POTATO GROWTH AND DEVELOPMENT

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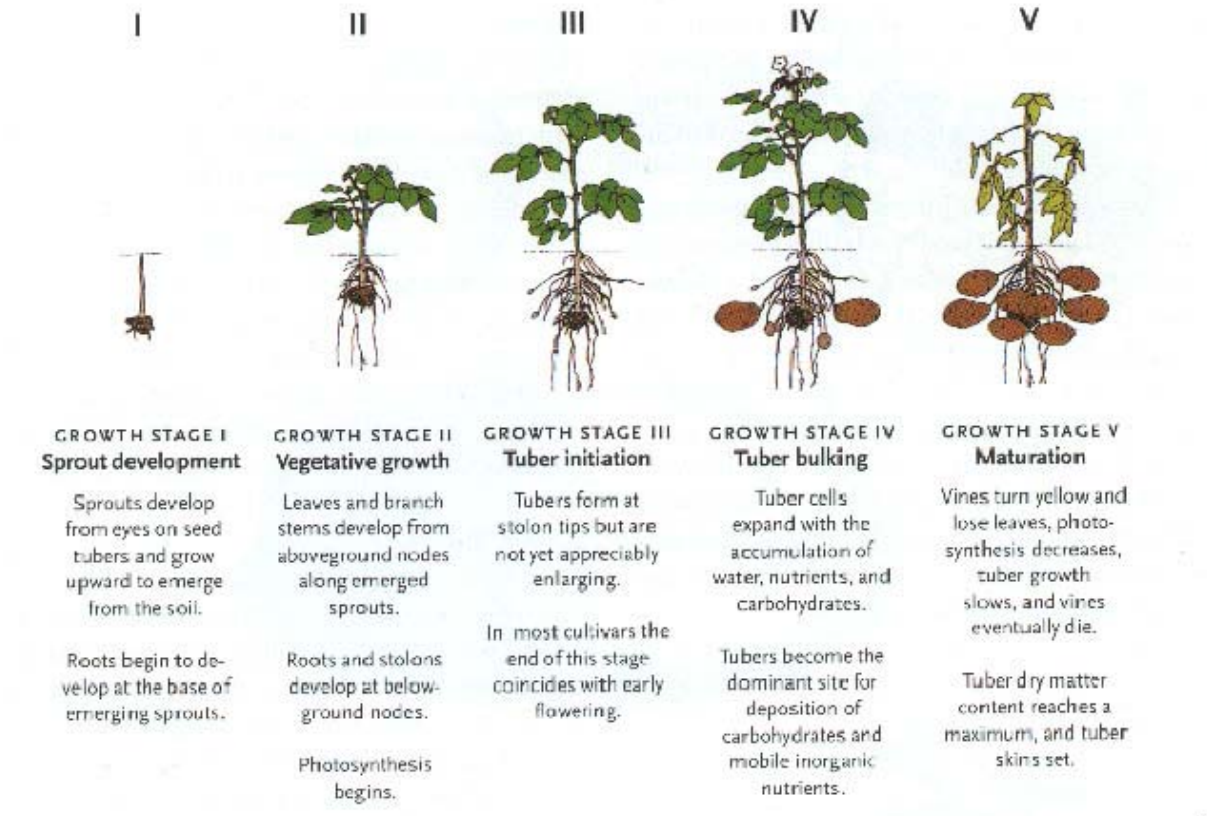
Growth Stages

Growth of a potato plant occurs in several stages: sprout development, plant establishment, tuber initiation, tuber bulking, and tuber maturation. Timing of these growth stages varies depending upon environmental factors, such as elevation and temperature, soil type, availability of moiture, cultivar selected, and geographic location. At northern latitudes, emergence of new plants (Growth Stage I) can occur as early as March or as late as June, and harvest (after completion of Growth Stage V) typically occurs between August for early-maturing cultivars and as late as October for late ones.



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Sprout Development (Growth Stage I)
Once tubers have broken dormancy, they are capable of growth, and if environmental conditions are favorable for growth (e.g., warmer temperatures), they will begin immediate sprouting. However, if steady, cool storage conditions (generally 38° to 40°F) are maintained, the “rest period” for tubers can be prolonged until planting time. Even after planting in the field, continued cool temperatures may prolong the rest period until more favorable conditions for growth occur.

Plant Establishment (Growth Stage II)
“Plant establishment” refers to the growth period from early sprouting until initiation of new tubers occurs, and this includes development of both roots and shoots. Many growers refer to this stage as “vegetative growth.” The mother tuber (seed piece) is important during early plant growth but becomes less important as the new plant establishes. A well-established root system is important for subsequent growth and can allow for quick regrowth after early season defoliation from frost, hail, or insect damage.

