Cultivation 1:

Preparation through Propagation

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Table of Contents

Learning Objectives

1) The essentials for growing cannabis are needs light, air, water, nutrients, a growing medium, and heat.
2) Cannabis can be propagated through sexual (seeds) and asexual (cloning) methods.
3) A mother plant needs to be greater than 2 months old to take cuttings from it.
4) The benefits to growing indoors is complete control over the environment. Growing outdoors results in much larger yields with less overhead costs. Greenhouses offer the best of both indoor and outdoor cultivation.
5) Soil consists of three main components - minerals, organic matter and the living organisms that reside in it. Soilless grow mediums are a means to provide support for root structure and delivery of water, nutrients and oxygen to the plant.
6) Both soil and soilless grow mediums need to drain well, yet hold water and nutrients.
7) The differences in varieties of cannabis (Indica, Sativa, Ruderalis, Afghanica) are expressed through plant structure, medicinal qualities and geographic origins.
8) The three groups of nutrients are -
9) Primary (macro nutrients)
10) Secondary
11) Trace elements (micro nutrients)
12) Compost is decayed organic matter used as a plant fertilizer.
13) Three things need to be considered for an optimal growing environment. They are temperature, relative humidity and CO2 concentration. Temps should stay between 72-76 degrees during the light cycle and no more than 15 degrees cooler during the night cycle. Humidity requirements will change depending on the stage of growth the plants are in. Clones and seedlings will have a relative humidity of 80-100%, vegetative plants will want it to be 50-60% and flowering plants will want 40- 50% relative humidity.
14) Cannabis prefers a CO2 level of 1200-1500 ppm.
15) Ozone generators neutralize odors by converting oxygen (O2) into ozone (O3) by the exposal of ultraviolet (UV) light.
16) When using a carbon filter make sure that the relative humidity doesn't exceed 55% as the moisture will clog the odor neutralizing carbon.
17) The biggest threat to any garden is theft.

Introduction

The key to successful indoor cannabis cultivation is to understand how cannabis produces food and grows. Cannabis, whether cultivated indoors or out, has the same requirements for growth. It needs light, air, water, nutrients, a growing medium, and heat to manufacture food and to grow. Without any one of these essentials, growth stops and death soon results. Indoors, the light must be of the proper spectrum and intensity; air must be warm, arid, and rich in carbon dioxide; water must be abundant but not excessive, and the growing medium must contain the proper levels of nutrients for vigorous growth. When all these needs are met consistently at optimum levels, optimum growth is the result.[1]

Lighting

Growing cannabis plants requires light. This light must be the right spectrum and intensity. Light is comprised of different bands of colors referred to as the "spectrum." Each color in the spectrum will send a different signal to the plant and promote different types of growth, such as positive tropism, which is the plant's ability to orient itself towards the light.

Cannabis plants will only use certain parts of the spectrum. The most important colors in the spectrum for maximum chlorophyll production and photosynthetic response are in the blue and red range. Light is measured by wavelengths and these wavelengths are measured in nanometers. The main portion of light

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

used by plants is between 400 and 700 nanometers (nm). A nanometer is the equivalent of one-billionth of a meter. This region is called the Photosynthetically Active Radiation (PAR) zone. Light energy is absorbed and radiated in photons. Photons are a way of measuring this light energy. "PAR watts" measure the amount of specific photons a plant needs to grow. Photosynthesis is activated by this absorption of photons.

Light can be measured in various ways. The human eye cannot see the same spectrum of light that the plant sees. The human eye is most sensitive to light between 525-625 nm. This makes understanding how light is measured that much more important.

Most light is measured in foot-candles, lux, and lumens. Foot-candles and lux are ways of measuring light that is visible to the human eye. A foot-candle is a unit of illumination equal to one candle at a distance of one foot. Measuring light on a lux scale is similar to foot-candle scale whereas one foot-candle equals 10.76 lux. A lumen is the amount of light emitted by one candle that falls on one square foot of surface one foot away. Using any of these three ways of measuring light lessens the importance of spectrum but it remains a good way of mapping out coverage area.

Because foot-candles, lux, and lumens don't measure spectrum and PAR watts measure photons in light energy this leaves us with having to find a way to measure spectrum. This is where Kelvin temperature readings are used.

Watts – A measure of the amount of electricity flowing through a wire. Watt hours measure the amount of watts used in one hour. A kilowatt/hour (KWH) is 1000 watt/hours.

Kelvin is a unit of measurement used to describe the hue of a specific light source. This is not necessarily related to the heat output of the light source but rather the color of the light output. The higher the Kelvin value of the light source, the closer the light's color output will be to actual sunlight. Bulbs with an output of 3500K or lower on the scale will have an amber hue. Bulbs in the mid-range of 3500K-4100K will have a white hue. Bulbs in the higher 4200K+ range will tend to have more of a blue hue closer to, or exceeding, that of sunlight.

