BEST-SELLING AUTHOR

JORGE CERVANTES

WE GROW CANNABIS!

A COMMUNITY-INSPIRED GROWERS GUIDE FOR BEGINNERS

INTERACTIVE BOOK

CO-AUTHORS

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STEFAN MARTIN MEYER

VERSION 1.0

Co-authors

Co-authors left to right in the photo: Jorge Cervantes, Dr. Gary Yates and Stefan Meyer.

Jorge Cervantes - www.jorge-cervantes.com/about

Dr. Gary Yates is a well-rounded plant scientist with experience in nearly all aspects of plant life. Dr. Yates, as a world-class genetic problem solver, offers scientific know-how aspects that are normally lacking in cultivation advice. Dr. Yates also brings to the forefront knowledge of the most recent technology in infrastructure/equipment and scientific advances, as well as pathogen mitigation and pest management. He is an experienced micro-grower and plant health assessor known for his ability to maximize limited resources to produce outcomes that exceed expectations.

Having collected his first harvest over 20 years ago and before embarking on a career in science, Gary has had a keen eye on the progression of the medical use of Cannabis, including its biochemistry, genetic development, and cultivar suitability for many years.

Stefan Martin Meyer, MBA, was raised in the Italian side of Switzerland, near the city of Lugano. He then moved to Spain, where he co-founded Phytoplant Research SL, which was granted the first research license for medical cannabis in Spain in 2012. While there, he got various R&D grants from the European Union for projects related to cannabinoids and medicine and published results in high-impact scientific journals.

In 2019 Stefan joined Plena Global Holding Inc (Canada) as Chief Strategy Officer, where he has been leading a project licensed to grow medicinal cannabis in Colombia.

In 2020 Stefan founded Phytoflow GmbH, a Swiss-based company providing experience-driven strategic business advice to companies active in the medical cannabis sector.

Stefan has worked with Jorge for over two decades and, like him, is a huge cannabis aficionado.

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INTRODUCTION

Thank you for downloading my free digital book, *We Grow Cannabis!* My goal in writing this free book is to work with cannabis growers worldwide to help promote simple techniques available today to grow more and better cannabis.

We Grow Cannabis is adapted from the unpublished manuscript of the Sixth Edition of Marijuana Horticulture, AKA the bible. This book gives you a glimpse into the new interactive Sixth Edition. This is just the beginning of easy fast access to the most informative and productive information for hobby and retail cannabis growers. Cannabis growers apply these techniques immediately to grow their own cannabis gardens.

We Grow Cannabis provides everything you need to know to start seeds and clones indoors and move them to a larger indoor grow room, greenhouse or outdoors. Starting seeds indoors that grow into strong seedlings will help ensure your garden gets off to a healthy start. Growing seedlings and clones until they are 12-18 inches (30-45 cm) tall before transplanting into a greenhouse or an outdoor garden will give them a head start on the growing season.

Chapter one, Cannabis Botany, and chapter two, Cannabis Life Cycle, are easy to understand and will give you an essential base of knowledge before you start your cannabis garden. This background knowledge will save you hours of time and help guide you to a heavy harvest.

Selecting the perfect cannabis seeds for your garden needs will help ensure a successful garden. Germinating and growing cannabis seedlings requires skill and tender loving care. Chapter three, Cannabis Seeds and Seedlings will take you step-by-step through the process to ensure your success.

Setting up an indoor garden requires planning, time and a bit of money. Making a simple plan will save you both time and money. Chapters four, Plan Your Garden and five, Grow Room Setup will help you plan and organize each step of planning and setting up your garden. Proper planning and equipment setup is essential to ensure a successful cannabis garden.

Chapter six, 12-week Garden guides you through an indoor cannabis crop week-by-week. The simple breakdown of plant needs, including light, air, water, nutrients and soil is easy to follow. The schedule helps you anticipate possible problems and take preventive measures.

Post-harvest is covered in chapter seven, Harvest, Manicuring, Drying, Curing & Storage. Once harvested, cannabis flowers must be handled properly to retain potency during storage. Each stage of post-harvest processing is covered in detail to ensure your crop retains potency.

Unfortunately, cannabis gardens suffer the wrath of plagues and cultural problems. Chapter eight, Diseases, Pests & Problems shows you images of the most common diseases and pests as well as prevention and control measures. Simple preemptive solutions help you avoid common cultural problems. Please read on and enjoy the pleasures of cultivating your own cannabis garden that will yield an endless supply of your favorite flowers.

Please sign up for my mailing list at my site, ***www.marijuanagrowing.com***, so that you receive updates to *We Grow Cannabis*. This is version 1.0. We can add more grow information and develop improved versions 1.1, 1.2,... with your help and that of other members of our community.

We plan to publish ***We Grow Cannabis*** in Spanish, German, Portuguese, French, Italian, Thai, and other languages in the future.

JORGE'S LEGACY

During the worst decades of cannabis prohibition, Jorge wore a disguise so that he could travel the world freely and avoid arrest. This picture was taken in the Basque Country, Spain.

Jorge gives thumbs up to Atlas Seeds' test breeding grounds in Sebastopol, California.

When I self-published Indoor Marijuana Horticulture in 1983, I had no clue that my work would have such a global impact on cannabis cultivators. Now, 40 years

later, I've authored and published more than 50 books in eight (8) languages, innumerable cannabis cultivation articles in ten (10) languages, and hundreds of YouTube grow videos. I gave over a hundred personal talks at cannabis trade shows on four continents. I'm quite glad to report that this collection of cannabis cultivation information has inspired millions of cannabis growers all around the world. More information can be found at https://jorge-cervantes.com/about/

I'm entering the fifth decade of helping cannabis growers produce more and better cannabis. But I'm just one person. I discovered that when I share the best cannabis cultivation information I can find with you and other growers, we all learn more and grow together. Sharing information with you and other like-minded gardeners miraculously built a global network. This is the power of sharing. Our community's organic growth is being supported by YouTube, Facebook, Instagram, and other social media platforms. We are all united in our own community because of you.

I want to keep sharing and extending my legacy with you and all cannabis growers throughout the world. I intend to continue gathering and disseminating cannabis cultivation knowledge. I cannot accomplish it alone; I need your help, let's grow together.

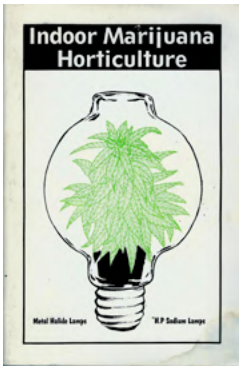
The first step in achieving our shared "Jorge's Legacy" goal is to distribute this FREE book, We Grow Cannabis. More than 270 color graphics illustrate the 100-pages of text that is packed with detailed grow info. Please take the first step in participating in Jorge's Legacy by signing up for my newsletter here: ***https://marijuanagrowing.com/***

In the future, we will release more interactive FREE digital cannabis cultivation books. We'd love to see photos of your garden and hear about your experiences. Sharing your cannabis cultivation experience and information benefits all growers. To learn more about sharing your cultivation experiences, opinions, photographs, and information, please visit www.marijuanagrowing.com - community@jorge-cervantes.com

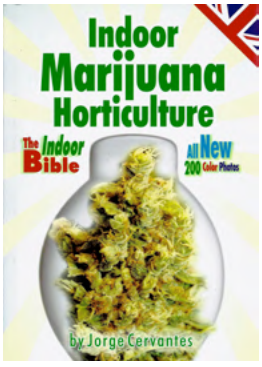
This is the start of a beautiful collaboration between us.

Thank you for joining Jorge's Legacy Community!

1983



2002



2006

PARTNERSHIP WITH SEEDSMAN

Jorge Cervantes and the Seedsman crew hanging out in Barcelona during Spannabis 2019

The Internet made me stop doing things the old way - printing books and magazine articles on paper. Finally, I was able to wrap my brain around the concept of digital information. Now I realize that I can help more growers cultivate more and better cannabis. Seedsman was instrumental in this revelation. We decided to collaborate in order to provide (FREE) *We Grow Cannabis* to millions of growers around the world. This allows me to continue my heart-felt lifetime goal of "teaching the world to cultivate more and better cannabis." My wildest fantasies are becoming a reality!

Seedsman is fantastic! Tom, the owner, and I have a long history. For many years, we have moved in the same circles of friends and associates. Tom and I started talking about the opportunities that decent WiFi connectivity to the internet provides around the world. We could see how greater internet access, combined with the global wave of cannabis legalization, brought new liberties. We developed a simple plan with our incredibly talented crews: supply good quality, well-organized, non-conflicting information to help growers globally cultivate more and better cannabis, and to distribute this information for FREE online. My role is to gather, collate, and organize cultivation information that is accurate and easy to use. Tom's specialization is information distribution. We all profit from it. *We Grow Cannabis* is available for FREE on your smartphone, tablet, and laptop with a few clicks. All of your basic cannabis gardening knowledge is just a few clicks away!

Why choose Seedsman? For the past four decades, I've kept my finger on the pulse of cannabis cultivation knowledge. Many companies and individuals have come and gone. Seedsman has been in business for 20 years and is still expanding. I must say that Tom, like many of the Seedsman crew, is a friend. Aside from friendship, I appreciate and respect Tom and the Seedsman team for their innate honesty, ethics, innovation, and dominant position in the cannabis seed business. Their verification process for weeding out marginal seed breeders is exceptional. They stock seeds from the industry's greatest breeders, and the supply is consistent. I am honored to be able to collaborate with my Seedsman colleagues.

