1 - Growth and Development

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Corn seeds, growing under the right conditions, will eventually grow into small factories with the ability to produce ample amounts of food. Understanding the conditions under which a seed may properly germinate, develop into a plant, and produce grain should help us prepare and manage the crop to achieve expected yields.

The yield of a corn plant depends on the genetic potential of a given hybrid, in addition to a number of environmental conditions and in-season management. Although there is little a corn grower can do about mother nature and the genetics of a plant (other than selecting the hybrid best adapted to a given location, and properly supplementing the site's inherent fertility and availability of water), in many instances yield losses may be due to poor planning and management, factors that are under the control of a grower.

The seed is obviously the starting point. It consists of three major parts: the pericarp, the endosperm and the embryo (Figure 1-1). The pericarp is the outer part of the seed, and is made up of several cell layers, which act as barriers to diseases and moisture loss. The endosperm is the seed's food storage compartment, which contains starches, minerals, proteins and other compounds. The embryo is in reality a miniature plant consisting of several parts: the plumule (leaves) at one end, the radicle (roots) at the other end, and the sculletum which absorbs nutrients stored in the endosperm.

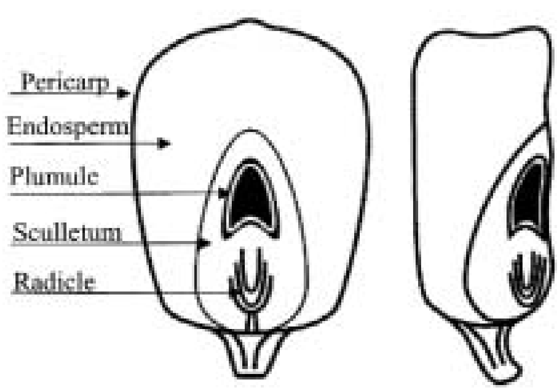

Figure 1-1. Components of a corn seed.

Table 1-1. Vegetative and Reproductive Stages of a Corn Plant

Vegetative Stages	Reproductive Stages
VE emergence	**R1** silking
V1 first leaf	**R2** blister
V2 second leaf	**R3** milk
V3 third leaf	**R4** dough
V(n) nth leaf	**R5** dent
VT tasseling	**R6** physiological maturity

When a seed is placed in moist soil, it absorbs water which in turn dissolves the nutrients stored in the endosperm. These nutrients are then absorbed by the embryo through the sculletum. The radicle will emerge from the seed and will eventually become the plant's root system. Leaves (plumule) also start to grow at this time. Under Arkansas conditions it may take between 5 and 21 days for a seedling to emerge, with depth of planting, soil moisture and soil temperature all significantly affecting the time required for seedling emergence.

A system to identify crop growth stages was developed by researchers from Iowa State University. This system classifies growth stages into vegetative (V) and reproductive (R) stages (Table 1-1), with each stage designated numerically as V1, V2, V3 and so on. Each number represents the uppermost

As stated before, it may take 4 to 5 days for a seedling to emerge if conditions are appropriate, but up to 21 days if they are not favorable. The radicle is the first part of the seed to begin elongation, with VE (emergence) observed when the growing coleoptile reaches the soil surface. The nodal root system is established around VE and eventually becomes the supplier for water and nutrients (Figure 1-3).

During the next two to three weeks following seedling emergence the plant is fairly resistant to hail and other stresses, since the growing point is still below ground. **By the V3 stage, although still very young, the plant has already finished deciding how many leaves and ear shoots is going to produce.**

