TUBERS

CROP SOLUTIONS SHEET

Biorizon biotech

Tuber Crop Cycle

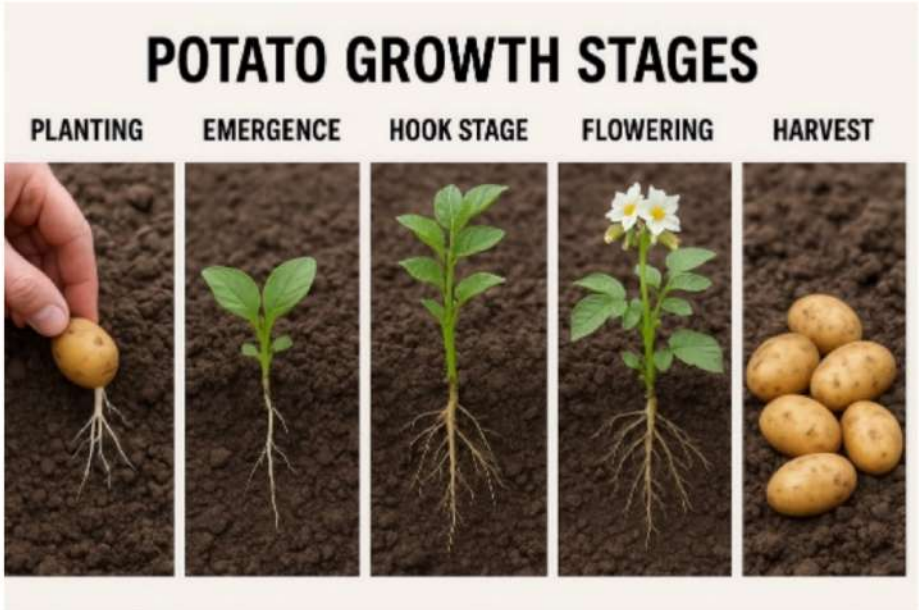
The crop cycle begins with the planting of seed tubers in well-prepared soil. These tubers germinate and develop plants with stems and leaves. As the plant grows, it goes through several phenological stages, including germination, vegetative growth, tuber initiation, tuber bulking, and maturity. The duration of each stage can vary depending on the potato variety and growing conditions.

Crop Characteristics

Tubers are a versatile crop that thrives in temperate climates.
They require fertile, well-drained soils and regular irrigation.
The plants have a relatively shallow root system, and their development is highly conditioned by soil temperature and moisture levels. They produce flowers whose color varies by variety and develop abundant green foliage.

Main Phenological Stages

- Germination: The tuber/seed sprouts and the first shoots emerge from the soil.
- Vegetative Growth: The plant develops leaves and stems, forming a canopy that captures sunlight for photosynthesis.
- Tuber Initiation: The formation of tubers underground begins, generally when the plant has already developed a full canopy.
- Tuber Bulking: Tubers increase in size as the plant continues to photosynthesize and transport nutrients to them.
- Maturity: The foliage turns yellowish and begins to dry, indicating that the tubers have reached their optimal size and are ready for harvest.



Potato

Cassava

Beet

Carrot

TUBERS

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MAJOR CROP PROBLEMS FOR TUBER PRODUCERS

DELAYED OR ABSENT GERMINATION IN TUBERS

Delayed or absent germination of potatoes can significantly affect crop development, uniformity, and final yield. The main causes and factors involved include:

Poor Tuber Quality

Physiological age: Tubers that are too young (dormant) or too old (depleted reserves) show poor sprouting.

Mechanical damage: Cuts or bruises during harvesting or handling can affect sprouting points (eyes).

Diseases: Infections such as soft rot or *Fusarium* can destroy the tuber or delay emergence.

Unbroken Dormancy

Tubers naturally go through a dormancy period after harvest. If stored under inadequate conditions, this dormancy can be prolonged:

Low temperatures (< 4–5 °C): Prolong dormancy.

Lack of light or poor pre-germination conditions: Do not stimulate growth.

Insufficient use of dormancy-breaking agents: In some cases, gibberellic acid or other biostimulants may be required.

Unfavorable Soil Conditions

Cold soil (< 8–10 °C): Slows metabolism and sprouting.

Waterlogged or excessively dry soil: Can damage the tuber or impede root development.

Soil compaction: Limits oxygen availability, hindering emergence.