Est. 2002

Seedsman

CHAPTER ONE

CANNABIS BOTANY

Introduction

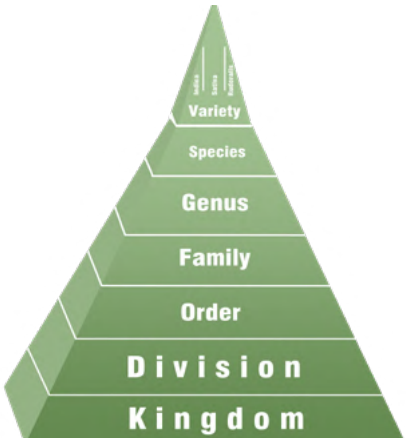
You can grow big cannabis plants like this at home. Big containers are expensive to fill with soil but offer perfect soil when native soil is lacking. Choosing the proper varieties (strains) of cannabis and regular maintenance will be rewarded with a heavy harvest.

Understanding the basics of cannabis botany will improve your gardening skills and help you become a savvy consumer. It will give you a background on the species of *Cannabis Sativa L.* and different subspecies, *C. indica* and *C. Ruderalis.* This is the way cannabis is classified botanically. *Cannabis sativa* and subspecies *C. indica* and *C. ruderalis* have many similar traits, including taste, fragrance, and effect.

This chapter gives a basic overview of the botanic classification, including basic nomenclature and physical aspects –growth habit, branching, root mass, etc. The geographic origin of these species sheds light on how they evolved and are used today. Simple genetic qualities differentiate CBD-rich, THC-rich, and industrial fiber and seed varieties.

Terpenes give cannabis distinctive fragrances and tastes. Feminized cannabis is also examined.

Botanical Classification



Cannabis is a member of the Plant Kingdom. Botanists classify the Plant Kingdom into categories based on qualities found within the plant. Cannabis, botanically speaking, is classified as follows:

Kingdom: Plantae—all plants
Division: Magnoliopsida—magnolia class
Order: Rosales—nine families
Family: Cannabaceae family

Genus: Cannabis L.
Species: Cannabis sativa L.
Subspecies: Cannabis sativa / Cannabis indica / Cannabis ruderalis

Note

The term "strain" is often used incorrectly to describe "varieties."
Strain is the term used to classify fungi, bacteria, and viruses. For example, there are different strains of the Coronavirus.

Here is an easy way to remember these botanical terms:

genus = last name
species = first name
variety = nickname

Cannabis genus and species are lumped together by laws imposed by governments. All cannabis is classified as *Cannabis sativa (C. sativa)* under international law. Within this species, it is additionally classified as: *Cannabis sativa (= C. sativa var. sativa), Cannabis indica (= C. sativa var. indica), Cannabis ruderalis (= C. sativa* var. *spontanea)*. The good news is that cannabis laws are changing!

In the seventies, a new classification was proposed, breaking down cannabis into chemotypes:
Type I: THC dominant
Type II: Balanced THC:CBD ratio
Type III: CBD dominant with low concentrations of THC and/or CBG

Read more about chemotypes and chemovars in this article by the Cannigma.

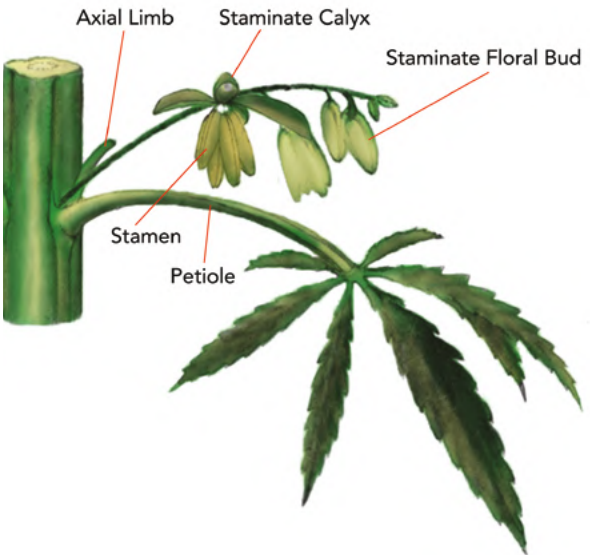
Landrace cannabis plants grow in the same area for years. The genes of the male and female plants mix over the years. The resulting generations have consistent, stable genes that adapt the stand of cannabis plants to the localized climate and growing conditions.

Landrace cannabis is a term that is bounced around freely as a buzzword among many cannabis aficionados. Landrace cannabis plants are localized domesticated species that have adapted over time to the natural and cultural environment in which they live. Landrace cannabis differs from cultivars bred selectively to conform to a specific criterion.

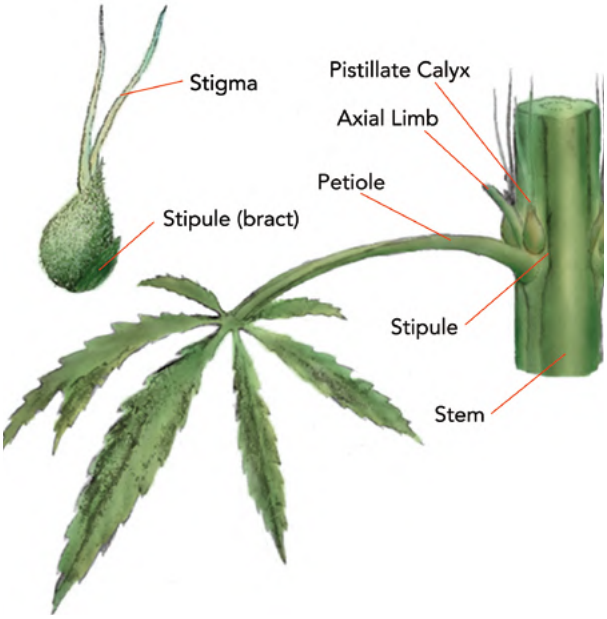
Cannabis is distinguished by a combination of qualities that set it apart from all other plants in the Plant Kingdom. The first five points below include general cultural aspects. These are essential points to understand to grow cannabis. The last two points include medicinal and recreational aspects. Fragrance, taste, and cannabinoid profile are the main reasons we grow cannabis.

Annual flowering herb completes its life cycle in one year. In nature, all cannabis germinates, grows, flowers, and produces seeds in less than one year. Annual flowering plants include an exhaustive list of annual flowers, vegetables, and weeds. This StinkBud plant is nearing the end of the flowering cycle.

Wind pollinated. The wind carries microscopic grains of pollen produced by male plants for great distances. Male plants do not rely upon insects, birds, or mammals to transport pollen to fertilize females. About 12 percent of flowering plants are wind pollinated.



This botanical image of a male cannabis plant shows each flower part, including the location of the pollen in the male flower.



This botanical drawing of a female cannabis plant shows each flower part, including the location of the fertilized seed inside the seed bract.

Dioecious plant with imperfect (male and female) flowers on male and female plants. Female cannabis is most desirable because it contains about ten times more cannabinoids than male plants. Female plants also yield much more biomass than males. About 7 percent of flowering plants are dioecious.

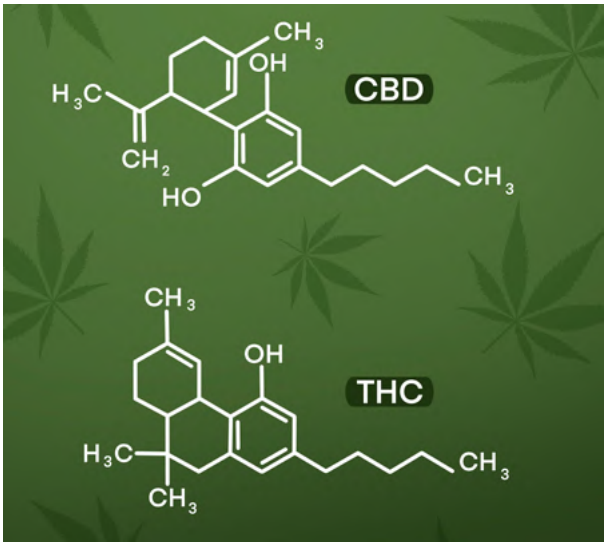
This vegetative cannabis garden in Thailand is under 18 hours of LED light and 6 hours of darkness. This light schedule ensures plants stay in the vegetative growth stage. My old friend from Spain, Jaime Carrion, set up this garden for the Golden Triangle Group Co., Ltd.

Short-day (long night), "AKA photoperiod," cannabis blooms under long nights and short days. C. Sativa and C. Indica are in this category. These short-day plants are triggered to flower outdoors when the nights become long and days short. Indoor and greenhouse growers give regular cannabis 12 hours of darkness and 12 hours of light to ensure the flowering mechanism is triggered. Cannabis, Christmas cactus, chrysanthemum, cotton, poinsettias, rice, soybeans, and sorghum are examples of this relatively small category of short-day plants.

Note: Up to 13.5 hours of light and 10.5 hours of darkness will trigger flowering in many cannabis varieties.

Day-neutral, AKA "auto-flower" C. ruderalis blooms and sets flowers regardless of hours of darkness and light. This day-neutral species flowers according to chronological age, typically after the fifth to seventh pair of internodes appear, about three weeks after germination. The vast majority of flowering plants are day-neutral.

