

Cultivation 2:

Vegetative Phase and Troubleshooting

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Learning Objectives

- Preparation for vegetative stages
- Expectations for lighting needs
- Stages before Vegetative Phase
- Expectations for the vegetative phase
- Transplanting requirements
- Best ways to prepare root systems
- How the container determines aspects of plant growth
- Shaping the plant to maximize yield
- Preventing against insects
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Introduction

Before starting a garden one must have the proper preparation. A simple calendar should do the trick. It will facilitate recording and tracking the vast amount of data that can be compiled over the course of the crop.

Documenting information such as nutrient feeding regimens, propagation cycles, light bulb replacement dates, and filter changes will help ensure better crops year after year.

Today there is computer software available to track every detail of the grow from the location to the cost of each individual plant. These programs tend to be used in a commercial applications due to the amount of information that needs to be calculated in real time. The cannabis software industry is beginning to thrive as most states, including Massachusetts, are requiring a **seed-to-sale** tracking system for the growth and sale of Medical Marijuana.

Environmental Parameters

When beginning cultivation it is essential to create the ideal space for cannabis to thrive. Start by adjusting the light timer to a light cycle of 18 hours of light to 6 hours of darkness. This mimics the elongated daylight period that we experience in the late spring to early summer months. Keep the day and night temperatures within 10 degrees of each other helps keep tighter node spacing.

Now select a light bulb that is rich in a blue spectrum; somewhere in the area of 6500 Kelvin. The plants will keep a shorter inter-node spacing as well as thicken stocks in preparation of bearing weight. Lighting spectrums can help or hurt your plant growth, the different colors represent the difference stages of sunlight throughout the year. You wouldn't want to make a seedling think it was autumn.

Germination:

Cannabis germination is greatly dependent upon 3 factors: air, water, and temperature. During this time the protective shell separates and exposes a tap root. This first sign of life is in search of a food source and a medium to plant its feet. The first set of leaves, known as cotyledons, will soon after appear from the shell and the process of photosynthesis will begin. Tap water has enough dissolved solids to sufficiently sustain a seedling through the first week of its life.

Seeds should always be stored in a dry, cool, and dark location prior to germination. For elongated storage an environment of 5 percent humidity and a temperature of 35-40 degrees Fahrenheit must be achieved.

There are a couple of methods that are commonly used, both with high success rates. The first method involves soaking a paper towel in tap water. Be sure not to leave the towel too wet. Give it a squeeze but make sure to leave plenty moisture. It is very important not to let the paper towel dry out over the course of the germination process.

Some will soak each seed in water for 12-24 hours to speed up the germination process. After 12 hours you may gently tap on each seed to see if it sinks. If so, it is ready to be placed into the moist paper towel.

Remember that air is an important component of this whole process. If the medium, or paper towel, is too moist the oxygen supplied to the seedling will drastically be reduced ultimately drowning it. This must also be taken into consideration when planting the seed into the medium. A good rule of thumb is to plant the seed twice as deep as its width. This is also done because the seedling is not strong enough to fight through layers of material when sprouting.

Ideal conditions of the medium are 78 to 80 degrees Fahrenheit with air temperatures between 72 to 74 degrees Fahrenheit during the germination process.

Seedling:

Once the seed has been transplanted to the growing medium it's time to introduce low intensity lighting. A fluorescent light 12" over the plant works best; giving off little heat and providing enough light for the first few weeks. High Intensity Discharge (HID) lighting may be used at a distance of 4' to 6'. This will ensure that when the sprout breaks the surface, it will not stretch. Once the plant begins to stretch it will require extra support to hold itself up. This is typically done by placing a wooden skewer about 1" away from the stem and gently applying a twist tie for stability.

The **cotyledon** leaves have appeared and the stem has begun to elongate. Within a few days the first **true leaves** will appear; this is the first sign of a cannabis plant. A low dose nutrient solution, about one quarter strength, will help the plants as they consume nutrients for future growth.

During which time the roots may be protruding out of the **peat pellet** or **rockwool** cube. The plants now need to be **transplanted** into a bigger container, allowing the roots to stretch into a larger space. Select a small container to promote a stronger root system this also helps minimize the chance of over watering.