Planting Problems

Inadequate depth: If planted too deep, emergence is delayed; if too shallow, the tuber is exposed.

Poorly healed cut tubers: Increase the risk of infection and reduce viability.

Low vigor or too small seed: Insufficient reserves to initiate sprouting.

Pest or Pathogen Pressure

Wireworms, nematodes, and soil fungi (such as *Rhizoctonia*): Can damage the eyes or developing sprouts, causing premature death.

Consequences

- **Non-uniform emergence → uneven plants and competition between individuals.**
- **Lower number and size of tubers → penalty in yield and quality.**
- **Increased pressure from diseases and weeds in areas with emergence failures.**

BIORIZON SOLUTION FOR DELAYED OR ABSENT GERMINATION

To promote the germination of planted tubers, it is essential to ensure adequate hormonal stimulation that promotes both the emission of the first sprouts and root development.

During germination, soil temperature plays a key role in accelerating tuber metabolism, but also in stimulating nutrient availability and the activity of soil microorganisms, which are responsible for multiple benefits for young plants.

Therefore, Biorizon Biotech recommends, if direct applications can be made to the seed or in the planting furrow, to use ALGASEED as a source of natural plant hormones related to germination, such as gibberellins and auxins, in addition to polysaccharides that will nourish both incipient roots and the surrounding microorganisms. This product also provides beneficial natural vitamins and polyphenols that support the initial plant metabolism. Finally, its high quality in the combination of amino acids will facilitate the germination process and the growth of the first tissues, providing immediate energy and reducing the time the plant needs to synthesize them internally.

ALGASEED should be applied in 1 or 2 treatments (if applied to seed and in furrow) at a dose of between 0.5 and 2 L/ha, depending on the application method.

Non-uniform emergence → Plants of different sizes and competition between them.

Lower number and size of tubers → Penalty in yield and quality. Increased pressure from diseases and weeds in uncovered areas.

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MAJOR CROP PROBLEMS FOR TUBER PRODUCERS

LACK OF VEGETATIVE GROWTH

The lack of vegetative growth in tuber crops, where plants fail to develop strong stems, leaves, or adequate foliage, can be due to several factors, which often overlap.
The most common causes are detailed below:

Poor or incomplete germination

Even if sprouting occurs, weak or uneven emergence can limit initial vegetative growth. Causes include:
Low-quality tubers/seed (e.g., virus-infected, aged, or small size).
Dormancy not fully broken before planting.
Planting in cold or excessively wet soils that delay shoot emergence.

Nutritional deficiencies

Nitrogen (N) deficiency is the most common, directly affecting foliage development.
Phosphorus (P) deficiency can slow root development, limiting nutrient uptake.
Micronutrient imbalances (especially zinc or manganese) can affect enzyme activity and photosynthesis.

Water stress

Drought reduces leaf expansion and shoot elongation.
Waterlogging suffocates roots, decreasing nutrient uptake and causing stunting.
Irrigation errors (excess or deficit) are particularly detrimental in the early stages.

Soil problems

Compacted soils restrict root penetration and gas exchange.
Poor drainage or low organic matter content limits root functionality and microbial activity.
Low soil temperatures slow growth, even if tubers have emerged.

Pests and diseases

Rhizoctonia solani (black scurf) attacks roots and stems, affecting development.
Aphids, beetles, or mites feeding on young plants can cause early stress.
Using virus-infected seed can reduce vigor, even if emergence appears normal.

Environmental stress

Frost damage to emerging shoots.
High temperatures at the beginning of development (above 30 °C) can inhibit vegetative growth.
Hail or wind can cause physical damage to young plants.

Herbicide damage or chemical residues

Residual herbicides in the soil from previous crops can slow initial development.
Drift from treatments in neighboring fields or improper application can cause phytotoxicity.

Genetic or physiological factors

Varietal differences: some varieties naturally exhibit slower vegetative growth.
Physiological age of the tuber: very young or aged tubers can hinder foliage formation.

Consequences

- **Poor foliage → less photosynthesis → reduced yield and tuber size.**
- **Increased plant vulnerability to thermal stress, weed competition, and diseases.**

BIORIZON SOLUTION FOR LACK OF VEGETATIVE GROWTH

To help and support vegetative growth, we need to understand what is essential during this period. Plants will require a proper hormonal balance to show their full genetic potential, but they will also need appropriate climatic conditions, adequate soil fertility (nutrient availability and microbial activity), water availability, and protection against pests and diseases. Based on this information, Biorizon Biotech recommends working in parallel with two strategies:

Root development to improve nutrient and water use efficiency:

When irrigation is available, we suggest ROOT BEST applications every 15 days (5-10 L/ha), and for the first two applications, we recommend a possible combination with BIOPOWER 0.5 L/ha, as there is strong synergy between both products. When irrigation is not available, we suggest 2 foliar applications of BIOPOWER at 1 L/ha.