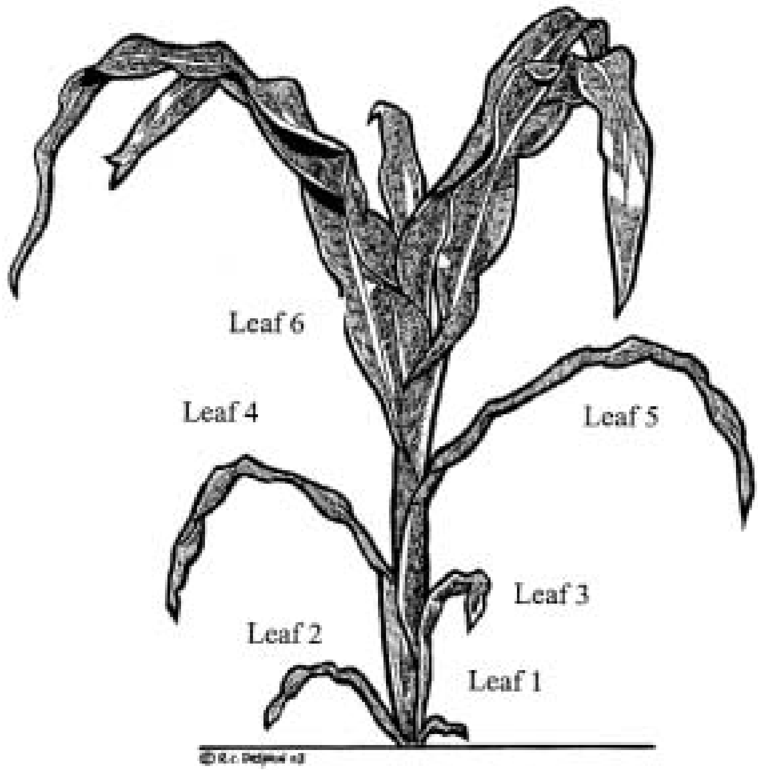

Figure 1-2. Corn plant at the V5 growth stage. Leaf collar of 6th leaf is not visible.

leaf with a visible collar, with the leaf collar being a visible light-colored narrow band at the base of the leaf (Figure 1-2). The last vegetative stage is named VT, to denote tasseling. The last branch of the tassel is visible at this time, while the silks are not.

This classification system allows for a relatively easy way to identify growth stages when plants are young but, as they grow, it requires more detailed examination since plants will eventually slough off their first three to four leaves. Also, early-maturing hybrids may develop fewer leaves or progress through different stages at a faster rate than late-maturing hybrids. Consideration should also be given to the fact that plants in a given field may show different growth stages; **for that reason a stage should be assigned only when 50 percent or more of the plants are in or beyond that stage**.

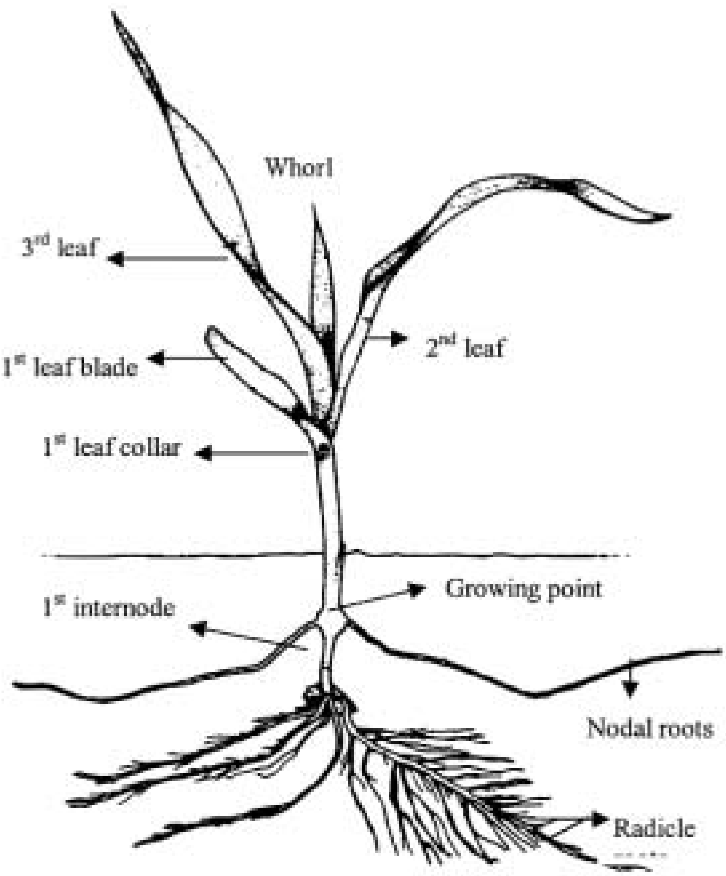

Figure 1-3. Corn seedling at the V1 (almost V2) growth stage.

By the time the plant reaches the V6 stage (plants are normally “knee high”), the growing point and tassel are above the ground and the plant becomes much more susceptible to stresses. At the V6 to V8 stage, **the plant will experience a rapid rate of growth, with proper and sufficient fertilization and irrigation, which are critical at these stages**. The number of rows per ear is established around this time, and the lowest two leaves are no longer present.