Tuber Initiation (Growth Stage III)
Under appropriate growth conditions, the tips of stolons will “hook” and begin to swell, resulting in initiation of new tubers. For many cultivars, including Russet Burbank, this occurs during early flowering, although there’s no causal relationship between the two events. Potatoes need moderate amounts of nitrogen and cool nights for good tuber growth.
Water stress (inadequate water) will lead to earlier tuber initiation.

Tuber Bulking (Growth Stage IV)

This is the critical growth period for both tuber yield and quality. Under optimal growing conditions, tuber growth rates remain relatively constant during this period, which is often referred to as the linear tuber growth phase. Russet Burbank potatoes in southern Idaho will typically add about 6 to 10 hundredweight (cwt) per acre per day throughout the period of active growth. Any interruption of ideal conditions, however, can result in reduced tuber growth rates and losses of both yield and quality. Research has shown that two major factors influence tuber yield: (1) the photosynthetic activity and duration of the leaf canopy, and (2) the length of the linear tuber growth phase. The longer a canopy is able to produce

photosynthate at a relatively high rate, and the longer tubers are bulking at their maximum rate, the higher the yield.

Tuber bulking rate and duration can be influenced by several environmental and cultural factors. Any condition that limits growth of healthy foliage, disrupts tuber growth, or shifts dry matter partitioning from the tubers to the foliage decreases yield potential. Some of the key factors that affect tuber bulking are temperature, fertilization, seed physiological age, plant spacing, planting date, irrigation, and pest management.

Temperature: Potato vines and potato tubers are often competing with each other for limited nutrient resources, and excessive vine growth can result in reduced tuber growth. Several factors can shift the balance between vine and tuber growth, and one of these is temperature. For the Russet Burbank cultivar, for example, the optimum soil temperature for tuber growth is about 61°F (16°C), while the optimum air temperature for vine growth is about 77°F (25°C). However, with a full leaf canopy shading the soil, it's possible to have 77°F air temperatures at the same time as 61°F soil temperatures. High soil temperatures will delay tuber growth.

Fertilization: Developing healthy plants necessary for maximum tuber growth requires that all essential nutrients be supplied at optimal rates. Both deficit and excess fertilizer situations can reduce tuber bulking rates. Nutrient deficiencies limit canopy growth and shorten canopy duration resulting in reduced carbohydrate production and tuber growth rates. Excessive fertilizer applications can cause nutrient imbalances that delay or slow tuber growth rates.

Seed Physiological Age: Aged seed tends to produce potato plants with numerous stems that sprout and develop rapidly and die early. High stem numbers usually result in a high number of tubers per plant, which reduces average tuber size by reducing the amount of carbohydrate available to each tuber during bulking. Early death also shortens bulking time and limits overall productivity. By comparison, plants from physiologically young potato seed begin to bulk later than those from aged seed, which may shorten the linear tuber growth phase in areas with a short growing season.

Plant Spacing: Closer than optimal plant spacing has a similar effect on tuber growth as does aged seed in that it increases tuber density relative to canopy size, thereby limiting the photosynthetic capacity to bulk each tuber. Although total yields may not be reduced, bulking rates of individual tubers decrease, which results in smaller tubers and lower marketable yields. Wider than optimal spacing can lengthen the time it takes to reach full canopy, which reduces carbohydrate supply to the tubers.

Planting Date: Planting too early can lead to seed piece disease and rot, slow emergence, and decreased plant vigor, which can slow tuber growth rates. Planting too late delays canopy development and reduces the time available for tuber bulking. The

optimal planting date varies by region, but in all areas growers should wait to plant potatoes until daytime soil temperature warms to 50°F or higher.

Irrigation: Allowing soil moisture to drop below critical levels reduces or stops canopy and tuber growth during the stress period and for several days thereafter. This effectively shortens the tuber bulking period and can also cause a variety of internal and external tuber defects.
Excessive irrigation can also reduce tuber growth by restricting plant physiological activity and nutrient uptake and increasing disease susceptibility.

Pest Management: Any insect or disease that damages leaves can reduce the amount of light intercepted by the canopy and limit tuber growth. Among the most serious of these pests are Colorado potato beetle, late blight, early blight, and Verticillium wilt

Tuber Maturation (Growth Stage V)
As potato vines die back, several important things happen to the tubers. The skin or periderm thickens and hardens, which provides greater protection to tubers during harvest and handling and blocks entry of pathogens to the tuber. During tuber maturation, specific gravity (dry matter) increases, which improves quality for both processing and fresh market consumption. In addition, free sugars are converted to starch, which allows for lighter colored and better quality chips and fries. Also with proper maturity, tubers in storage have lower respiration rates, which results in less dry matter loss, remain dormant longer, and consequently sprout later. Properly matured tubers also have greater resistance to pathogens in storage. If tubers remain too long in the soil after vine death, however, they can become over mature. In such cases, starch converts back to sugar, and specific gravity declines.

By knowing how any management activity will affect the plant, growers can make proper decisions that result in maximum harvest yield and highest quality tubers.