Growth may appear to be slow over the next four weeks as a complex rooting system is develops under the surface. If you are ever going to overwater your plants, it will probably be within this time period. During this process provide consistent moisture without waterlogging.

Vegetative Cycle:

The **vegetative state** officially starts when rapid growth begins. Some plants will grow at different rates, this is normal. This is where stronger genetics begin to separate themselves from the pack. Any plants not developing proper leaf structure or appear to be sickly and weak should be **culled** from the garden. A thriving cannabis plant can grow 2" to 4" a day.

You may notice your plants are **up-taking** a considerable amount of nutrients and water as the vegetative process continues. **Transpiration** is happening at a much higher rate and the plants are craving large amounts of nitrogen. Of course it still requires the addition of *phosphorus, potassium, calcium, magnesium* and many other **micro-nutrients** but gains its greatest benefit from *nitrogen* at this time.

A good thing to remember when analyzing your plants health and structure is "As above, so below."

Cloning:

Once the plant has reached this level of maturity, you may now begin to propagate. This means you will cut off the tip of the growing branch and essentially create another plant with the identical genetic code of its host. Most cannabis growers often refer to this as cloning or taking a cutting. There are several advantages to doing this as it drastically reduces the time for the plant to mature and also guarantees a consistent medicine with the same cannabinoid profile.

Most growers will turn a plant they wish to further propagate into a "Mother." This is achieved by keeping the plant in a vegetative life cycle and cutting the branch tips to root as clones. Any plant can have cuttings taken from it regardless of its age or state of growth. It is recommended to take clones from a well-established plant preferably 2 months or older. It is possible to cut clones from other clones if you cannot designate enough space

for a big bushy plant. It is possible to degrade the vigor of the plant over time especially if the host was induced to excessive stress. A new mother plant should be started yearly to maintain the proper health of the host.

You can also take a cutting from a flowering plant. This is commonly referred to as monster cropping due to its appearance while rejuvenating. Though it takes longer to root, you might just be able to save your favorite fruiting plant. Be patient as powerful hormones are undergoing major change. The earlier the cutting was taken into the flower stage; the higher the success rate will be. Cuttings taken from flowering plants should be taken from lower branches and handled with extreme care. They will require extra attention as they are more susceptible to attack from pest and diseases.

A cutting will root quicker if the temperature of the growing medium is a few degrees warmer than the surrounding environment. This can be easily done by placing a heating mat under the propagation tray. Be careful not to exceed 85 degrees Fahrenheit or you will cause damage to the developing root zone. Providing the cuttings with an ambient air temperature in the range of 65 to 75 degrees Fahrenheit will result in optimal growth.

Transplanting

Transplanting before the roots outgrow their container is critical for maintaining rapid growth. The first sign that your plant has become root bound is slow growth with increased inter-node spacing. Using a similar type of medium is highly recommended for proper nutrient uptake. Encouraging roots to develop a more extensive root system many growers will do what is called **potting up**. This means transplanting at least two times before reaching its final container size. This can prove difficult in large commercial scale operations due to the high volume of plants and short crop times.

The plant must be handled with extreme care during this time. Disturb the root system as little as possible to drastically reduce the shock of the transplant. It may be a good idea to do this at the end of the day to allow the plant to recuperate overnight. During this time growth may slow down while the plant is adjusting to its new home. Raising the lights for a few days will reduce the amount of stress on the plant.

Prepare the plant for transplanting by watering the plants a couple days in advance. This will help keep the root ball together during the transplant; a dry medium tends to crumble.

Decide what stage of life your plants are to determine the proper container to accommodate the next phase. Most often a cutting is transplanted into a 4" x 4" container and later moved to a 2-3 gallon container. For most commercial crops this is its final resting home. This will require watering more frequently but it can produce a yield similar to a five gallon container. Smaller operations will continue to transplant into yet another larger container; up to 5-7 gallons.

Now fill the container with the medium of your choice; some mediums are ready to use right out of the bag and other will need to be conditioned before use. When using most **coco** or rockwool mediums, you must first begin by submerging them in a low dose nutrient solution to buffer the PH of the material and to remove excess salt deposits.

Determine how much medium to put into the bottom of the container. There should be enough material to elevate the root ball within 2" from the top of the soil. Burying your plants too deep can cause stem rot. The better prepared you are for each step the smoother the process will go. When issues arise and roots are exposed for extended periods of time can cause unnecessary stress.