There are several types of lights used to grow cannabis. Some give-off relatively low-intensity, like florescent lamps, which must be positioned closely to the tops of the plants and emit light that penetrates only several inches into the plant canopy. Fluorescents do not put out much heat and can be as close as one or two inches, but plants will grow into the light quickly, sometimes 2-3 inches a day, check them frequently for proper spacing.

Other lights, including metal halide, high pressure sodium, Philips double ended, ceramic and plasma, emit light of much higher intensity that penetrates deep enough into canopy light lower branches of a large plant and can be positioned further above the plant canopy. These are referred to as high-intensity discharge (HID) lamps.

Ballasts are either mounted in the fixture or are connected by a large gauge wire and they condition the electricity so the lamp will operate properly. Older ballasts are referred to as “magnetic ballasts”, which tend to shed some energy in the form of heat, and newer ballasts are “digital ballasts” that can be switched to lower and higher wattage and do not shed as much heat.

Metal halide and high pressure sodium lamps both use large-thread screw-in sockets and share fixtures and ballasts. Ballasts for these lamps have a switch that allows use with either metal halide or high-pressure sodium lamps.

While metal halide lamps emit light with a spectrum similar to that of a mid-summer sun, used for vegetative growth, high-pressure sodium lamps emit yellow light, more similar to sunlight in late fall, and are used for flowering.

Metal halide and high pressure sodium lamps both use large-thread screw-in sockets and share fixtures and ballasts. Ballasts for these lamps have a switch that allows use with either metal halide or high-pressure sodium lamps.

While metal halide lamps are very efficient, in that they produce more lumens per watt than most lamps, high-pressure sodium lamps are even more efficient.

Philips double ended, ceramic and plasma lamps require digital ballasts and must be used in a fixture designed for those lamp-types. These lamps are more efficient than high-pressure sodium lamps.

When first introduced light-emitting diode (LED) lamps did not penetrate canopies deeply, but advances in LED technology have greatly improved their penetration. These lamp-types are even more efficient and produce more lumens per watt than all HID lamps do. They do not require a ballast

LEDs use a series of diodes, each with a different color. They are mounted in a fixture in rows and columns. Some LED fixtures come with a series of slide controls, one slide control for each color of the spectrum. This allows for the adjustment of spectrum

Today's high tech bulbs vary the Kelvin value by altering the composition and materials of the thin glass crystal that encloses the bulb. This enables them to increase the light output over older technology lamps that used a thick, colored lens on the lamp housing to filter the light output.

Bulbs with an output in the lower, amber Kelvin range are made up of a much longer wavelength band of the visible light spectrum.

Light intensity, when managed properly can have great benefits to for overall yield. Intensity is the magnitude of light energy per unit of area. The greatest intensity is at the bulb's surface and diminishes rapidly as it moves away from the source. Light intensity basically doubles every six inches closer the HID lamp gets to the canopy of the garden. An even distribution of light over the entire garden will help increase yield. This can be done a number of ways. First, choose a reflective hood that best matches the footprint of the garden. There are hoods that will reflect light in a circular pattern (parabolic) as well as ones that will reflect in either a square or rectangular pattern. A winged reflector would be beneficial if ceiling height is an issue or more light disbursement over a larger area is needed from one lamp. Light the room, not the plants. An even distribution of light from wall to wall will ensure optimal yields.

Lumens per square foot:

The minimum amount of lighting needed is around 2000 lumens per square foot. Mid range is around 5000 lumens per square foot. Optimal is 7000-7500, or higher, lumens per square foot.

Watts per square foot (wattage per square foot will vary by light source): Minimum per sq ft is 30w, mid-range per sq ft is 50w, optimal range per sq ft. 50-80w.

To most accurately ascertain the proper amount of lighting needed for the space, there are several things to determine. Lumens per square foot are measured by square footage of your space. (Width x Depth = Square feet.) Divide the lumens available by the square footage. This will determine lumens per square foot.

Say the space is 3 feet deep by 4 feet wide, 12 square feet. For example, assume the total lumens available from the light(s) is 45000 lumens. 45000/12 = 3750 lumens per square foot.

To determine how much light needed in watts; the general rule of thumb for providing light for an area is a minimum of 30 watts per square foot. 50+ watts per square foot is optimal. Determine the proper lighting for the area by using this formula: 50 watts (or the total watts being used) x (square footage).

If there is an area of 10 sq. ft. – 50w x 10 sq ft = 500watts/sq ft minimum or 50 watts x 10 sq ft = 500 watts/sq ft (optimal). Also, remember that fluorescent's are weaker and emit less light than an HID. This means five times the amount of wattage is needed to equal the output of an HID. So, 30 watts of HID would equal 150 watts of fluorescent's. This is why it is advised to provide a minimum of 30 watts per square foot for HID lights and a minimum of 150 watts per square foot for fluorescents'.

Chlorophyll and photosynthesis both peak at both ends of the visible light spectrum. Technology has advanced so much in the last 15 years that we are constantly refining the process and updating what we know works best for growing. Current theory holds that the minimum amount of lighting needed to sustain growth is around 2000 lumens per square foot. Mid range is around 5000 lumens per square foot. Optimal is 7000-7500, or higher, lumens per square foot.