Auto-flowering cannabis plants grow incredibly fast and are super productive in both short-season and long-season climates.



Cannabis produces naturally occurring terpenoids, organic compounds that provide cannabis with therapeutic aroma and flavor. More than 100 fragrance-imparting terpenes are present in cannabis. A short list includes myrcene (earthy), limonene (citrus), pinene (pine), beta-caryophyllene (spicy-sweet), etc. Often referred to as "terps," almost all plants produce terpenes. Terpenes are often collected from other plants and sold as infused (cannabis) terpenes. Much has been written about specific terpenes, there are many articles available on the internet.

Cannabis produces naturally occurring cannabinoids. Naturally occurring phytocannabinoids are produced by plants. Endocannabinoids are made inside the bodies of humans and animals. Quite a few plants produce a limited number of phytocannabinoids that will engage with at least one cannabis receptor (CB1 and CB2), including Echinacea *(E. purpurea and E. angustifolia),* Electric Daisy *(Acmella oleracea),* Helichrysum *(Helium italicum)* and cacao *(Theobroma cacao)*. Cannabis is the only plant with a complete array of more than 100 cannabinoids. The bulk of cannabinoids, including THC, CBD, and CBG, are produced and concentrated in glandular trichomes resin glands that appear on the foliage, primarily on female floral clusters.

Cannabinoids are the chemical compounds found in cannabis, including THC, CBD, CBG, etc. There are more than 110 different cannabinoids that have been isolated from cannabis.

Trichomes and Resin Glands

Cannabinoid-rich resin glands and other trichomes become visible during flowering with the naked eye. Use a 10-30X handheld lens to distinguish resin glands—bulbous, capitate-sessile, capitate-stalked, and non-glandular trichomes. The capitate-stalked glands cover flowers, seed bracts, and small bud leaves of the plant. Bulbous and sessile resin glands on the surfaces of all flowers, leaves, stalks, and branches. Recent studies show different ratios of cannabinoids in different trichome types. Sessile glands are most likely immature stalked trichomes. Furthermore, the terpene variation is much greater than bulbous glands.

Trichomes may have evolved as a defense mechanism for plants, according to one theory. Another theory is that a sticky, resinous surface attracts more pollen from wind-pollinated cannabis. Trichomes are said to form a protective layer against diseases and pests that prevents them from reaching and penetrating the surface of the plant. Some trichomes can inhibit the growth of a few types of fungus. The chemicals in the trichomes make cannabis less appetizing to animals by secreting a bitter substance and distasteful aroma.

The protective trichomes may also help insulate plants from temperature extremes, excessive water loss caused by wind, and low humidity and protect from excessive moisture. They also form a natural "sunscreen" to shield against ultraviolet light rays.

Trichomes are little appendages that grow on all plants. For example, foliage hairs are trichomes. Trichomes differ immensely. Some are glandular, with a stalk and a glandular head. Others are non-glandular, elongated, and tapered. The term "trichome" that describes "capitate-stalked resin glands that contain the bulk of desirable cannabinoids" is only partially correct. It is similar to describing all roses as "flowers." All roses are flowers, but not all flowers are roses.

Trichome types

Sessile and cystolith glands, AKA plant hairs, are common on many plants. In fact, sessile glands are most likely immature stalked trichomes. These trichomes have a pointed tip and are often long and hair-like. The waxy protective trichomes are most common on leaf undersides, petioles and stems. They are trichomes with pointed tips that help protect cannabis from diseases and pests.

Most abundant on outdoor plants, sessile and cystolith trichomes are more common on some varieties than others. More of these trichomes form on plants when they harden-off and are moved from indoors to outdoors. The trichomes (glands) exude insecticidal, and miticidal substances repel them, but they contain no useful cannabinoids.

If you look closely at small leaves, you can see little balls of resin sticking directly to the foliage. Each of these balls has a foot that will grow as the glands grow and accumulate cannabinoids.

Bulbous glands are the smallest trichomes and barely visible with the naked eye, ranging in size from 15 to 30 micrometers. One to 4 cells constitute the "foot" and "stalk," and 1 to 4 cells make up the "head" of the gland. Head cells secrete a resin, believed to be cannabinoid-rich, along with related compounds that accumulate between the head cells and the cuticle. A nipple-like bulge may form on the membrane from the pressure of built-up resin as these glands mature. Look for bulbous glands scattered about on foliage surfaces.

This image is spectacular, you can actually see the cells and the pink secretion in the translucent capitate-stalked resin glands.

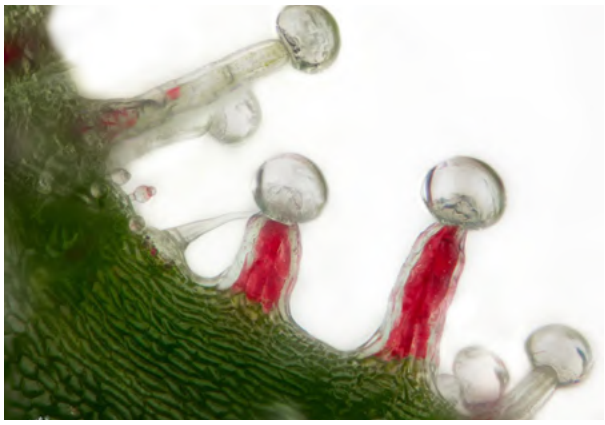
Capitate-sessile resin glands develop before and during flowering growth. The bulb head measures 25 to 100 micrometers across the globular-shaped head or bulb. The bulb appears to lie flat on young and immature plants. The stalk elongates and grows during flowering to transform the capitate-sessile gland into a capitate-stalked resin gland. Glands accumulate progressively more resin that concentrates between the stalk and the bulbous head.

Capitate-stalked resin glands are covering this flower so completely that foliage is obscured.

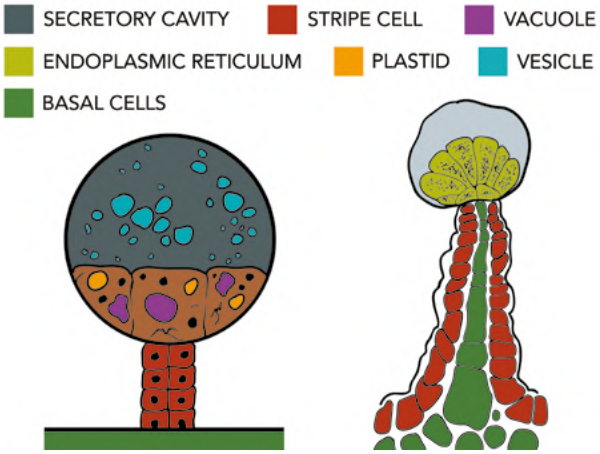
Capitate-stalked resin glands (trichomes) appear and become visible to the naked eye when flowers form. Look for them on female flower bracts and new flower growth and surrounding foliage where they form heavily on the plant. The resin glands also tend to accumulate heavily on veins of lower leaf surfaces around flowers. They also accumulate on somewhat larger leaves and petioles. Cannabinoid-potent varieties typically contain higher concentrations of capitate-stalked resin glands. Use a 30X handheld microscope to see close-up.

Capitate-stalked resin glands hold the bulk of CBG, CBD, and THC. These resin glands consist of a stalk with a spherical, bulb-like head on top. They look like a post with a knob, ball, or bulb at the top. They form mainly on flowers and small leaves. The highest concentration of cannabinoids is located at the base of the bulbous resin head.

A 10-30X handheld lens or microscope will help you examine capitate-stalked resin glands closely to determine peak CBG, CBD, and THC content. Check flowers every day starting the sixth week of flowering. Check several flowers from different plants to ensure the maximum amount of capitate-stalked resin glands are ripe for harvest.



Images like this show every detail of the capitate-stalked resin glands. We are still figuring out why two of the stems are full of a red substance.



Capitate-stalked resin glands are full of chemical activity. This is where the majority of cannabinoids occur. Disc cells and principally the secretory cavity of the gland perform a key role in the physiology of secondary products. In the above illustration, disc cells are shown attached to foliage by stipe cells (red) and basal cells (green). The plastid (orange) in disc cells secrete lipoblasts where they synthesize lipophilic substances that accumulate and ultimately migrate and form BLUE vesicles. THC occurs in the top of the capitate-stalked resin gland.

Male plants and flowers have much lower concentrations of less cannabinoid-potent capitate-stalked resin glands than found on female plants.

Older leaves contain few cannabinoids unless clearly visible on leaf surfaces. Leaves around flowers are much more densely populated with capitate-stalked resin glands rich in cannabinoids.

Cannabinoid Profile

Many cannabinoids, not just THC, have unique effects on brain functions, which in turn cause different

effects on human cognition and psychiatric symptoms. Different levels of cannabinoids relative to one another produce different effects. As a result, measuring the "potency" of cannabis plants is problematic.

A very resinous plant could have low levels of THC and high levels of CBD. Or a plant with little resin could contain high levels of THC and low levels of CBD. Cannabinoid profile depends on the makeup of cannabinoids and other active ingredients. For example, resin consists of cannabinoids and other molecules such as phenolic and terpenoid polymers, glycerides and triterpenes. When resin is concentrated in kief or hashish, about a third is water-soluble plant material, another third is non-psychoactive resins and the remaining fraction are cannabinoids.