Carefully remove the plant from the original container by placing the stem between your middle and index fingers. Turn the pot upside-down and allow your palm to support the root ball. You may need to tap on the container to remove a stubborn plant. Never pull on the stem as this will only cause damage to the root zone; possibly killing the plant.

Gently place the root ball into its new home as quickly as possible. Roots may become damaged and die back if exposed to light and air for a prolonged period of time. Try your best to center the plant in the container to allow roots to grow evenly in all directions. Backfill the container until the root ball is covered with about 1" of material. Firmly pack the medium to ensure contact is being made with the root ball. Packing too tight can damage the root system and limit the fresh supply of oxygen or cause poor drainage.

If using a soilless medium; a full dose hydroponic fertilizer mixture may be used to water the plants. Fresh potting soil should contain enough nutrients to sustain growth for a week or two allowing plain water with the proper PH value to be used. Make sure to fully saturate the medium to further the bond of the loose material to the root ball.

Maintaining the proper run off will help keep the root zone in check. Allowing an additional 10-20% of water to run through the medium will help prevent excess salts from building up. Remember a healthy root zone equals a happy plant.

Containers

Containers come in many different shapes and sizes and can be made of many different materials. The size, shape, and even color can affect the health and vigor of your plants. They can be constructed of anything from clay to wood fiber. Plastic containers are inexpensive and commonly used for indoor growing. Another type of pot

gaining popularity is the grow bag. They can be stored with minimal amount of space and weigh next to nothing. They can be reused and offer more oxygen to the roots.

Make sure any container you choose to use has holes located in the bottom to draining excess water. Put a saucer under the container to catch the nutrient rich water that drains from the medium. Make sure to remove the water from the saucer to avoid root rot.

Try to select a container that has more depth than width. The roots of a cannabis plant penetrate deep into the ground, the volume of the container dictates the size of the plant. The container should be just big enough to contain the root system leading up to harvest.

The roots will quickly grow to the edges of the container to travel downward where they will create an elaborate system. This part of the root system is the most vulnerable as it experiences a greater amount of stress from outside elements. When the medium becomes dry it contracts, separating itself from the container wall. If the temperature of the medium exceeds 75 degrees Fahrenheit damage to the root zone can occur. Keep the container from coming into direct contact with any heat sources, as this will both raise the temperature and cause the root system to become warm. Any roots that appear to be turning green have experienced prolonged exposure to direct light.

Pruning

The cannabis plant can be manipulated by rerouting growth hormones through the practice of **pruning** and **bending**. Even though cutting a branch tip will stress the plant, it may be required for optimal growth. Removing the growing tip of a branch will force the hormones to relocate to the lower branches. The concentration of hormones are affected far less when bending a growing tip.

Topping is the term that is widely used among the growers referring to the removal of the highest growing tip attached to the main stem. Once the plant has been pruned it will begin to widen. The plant will soon become very bushy and will need proper selective pruning of lower branches to correct its growth structure. A properly pruned cannabis plant should have four to six main branches that lead to a number of growing tips. You may even need to remove several smaller branches to provide more air and light flow beneath the canopy.

Remember to always make a 45 degree angle cut to discourage moisture from pooling in the wound. This is a great place for the plant to be attacked by pests and pathogens. Always sterilize cutting utensils between cuts to reduce the transfer of diseases.

Cutting the top of the plant will cause two growing shoots, just below the cut, to increase in size and take over as main branches. This will diffuse floral hormones and stunt the growth of the lateral bud sites. To top your plant cut just below the last double set of fan leaves and move to the outer edge of the garden for the next few days.

Avoid making any drastic changes that will diffuse hormones on month from the beginning of the flowering cycle. Pruning a plant just before you induce it to fruit will stunt the growth of the plant for at least a week. Try to leave as many large fan leaves as possible; this is where the plant has stored energy to grow and produce flowers. Removal of a couple fan leaves may be necessary if heavy overlap occurs, which creates an ideal environment for pests and fungi to thrive. Removing too many fan leaves not only stresses the plant it also slows chlorophyll production. A fan leaf should only be removed if the site is more than 50% damaged.

At some point you will need to remove a couple of lower branches that become weak due to a lack of light reaching deep under the canopy. After removing the lower growth, the plant will send those hormones to the upper branches causing a spike in growth.