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This is all important because the light intensity will directly affect the quality and yield of the crop. Less than optimal lighting will cause yield and potency to be reduced and buds will not develop as dense.

The question is often asked, "can there be too much light?". Theoretically, yes there can be, but in practicality it probably isn't a concern.

Experimentation is the only sure method to determine the best solution for each plant. If plants are not receiving enough light, they begin to grow tall and spindly as if stretching for the light and foliage becomes

pale green. Or, if they need to be moved closer to the light, or given a longer light exposure period. Too much light may lead to bleaching of leaves and flowers, browning and shriveling. Leaves would become overly compact and curl under at the edges.

Light bleaching from being too close to the LEDs. Looks cool, but smokes like ass. Don't burn the plants by getting them to close to the light(s).

HID lights get much hotter and will need to be farther away. A good test is to put your hand between the light and the plant. If your hand gets too hot for comfort, the light is too close.

LED lighting is only warm to the touch, but its soft intensity can be misleading. Keeping an LED grow light too close to plants can result in bleaching, but is easily fixed by keeping a 8″-24″ (depending on lamp wattage) distance between the tops of the plants and the LEDs.

There are some common lights that may induce a seed to come up, but are worthless for growing purposes. These lights include; any incandescent (regular) light bulb, halogen lights, black lights and heat lamps. Don't waste time trying to grow with these lights, they will only be disappoint.

Plants convert light energy into plant energy via photosynthesis. There are two primary compounds that achieve photosynthesis: Chlorophyll A, and Chlorophyll B. These compounds absorb blue and red light, while nearly all other spectra are reflected away from the plant and into the nether. There is a term called the "absorption peak" which is the point at which chlorophyll converts light energy into plant energy the most efficiently. These absorption rises can be measured in units called nanometers (nm).

L.E.D's (LED grow lights) are light sources that emit narrow wavelengths of light, and can be tailored to nearly any nm that a grower desires. By using L.E.D's at the same nm as each of the absorption points for Chlorophyll, high-quality systems (like the Pro-Grow series we use) convert light energy into plant energy much effectively than HIDs, a Pro-Grow 180 LED lamp is easily comparable to a 400 watt HPS.

High Intensity Discharge lights, like HPS and Metal Halide, emit full spectrum's of light (most of which is unused by plants in the form of heat). Quality LEDs emit only the spectra that plants require, which results in much higher efficiency in terms of growth per wattage used. By using the ideal ratio of L.E.D's, 95% – 100% of the light generated by the lamp is used for photosynthesis. The bottom line is that the plants will utilize less overall wattage and produce the same yields as under HID lamps.

Propagation

Cannabis is an annual plant. Seeds planted in the spring will germinate in about 3-7 days. Throughout the summer cannabis vigorously grows tall and strong and flowers in the fall producing seeds for the next year's crop. However, this is not the only way to **propagate** cannabis. A common method of propagation is cloning. Cloning, simply put, is taking a cutting of a cannabis plant and growing roots to form an identical genetic replica of the plant that the cutting was taken from (mother plant). This is a way of preserving genetic anomalies that would otherwise have been lost.

Cultivation methods

Cannabis can be grown indoors, outdoors or in a greenhouse. They can be grown in soil, soilless mixes or hydroponically.

Indoor

Growing indoors allows you to accurately control the environment throughout the plants' life span. While this is a more expensive approach to cannabis cultivation you won't be dealing with the nuances of Mother Nature. Indoor growing allows you to manipulate the climate to survey the optimal environment for strain-specific grows.

Outdoor

Outdoor growing is more common in places with relaxed laws. Electricity costs money and sunshine is free. These are the biggest determining factors when choosing where to grow. Another reason for growing cannabis outdoors is yield. When cannabis is grown outdoors it can result in 10-20 times the weight of that same plant grown indoors.

Greenhouse

Think of greenhouse growing as the best of both worlds. Sun is free and greenhouses, whether constructed with glass or plastic walls & roofs, supply a barrier to the elements. There are also ways of producing perpetual harvests in greenhouses like those produced indoors with the aid of light deprivation cloth and supplemental lighting. Light deprivation cloth can be operated manually or mechanically depending on the size and complexity of your greenhouse. Light deprivation cloth keeps a consistent flowering photoperiod intact by sealing out sunlight during the months that there is more than 12 hours of it during the day.

Greenhouses that run perpetual cycles can also be outfitted with supplemental lighting for those winter months of less than 12 hours of sunlight. A 1000 watt light covers an area of about 100 square feet in a greenhouse opposed to the 25 square feet of indoor canopy coverage.

Greenhouses benefit greatly from the addition of CO2. Because the greenhouse stays buttoned up for lengths of time the plants use up all available CO2 in the air. Keeping your CO2 enrichment in the greenhouse at the optimal levels of 1200-1500 ppm will ensure healthy, vigorous plants capable of supporting heavy yields.