The tassel develops rapidly (inside the stalk) and the stalk continues elongating during the V9 to V10 stages. Soil nutrients and water are in greater demand at this time, and upon dissecting a corn plant at the V9 stage, ear shoots become visible.

The period between V12 and V17 is particularly important since the number of ovules (kernels) per ear and the size of the ear are being determined. **Moisture and nutrient deficiencies during this time may result in unfilled kernels and light ears**. The tip of the tassel as well as the tip of the ears may be visible by the time the plant reaches the V17 stage, and silks have started to appear at this time. Stress during the V18 stage will delay silking until after the pollen sheds, with ovules that silk after completion of pollen shed not filling and consequently not contributing to final grain yield. Tasseling (VT), the last vegetative stage, begins a few days before silk emergence. At this time the plant has reached full height, with pollen shed occurring primarily during late mornings. Silks that have not emerged by this time will not be pollinated, and consequently will not be developed.

The reproductive stages (R) relate to the development of the kernels, with the R1 stage being characterized by the silks being visible outside the husks. It is defined when even a single silk strand is visible from the tip of the husk. Every potential ovule (kernel) on an ear develops its own silk, with environmental stresses and especially the lack of water resulting in poor pollination and in some cases a bald ear tip. Pollination occurs when the pollen grains are captured by moist silks, with this process moving progressively from kernels near the base of the ear to the tip ear kernels. Kernels reach the R2 (blister) stage about two weeks after silking; at this time they physically resemble tiny blisters. Starch has begun to accumulate in the endosperm, with moisture being around 85 percent.

The milk stage (R3) is generally observed a week after blister. Fluid inside the kernels is milky white due to the accumulation of starch, and the silks turn brown and dry. **The milk line can easily be seen by breaking a cob in half**. Starch continues accumulating in the endosperm at the R4 (dough) stage. The milky fluid thickens and attains a doughy consistency, with moisture content being around 70 percent. The R5 (dent) stage is normally reached a week after the R4 stage, and is recognized by the appearance of the starch layer. This layer appears as a line across the kernel that separates the liquid (milky) and solid (starchy) areas of the kernels. As the kernel matures, this line progressively moves toward the cob. Kernel moisture has decreased to 55 percent, and any stress at this stage will affect kernel weight only, since kernel number has already been decided.

Kernels reach physiological maturity (R6) two to three weeks after R5 (dent), and no further increases in dry weight will be observed. The starch layer has reached the cob, and a black layer is formed. Black layer formation occurs gradually, with kernels near the tip of the ear developing this layer earlier than kernels near the base of the ear. Grain moisture at this time ranges between 25 and 35 percent.

It is obvious now that being able to identify the growth stage of a particular field can help in making replanting decisions, and in scheduling fertilization, irrigation, pest management and harvesting operations in a timely fashion to achieve maximum yields.

References

How a Corn Plant Develops. Special Report No. 48. Iowa State University of Science and Technology, Cooperative Extension Servce, Ames, Iowa. Reprinted 2/1996.

Growth Stage	Approximate days after emergence	Significance
V3	8 - 10	Leaves and ear shoots determined. **Flooding could kill the corn plant if conditions persist for a few days.**
V6 – V8	21 – 36	Growing point above ground. Plants are susceptible to wind and hail damage. **Moisture and nutrient stress should be prevented.**
V12 – V17	36 – 60	The number of rows per ear and ear size are determined. **Moisture and nutrient stress may result in unfilled kernels.**
VT – R1	54 – 62	Tassel and ears shoots visible. **Considerable yield loss will result from water stress at this stage.**
R2	66 – 74	Blister stage. Kernels moisture is about 85 percent. **The cob is close or at full size.**
R3	76 – 86	Milk stage. Kernel moisture is 80 percent. **Stress at this point can still reduce yields.**
R4	84– 88	Dough stage. Kernel moisture is 70 percent. **Kernels have accumulated close to half of their mature dry weight.**
R5	90 – 100	Dent stage. Kernel moisture is about 55 percent. **Stress may reduce kernel weight.**
R6	105 – 120	**Physiological maturity.** A black layer has formed. Kernels have attained their maximum dry weight.