Not topping your plants may have many advantages, especially if turning a short crop. Many growers do not top their plants at all. It is not always necessary if you are able to keep the plant within three feet tall.

Supercropping is yet another way a grower may control the height of their plants. This is done by squeezing the stem a few inches below the main bud, snapping the cellulose, causing the branch to lay over. These branches also tend to receive more light over a greater surface area and can provide an impressive yield.

Low stress training (LST) is a great way to control height and get an increase yield. Bending the plant in the desired direction and tying it down; will encourage the bud sites to grow vertically. This stresses the plant far less than pruning and is often more effective. Allow plenty of room for growth when securing wire ties to the stem. Cutting off the plant's circulation will most certainly result in the loss of a limb. Young stocks and branches will bend much better than older woodier ones, so make sure to start this at an early stage of life. In the case of bending a plant too far and snapping the cellulose, place a wooden splint on the affected area and secure with wire ties or tape. The plant will soon heal itself and resume growth.

Sea of Green (SOG) and Screen of Green (Scrog) are two ways of growing cannabis in the flowering stage. SOG is taking many cuttings from the same mother plant and flowering them close together after a very short veg time. This creates an even canopy so that all plants get a near equal amount of light. Scrog is a way of growing few plants with a screen suspended above the canopy. This screen is used to shape the branches of the plant into an even canopy as well as support the weight of the flowers.

Troubleshooting

If the overall health of your plants is lacking you will have to identify the symptoms and determine what is causing problems. Pests, diseases or nutrient deficiencies/toxicity could cause this. Remember that the best action to take is preventative action. Cleanliness is the most important preventative measure. Keep your grow room

completely enclosed and free of dirt and debris. Insects and fungi like to hide under decaying leaves and any dirt that is lying around the garden. Keeping the grow room and your tools clean is of utmost importance. Do not leave old soil lying around as this is a perfect location for pests and fungi to live. Keeping a good amount of air circulation in the garden will also help to mitigate any potential problems with pests and fungi as it makes it more difficult for either of them to latch on to the plant. Proper ventilation is also key in keeping the humidity down to reduce the chance of mold taking root. Lastly, washing your grow room in between crops with a H₂O₂/water mix will keep the area as sterile as possible.

Pests

Even if all preventative measures are taken there may still be an attack on your garden from pest. For insect control in a garden always start with preventative measures such as cleanliness, a completely sealed grow room, disinfected tools, personal hygiene, and lastly creating the optimal environment for growing cannabis (keeping temperature and humidity in check). If problems arise, move to manual removal; using fingers or sponges to squeeze the pests and their eggs. If the problems persist use organic sprays such as pyrethrum and neem in conjunction with a wetting agent. These wetting agents increase sticking and absorption through the foliage. All sprays will slow the growth of the plant. The stomata become clogged from a filmy residue caused by the sprays. Spray as little as possible as some stronger sprays are **phytotoxic**, burning foliage. Do not spray seedlings or unrooted cuttings. They are too weak to handle the chemicals. Wait until they are at least a month old. Stop all spraying at least two weeks before harvest. The more ideal situation is one **where** you catch the problem while the plants are in the vegetative room. This allows time to treat the problem before transferring to the bloom room. This progression continues with natural predators (ladybugs, predatory mites) and ends with the use of chemicals.

The grow room can be infested by virtually any pest. The following list will help identify and treat the most common pests found in a garden.

- **Spider mites**

Spider mites are the most common and most damaging for any indoor plant. They are classified as spiders and not insects due to them having eight legs instead of six. These mites are microscopic and easily looked over by those unfamiliar with them. To find them, look on the underside of the leaves. This is where they feed off the fluids the leaves provide. If you cannot see them with the naked eye you can still tell if they are there by the signs of them feeding; yellowish-white **stippling** on the tops of the leaves. As the infestation progresses you will see small webs on the stems and underside of the leaves. If you are not sure if they are webs you can spray them lightly with water which will make them easily identifiable. After a single mating the female spider mite becomes fertilized for life and will lay approximately 100 eggs at a time. Spider mites prefer a dry climate with temps between 70-80 degrees. Anytime temps get beyond 80 degrees spider mites will reproduce every 5 days. An early physical control method to use, if you catch them early, would be to drop the temps down to 60 degrees and spray the undersides of leaves with cold water. Remove leaves that have 50% or greater damage. Another method is to introduce predatory mites to your garden. If the infestation is too advanced they may not work well as they only eat up to 20 eggs per day. This method can be used when caught early on and done once a month thereafter. For sprays you should concentrate on stronger ones such as pyrethrum, this is the best natural miticide. Weaker sprays such as soap spray, citrus oil and hot pepper sprays work great as a deterrent but if the infestation has taken hold they will do little if anything to combat it.