Seeds and clones

A seed contains all the genetic characteristics of a plant. Seeds are the result of sexual propagation and contain genes from each parent, male and female.[2]

Clones are cuttings from a donor plant. Also known as the mother plant. These cuttings, when successfully rooted go on to become genetic replicas of the mother plant from which they were taken.

The environment for growing from seed requires water, heat and air. Germination of seeds will take anywhere from 3-7 days. There are a couple of ways to **germinate** seeds. The first one is to put the seeds in a glass of water until they sprout their tap root. This is only advisable if you are diligently watching over

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

them. If left in the water too long they can become susceptible to oxygen deprivation and rot. The other way to germinate them is to place them in the fold of a paper towel and wetting the paper towel. Place the paper towel in an area which is dark and has temps between 70-90 degrees. Do not let the paper towel to dry out. With both of these techniques you will see the seed split open and a white tap root emerge. Take those germinated seeds and place them in a rockwool cube or a pot of soilless mix with the tap root facing downward.

When the **cotyledon** (seedling leaf) appears the seedling stage has started and will last 3-6 weeks. You'll know when this stage is over when vigorous vegetative growth starts.

Cannabis seeds grow best at 78degrees F.[3] **Do not fertilize seedlings!**

To preserve genetics and to minimize time spent in the seedling stage you will take cutting of your plants, also known as cloning.

Step-by-step cloning

1) Choose a mother plant greater than 2 months old.
2) Make a 45 degree cut across firm, healthy branches. Use a clean razor blade, not scissors. Make the cut in between two sets of nodes. Make sure there are a couple sets of leaves above the soil line and one or two sets of trimmed nodes below the soil line. Place clones in a cup of water while you take more cuttings to prevent embolisms.

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

3) Saturate your substrate with water. If using rockwool cubes make sure to balance the ph of the water so that it is in the 5-6 ph range. Place all of your cubes into a nursery rooting tray.
4) Dip cuttings into a rooting hormone. These hormones come in gel, liquid or powder. Place the cutting into your medium and gently pack it around the stem. If using rockwool cubes there are pre-packaged holes to place the cutting in.
5) Keep cuttings moist but not soggy. These cutting have no way of bringing in water other than the leaves and cut stem.
6) Place clones under an 18/6 or 24/0 light cycle under fluorescent lighting six inches above the canopy.
7) Clones root fastest when humidity levels are 95-100 percent for the first two days and gradually reduce to 80-85 percent during the following week.(jc fn g 42) A vented humidity tent will help regulate these levels as well as regular misting. Cut the fan leaves in half to reduce transpiration rates and to prevent overlapping of clones as these areas harbor fungus.
8) A growing medium warmer than the ambient temperature will result in the fastest cloning. Chemical activity in the root zone is increased when the substrate is warmer than the ambient temperature. **Transpiration** slows down when the ambient temperature is kept cooler than the root zone. Keep the growing media temperature between 75-80 degrees and the ambient temperature 5-10 degrees cooler. To accomplish this use a vented tent over the clones and a nursery heating pad under the tray.
9) Clones will wilt and perk back up by the end of a week. Any plants still not showing signs of improvement by the end of the week need to be culled out.
10) Cuttings will fully root in 1-2 weeks. Look out for leaves turning a darker shade of green and lower leaves turning yellow as well as fuzzy white roots coming through the bottom of the cube.

Grow Mediums

Growth mediums are the substrate that your plants grow in. Growth mediums for cannabis fall within 2 categories, soil or hydroponics.

- **Soil**

Soil consists of three main components – minerals, organic matter and the living organisms that reside in it. The proportion of these will determine how well your plants will grow. Cannabis prefers soil with a texture that is similar to loam soil – drains well, yet holds water and nutrients. Soil growing is far more forgiving than hydroponics.

"Super Soil" is a term used when creating your own composted soil. It delivers exactly what the cannabis plant needs at exactly the right time. Correctly composted super soil mimics the root condition that would cause the cannabis plant to thrive in the wild. By creating your own organic living soil you will make the growing of cannabis a relatively easy process. A good super soil will negate the need for a complicated nutrient regimen as well as the use of chemicals and ph testing. Growing cannabis in super soil is thought to be the easiest method for producing top quality product. This method only requires accurate environmental conditions and the gardener to water his plants with pure water and compost tea when needed.

The advantages of growing in super soil are vast. Many growers report that cannabis grown in super soil will have a better taste, stronger aroma and an overall smoothness not found in plants grown with chemicals or over-fertilized. A good super soil can also be used indoors or outdoors. Super soil uses all organic ingredients, which can be broken down naturally. This process replicates what happens in the richest soil in nature. Because there are no chemical salt build ups, which can alter the taste and aroma of the bud a lot of growers using it don't put their plants through a flushing phase before harvest.

The disadvantages to making your own super soil are the cost, planning and labor. Making your own super soil requires a larger initial budget as it is made in large batches. However, there are now brands of super soil sold in hydroponic stores. Making your own will require more money upfront but will save you money

over the long run compared to purchasing it premade. When you make your own super soil it is imperative that you plan ahead. Composting your own will require a 30-60 day period in which the soil is breaking down to a point that the plants will be able to access the nutrients from within, The labor that goes into making super soil is no small feat either. Making large batches will require constant turning and raking from the beginning and throughout the 30-60 day period.

