Conditions Impact Soybean Seed Germination and Emergence

- A viable soybean seed undergoes a specific sequence of events during germination, starting with imbibition followed by the development of a primary root, emergence of the first two seed leaves, then the development of the first two photosynthetic leaves.
- Imbibition is the key process that converts a dry, dormant seed to the embryo growth.
- Dry and/or flooding, cool temperatures, lack of oxygen are conditions that can hinder soybean germination and emergence.

Germination Process

Dormant soybean seeds are viable and respire at very low rate before planting. Favorable soil and weather conditions can promote germination and emergence. Soybean seed can begin to germinate when soil temperatures are less than 55° F; however, germination is likely to be slow until soil temperatures warm to the upper 70’s.

Soybean seed germination is referred to as “epigeal”, because food storage structures (cotyledons; Table 1) are pulled above the soil surface. In contrast, corn germination is considered “hypogeal”, where the storage structure remains below the surface when corn seed germinates.

After soybean seed is planted in the soil, it will start to absorb or imbibe water and swell, and as a result changing the moisture content from less than 13% to almost 50% in several hours. With favorable temperatures and within one or two days, the first root (radicle) of the swollen seed emerges through the seed coat (Figure 1) and grow downward to develop the primary seedling root. Lateral roots quickly emerge from the radicle as it elongates and root hairs grow from the radicle and the lateral roots. Root hairs are barely visible and should not be confused with later developing and easily seen branch roots. The root hairs become the main absorbing structures.

Five to ten days after planting, the new seedling emerges. The hypocotyl (Table 1) begins to elongate and forms a hook that pushes through the soil surface, pulling the cotyledon (oval seed leaves) (Figures 2-3) upward. The hypocotyl can be easily broken if the soil surface is too hard or crusted to push through. Seedlings usually die if the hypocotyl is broken.

The cotyledons are temporary source of stored food for the seedling. Shortly after emergence, they open and turn green, because of their exposure to light, and start making additional food through photosynthesis process (Figures 4-5). As the cotyledons open, the epicotyl is revealed (Figure 3). The epicotyl contains small leaves, buds, and the growing point.

Factors Affect Germination & Emergence

Moisture. Planting into a moist seedbed with good seed-to-soil contact is necessary as moisture needs to move into the seed for germination to occur. If irrigation is required for adequate soil moisture, it should be applied ahead of soybean planting, and not immediately after planting. Planting into dry soil with rainfall or irrigation occurring too soon after can result in crusting and poor soybean emergence.

Table 1. Parts of Soybean Seed.²

<table>
<thead>
<tr>
<th>Part</th>
<th>Function/Characteristic</th>
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<tbody>
<tr>
<td>Testa (Figure 1)</td>
<td>Seed coat</td>
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<tr>
<td>Seed hilum or scar (Figure 1)</td>
<td>On the back edge of the seed coat, (where the seed was attached to the plant ovary within the pod)</td>
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<tr>
<td>Radicle (Figure 1)</td>
<td>First part of the embryo to penetrate the seed coat; develops into a root</td>
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<tr>
<td>Hypocotyl (Figure 2)</td>
<td>Tissue between cotyledons and radicle that becomes the stem of the plant after germination</td>
</tr>
<tr>
<td>Cotyledons (Figures 3-5)</td>
<td>Seed leaves</td>
</tr>
<tr>
<td>Epicotyl (Figure 3)</td>
<td>Stem area above the first leaves that is made of a stem, two primary leaves</td>
</tr>
</tbody>
</table>

Conditions Impact Soybean Seed Germination and Emergence

**Soil Conditions.** Soil crusting can delay or prevent seedling emergence and cause soybean hypocotyls to become swollen or broken when trying to push through the crust. Fields with fine-textured soils, low organic matter, and little surface residue can be vulnerable to crusting, especially where excessive tillage has taken place.

**Temperature.** Seed can begin to germinate when planted in soils less than 55º F, but emergence is likely to be slow and seedling vigor can be reduced. Cold soil temperatures can cause seeds to remain dormant causing them to become increasingly vulnerable to feeding by wildlife that dig up seeds, insects, and seed/seedling diseases. When soil temperatures are between 70º F and 90º F, seedling emergence should occur in less than a week. Soil temperatures above 95º F can also cause poor soybean germination and emergence resulting in reduced stands.

**Oxygen.** Because seed respiration increases during the germination process, saturated, flooded, and compacted soils can reduce germination and emergence due to the lack of oxygen. Soil pore spaces filled with water reduces the amount of oxygen available for seed respiration. Compacted soil reduces the availability of water and oxygen required for germination, root and plant growth, and nutrient uptake.

**Summary**

- Germination process starts with the seed absorbing soil moisture until seed moisture content reaches about 50%.
- The first sign of visual germination is the emergence of the hook-shaped hypocotyl, which straightens out pushing through the soil surface and pulling the cotyledons upward.
- Generally, emergence occurs about 5-21 days after planting, depending on the field conditions.
- Cotyledons are the first leaves that provide a temporary source of foods before the first set of true photosynthetic leaves is formed.
- Favorable soil conditions of temperature, moisture, and oxygen can help soybean seedlings to develop faster and with higher rates of survival.


For additional agronomic information, please contact your local seed representative. Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Leaf Design® are registered trademarks of Monsanto Company. All other trademarks are the property of their respective owners. ©2014 Monsanto Company.

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**Figure 1.** Imbibition of a treated seed causes the radicle (red arrow) to emerge through the seed coat (yellow arrow).

**Figure 2.** Hook-shaped hypocotyl cracking through the soil surface. Emergence can be hindered by soil crusting.

**Figure 3.** Cotyledons (green arrow) open to expose epicotyl (red arrow). Frost can kill the plant once emergence occurs.

**Figure 4.** Cotyledon (green arrow), unifoliolate (red arrow), and trifoliolate leaves (yellow arrow).

**Figure 5.** Soybean seedlings with fully expanded cotyledons (green arrow), unifoliolate leaves (red arrow), and growing point above the soil surface. Start of critical weed-free period.