
• Seedling development, tillering, & elongation may occur simultaneously
• GDD, base 32° (42°), 70° before stage 13; 95° after stage 13
• Dead leaves/tillers are counted
Seminal roots emerge from the coleoptile node
Coleoptile will extend no more than 3”
• Subcrown internode between the coleoptile node & subcrown node does not elongate if seed is planted 1” deep. It can elongate up to 4 inches.
• Second root system, crown roots emerge from subcrown & other nodes
• Complete emergence, 1st leaf is 50% emerged from coleoptile & expanding
• Growing point remains at the crown until stem elongation.
Seedling Development – stage 13

- 730 GDD to develop 6 leaves if planted early enough
- Leaves develop on main shoot (3-4 days/leaf) while tillers develop simultaneously
- Tillering begins after 3 leaves develop (stage 13)
- Applying nitrogen at planting to promote tillering
• More tillers with nitrogen, cool temps, light, low seeding rate.
• Tillering last about 2 weeks
• > 1 tiller may form from each leaf axil
• Some tillers typically die after 4 weeks depending on stress.
• Seed heads begin developing @ 4-leaf stage on each tiller & before stem elongation.
• Growing point protected from growth regulator herbicides
**Nitrogen**

- Nitrogen at planting promotes tillering and in early spring for winter annuals will promote final tillering.
- Nitrogen after tillering increases grain protein (good or bad depending on use)
- Split N applications reduce lodging
- N is needed throughout the growing stages (fertilizer or nutrient cycling)
- Applying manure or compost to the crop may increase weeds. Apply manure & composts months before the crop
- Measuring soil organic matter and nitrates will help you manage nitrogen
- Traditionally we do not plant small grains after a sod to prevent lodging.
Stem Elongation – stage 30

- Internodes elongate, hollow
- Growing point rises above the soil
- Seed head continues developing, nutrient sink
- Growth regulator herbicides can cause crop damage
- Apply additional N at jointing to increase protein and yield
**Boot (40) & Heading Stages (50)**

- Flag leaf collar visible
- Head swelling in flag leaf sheath
- Most of photosynthate for grain comes from flag leaf & penultimate leaf
- Number & kernel length determined already
- Barley flowering begins in the boot & ends when head fully emerges (less head blight)
- Wheat flowers after head emergence
- One day to fertilize a floret
- Pollination 1 week, except in rye (2 weeks)
Figure 2. Stages of barley at or near spike emergences.
Figure 1. Stages of wheat at or near flowering.
Flowering – stage 60

- Wheat, barley, oats self-pollinate
- Rye cross pollinates (longer time, more susceptible to ergot)
- The time to apply fungicides is at very first anthesis, but earlier is better than later
- Pollination begins in the middle of the head and moves up & down
Monocot reproductive anatomy

Inflorescence type - spike
Flowering unit - spikelet
Individual flower - floret

Inflorescence of type spike has no branches and no pedicels: spikelets are attached directly to the rachis.

rachis
glume

awn
anther
filament

lemma
ovary

rachilla

stigma
style
palea
lodicles

Nemose
• Kernel weight, plumpness determined
• Starch more affected than protein: high temp & low moisture = low starch
• Health of upper canopy is critical
Ripening – stage 9

- Fully ripe when head and peduncle have lost chlorophyll
- 25% - 35% moisture
- Pre-harvest sprouting increases with high temps just prior to seed maturity and several wetting / drying cycles.
- PHS also affected by head angle & awns which absorb more water
Questions?