The following is a recipe for making your own super soil –

- 9 cubic feet of organic potting soil
- 3 cubic feet of a light mix soil
- 60 lbs. of earthworm castings
- 6 lbs. of fish bone meal
- 1 cup of dolomite lime
- ½ cup of azomite
- 5 lbs. blood meal
- 4 lbs. of bat guano
- ¾ cup of Epsom salts
- 25% perlite added for drainage.

When making your own make sure to use a "layered" approach. Simply dumping the ingredients into a pile can be done but in order to get a more thorough mixing of the ingredients it is better to empty them in layers. Once your ingredients are layered you can begin mixing them together. Mixing should take about a week. Once the mix has been thoroughly mixed they should be put into containers. Clean trash barrels with lids work well for this. Once in the containers you will need to add water to initiate the microbial process. It

needs to be moist but not soggy. Put the lid on the container to keep unwanted pests from making a home and this will also keep the super soil from drying out which will stop the process of composting. Place the containers in a sunny area and allow them to "cook." The microbial process happening within the medium will cause the soil to be hot to the touch. This is why it is called cooking and it is perfectly normal. As the soil cooks it breaks down the ingredients to a form that the cannabis plants can use.

Super soil should never be used for germination or for seedlings. Only well-established plants that are growing in the vegetative or flowering phase will be able to withstand the nutrients in the medium.

- **Hydroponics**

Soilless grow mediums are a means to provide support for root structure and delivery of water, nutrients and oxygen to the plant. There is a plethora of growing mediums used for hydroponic gardening. Whichever medium you choose keep in mind that you want it to drain well and have the ability to hold water, nutrients and oxygen. Stay clear of any mediums that may compact. The most common mediums used are rockwool, expanded clay aggregate, perlite and coco coir. Some will need to be cleaned or charged prior to using and if it is a recyclable product it will need to be cleaned prior to the next crop being planted. This is done using a mix of water and hydrogen peroxide at a rate of 1.5ml of 35% hydrogen peroxide to 1 gallon of water. Do not clean with bleach! Bleach leaves a toxic residue behind.

Indicas, Sativas, Ruderalis and Afghanica

Although all cannabis is technically and legally sativa we can further classify them as Indica, Sativa, Ruderalis and Afghanica.

Indica

Indica originated in Pakistan and India.(fnjc11) The qualities of the Indica variety are squat, bushy plants with broad leaves. Their flowers are dense and heavy. The high associated with Indica is the heavy, narcotic couch lock.

Sativa

Sativa plants originated all over the world in equatorial and sub-equatorial locations. They are known for their tall stature. They have paler thin leaves with looser, less compact flowers. Sativas produce a cerebral high and the pure Sativas can be very difficult to grow indoors.

Ruderalis

Ruderalis is also known as ditch weed. It was originally found growing wild in central Europe. It does not require a **photoperiod** to induce flowering and is mostly used to create auto flowering strains. They produce very little, if any, THC.

Afghanica

Sometimes confused with Indicas, Afghanicas developed in Afghanistan. Rarely growing above 6 feet tall with broad with dark green leaves, Afghanicas are responsible for hashplant varieties grown today.

Kush *varieties grown today developed in the Hindu Kush valley in northern Afghanistan.*

All varieties of cannabis should be harvested when the trichomes have matured. For Indicas this can happen any time from 6 weeks of flowering to 9 weeks. The maturation of **trichomes** on Sativa varieties can happen from 10 weeks to 20+ weeks. Ruderalis varieties flower automatically, without any trigger from the light cycle. These factors will play into how and where you cultivate cannabis. Whether you grow in SOG or Scrog, indoors or outdoors, these general descriptions will facilitate your decision-making. Breeders have combined both Indica and Sativa to create hybrids that will display the effects of both with the added benefit of a shorter flowering time. Recently breeders have introduced Ruderalis varieties into their breeding projects to create plants that will produce a high but doesn't require a photoperiod. This allows those growing in very small spaces to produce their own cannabis without utilizing the two-room perpetual harvest set up.

Feeding

All cannabis plants grown in soil or soilless mediums need a container large enough to contain the large root mass the cannabis plant produces. Using inexpensive grow pots or rigid plastic containers are the best options.

When growing in soil or hydroponically one of the important factors to consider is ph. Cannabis grows best in soil when the soil ph is between 6.5 - 7.0 and when growing cannabis hydroponically the ideal range is between 5.8-6.8. Most soil bought from a hydroponic store will already be in the optimal range. If you are growing outdoors you will want to take a reading of your soils' ph with an inexpensive soil test kit.

Nutrients

Nutrients are elements that the plant needs to live. Carbon, hydrogen and oxygen are absorbed through the air. The rest of the elements, called *nutrients*, are absorbed from the growing medium and nutrient solution.[4]

There are three groups of nutrients-

- Primary (macronutrients)
- Secondary
- Trace elements (micronutrients)

The primary nutrients cannabis uses are Nitrogen, Phosphorus and Potassium. On the periodic table they are designated N-P-K.