Vegetative growth and development to increase photosynthesis:

Foliar application of ALGAFERT at 1 L/ha to balance the plant's hormonal system and provide high-value biostimulant molecules such as polyphenols, vitamins, amino acids, and polysaccharides. This application can be enhanced by adding 2 L/ha of MICROMIX BASIC, thus ensuring that no essential microelement for normal crop growth is lacking.

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MAJOR CROP PROBLEMS FOR TUBER PRODUCERS

INCREASING THE NUMBER OF TUBERS

Most of the time, the number of tubers is directly related to yield; the higher the number of tubers per plant, the greater the productive potential. It is equally relevant not only to increase quantity but also to ensure homogeneous growth with the desired commercial size.
The number of tubers can be determined by internal hormonal signaling within the plant during the "hook" phase, which would be related to the auxin/cytokinin ratio within the root tissues. It is important to remember that auxins are mainly produced in young growing tissues (new leaves and flowers) and apical meristems, while cytokinins are synthesized in the root tips during their active growth.
After years of research and trials, it has been identified that foliar applications of cytokinins during the "hook" phase can induce greater cell division in the aerial part of the plant and increase chloroplast activity. This additional active tissue is capable of producing a greater amount of carbohydrates, which descend to the roots and induce the formation of a larger number of tubers.

BIORIZON SOLUTION FOR INCREASING THE NUMBER OF TUBERS

For this reason, the Biorizon Solution for this challenge, need, or problem of increasing the number of tubers consists of applying BIOFAT 600 foliar at a rate of 2 L/ha. The application of BIOFAT 600 is relevant from the beginning of the "Hook" phase up to the "Flowering" phase. This solution provides plants with key factors directly related to increasing the formation of the "hook" at the root tips and, therefore, to the increase in the number of tubers. These key factors are cytokinins, carbohydrates, and jasmonates.

INCREASE TUBER SIZE AND WEIGHT

The filling of young tubers represents a significant challenge for farmers. Achieving homogeneous growth and reaching optimal commercial size is fundamental. The more efficient this process, the greater the benefits obtained by producers. From a nutritional standpoint, it is essential to ensure an adequate supply of Calcium, Boron, and Potassium. Furthermore, it is crucial to maintain active photosynthesis during the tuberization period, as it constitutes the source of carbohydrates necessary for tuber filling.
Biorizon Biotech has developed a solution based on all this nutritional and physiological knowledge, providing plants with both essential nutrients and the natural hormonal signaling and biostimulation necessary for this purpose.

BIORIZON SOLUTION TO INCREASE TUBER SIZE AND WEIGHT

Foliar application:
BIOFIX 2–3 L/ha, one or two applications starting from the "flowering stage" to ensure high levels of calcium and boron in plant tissues.
BIORIZON FINAL 2 L/ha to induce the appropriate signaling that favors the translocation of sugars from the leaves to the tubers. This product should be applied mid-way through the "tuber filling stage".
KOLOR (NEUTRAL, BASIC,...) as a source of potassium, an element responsible for increasing carbohydrate production. This product is applied at 2 to 5 L/ha throughout the entire "tuber filling stage". It can be mixed with BIORIZON FINAL.
PHOTOPOWER 1 L/ha from the beginning of the "tuber filling stage". This product improves the photosynthesis rate and, therefore, carbohydrate production in the leaves.

Drip irrigation
(when possible or available)
PLENTY 5 L/ha every 15 days from the beginning of the "tuber filling stage". This product supplies potassium without nitrates and feeds the roots to maintain their growth activity. This will promote healthy aerial activity.

TUBERS

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MAJOR CROP PROBLEMS FOR TUBER PRODUCERS

IMPROVE PLANT HEALTH AND ITS IMMUNE SYSTEM

Tubers face a significant number of threats in terms of diseases, and the first barrier to protect them is their own immune system.

Every day there are fewer and fewer active ingredients available to farmers to combat all these diseases, and consumers are demanding a safer and healthier source of vegetables.