In many cannabis plants, THC may be only a very small percentage of the total cannabinoids. The remainder (5-10%) of the resin will be oils, sterols, fatty acids, and various hydrocarbons common to plants.

About 80-90% of the cannabinoids are synthesized and stored in microscopic resin glands that appear on the outer surfaces of all plant parts except the root and seed. The arrangement and number (concentration) of resin glands vary somewhat with the particular variety examined. Marijuana varieties generally have more resin glands, and they are larger than resin glands in non-drug varieties.

I'm always amazed when I see a small leaf covered with so many resin glands. It is like a magician magically made them appear. Transparent resin glands show CBGA early cannabinoid synthesis. As they progress to a milky color, a combination of CBGA and THCA are present. Amber resin glands signify a combination of THCA and THC.

GMO is the name of this THC-rich flower.

Resins occasionally secrete through pores in the membrane of gland heads when they are knocked around. Usually, secretion occurs many weeks after stalked glands appear. The glands seem to empty their contents, leaving hollow spaces (vacuoles) in the stalk and head cells. After secretion, the glands cease to function and begin to degenerate. Gland heads, stalks, and trichomes become clumped together, and the whole flowering surface becomes a sticky mass. Mechanical stress from manicuring and fondling flowers will knock off the round head on top of the stock.

Small quantities of cannabinoids are present in the internal tissues of the plant. The bulk is found in small single cells that elongate to form small, individual resin canals. Other plant cells contain insignificant amounts of cannabinoids, and probably a good 90% of the cannabinoids are localized in the resin glands.

Terpenes are lightweight and belong to a large group of unsaturated hydrocarbons, several of which can be extracted with steam distillation. The product holds aroma, flavor, and specific character.

Five mono- and sesqui-terpenes, including alpha-and beta-pinene, limonene, myrcene, and beta-phellandrene, impart virtually all of the sweet, unique, minty, citrusy, etc., qualities found in odorless cannabinoids. The volatile terpenes enter the atmosphere and dissipate over time. This causes cannabis to lose much of its bouquet and flavor when stored.

Terpenes constitute 1-3% of the dry weight of a fresh cannabis sample—about 10% of the weight of the cannabinoids. For every 1,000 grams of dry flower, from 1 to 3 grams of terpenes can be extracted.

Cannabis Varieties (AKA Strains)

Each variety has distinct characteristics, including, growth habits, cultural preferences, fragrance, taste, and cannabinoid profile. When you see cannabis

advertised, they are referencing different varieties such as ´Skunk,´ ´Hash Plant´, and ´Durban Poison.´ There are an infinite number of cannabis varieties. But not all varieties are created equally. Each variety of cannabis has distinct dominant and recessive traits. Breeders do their best to encourage dominant traits from *Cannabis sativa, C. indica* and *C. ruderalis.* However, recessive traits will show in one of four plants in the F2 generation. Different species are crossed with one another. They select for desirable qualities in the offspring. Desirable characteristics include cannabinoid profile (CBD, THC, CBG, etc.), genetic stability, growth habit, disease and pest resistance, climate tolerance, etc. Due to the illegal nature and the booming underground worldwide drug cannabis market, most popular cannabis varieties have been developed solely for high THC content. Only in the last 15 years has there been an interest to develop CBD-potent varieties. More recently, university-educated breeders have developed stable CBD and CBG-rich cannabis varieties. Several agriculture-oriented businesses have started to breed for other characteristics – disease and pest resistance, climate tolerance, finite harvest times, etc.

This backyard cannabis garden was recently transplanted. Large plants grown in containers were moved outdoors to get a good start on the growing season. Raised beds warm earlier in the year to add extra heat to promote growth.

Hobby medical cannabis gardeners grow varieties with different cannabinoid profiles. However, maintaining a consistent cannabinoid profile is difficult because most cannabis varieties are genetically unstable. The majority of "breeders" do not take the time to stabilize cultivars before selling seeds. They do not develop "true breeding" parents that are consistent. These true-breeding parents must be bred with one another to produce true F1 hybrid offspring. Consequently, they are not able to produce true F1 hybrid seeds. But as a passable alternative, they sell F2 and F3 seeds that typically lack vigor. A quick look at the Galaxy on the Phylos Bioscience site will show you that almost all cannabis varieties available today are not stable. Study the Galaxy of more than several thousand varieties to see their commonalities and differences. You may notice that only a handful of the varieties are unique.

Cannabinoid levels change in relation to cultivation conditions. Cultivation inconsistencies between crops, often brought on by weather conditions, are another reason cannabinoid profiles fluctuate.

If you are interested in breeding cannabis, please see the Breeding chapter in the *Cannabis Encyclopedia* by Jorge Cervantes, available in English only on Amazon worldwide.

Cannabis Sativa

Classic cannabis sativa leaves are thought to be long and thin. This plant is of Mexican origin and fits the criteria of cannabis sativa.

Cannabis sativa *(= C. sativa var. sativa)* originated predominately in warmer tropical climates of Asia, the Americas, and Africa. Each area of origin lends specific characteristics, but all *sativas* share similar traits: plants are tall, sometimes leggy in stature, with more distance between internodes than *C. indica*; a large sprawling root system, large narrow-bladed leaves; and somewhat sparse flowers. This is compounded when grown indoors under low light conditions. Female flowers start at branch nodes and typically develop along the length of the stem and branches rather than clustering around branch nodes. Flower formation is slower and less dense, allowing more air circulation within the foliage, a trait that helps prevent fungal attacks.

Recreational THC-dominant *C. sativa* typically causes an energetic, cerebral, and inspiring effect, often followed by a desire to eat (especially sweet items)—aka "the munchies." Craving food is especially

important for patients who suffer from nausea or lack of appetite while undergoing chemotherapy, HIV/AIDS treatment, and other procedures.

Overall, *sativa* varieties bloom later than *indica* varieties. While good producers outdoors, often growing to 15 feet (4.6 m) or taller, in an enclosed garden pure sativa varieties typically grow too tall too fast to be practical for garden room and greenhouse cultivation.

Central African *sativas*, including THC- potent 'Congolese', grow similarly to some Colombian varieties with tall leggy stature, often growing to more than 15 feet tall (4.6 m) with loosely packed flowers.

South Africa has major seaports. Sailors brought *C. sativa* from many different genetic profiles and planted them. Consequently, the potency of South African cannabis can be very high or very low, and it can be short, tall, leggy, bushy, etc. The famous 'Durban Poison' yields pale-green, potent early flowers and is the best-known South African variety.

These sativas are growing in Asia at Thailand Organic Cannabis farms. They have a podcast on YouTube, "The Perfect High". Cannabis will be legal in Thailand in 2022.

Asian *sativas*, including Thai, Vietnamese, Laotian, Cambodian and Nepalese, have diverse growth characteristics and vary significantly in potency. While Thai and other sativas from the area are often very potent, they are some of the most difficult to grow indoors and the slowest to mature. Thai varieties produce light, wispy flowers after flowering for about four months on plants with large, sprawling branches. Thai, Vietnamese, Cambodian, and Laotian sativas are more prone to grow into hermaphroditic adults.

Nepalese *sativas* can grow oversized leaves on tall, leggy plants that produce sparse, late-blooming flowers, but other varieties from this region develop into short, compact plants that bloom earlier. THC production and potency are often quite high but can also be second-rate.

Mexican, Colombian, Thai, and Jamaican varieties can be very potent, with a high THC:CBD ratio that produces a soaring, energetic, "speedy" high. But potency can also be minimal, with low levels of THC. Most of the exported Colombian cannabis available on the open market is of mediocre quality, even though some of the best cannabis I have consumed over the years came from Colombia.

Cannabis is poorly treated in many regions of the world. It is grown under adverse conditions and abused when dried and packaged. This ill-treatment causes more rapid degradation of THC and other cannabinoids. When these imported products arrive, they are a basic representation of the original plant. Consequently, seeds from fair smoke are often more potent than the parent.

C. sativas and *C. indicas* are crossed with one another to develop desirable traits of both types of plants. Most of the crosses you see on the seed market are crosses of *C. sativa* and *C. indica*.

Cannabis Indica

Cannabis indica is known for being short with broad leaves and heavy foliage including flowers. This image of a little plant was simply called La Indica.

Cannabis indica (= *C. sativa* var. *indica*) probably originated in the Asian subcontinent and maybe in present-day Afghanistan. *C. indica* is popular among indoor, outdoor, and greenhouse gardeners and breeders for its squat, bushy growth; condensed root system; thick stout stems; broad leaves with wide

blades; and dense, THC-laden, fat, heavy flowers. Typically, *indicas* grow a maximum of 6.5 feet (1.9 m) tall and produce more side branches than *sativas* do. Typically, foliage is very dark green and in some varieties, leaves around flowers turn reddish to purple. Short, whitish stigmas may turn reddish to purple under natural sunlight. Flower formation starts around branch nodes, and thick clusters of buds develop. Dry flower weight is typically much heavier for *indicas* than *sativas*.

Indica-dominant varieties are very popular because they naturally flower early and the trait is easy to select.

C. indica tends to produce more corporeal effects, often described as a more physical, relaxing, and even incapacitating "couch-lock" effect. Side effects such as dry mouth may also occur.