(N) Marijuana loves nitrogen and requires high levels of it during vegetative growth but lower levels during the balance of life. Nitrogen is easily washed away and must be replaced regularly, especially during vegetative growth. Excess levels of nitrogen in harvested plants cause the dried marijuana to burn poorly.

(P) Cannabis uses the highest levels of phosphorus during germination, seedling, cloning and flowering. Super bloom fertilizers, designed for flowering, have high levels of phosphorus.

(K) Potassium is used at all stages of growth. Soils with a high level of potassium increase a plant's resistance to bacteria and mold.

The secondary nutrients are magnesium, calcium and sulfur (Mg, ca, s). Although cannabis uses N-P-K in large quantities they also use these secondary nutrients in large quantities. Most growers therefore opt for a 2 or 3 part fertilizer to provide all necessary nutrients and trace elements.

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

(Mg) Marijuana uses a lot of magnesium. This secondary nutrient facilitates absorption of light, utilization of nutrients and aids in the production of carbohydrates and sugars which, in turn, are transformed into flowers.

(Ca) Calcium helps in cell manufacturing and growth. It helps with the flow of nitrogen and sugars. Cannabis uses nearly as much calcium as it does the macronutrients.

(S) Sulfur is a building block of hormones and vitamins. Sulfates help buffer the ph of water. Virtually all fertilizer mixes have an adequate amount of sulfur so that deficiencies are very rare.

Micronutrients or trace elements are essential to chlorophyll formation and must be present in minute amounts.[5] These trace elements include zinc, manganese, iron, boron, chlorine, cobalt, copper, silicon, nickel, sodium and fluoride.

Compost

Compost is decayed organic matter used as a plant fertilizer. When growing in soil either indoors or outdoors, compost is an excellent soil amendment. It holds water and nutrients very well. However, using compost made in your own backyard can become finicky when growing indoors. Outdoor growers love good compost as it helps with virtually every aspect of growing. Water retention, drainage, and nutrient uptake are all results of good compost. Indoors this compost can have unwanted pests trapped within. If you use your own compost make sure to screen it very well before introducing it to your garden.

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

Drainage

Drainage is an important factor when growing in soil. Make sure there are holes in the bottom of the container that are big enough to let water flow through them but not so big that the soil washes away.

Water

Water provides a medium to transport nutrients necessary for plant life and make them available for absorption by the roots.[6]

To determine how "hard" or "soft" the water source is you'll need to determine the levels of calcium and magnesium. Anything above 150 milligrams per liter of calcium is considered hard. Anything below 50 milligrams of calcium is considered soft and should be supplemented with calcium and magnesium.

Chloride (chlorine) is necessary to the use of oxygen during photosynthesis, root and leaf cell division. The water source should be tested using a parts per million (ppm) tester. Any levels below 140 ppm are usually safe for cannabis plants. Home filtration devices will not suffice in cleaning the water. In order to clear the water of total dissolved solids (TDS) you will need to run your water through reverse osmosis(RO). RO filters out the dissolved solids through small polymer, semi permeable membranes. This is the most effective way of cleaning raw water.

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

Optimal watering temperatures for cannabis plants are 60-75 degrees. Anything outside of this range will be detrimental to your plants. The lower end of this range will allow more accessible oxygen to be present.

Overwatering vs. Underwatering – Both of these are not good for any plants. Most novices make the mistake of caring too much for the plants and end up overwatering whereas the experienced grower is more apt to underwater. A simple test for watering issues in soil would be the "weight test." Once you fill your pot up with the soil or soilless mix lift the pot up off the ground to get a feel for how heavy it is without any water present. Once you water your plants you'll want to lift it to understand the difference in weight. You'll then want to wait until the potted plant is almost as light as it was before you watered it. There are water meters you can purchase at any gardening store although they are highly unreliable. If watering continues to be an issue there are numerous drip irrigation systems that you can set up to water your plants automatically. Some even have the ability to be injected with fertilizer. This is called fertigation.

Underwatering is less of a concern although it is still a concern. To identify it correctly you will notice a wilt in your plants' leaves that happens quickly. Due to most gardens being cared for regularly this is much more uncommon than overwatering and can usually be rectified quickly if caught early enough.

Environment

Ideal temperatures for cannabis are 72-76 degrees. At night these temperatures should not drop more than 15 degrees. Any fluctuation in temperature greater than that will cause excessive humidity to build up making mold a very real threat. Anything outside of 55-85 degrees will slow or stop growth.

Humidity levels can vary when growing cannabis. It depends on the stage of growth. Clones and just germinated seedlings prefer a higher humidity range (80-100%). Vegetative and mother plants prefer lower humidity levels (50-60%). Flowering cannabis should have a relative humidity of 40-50%.