- **Aphids**

Aphids are about the size of a pinhead and are easier to spot with the naked eye than a spider mite. They are normally gray to black in color and sometimes green to pink. Aphids give birth to mostly female larvae, without mating. It is normal for them to birth up to 100 larvae a day and those quickly start reproducing themselves. As they eat they emanate sticky honeydew that attract ants. If you have a line of ants on your plant simply follow the trail and you'll find the aphids. Look for aphids under the leaves,

near the branch nodes and amongst the growing tips. A great preventative measure for aphids is yellow sticky traps. Place one at the base of each plant and a few more at the canopy, as these will attract the winged aphids, which are typically the first to enter your garden. Once an aphid latches on to the plant to start eating they are then unable to move, which makes manual removal quite easy. Squish them between your fingers or a sponge to kill them. For biological controls you can use lacewings or ladybugs, both of which are aphid predators. Depending on how far along the infestation is you will want to release anywhere from 1 to 20 per plant. Though, if you do not have an air-cooled lighting fixture, which is, completely enclosed these predators tend to fly directly towards the light resulting in their death. Weaker sprays and insecticidal sprays are very effective in combating aphids but if the infestation has greatly progressed you will need to spray with pyrethrum a few times at 5-10 day intervals.

- **Fungus Gnat**

The fungus gnat larvae are approximately 5mm in length. They have translucent bodies with black heads. The winged adult gnats are 2-3mm in length with long legs and are grayish to black in color. Look for these at the base of your plant when growing in soil or soilless mediums. Adult females lay approximately 200 eggs per week. They love moist cool environments. They damage cannabis plants by infesting the growing medium at the surface. They will eat fine root hairs and scar the surface of larger more established roots. It will cause your plants to lose vigor and the leaves will begin to pale. They also eat decaying foliage so keeping dead leaves off of your medium is paramount. They stick to resinous flowers very easily and are nearly impossible to clear them from the buds once they are there. The easiest method of control is to not overwater your plants and keep the ambient humidity low. You can also cover your growing medium to keep green algae from growing (another fungus gnat food source). A great biological control for this is the use of beneficial nematodes. Beneficial nematodes are microscopic roundworms. They are parasitic to fungus gnats and are added to the water for your plants. The last resort is to apply a neem or insecticidal soap solution and drench your soil.

- **Thrips**

Thrips are tiny winged bugs that are very fast. They range in color from white-gray to dark and sometimes with very small stripes. To find them you just need to look at the underside of the plants' leaves. Gently shake the plant and you will see them jump and scurry away rather than fly away. You will notice yellow-white stippling on the leaves as thrips suck the juices from the underside of leaves where they have scraped away the plant's tissue. Chlorophyll production will diminish and leaves will become brittle. Manual removal is very difficult with thrips because they are so hard to catch. Cleanliness and the use of blue and pink sticky traps are great preventative measures. The introduction of predatory mites or the use of sprays will be needed if there are more than just a few thrips in your garden. Nicotine based sprays or pyrethrum sprayed 2-3 times in 5-10 day intervals will be the course of action to take when you have an infestation. Thrips are found in indoor gardens but tend to be more common in greenhouses.

Fungus

Fungi are very primitive plants and do not produce chlorophyll, the substance that gives higher plants their green color. Fungi reproduce by spreading tiny microscopic spores rather than seeds.¹

Fungal spores are present in the air at all times. Whether they settle and start growing will depend on the environment. Overly wet soil, excessive humidity, and lack of air circulation provides the perfect environment for fungus to thrive. As with pests, fungus can best be controlled by taking preventative measures. Those measures are cleanliness and climate control. Make sure humidity doesn't exceed 50% to prevent fungus outbreaks. The following list of fungal attacks will help you identify and treat them.