Some *indicas* have a distinctive odor similar to that of a skunk or cat urine, while others smell sweet and exotic. Heavily resin-laden plants tend to be the most fungus- and pest-resistant. Few indicas with heavy, dense, compact flowers are resistant to gray (bud) mold.

This small garden shows several different types of plants. The Afghani plants are in the center-right of the image. These plants are the ones with the broad leaves just to the left of the narrow-leaf sativa on the right.

Cannabis afghanica (= *C. sativa* var. *afghanica*) could be classified as a sub-species of *C. indica.* It originated near present-day Afghanistan. It is quite short, seldom reaching 6 feet (180 cm), with distinctive, broad, dark green leaflets and leaves. Dense branching and short internodes, most often with long leaf stems (petioles), dominate the profile of *C. afghanica.* The most common examples of pure *C. afghanica* include the many different hash plants and Afghani varieties. *C. afghanica* is cultivated exclusively for drugs with much of the resin being made into hashish. It is known for its high cannabinoid content. Many growers and breeders do not distinguish *C. afghanica* from *C. indica,* lumping them both into the *C. indica* category. 'Hash Plant', of which there are many, is one of the classic *C. afghanica* varieties.

Cannabis Ruderalis

Cannabis ruderalis (= C. sativa var. ruderalis) (= C. sativa var. spontanea) is very short, from 1 to 2.5 feet (30–75 cm) tall at harvest, and has a weedy, scrubby growth habit. Branching is sparse and leaves have wide blades similar to C. indica but are often a somewhat lighter shade of green. Stems are thick and sturdy. Flowers are small and moderately dense. Root systems are adequate to support small plants.

Believed to be native to Asia, Central Europe and Russia, *C. Ruderalis,* is believed to have been disturbed by humans or natural occurrences. This tough little plant adapted to the harsh environments found in these short three-month-long growing seasons.

C. ruderalis varieties are crossed with *C. sativa* and *C. indica* varieties to incorporate the daylight-neutral gene. Breeders are hybridizing plants with the day-neutral gene(s) from *C. ruderalis* that incorporate qualities from *C. sativa* and *C. indica:* robust growth stature, large flowers, and CBD-rich and THC-rich cannabinoid profile. *C ruderalis* crosses available today usually flower 21 to 30 days after planting seeds. Mature plants are ready for harvest in 70 to 110 days regardless of the hours of darkness and daylight.

Feminized Cannabis

Feminized cannabis seeds that produce this Dutch Crunch plant have become very popular because they produce up to 99+ percent female plants. Female cannabis is more desirable because it produces more cannabinoid-laden resin and bigger flowers than male plants. Feminized cannabis seed that is not the product of truly stable plants will produce a higher percentage of male flowers on female plants. Less stable plants produce a higher percentage of male flowers. These plants are called intersex plants and are often referred to by the misnomer, "hermaphrodite."

Before feminized plants became widely available, the only way to ensure female plants was to take stem cuttings, AKA clones, from a female plant.

Auto-flowering Feminized Cannabis

Auto-flowering (feminized) cannabis plants were originally popularized in the cannabis industry by the Joint Doctor, a lifelong dedicated cannabis gardener, and breeder. These varieties have almost all the characteristics of regular cannabis varieties, but they flower automatically, regardless of hours of darkness or light.

Auto-flowering plants contain day-neutral traits. This means they flower without a reduction in light. cannabis plants. The day-neutral trait replaces the short-day plant trait of flowering under short 12-hour nights and days. When the day-neutral trait dominates, cannabis flowers flower after 21-30 days of growth.

Auto-flowering cannabis is perfect for cool and cold climates with short growing seasons. Auto-flowering cannabis grows relatively well outdoors in alpine and northern climates having short summers with very long days and short nights. Long sunny days yield larger harvests. The plants can be started indoors and moved outdoors after they have sprouted. Protect little transplants at night and make sure the soil has warmed. Auto-flowering plants are generally resistant to colds, diseases, and pests. Outdoors in warm climates, gardeners can harvest 3-4 crops of auto-flowering cannabis annually. Auto-flowering plants hold great promise for mechanized agriculture.

Sativa / Indica / Ruderalis Crosses

Day-neutral AKA auto-flowering, c. ruderalis crosses are becoming very popular among hobby growers and commercial farmers. C. ruderalis with dominant day-neutral genes are crossed with c. indica and c. sativa varieties. These crosses have advanced immensely during the past 10 years. New varieties are more productive and grow incredibly fast. The cannabinoid and terpene profiles also improved immensely. Dry flower yields have increased from a few grams per plant in the early days to more than 100 grams of dried flowers in some of today´s varieties. The cannabinoid and terpene profiles are improving by leaps and bounds too. To stay abreast of improvements in auto-flower varieties, check in regularly with internet newsgroups and social media posts.

Auto-flower plants typically have a small root system that requires less water than plants with a large root system. If the autos you are growing have a small root system they may be easy to over-water. Just because plants alongside may need water, but the auto-flowesr do not. Always check the container to actually see if water is needed.

Clint Shock, PhD, professor emeritus, Oregon State University, shows CBD-rich budding auto-flower cannabis plants that he developed. Clint is one of the few professional, well-educated breeders with a lifetime of experience that have entered the cannabis arena.

Super-autos are bred by crossing a *c. sativa-dominant* variety with a *c. ruderalis* cultivar. Others cross *C. indica-dominant* varieties. *C. ruderalis* supplies the day-neutral traits and the *c. sativa-* or *c. indica-dominant* cross provides the balance of the traits including exponential growth habit, cannabinoid potency, and terpene levels. Super autos grow extraordinarily fast during their lifespan of 70-120+ days. Super-auto yields are often in excess of 150 grams in most climates. Super-autos are a breakthrough in selective cannabis breeding. Many breeders are working with super-autos.

Agricultural yields of day-neutral cannabis are often quoted as grams of biomass rather than dried flowers per plant. Or the yield per square meter is listed, with yields of up to 600 grams per square meter (m2). Cannabinoid potency readings are most often taken from dried flowers. Some auto-flower varieties can yield THC levels above 20%.

CBD-rich Varieties

Ben Rogers from Singing Pig Farm, Inc. puts his arms around one of the CBD-rich cannabis plants he is growing.

CBD-rich varieties have medicinal qualities without the mind-bending effects found in THC. CBD-rich cannabis effects are limited but increased when other cannabinoids including THC are combined. When incorporated with the entire range of cannabinoids and terpenes, an "Entourage Effect" occurs.

The first CBD-rich varieties include ´Cannatonic´ and ´Sour Tsunami´. These strong, stable varieties with dominant CBD-rich traits form the building blocks for many of the cultivars available today. They are landmark varieties, but far from unique. Back in the late 1970s, a few volunteer CBD-rich marijuana plants sprouted in a friend's backyard. He asked me to help cultivate them. We harvested the plants and dried the

flowers. We smoked and smoked but never got high. We called it "no-high dope." Little did I know at the time, that this was my first experience with CBD-rich cannabis. Similar stories have surfaced during my four-decade-long career.

About one out of 500 flower samples brought into California cannabis testing labs in the early 2010s had high levels of CBD. During the last 10 years many, many CBD-rich varieties have appeared on the market. Some seeds are produced by bona fide scientific seed breeders, and many are sold by pollen-chucking "breeders." Unstable seeds are usually adequate for home gardeners. But, unless accompanied by a complete written analysis of genetic stability, these "unique" varieties are generally unstable, susceptible to diseases and pests, and lack the growth habit and biomass required for economical large-scale agricultural production.

True F1 hybrids are being produced by a few US seed companies. Thanks to the 2018 US Farm Bill that defined hemp as cannabis with a THC content of less than 0.3%. Today several hundred thousand acres of CBD-rich cannabis are planted in the US annually. If growing commercially for resale, always purchase certified CBD-rich seed from a reputable company. Many seed companies produce CBD-rich seed that is unstable. This seed often fails a THC level field test inspection. The level of THC is too high.

Phylos Bioscience offers AutoCBD™ and PhotoCBD™, a true vigorous F1 hybrid, short-season photosensitive variety for commercial CBD farmers. Phylos describes these varieties as low-touch, high-yield, and disease-resistant auto-flower varieties for commercial-scale grows.

CBG-rich Varieties

Non-psychoactive cannabigerol (CBG) is at the forefront of cannabinoid breeding today. CBG is the non-acidic rendition of cannabigerolic acid. Cannabigerolic acid (CBGA) is the essential cannabinoid (precursor) that must be present to synthesize CBD and THC. CBGA is an essential building block to produce CBG, CBD and THC. Cannabis must produce massive quantities of CBGA so that it can produce large amounts of CBD and THC. Growers can grow CBG-rich plants without going beyond the THC barrier.

CBG has shown promise therapeutically for neuro-inflammation, stress, Alzheimer's, schizophrenia, Parkinson's as well as glaucoma, and as an antibacterial.

CBG-rich varieties were released by Oregon CBD Seeds in 2021. Other seed breeders are following with seeds that will be available in 2021-2022. Professional breeders are working to develop more cannabinoid-specific varieties. The new varieties enjoy high ratios of CBG with very low levels of THC and CBD. The high CBG varieties have a typical range of CBG: THC of 80-100:1 vs 25-50:1 CBD: THC. The price of CBG-rich cannabis fluctuates.

THC-rich Varieties

Tangie is a very popular cannabis variety in California and Europe too. There are several different versions of Tangie available. My favorite is heavy on Sativa genetics.