Constant air circulation will help produce very strong, vigorous plants especially in flowering. Oscillating fans kept at canopy level will ensure this. It will also help mitigate any pest problems.

Carbon Dioxide (CO2) is a colorless, odorless, nonflammable gas that is around us all the time.[7] Cannabis grown indoors will use up all the available CO2 within a few hours. When CO2 levels drop too low growth slows down. CO2 enrichment will stimulate growth; in turn producing much better yields.

CO2 is present in the air at approximately 300-400 ppm. Cannabis will easily use up this amount in an enclosed grow room. Once the CO2 is depleted photosynthesis slows to a crawl. When you introduce a source of CO2 you will want to keep the levels at 1200-1500 ppm constantly. A regulator on a compressed CO2 tank set to a timer or a sophisticated environmental controller will allow you to set this optimal range.

Electricity

Older-homes have a 120v supply of electricity, and newer/updated homes have a supply of 240v of electricity. Each piece of equipment you use, that uses electricity, will have an **ampere** (amp) rating stamped on it. For

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

instance, a 1000 watt HID lamp will use about 9.5 amps.[8] If your household service is 120v with an outlet tied to a 20-amp circuit that will leave you with 10.5 amps on your breaker to be used. A breaker/fuse is considered overloaded when 80% or more of the rated amperage is being used. For a 20-amp circuit this means only 16 amps are available before it becomes overloaded and in turn the circuit will be tripped, or worse become a fire hazard.

To determine which service you have simply look on the circuit breakers themselves. They have the amp ratings imprinted on the switch or the box. Fuses will have them printed on the front.

When running electricity for larger gardens it is beneficial to update your electrical service to 240v or 480v (also called 3-phase voltage). The higher amperage will be needed for running an efficient HVAC system along side a commercial operation. The amperage draw decreases by half for every upgrade that doubles in voltage.

Once you determine your electrical power supply and its corresponding amperage capabilities you can then determine how much power can be drawn from each circuit and in turn decide if you will need any additional outlets. Any licensed electrician will know exactly what to do when you give them your parameters, and they will do it so that it is up to local building codes.

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

You will want more outlets than you think you need. Many times throughout growing you'll want an extra circulation fan or a higher-powered exhaust fan. Maybe you started growing in the winter and didn't realize that you'd need an air conditioner in the summer or vice versa—you didn't know you'd be in need of a dehumidifier in the winter when the temps drop, spiking the relative humidity. Whether you are getting an electrician to wire your grow room or decide to do it yourself, add extra outlets! It is better to have too many unused outlets than needing one that is not there.

Security

The biggest issue you have growing cannabis is theft. You don't want people knowing what you are doing behind closed doors because of this. If you are growing indoors make sure to cover all the windows with stretched polymer film so that no light leaks to the outside. Make sure that any ventilation ducting has two 90 degree turns before exhausting outside to prevent light leaks.

Once your grow room is completely built you can add measures of security such as dead bolt locks, fingerprint scanning and optical scanning. You may also invest in a security system that includes cameras to keep your plants safe.

Odor is a big issue when growing keeping cannabis. There is not

Much you can do about it when growing outdoors. However, there are numerous measures to take to control it when growing indoors. For smaller gardens you can use odor-neutralizing gel that comes in various container sizes. Simply unscrew the cap and place it in the garden. For the larger gardens you will want to attach a **carbon filter** to your exhaust fan. Carbon filters come in many sizes, each rated for cubic feet per

minute (cfm). Your choice will depend on the total volume of your grow room. When using a carbon filter for odor controls make sure that the humidity levels do not exceed 55 percent. Anything higher and the activated carbon can absorb the moisture and clog. **Ozone generators** are another option for odor control. They neutralize odors by converting oxygen (O2) into ozone (O3) by the exposal of ultraviolet (UV) light. All odors are negatively charged. The extra molecule in ozone is positively charged. When they are exposed to each other they neutralize each other, along with odor too. These ozone generators should be attached to any exhausting air, outside of the grow room. Ozone leaks can cause damage to your garden resulting in chlorotic spots on the plant and eventually growth will slow to a crawl.

When you are growing outdoors you still want to prevent loss from theft. To do this you will want to plant your cannabis around other plants that aren't cannabis to provide a level of camouflage. You can also train and bend the plant so that it keeps a low profile and doesn't grow above the fence that is protecting it.

Environmental Controllers

There are various monitors that can help any grower, in any space, fine tune their growing environment. These environmental controllers take all the guesswork out of creating the ideal conditions for a grow room. These monitors vary in size and price but are worth the investment. They will monitor your grow room when you are unable to do it yourself and make adjustments accordingly.

The simplest version of an environmental controller would be a thermostat that has a **diode**, which measures the temperature at canopy level, and has an exhaust fan plugged into it. Simply set the thermostat at the desired high temperature and the exhaust fan will exhaust the hot air when that setting is surpassed.

For larger gardens you will want a more sophisticated monitor, one that also reads the relative humidity and has the ability to exhaust excessive amounts of it along with a built in CO2 ppm monitor and the capability of triggering the source of CO2 to start producing more when those levels become too low.

