

Understanding Purple Corn and Uneven Seedling Growth

Purple Corn



This purpling does not affect stand, growth or yield.

When corn plants emerge, it's not uncommon for seedlings to have a purplish tint or some uneven early growth. These observations often worry some corn growers. However, when the purple color disappears - usually after the six-leaf stage - so do growers' concerns. The ultimate goals of corn production are harvestability and yield, and current evidence shows purple seedling color does not relate to either.

Concern about purple seedling color is understandable. If there is something wrong, growers want to know the cause of the problem. What causes corn to turn purple? Is it bad? Will it affect crop development or yield? What can or should be done about it?

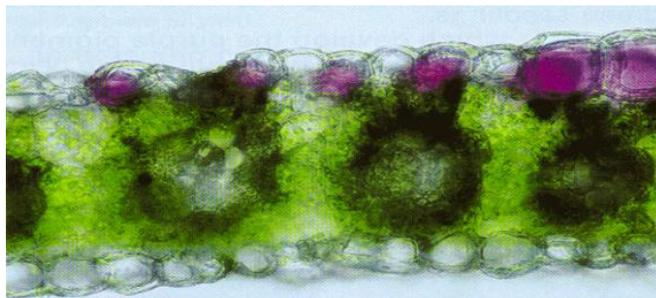
This article will discuss factors that can influence purpling in corn seedlings and explore another seedling condition; uneven early growth. It is important to remember that while both these conditions occur during the seedling stage in corn growth, they are not correlated.

What causes purple corn? Purple corn is not a new phenomenon. It has been observed over the years in many inbred and hybrid lines all over the world. Wild corn found growing in the cool mountain regions of Peru and Mexico is often purple.

Purple seedling color results from the expression of genes for anthocyanin pigment formation. Several plants have similar genes. For example, red maples have red leaves in the spring, but other maple varieties have green leaves. Similarly, most cabbage is green, but there is also red cabbage. The differences between the varieties—corn, maple, or cabbage—include the genes for pigment production. That trait, along with other traits you do not see, is inherited in the hybrid or variety.

Most of the corn grown in the United States contains five of eight genes required to produce the purple color. The other three genes are present in certain hybrids, and some of these genes are cold sensitive. When exposed to cool temperatures, they induce purpling in the young plants. Nighttime air

temperatures in the 40's when day temperatures are in the 60's are often adequate to trigger purpling.



This cross section of corn leaf tissue illustrates the accumulation of anthocyanin pigments. Notice that the purple pigmentation is produced in the top layer of cells and does not affect the chlorophyll content in the plant.

These temperature-sensitive genes are only expressed in seedlings prior to the six-leaf stage. Since there are likely to be early spring cold temperatures somewhere each year, hybrids with the eight genes for pigment formation will probably produce some purple seedlings each spring.

Purple pigments can accumulate in mature plants as well, but pigmentation then results from the action of different genes. Corn breeders often use hybrids with the genes for purple leaves and husks as plot markers in yield tests.

Research shows no difference. Testing of corn plants that exhibit genetic purpling at the seedling stage has shown no evidence of adverse effects on metabolism, growth, chlorophyll production, or yield. The cold temperature stress which induces purpling, however, does affect early plant growth. Regardless of whether the corn is purple or green, cool temperatures slow growth. Researchers studying purple corn have observed no difference between cold-stress effects associated with purple seedlings compared to green seedlings. Hybrids that develop the purple pigment when exposed to cold temperatures have been found to contain as much chlorophyll (the green pigment) as hybrids that remain green when grown under the same cool conditions.



When breeding corn, researchers select inbreds and hybrids with important economic characteristics. Genes for purpling are neither purposely bred into or out of new lines. Some of today's most popular hybrids carry genes for purpling and routinely turn purple when exposed to cool temperatures at the seedling stage. Many of these hybrids have consistent high yield potential.

Young corn plants that do turn purple grow out of the coloration after the six-leaf stage. This can occur quickly if the weather warms up and the corn grows rapidly, or it can be slow if the weather remains cool, retarding both root and shoot growth in the seedling. The cool temperatures—not the purple pigment—cause slower growth.



Most occurrences of purple seedlings are the result of a combination of cool weather and the genes present in the plant. Reputable seed suppliers can tell you if a specific hybrid has a tendency to turn purple under cool conditions.

Phosphorus Deficiencies

Phosphorus deficiency symptoms have been characterized as an accumulation of purple pigments in leaves. Phosphorus level as determined by soil tests and an examination of the fertility programs used, may determine whether phosphorus is likely deficient. If sufficient levels of phosphorus are already present, adding extra phosphorus will not turn purple seedlings green.