¹ Cervantes, Jorge. *Marijuana Horticulture The Indoor/Outdoor Medical Grower's Bible*. China: Van Patten Publishing, 2006. Print.

- **Gray Mold (Botrytis)**

Gray Mold is the most common fungal attack in an indoor garden because it starts within the bud and is difficult to see. It is gray/white to blue/green in color. It looks similar to lint and is dry to the touch. When you touch an area affected by Botrytis it will crumble. Keep an eye out for a leaf that is sticking out from the bud that inexplicably wilts. Cool, humid grow rooms will create slimy buds if Botrytis attacks and hot, dry grow rooms will create buds that crumble to powder. Botrytis can ruin a crop in a week's time. Keep the humidity below 50%, keep a great deal of air circulation and make sure to have proper ventilation to prevent Botrytis from taking hold. If you do have an outbreak you will need to remove the infected areas from the plant and remove it from your garden before it can spread any further. To do this you will need to cut away the infected areas with pruners sterilized in alcohol. Be sure to remove a couple of inches below the infected area to be sure you got all of it. When removing it from the garden make sure it does not come in contact with any other plants. Wash your hands and tools before reentering your garden. Increase the temperature to 80 degrees and keep the humidity below 50%. Excessive nitrogen and phosphorus levels can make foliage weak and more susceptible to an attack. Keep your ph balance at 6 to help with calcium uptake. Avoid overcrowding of plants and keep the light levels as bright as possible. The real control for gray mold is preventative action. There are sprays that will help with very early detection but once the plant becomes infected the only solution is to remove it from the garden as to not affect any other plants.

- **Damping-off (Pythium wilt)**

Damping-off attacks seedlings and can also prevent germinated seeds from sprouting. It attacks plants at the soil line, weakening the plant and finally cutting off the fluid circulation. Damping-off is a combination of fungi that are present in an unsterile medium, overwatering/soggy growing mediums and excessive

humidity. An easy solution to decrease the chances of damping-off is to switch out your fluorescent lights for a more intense HID light. The stronger light inhibits the chances of damping off.

- **Powdery Mildew**

Powdery mildew infections can be first identified by small spots on the tops of leaves that progress to fine, pale, white powdery coating on growing shoots, leaves and stems. Plants can be infected for weeks before showing any symptoms. Prevent powdery mildew by avoiding low light levels and cold, damp grow rooms. Also avoid large fluctuations in temperature and humidity. Make sure to keep light intensity high. Space plants enough apart to allow adequate air circulation. If you foliar feed your plants allow the leaves enough time to dry before the lights turn off and take care to avoid excessive nitrogen feeding. When you've identified powdery mildew you can use a spray mix of baking soda and water. The baking soda will dry to a fine powder on the leaf's surface and change its ph to 7 making it impossible for powdery mildew to grow.

- **Root Rot**

Root rot fungi cause healthy white roots to turn brown and eventually followed by leaf chlorosis and wilting of leaves through the entire plant. Root rot is most common in oxygen deprived grow mediums. In order to control root rot make sure to use fresh, sterile medium. Also ensure that the calcium levels are adequate and you don't over fertilize with nitrogen. In soil keep the ph above 6.5 and in hydroponics keep it above 6.0.

Viruses

Viruses are still a large unknown. They enter through the wounds of the plant. They are carried by insects, plants, humans, and animals. Symptoms of a viral infection are sickly growth, leaf spots, yellowing and low yields. There is nothing you can do once your plant has a virus.

Nutrient Deficiencies & Toxicities

When pests, diseases, fungi and environmental conditions have been ruled out it is time to check for any nutrient deficiencies or toxicities. These problems are more common in primary and secondary nutrients but can happen with trace elements. The following is a list of what to lookout for in each case.