Plants can defend themselves against pathogens, and two factors must be improved to facilitate their defense: reducing stress in plants, as ethylene can hinder the response and activation of the immune system, and strengthening all defensive metabolisms within plants.

Tubers are vulnerable to a wide range of diseases caused by fungi, bacteria, viruses, and nematodes. These can affect the plant at various stages, impacting both yield and tuber quality.

Here are the main potato diseases grouped by pathogen type:

Fungal Diseases

Late blight (Phytophthora infestans)

- Most devastating potato disease worldwide

Early blight (Alternaria solani)

- Dark concentric spots on leaves ("target spots")

Black scurf (Rhizoctonia solani)

- Causes stem cankers, stunted growth, and black sclerotia on tubers

Fusarium dry rot (Fusarium spp.)

- Post-harvest disease

Bacterial Diseases

Common scab (Streptomyces scabies)

- Corky, scabby lesions on the tuber surface

Soft rot / Blackleg (Pectobacterium spp. Dickeya spp.)

- Soft rot with a foul odor in tubers or stems

Viral Diseases

Potato virus Y (PVY)

- Causes mosaic, leaf drop, and yield loss

Potato leafroll virus (PLRV)

- Rolled leaves, stunted growth

Potato virus X (PVX)

- Usually mild or asymptomatic
- Can cause mosaic when combined with other viruses

BIORIZON SOLUTION TO IMPROVE PLANT HEALTH AND ITS IMMUNE SYSTEM

Biorizon Biotech has spent years developing a solution for this need, and thanks to the properties of one of our microalgae hydrolysates, which contains significant amounts of defensive phytohormones such as salicylic acid, jasmonates, and natural defensive peptides, we can recommend strengthening the potato plant's immune system by applying ALGADEFENSE at a rate of 1.5 L/ha every 2 weeks, either via foliar spray or drip irrigation.

These treatments will help farmers reduce the presence of diseases in crops and therefore, decrease the need for chemical phytosanitary treatments.

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MAIN CROP PROBLEMS FOR TUBER PRODUCERS

NEED TO IMPROVE SKIN FORMATION AND CROP DRYING FOR HARVEST

Skin formation, also known as periderm development, is a vital physiological and protective process that occurs mainly after tuber initiation and continues during its maturation. It replaces the epidermis and acts as the tuber's outer skin.

Skin Formation Mechanism (Periderm Development)

Skin formation involves the development of three layers in the periderm:

1. Phellogen (corky cambium): meristematic layer that produces new cork cells.
2. Phelloderm (internal parenchyma cells) with some metabolic activity.
3. Phellem (cork cells): outermost suberized cells that form the final skin.

The process occurs in three key phases:

- Initiation phase.
- Immature periderm phase.
- Skin maturation or hardening.
- Occurs at the end of the tuber thickening phase.
- The phellogen becomes inactive.
- The periderm is completely suberized, forming a hard and protective barrier.

Importance of Skin Formation

- Physical protection
- Barrier against pathogens
- Reduction of water loss
- Commercial quality
- Suberin, a complex polyester, is the key component of cork cells.
- Its biosynthesis is regulated by environmental factors, hormones (such as abscisic acid, ABA), and stress situations.

ABA and ethylene are the two most relevant natural hormones in potato skin formation. It is necessary to increase the levels of both within the plant to complete this process and allow for harvest.

This is considered the last step before harvest, but it can last for weeks. It is not only a process in which the potato skin forms correctly, but also a key moment for the last stored carbohydrates in the leaves to be mobilized towards the tubers.

BIORIZON SOLUTION TO IMPROVE SKIN FORMATION AND CROP DRYING FOR HARVEST

For this reason, Biorizon Biotech has designed a solution focused on solving these two problems: rescuing the last carbohydrates present in the leaves and transferring them to the tubers, as well as promoting the formation of healthy skin, which will be a key factor in final commercial quality.

Biorizon Biotech's proposal is to apply BIORIZON FINAL at a dose of 3 to 10 L/ha, depending on whether a gradual cycle closure or a more drastic drying effect on the crop is sought.

These solutions will stimulate the mobilization of sugars from the leaves to the tubers, in addition to activating skin formation.

Application should be made between one and two weeks before the planned harvest date; the drier and sunnier the climate, the more efficient and faster the effect will be.

This solution may show synergy with herbicide applications, if performed.