Wedding-Crasher is a good example of a high THC, low CBD plant that grows well indoors and in greenhouses.

THC-rich "varieties" are available from hundreds of seed purveyors. Study their offerings carefully to ensure the varieties grow well in your climate and growing conditions. Some cultivars were bred to grow indoors, others outdoors and varieties grow best in a greenhouse.

Most of the varieties are loaded with THC-rich cannabinoids and grow well indoors, outdoors, and in greenhouses. Many of these offerings are not genetically stable. See the discussion above under "Cannabis Varieties" for more background information.

You can find many of these varieties by making the following internet searches, "cannabis seeds", "CBD cannabis seeds" and "THC cannabis seeds." "Auto-flower seeds" "super-auto cannabis"

Industrial Hemp

Industrial hemp is C. sativa. The tall stemmy varieties produce little foliage and the longest fibers that have a wide range of industrial uses. Hemp, affectionately referred to as "rope" and drug cannabis as "dope," is often seeded and contains extremely low levels of THC and often high amounts of CBD.

Industrial hemp is defined in most countries as cannabis that contains less than 0.3% THC. Legal industrial hemp is gaining popularity but has a long way to go before becoming a viable commercial crop. Versatile, durable, and sustainable, hemp can be used to make biofuel, paper, rope, cloth, food, medicine, etc.

According to the US Congressional Research Service, some 25,000 products are made from industrial hemp. Industrial hemp was used until synthetic substitutes such as nylon, rayon, etc., were developed.

CBD-rich cannabis seed certified in the US must pass a THC compliance test. Testing programs are administered by individual states. Although individual state compliance programs differ, all must comply with federal USDA rules. Certified hemp seed must be purchased from official European Union certified sources or the end product cannot be legally sold.

Cannabis Botany - MJ 01 Cannabis Varieties Spreadsheet

THC Cannabis	Male	Female	Seeds	Female Clone
Regular	X	X	X	X
Feminized	O	X	X	X
Auto-flower	X	X	X	O
Auto-flower Fem	O	X	X	O

CBD Cannabis	Male	Female	Seeds	Female Clone
Regular	X	X	X	X
Feminized	O	X	X	X
Auto-flower	X	X	X	O
Auto-flower Fem	O	X	X	O
Industrial Hemp	X	X	X	X

When you look at this chart remember that the auto-flowering genes work like an on/off switch. The switch is "on" in auto-flower mode and photoperiod mode is turned "off". The auto-flowering genes turns on the "daylight neutral" switch so that plants start flowering after three weeks of growth regardless of the hours of light and darkness they receive. If the auto-flower is crossed with a (photoperiod) parent that takes 8 weeks to complete flowering, auto-flower plants should become ripe in 77 days, 11 weeks (3 weeks vegetative, 8 weeks flowering). If the auto-flower is crossed with a (photoperiod) parent that takes 12 weeks to complete flowering, the auto-flower plant will become ripe in 105 days, 15 weeks (3 weeks vegetative, 8 weeks flowering).

Growth Habit

New hybrid varieties can grow into several shapes. Dominant single flower forms on the central stem and several (4-8) lower branches develop fat flowers while smaller branches yield small flowers.

Hermaphrodites and Weird Cannabis Plants

This intersex plant is full on! It is packed with both male and female flowers. Seldom do growers let intersex plants advance to the stage where they can shed pollen to fertilize nearby flowering females.

Intersex plants inherit genes that trigger both male and female flowers on the same plant. Environmental stress promotes more pronounced intersex characteristics in plants. However, intersexuality is the product of genetics and is passed on from one generation to the next. Cannabis can demonstrate a high or a low degree of intersexuality. The ratio of male to female flowers varies according to genetic makeup. In some cases, intersexuality is very pronounced; many male and female flowers grow on the same plant. Other times just a few male flowers grow on a predominantly female plant. A few male flowers on an intersex plant are difficult to find. A single intersex male flower can pollinate female flowers and produce many, many seeds. Intersex plants are very, very poor choices for a breeding program. Intersex plants are often called by the misnomer "hermaphrodite."

Weird split leaves on Freakshow

Freakshow grows the strangest, most bizarre, shaped leaves! They remind me of a crinkled fern leaf. The breeder, Shapeshifter, who created Freakshow grew the plants from a couple of seeds he acquired. The foliage on the two mutants fascinated Shapeshifter. He backcrossed the mutant plants for several generations. He selected for the mutant leaf trait, developing a relatively stable line over time. Nice uplifting cerebral effect with more than 18% THC content. Humboldt Seed Company offers seeds, and Dark Heart Nursery now offers clones.

CHAPTER TWO

LIFE CYCLE OF CANNABIS

Introduction

This healthy greenhouse garden is close to harvest. Raised beds warm earlier in the year and cool later, which extends the growing season. The greenhouse protects the garden from extreme weather and extends the growing season.

Cannabis cultivated indoors, in a greenhouse, or outdoors has the same basic requirements for growth. It needs light, air, water, nutrients, a growing medium, and heat to manufacture food, grow and reproduce. Without each one of these essentials, growth stops, and death soon results. The light must be of the proper spectrum and intensity; air must be in the proper temperature range and rich in carbon dioxide (400-1,200 ppm). Water must be clean and of the proper chemistry, and the growing medium must retain water and air evenly so that nutrients are readily available for vigorous growth. When all these needs are met consistently at optimum levels, optimum growth results.

Cannabis grows naturally as an annual plant completing its life cycle within one year or less. A seed that sprouts in the spring will grow big and strong through the summer and flower in the fall, producing more seeds. The annual cycle starts all over again when the new seeds sprout the following year.

Note
Regular, feminized, and auto-flowering CBD-rich cannabis, THC-rich cannabis, CBG-rich, as well as industrial hemp (cannabis) all have specific requirements for growth, production, harvest, and post-harvest.

Approximate length of each stage growth

Growth Stage	Duration/Time
Germination	2-7 days
Seedling	25-30 days
Vegetative	7-150 days
Pre-flowering	after 30 days of vegetative growth
Flowering	6-12 weeks
Pollination	After mature female flowers form
Seed production	90+ days
Harvest	1+ days

Cannabis and Energy

This backyard garden full of healthy Stinky Pinky and StinkBud plants from Oregon´s SoFresh Farms are grown from seed and have developed to their genetic potential.

Cannabis Seed Germination

Germinating seeds is easy, but requires close attention to air temperature, substrate moisture content and temperature.

During the first growth stage, the seed germinates, establishes a root system, and grows a stem and a few leaves. After 3-7 days, regular and feminized plants enter the seedling growth stage, which lasts about a month. Auto-flowering seedlings start flowering after about three weeks of (seedling) growth.

At germination, moisture, heat, and air start a chemical sequence that stimulates hormones within the seed. Hormones signal cells - the embryo expands, nourished by a supply of stored food (energy) within the seed. The growth causes the seed's outer coating to split, and a white rootlet grows downward, probing for nutrients. Aboveground, a sprout with two opposing rounded seed leaves (cotyledons) pushes upwards in search of light.

Cannabis Seedling Growth

These flats of seedlings show the first set of rounded cotyledons and the first set of true leaves.

The single root, called a taproot, from the seed grows down and branches out, similar to how the stem branches aboveground. Tiny hair-like roots and rootlets develop to draw in water and nutrients.

Roots also serve to anchor a plant in the growing medium. Proper seedling growth ensures adequate energy for growth in the form of stored food.

This little auto-flower seedling got a fair start on life. At 21 days from germination, it already has three sets of leaves and is developing a fourth. The first tiny female flowers started to show a few days later.

Auto-flowering plants require special care during the seedling growth stage. They must grow very, very fast during the first 3-4 weeks of life. Auto-flowering plants must grow as much foliage as possible so that they will be able to produce more flowers on big plants. The root system must grow rapidly without impediments now and throughout life. Abundant branch and foliage growth translate into more and heavier flowers at harvest.

Cannabis Vegetative Growth

Strong, healthy unabated rapid growth is the key to a healthy, heavy harvest.

Vegetative growth is maintained in regular (male and female) cannabis by giving plants 14-24 hours of light every day/night. A point of diminishing returns is reached at 18-20 hours.

Auto-flowering cannabis produces best when they receive more than 16 hours of light.

Strong, healthy roots are vibrant white with little fuzzy parts found mostly near the tips. Strong healthy roots are white, the small ones are fuzzy and hairlike.

Roots take on specialized functions as cannabis plants mature. The center and old mature portions contain a water transport system and may also store food. The tips of the roots produce elongating cells that continue to push farther and farther into the soil in search of more water and nutrients. The single-celled root hairs are the parts of the root that absorb water and nutrients. Without water, frail root hairs dry up and die. They are very delicate and are easily damaged by light, air, and clumsy hands if moved or exposed. Extreme care must be exercised during transplanting.

The stem serves to transport water and nutrients from the delicate root hairs to the growing buds, leaves, and flowers. Sugars and starches manufactured in the leaves are distributed through the plant via the stem. This fluid flow takes place near the surface of the stem. If the stem is bound too tightly by string or other tie downs, it will cut the flow of life-giving fluids, thereby strangling and killing the plant. The stem also supports the plant with stiff cellulose located within the inner walls. Outdoors, rain and wind push a plant around, causing much stiff cellulose production to keep the plant supported upright. Indoors and in greenhouses, with no natural wind or rain present, stiff cellulose production is minimal. Hence, plants develop weak stems and may need to be staked up, especially during flowering.