Primary Nutrients

- **Nitrogen (N)** is the most common nutrient that is found deficient. The lower leaves will yellow while the veins remain green. Severely affected leaves will drop off the plant. The leaf stems may also turn reddish-purple in color, although this could be a genetic trait. These symptoms progress to newer leaves and the leaf drop becomes severe. When there is too much nitrogen present in the medium there will be great amount of lush green foliage and stems will become weak, folding over easily. The foliage becomes very soft, making it susceptible to stress, fungal and pest attacks. In a flowering cannabis plant too much nitrogen will cause the buds to become wispy. With a deficiency in nitrogen just add: either a fertilizer with mainly nitrogen or use a complete fertilizer. You will see results in a few days. With a nitrogen toxicity you will need to flush your growing medium with water and the next time the plants need watering after that you will need to use a very mild, complete fertilizer.
- **Phosphorus (P)** deficiencies cause stunted growth. The plant will produce smaller leaves that turn bluish-green and blotches will appear. Leaf stems can also turn reddish-purple starting at the leaf's underside. Leaf tips of older leaves will turn dark and curl downward. In flowering the plant will have delayed flowering, smaller flowers and a poor yield. To treat phosphorus deficiencies lower the ph to allow it to become more available to the plant (5.5-6.2 in hydroponics & 5.5-6.5 in soil). Signs of phosphorus toxicity will take several weeks to appear. Cannabis uses a lot of phosphorus throughout its life and can tolerate high amounts. Too much phosphorus will appear to be a deficiency in trace elements. Flushing your medium with three times the volume of water or a very mild complete nutrient solution will treat phosphorus toxicity.

- **Potassium** (K) deficiencies manifest as spots on older leaves, which turn a dark yellow, and stems that are weak and sometimes brittle. Potassium is almost always present in soil but can be locked out by a high salt content. Correct this deficiency by using a complete N-P-K fertilizer. A potassium toxicity problem will be difficult to diagnose as it can be confused with other nutrient problems as it impairs the absorption of magnesium, manganese, zinc and iron.

Secondary Nutrients

- **Magnesium** (Mg) deficiency is very common in indoor growing. The lower leaves and then the middle leaves will develop yellow patches between dark green veins. As this deficiency progresses, leaf tips, margins and between the veins will have rust colored spots appear. Most commonly a wet/cold or acidic/cold-growing medium is to blame. Treat this deficiency by watering with a solution of two teaspoons of Epsom salts per gallon of water and for fast results foliar feed with a 2% Epsom salt solution. Magnesium toxicity is very rare and more than likely you will never see it happen with cannabis plants.
- **Calcium** (C) deficiencies are uncommon indoors and will be difficult to detect. Look for weak stems with dark green foliage and very slow growth. Severe calcium deficiencies will cause new shoots to turn yellowish-purple and will become disfigured before shriveling up and dying. To treat this deficiency dissolve $\frac{1}{2}$ a teaspoon of hydrated lime per gallon of water and water the plants with this mix until symptoms disappear and make sure to keep a stable pH. Toxic levels are difficult to diagnose as they are confused by other nutrients becoming deficient due to the overdose of calcium.
- **Sulfur** (S) deficiency will cause young leaves to turn lime green to yellow in color. As it progresses leaves yellow between the veins and lack moistness. Leaf stems can turn purple and the leaf tips burn and hook downward. Sulfur deficiencies resemble nitrogen deficiencies and occur when the pH is too high. Treat this deficiency by lowering the pH to 5.5-6.0 and use a chemical fertilizer that has sulfur in its ingredients. Excess sulfur symptoms are smaller plants with smaller development in new growth. Leaf tips and

margins can burn when sulfur toxicity is severe. Treat this overdose by flushing with a mild complete fertilizer and correct the pH to 6.0.

Compost Teas

To combat pests and disease outbreaks try using a compost tea when watering your plants. A well-made tea will hold billions of beneficial bacteria and multiple feet of fungi strands. It will contain thousands of protozoa, nematodes and mycorrhizal fungi. These beneficial bacteria and fungi will cause disease-causing organisms to starve, as they are unable to compete with the vast amount bacteria. The tea will improve soil structure and water retention. All compost teas need to be brewed for 24-48 hours prior to use. Brewing consists of steeping the compost tea bag in oxygenated water. Without proper oxygenation, the good aerobic bacteria will cause the tea to smell foul and as soon as more fresh water and oxygen are added these bacteria will re-establish themselves. After 24-48 hour the tea is ready to be used at a dilution rate of 1 to 5 with water.

Summary

Starting your veg room with the correct photoperiod, lights with the correct color spectrum and an environment that is stable will ensure tighter node spacing, better root growth and an overall healthy plant that will be ready to support the weight of flowering.