These are a couple of examples of what is available, but there are also a number of controllers that fall in between these.

Summary

Understanding the essentials to growing cannabis (light, air, water, nutrients, a growing medium, and heat) will ensure successful production of the plant whether it be used as a food crop (hemp) or for its medicinal qualities.

Cannabis can be grown in many environments. Understanding the basic genetics of your seeds or clones will help you determine the proper environment to create. If cannabis is grown indoors and you know the ancestral lineage, you can help create a nearly perfect environment for specific strains. Outdoor growing will produce far greater yields with less of a concern for pest invasions. However, the climate you are growing in will dictate which varieties of cannabis will be more successful. Indica, Sativa, Ruderalis and Afghanica all come from specific geographical locations and will require similar climates to produce a quality product that can be easily acclimated to its new environment. Greenhouse growing will offer the best attributes of indoor and outdoor growing as well as significantly cutting down your overhead costs.
Regardless of growing method, all cannabis plants need nutrition. This can be accomplished with water-soluble fertilizer or making your own soil with specific nutrients in mind.

Cannabis uses three groups of fertilizers-Primary (macronutrients), Secondary and Trace elements (micronutrients). Primary nutrients (NPK) are used in abundance followed closely by secondary nutrients (Mg,Ca,S). Trace elements need to be present but in much smaller quantities.
Water will provide an avenue for the plant to access these nutrients through its root system. Whether growing in soil or hydroponically, there needs to be good drainage in the root zone. Avoid compactable mediums as these will restrict the roots from growing and access to water and nutrients will be limited. Proper ph levels in your aqueous solutions and soil will also directly affect the plants nutrient absorption. Maintaining a ph level of 6.0-7.0 in soil and 5.8-6.8 in a hydroponic system will guarantee nutrient uptake isn't inhibited.

A growing environment with minimal fluctuations in temperature, humidity and CO2 levels will make certain that your garden is successful. Temperatures during the day cycle should stay between 72-76 degrees with a night cycle temperature not falling more than 15 degrees below that. Humidity levels will vary depending on the growth stage of the plant. Clones like a higher humidity range (80-100%). Vegetative plants should stay between 50-60% and flowering plants should stay between 40-50%. Carbon Dioxide (CO2) is a colorless, odorless, nonflammable gas present in the air around us. The amount that is naturally occurring is around 300-400ppm (.03-.04%). Cannabis plants quickly use up all available CO2 in a sealed grow room. CO2 will need to be added to a grow room at higher levels (1200-1500ppm) than what is naturally present in order to stimulate growth and produce vigor in your plants resulting in much better yields.

Environmental controllers make the task of keeping all of these parameters in check more feasible. From a simple thermostat that is connected to your exhaust fan, to more sophisticated models which take into account humidity and CO2, environmental controllers are a cannabis grower's best friend.

To be successful in these endeavors you must account for a strong security plan. The biggest threat to a garden is theft. Camera systems, locks, fingerprint scanning, and fences can help prevent any loss from a garden. However, the first security measure one should take is odor control. The best deterrent to theft is to conceal the telltale odor of growing cannabis. Depending on the size and complexity of your grow this can be accomplished a number of ways. From simple odor neutralizing gels to carbon filters to ozone generators the ways to stop odors from exiting your grow room are vast.

Glossary

Propagate - breed specimens of a plant by natural processes from the parent stock

Germinate - to begin to grow or develop

Cotyledon - the primary or rudimentary leaf of the embryo of seed plants

Transpiration - the passage of water through a plant from the roots through the vascular system to the atmosphere

Photoperiod – the time cycle of light the plants are growing under

Trichomes - an outgrowth from the epidermis of plants

Primary (macronutrients) – Nitrogen, Phosphorus, Potassium (N-P-K)

Secondary Nutrients - Magnesium, Calcium, Sulfur (Mg, Ca, S)

Trace elements (micronutrients) - zinc, manganese, iron, boron, chlorine, cobalt, copper, silicon, nickel, sodium and fluoride

Ampere – a unit of electric current

Carbon filter – a tool used for filtering odor that uses a bed of activated carbon to remove contaminants and impurities

Ozone generators – a device that produces ozone gas, which is then released into an area containing either air or water to kill microorganisms and remove odors

Diode – the electrical sensor at the end of the thermometer wire

Thought Provoking Questions

- What are essentials for growing cannabis?
- What are the propagation methods used to grow cannabis?
- What are the steps to take when cloning from a mother plant?
- What are the benefits to growing indoors, outdoors or in a greenhouse?
- What is the difference between hydroponic and soil mediums?
- What are similar characteristics soils and soilless mediums need to have?
- What are the variety differences between Indica, Sativa, Ruderalis and Afghanica?
- What are the three classifications of nutrients?
- What is compost?
- What is the ideal environment for growing cannabis?
- What is the optimal level of CO2 in a grow room or greenhouse?
- How do ozone generators neutralize odor?
- What is an environmental concern when using carbon filters?
- What is the biggest threat to the security of your garden?