This beautiful cannabis plant was started indoors and moved outdoors in early May. The photo was taken on 12 July 2019. The plant will double in size by the time the first female flowers form.

Leaves manufacture food (carbohydrates) for the plant. Chlorophyll, the substance that gives plants their green color, captures light energy (photons), triggering molecular events that use carbon dioxide (CO_2), splitting water into hydrogen and oxygen. This process, photosynthesis, creates energy that can be stored as carbohydrates such as starch. Photosynthesis requires water drawn up from the roots, through the stem, and into the leaves, where it encounters carbon dioxide. Tiny breathing pores on the underside of the leaf, called stomata, work as gas exchange factories absorbing CO_2 and releasing oxygen. Water derived from transpiration is released from foliage to aid in cooling a plant in warm conditions. For photosynthesis to occur, the leaf's interior tissue must be kept moist. The stomata open and close to regulate moisture flow, preventing dehydration. Cannabis leaves are also protected from drying out by outer skin and resin. The stomata additionally permit the outflow of water vapor and waste oxygen. The stomata are very important to the plant's well-being.

Strong vegetative growth is essential so that cannabis plants will have enough foliage and an extensive enough root system to support many dense flowers. If plants suffer stress during the vegetative growth stage, roots do not develop properly and cannot supply enough nutrients to foliage and flowers. In nature, cannabis spends most of its life in vegetative growth. Cannabis has enough time to develop vegetative growth to produce more flowers.

Cannabis Pre-flowering

Little male cannabis flower pods full of pollen are developing on the stem at the base of a leaf and a new growing shoot. A low-power hand-held microscope makes identifying male flowers easier.

Female stigmas grow from seed bracts and appear as a pair of white fuzzy hairs. The first female pre-flowers appear after about 8 weeks of vegetative growth under normal conditions.

Regular and feminized pre-flowers on cannabis grown from seed appear about eight weeks from seed sprouting. Pre-flowers on regular and feminized cannabis generally appear between the fourth and sixth node from the bottom of the plant. Cannabis plants are typically either all male or all female. Cannabis is predominantly dioecious, imperfect flowers – staminate "male" and pistillate "female" flowers occur on separate plants. Each sex has its own distinct flowers. Pre-flowers will distinguish a plant as male or female. Growers remove and destroy the males (or use them for breeding stock) because they have negligible levels of cannabinoids (THC, CBD, CBG, etc.) and produce little foliage. Female plants are cultivated for their high cannabinoid content, including CBD, THC and CBG, and abundant foliage. Industrial hemp is grown for its long resilient fibers or for industrial seeds rather than foliage or cannabinoid-rich flowers.

Branches on auto-flowering cannabis plants are often fairly close together on the stem.

Auto-flowering cannabis starts flowering after about 21-25 days of chronological growth. Pre-flowers set, and soon, flowers develop. After 60-70 days, the flowers are ready for harvest. The entire auto-flower plant life cycle, sprouted seed to harvest, is complete in 70-90 days regardless of day length.

Cannabis Flowering

Early flowering male pollen pods are developing quickly. This male plant has abundant foliage.

This Amnesia Haze female is in the early stages of flowering.

A few male flowers will open ahead of the rest and start shedding pollen. If growing regular photoperiod plants or unstable varieties, keep an eye out for males that open early.

This beautiful crop of flowering females from the Original Breeders League is 3-4 weeks from harvest.

Male Stink Bud in full bloom.

This mature Swazi Landrace top is a mass of flower buds with classic narrow leaves found on many sativa varieties.

Mid-to-late-season regular and feminized cannabis varieties start to flower when the day length drops below 14 hours. Depending upon your latitude, flowering starts about midsummer nights and becomes progressively longer.

Short-season Kush and Afghani varieties typically start flowering the first week of August and are ready to harvest in mid-to-late September. Check with seed sellers for specific flowering times in your latitude.

The length of the night signals cannabis that its annual life cycle is coming to an end. At flowering, plant functions change. Leafy growth slows, and flowers start to form. Flowering is triggered in most commercial varieties of cannabis by 12 hours of darkness and 12 hours of light every 24 hours. Outdoors, nights become longer gradually, and flowering is initiated during a period of 3-4 weeks. In controlled indoor and greenhouse environments, days and nights are changed abruptly to 12 hours. Flowers appear in 10-14 days. Plants that originated in tropical regions with less variation between day and night often start flowering under more light and less darkness.

Flowers form during the last stage of growth. Left un-pollinated, female flowers develop without seeds, "sinsemilla." When fertilized with male pollen, female flowers develop seeds. Typically, unpollinated female plants develop dense heavy flowers with high levels of cannabinoids.

Unpollinated, female cannabis flowers continue to swell and produce more resin while waiting for male

pollen to successfully complete their life cycle. After weeks of heavy flower and cannabinoid-laden resin production, CBD, THC and CBG production peak out in the unfertilized, frustrated sinsemilla flower. CBD-rich plants are often harvested 10-14 days before THC-rich and CBG-rich crops. CBD and THC production develop simultaneously in lockstep. The CBD to THC ratio is thought to be predetermined by genetics, but environmental factors such as light spectrum may also cause an influence.

This frosted Zin auto-flower was harvested the day the photo was snapped. This cluster of flowers is an example of THC-rich auto-flower varieties.

Female flowers on auto-flowering cannabis start to form about a week after pre-flowers are visible. During this time, autos continue to grow at a rapid rate if properly maintained. Flower formation is slow at first and gains momentum during the following weeks. Flowers continue to form and swell until peak resin production is reached. The short life span makes it imperative for growth to be fast and strong so that the plant can develop completely and store enough energy to produce heavy dense flowers.

Cannabis Seed Production

Seeds swell as they mature. The increased girth of the seed splits open the external resin-laden seed bract.

Pollen production and shedding signal the end of a male plant's life. Seed production and maturation signal the end of the annual cannabis life cycle.

Do not forget that flowering feminized plants can be pollinated by any viable pollen from a male cannabis plant.

When both female and male flowers are in bloom, pollen from the male flower lands on the female flower, thereby fertilizing it. As the seeds mature, the female plant slowly reduces other life processes. In nature, the mature seeds fall to the ground where they tend to go dormant during the winter before germinating in the spring. Or seeds are collected by gardeners to germinate, grow and harvest to start the annual cycle again.

CHAPTER THREE

CANNABIS SEEDS & SEEDLINGS

Introduction

Cannabis seeds hold the genetic key to cannabinoid and terpene production. You hold the key to cannabinoid and terpene yield. Selecting the perfect seeds for your garden combined with keen cultivation techniques are rewarded with a heavy harvest.

Close inspection of these two groups of cannabis seeds reveals a spotty, mottled surface with numerous vein-like formations on the outer shell (testa).

A seed contains all the genetic material for growing a cannabis plant. The genes within a seed dictate a plant's size, disease and pest resistance, root, stem, leaf and flower production, cannabinoid levels and many other traits. Seeds are the result of sexual propagation and contain genes from each parent, male and female.

Mottled dark brown lines distinguish these StinkBud seeds.

The genetic makeup of a seed is the single most important factor dictating how well a plant will grow in different climates and under artificial light, sunlight and light available inside a greenhouse. Genetic characteristics also control the maximum amounts of cannabinoids a plant is able to produce. However, growth conditions also affect cannabinoid levels. A poorly grown plant produces lower levels of cannabinoids than a healthy well-grown plant.

Chapter One, Cannabis Botany, defines the following categories of seeds: (1) regular seeds (2) feminized seeds (3) auto-flowering regular seeds and (4) auto-flowering feminized seeds. Regular seeds are becoming less common in many parts of the world and numerous seeds companies offer only feminized seeds. Feminized seeds are very popular because they grow into female plants that have a high cannabinoid content. However, unstable feminized plants may occasionally develop male flowers.

Regular, Feminized & Auto-flowering Cannabis

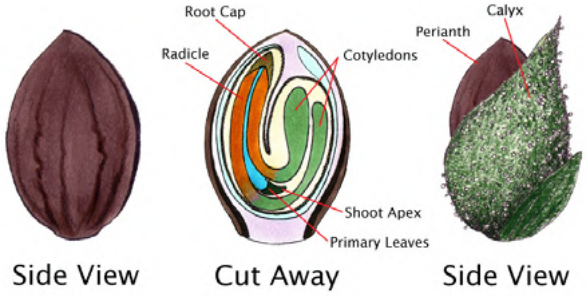
THC Cannabis	Male	Female	Seeds	Female Clone	Days to Mature
Regular	X	X	X	X	90-220
Feminized	O	X	X	X	90-220
Auto-flower	X	X	X	O	70-90
Auto-flower Fem	O	X	X	O	70-90

CBD Cannabis	Male	Female	Seeds	Female Clone	Days to Mature
Regular	X	X	X	X	90-120
Feminized	O	X	X	X	90-120
Auto-flower	X	X	X	O	70-90
Auto-flower Fem	O	X	X	O	70-90
Industrial Fiber Hemp	X	X	X	X	70-90

Strong viable seeds are produced by healthy parents that receive proper care. Seeds that have been stored properly germinate quickly and grow into healthy plants that produce heavy harvests. Seeds stored too long will germinate slowly and have a higher rate of failure. Vigorous seeds germinate within 48-72 hours and sprout aboveground within seven days. Seeds that take more than a week to germinate may grow slowly and produce less. However, some varieties take longer to germinate even under the best conditions.