Starting from seed will require different environmental conditions than starting from clones. Seed require a damp, cool environment to start the germination process. Clones need a warmer root zone temperature to initiate root growth. Once the seeds have sprouted they enter the seedling stage and can be treated the same as clones that have successfully rooted. Any seedlings showing signs of sickly growth should be culled out to prevent hosting any pests or diseases.

Once the plants have entered the vegetative cycle you can expect to see rapid growth. As much as 2"-4" per day is not uncommon. Once the growth slows down it may be time to transplant into a larger container. Choose a container that has more depth than width and has holes on the bottom to allow drainage of excess water.

Transplanting can be traumatic for a plant if not done correctly. Water the plant a couple days in advance to keep the root ball intact. Try limiting the amount of times you transplant to three times. Transplanting should be done towards the end of the light cycle so that the plant has some time to recuperate overnight.

The cannabis plant can be manipulated by rerouting growth hormones through the practice of pruning and bending. Bending is Low Stress Training. By bending the plant's terminal shoot over and tying it down it redirects the plant's hormones and causes secondary shoots to grow vertically while the terminal shoot will initially grow horizontally. Topping creates wider, bushier plants by cutting off the terminal shoot. Once that terminal shoot is cut off the plant will replace it with two new terminal shoots. When this process is repeated over and over the plant becomes bushier as it concentrates on growth elsewhere. Supercropping helps when there are height restrictions. It is done by squeezing the stem a few inches below the main bud, snapping the cellulose, causing the branch to lay over. These branches also tend to receive more light over a greater surface area and can provide an impressive yield. SOG and Scrog are also ways to create an even canopy in a height restricted grow room. SOG is done by using cuttings from the same mother and put in the vegetative state for a very short time. Scrog is done with fewer plants and is aided by a screen suspended over the plant to ensure an even canopy.

However you choose to grow you will always be on the lookout for pests and diseases. Look for telltale signs such as stippling, unexpected wilting of leaves coming from a bud, sickly or weak slow growth and spider mite webs. The key to successfully combatting these problems is cleanliness and correct environmental parameters.

Glossary

- Seed-to-Sale - tracking systems for cannabis and cannabis product that work with government systems to identify how much cannabis there was at harvest to how much cannabis individual patients have purchased
- Germination - the process by which a plant grows from a seed
- Cotyledon - an embryonic leaf in seed-bearing plants, one or more of which are the first leaves to appear from a germinating seed
- True Leaves - a foliage leaf of a plant, as opposed to a seed leaf or cotyledon
- Peat Pellet - for seeding and can also be used for rooting cuttings, the pellets expand rapidly when soaked in water
- Coco - the fibrous material found between the hard, internal shell and the outer coat of a coconut
- Rock wool - inorganic material made into matted fiber
- Transplant - move or transfer (something) to another place or situation, typically with some effort or upheaval
- Vegetative State - period of growth between germination and flowering
- Cull- select from a large quantity; obtain from a variety of sources
- Transpiration - the passage of water through a plant from the roots through the vascular system to the atmosphere
- Micronutrients - essential nutrient, as a trace mineral or vitamin, that is required by an organism in minute amounts
- Potting Up - transferring plants into larger containers
- Pruning - to cut or lop off (twigs, branches, or roots)
- Topping - removing the top or cropping plants
- Super Cropping - bush style growing
- Low Stress Training - simple process of training your plant along a trellis laterally
- Phytotoxic - poisonous to plants
- Stippling - (in drawing, painting, and engraving) mark (a surface) with numerous small dots or specks

Thought Provoking Questions

- How can inadequate preparation damage your crop later in the vegetative cycle?
- What colors of lights are best for the late vegetative phase?
- What are the typical signals for the beginnings and endings of different stages?
- How can the grower effect how fast the crop is growing?
- Why do root systems grow to the bottom of the pot?
- What will happen to a root system transplanted into an incompatible medium?
- What damage can you do to a plant if it is left too long in a small pot?
- How much stress can you place on a plant while shaping?
- What should a grower do if there is an outbreak of pests in the grow space?
- What should the first line of defense when an issue is noticed?
- When cultivating outdoors, what animals will try to eat the cannabis plant?
- What do all molds have in common?
- When would a grower know when there was a nutrient issue?
- Is it possible to use one nutrient to counterbalance another nutrient?