How can growers tell the difference between genetic purpling and symptoms of phosphorus deficiency?

- First, examine the color of plants over the entire field. If the purple color is uniform through the field, the cause is probably genetic.
- If purpling is quite erratic, this may indicate that phosphorus is limiting to plants in those areas.
- If plants are beyond the seedling stage (more than six to eight leaves) and purpling is observed, then phosphorus deficiency is likely.

Stress Affects Early Growth

Some of the same stress factors that can limit phosphorus availability can also cause uneven early growth. Both

green and purple corn plants can exhibit uneven seedling development. There is little hard evidence to explain why uneven seedling growth occurs in the spring because so many environmental factors may be present. Cool-temperature stress is a factor, and this may interact with variable soil conditions, seed placement, compaction, fertilizer placement, and amounts of crop residue.

Literally, each seedling has a unique environment for growth and, as a result, some unevenness in plant development will occur. Growers should only be concerned when uneven growth is abnormally great. Perhaps a management strategy is needed to minimize some of the stresses to which the seedlings are being subjected.



Uneven early growth can be caused by a variety of environmental stresses. Genetically purple corn and green corn are equally susceptible to stresses that cause uneven development. In this case, uneven growth resulted from ammonia misapplication that allowed seedlings to closely contact ammonia.

The most critical assessment of seedling stress is stand establishment. If stands are reduced, yield potential may be limited. If adequate stands are achieved, then most research data show seedling growth has little influence on final yields. However, modern agriculture is pushing seedlings into a more stressful environment. Factors increasing stress on seedlings include:

- **Cold Soils:** Early planting increases the likelihood of cold temperatures during emergence and early seedling growth. Minimum tillage leaves more residues on the soil surface, thus insulating the soil and delaying its warming.
- **Tillage:** Shifts in tillage systems have resulted in less uniform seedbeds. Greater variation exists in aeration, seed coverage, and perhaps planting depth.
 - **Compaction:** Compacted zones can influence soil moisture for germination and limit root growth and nutrient uptake.
 - **Fertilizer Placement:** Current tillage trends result in less uniform fertilizer distribution in the root zone. Often times much of the fertilizer is localized on or near the soil surface.

- **Pesticide Application:** Misapplication of chemicals including over-application, non-uniform application, and improper incorporation, is a costly error that can also affect crop growth and performance. Take time to calibrate chemical applications to comply with label recommendations.

The stresses we cannot control, such as weather conditions, are likely the most critical. Whether too hot or cold, too wet or dry, the weather will rarely be ideal for plant growth.

Seedling Appearance Doesn't Predict Performance

Growers do need to monitor their crops during the seedling stage so that development can be observed and problems corrected before they become serious.

Purple seedlings do indicate cold stress, but be sure to assess the effects of that cold stress in all fields, not just those with purple seedlings. Remember, too, that stand establishment is the most critical seedling trait because stand differences can affect final yield potential.

Corn plants are very resilient. They can withstand a great deal of early-season stress and come back to grow and yield well. Seedling appearance generally does not affect final crop performance as long as there is an adequate stand.



If the seedlings are purple, chances are it's simply a genetic trait that won't affect performance. If the cause is not genetic, then there may be an actual or induced phosphorus deficiency caused by stress. "Induced" phosphorus deficiency is often due to inhibition of the root system in corn seedlings. Because the

inhibited root system may not take up enough phosphorus for normal growth, excess sugars accumulate in the plant and purple pigments develop.

One key to distinguishing genetic purpling from root inhibition is the distribution of purple plants. If distribution is uniform across the field, it is likely a genetic trait. If purple plants only appear in certain field areas, it may indicate that soil fertility or inhibited root development is playing a role. One or more of the following can inhibit early root development:

- cool soil and night temperatures
- dry, cool soils or wet, poorly drained soils
- shallow planting
- soil compaction
- seed slot compaction or 'smearing'
- insect or nematode damage
- seedling diseases
- herbicide overlaps or over-applications
- fertilizer injury

If seedlings develop unevenly, remember that some of the same stress factors that inhibit phosphorus uptake by plants can also cause uneven early growth. These factors include temperature, soil type, tillage practices, compaction, moisture, fertility, insects, pesticides and hybrid.

Appearances can be deceiving. Get the facts. Know the hybrid characteristics and be aware of environmental stress factors that could affect seedling growth. Recognize all stress factors and understand their effects. Then, manage the controllable factors for best production. These measures will help insure that your crop will reach its full potential at harvest time.