Cannabis seeds – THC-rich CBD-rich, etc. – can be large or small. Check out the difference in size of these seeds that were supplied by my friend Jerry from LeBlancCNE.com.

Avoid weak seeds. If the outer protective shell does not properly seal, a little moisture and air penetrate and try to activate growth. Seed and seeds become progressively less viable. Moisture-permeable seeds signal diseases and pests to move in. Weak seeds are immature, light-colored, fragile and crush easily with slight pressure between finger and thumb. Weak seeds do not have enough stored food to germinate and grow properly.



A seed consists of an embryo containing genes and a supply of food bundled in a protective outer coating. Mature viable seeds are hard, beige to dark brown and spotted or mottled have the highest germination rate. Soft, pale, or green seeds are usually immature and should be avoided. Immature seeds germinate poorly and often produce sickly plants. Viable, fresh, dry, mature seeds one or two years-old sprout quickly and grow robust plants.

Buy seeds in packages of 1, 3, 5, 10 and more. Selling very small quantities of seeds started with feminized seeds that are guaranteed to be female. But if a seed does not sprout or the seedling is weak and sickly, there is no backup sibling to take its place. I advise to start with at least three feminized or auto-flowering seeds and 5-10 regular seeds from each variety. If you have room and the budget, start 10 seeds of each variety. To help ensure a crop, start more seeds than you plan to harvest.

If you start with ten regular seeds from a reputable supplier and germinate them all at once, about half will be male. If you start with five feminized seeds, one or two could grow slowly or be less cannabinoid potent. Two, maybe four seeds will grow into strong, potent females. Of these females, one will be more robust and potent than her siblings. Select this "super" female to be the mother of your clones.

Cannabis Seed Germination

Cannabis seeds need only water, heat and air to germinate. At germination, moisture causes the outside protective shell of the seed to split. Moisture continues to wick in to trigger the dormant hormones that activate the small white radicle. The radicle penetrates the soil transforming into the tap root and green growth emerges above ground. Cotyledon, or seed leaves, emerge from within the shell as they push upward in search of light. A constant stream of moisture is essential to transport water, nutrients, and hormones for rapid growth. If seedlings suffer water stress now, they will take weeks to recover. Auto-flowering seeds and seedlings are extremely susceptible to moisture, heat, and oxygen stress. See below for several cannabis seed germination techniques.

Seeds do not need extra hormones or fertilizer to germinate. Once seeds emerge and a set of cotyledon leaves develop, a mild nutrient solution is necessary in inert substrates – coco coir, perlite, rockwool, etc. – that contain no nutrients of their own.

Timeline to germinate strong viable seeds and grow into grow into seedlings

Seeds absorb water in the presence of air to initiate germination

At 48-72 hours the white root tip (radicle) is visible

At 4-7 days roots grow, seed sprouts aboveground

At 5-8 days cotyledon leaves open

At 6-9 days true leaves are visible

At 6-21 days roots develop, little foliage grows

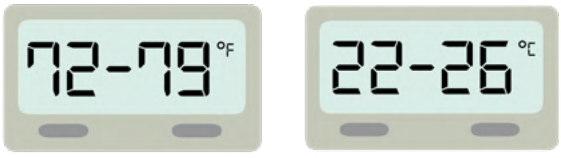
At 21-25 days root system matures and true leaves grow

At 25-30 days seedlings are ready to start vegetative growth

Once seeds grow a specialized root system, cell growth accelerates; stem, foliage and roots develop quickly. Promote this natural growth and harvest heavily. Seeds that do not root and start strong growth, often grow slowly later.

Seeds need air to germinate. Moist, soggy growing mediums will cut off oxygen supplies; seeds will literally drown if totally submerged for more than 20 minutes after germination. Planting seeds too deeply also causes poor germination. Seedlings do not have enough stored energy to force through too much soil before sprouting. One rule of thumb is to plant seeds twice as deep as the width of the seed. For example, plant a 0.125-inch (0.3 mm) seed, 0.25-inch (6 mm) deep. I like to explain it as putting a very small dab of soil on top of the seed and keeping it evenly moist. I like to set a moist paper towel on top of the soil until the seed emerges, see below.

Household water often contains enough dissolved solids (nutrients) to nourish seeds through their first few weeks of life. But household water may cause problems. Seeds are very sensitive to excessive salts in water that disrupt internal chemistry. I prefer to use deionized, RO, distilled, demineralised, rainwater, filtered - water. Watering seeds with a nutrient solution can inhibit germination.



Seeds need heat to germinate. Seeds sprout without light in a wide range of temperatures. Properly nurtured seeds germinate in two to seven days, in temperatures from 70-80°F (21-26.6°C). Temperatures above 86°F (30°C) impair germination and could lead to rot. Temperatures below 70°F

(21°C) slow germination. Below 60°F (15.5 °C) speeds stagnate and if the environment is too wet, disease could become a problem. Super hard seeds may need to be scarified (see below) to help initiate germination.

Seeds need total darkness to germinate. The rootlet or radical is the first to emerge. It needs darkness so that it can anchor the plant that will emerge aboveground. Bright light shining on a tender little rootlet can stunt growth and in extreme cases result in failed germination.

Viable seeds germinate quickly. If you have a few cannabis seeds to germinate, placing them in moist paper towels is very easy and efficient. The seeds in the moist paper towels can be placed inside a partially plastic bag to retain moisture or set on a saucer that retains moisture. Set the germinating seeds in a warm, dark location.

Three Easy Steps to Germinate Cannabis Seeds

1

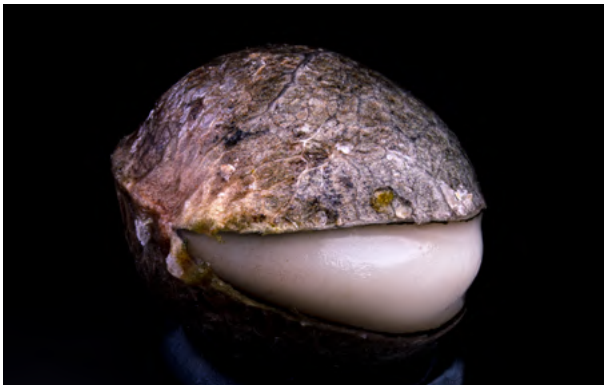
Soak seeds overnight in a glass of (in order of best to least) deionized, RO, distilled, demineralised, rainwater, filtered - water. Make sure seeds get good and wet to activate growth. At first seeds float. Seeds sink to the bottom as moisture penetrates the outer shell. Do not let seeds soak for more than 24 hours or they suffer oxygen deprivation and drown. Once soaked carefully place seeds in between moist paper towels on a saucer or plate.

Seeds float before the water tension is broken and moisture penetrates the outer. Growth is initiated once water enters the inner seed. Seeds sink as more and more water soaks into the interior.

Here is a selection of germinating seeds from Spain. All of the germinating seeds were given away free with Cáñamo magazine.

2

In a warm location (70-85°F, [21-29°C]), place seeds in several layers of moist paper towels on a saucer or plate. You may need to add a little water to the plate daily. Be vigilant of warm nights that cause paper towels to dry. Let excess water drain away freely. The paper towels will retain enough moisture for the seed to germinate within a few days. The seed contains an adequate food supply for germination. Prevent fungal attacks by watering with a mild organic surface fungistat solution. Remove germinated seeds when the little white rootlet grows from 0.25-0.5 inches (0,6-1.25 cm) and plant in substrate with the rootlet pointed downward.

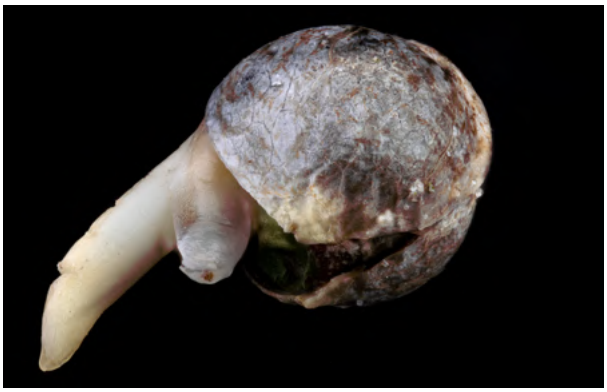


When water penetrates the outer protective shell to induce germination, plant growth is activated. A constant stream of moisture is essential to transport nutrients, hormones, and water to carry on life processes. Letting germinated seed suffer moisture stress now will stunt, even stop growth. Once the tip shrivels from lack of moisture, the plant is stunted and may take weeks to recover.

Rockwool rooting cubes retain structural integrity when moved into Deep Water Culture (DWC) gardens and other types of hydroponic gardens. Rockwool must be hydrated and conditioned by adjusting the pH to 5.5-5.8 and adding nutrient solution.

In rockwool seeds can “heave” (crawl out of the rockwool) during germination. Planting sprouted seeds with a longer white radical (0.5 inch (1.5 cm)) in rockwool avoids heaving. Take care not to expose the tender rootlet to prolonged intense light or air. Keep the growing medium evenly moist. Once the taproot sprouts, small fuzzy feeder roots will grow in a few days.

Soggy growing mediums keep seeds to stay too wet. Planting seeds too deeply causes poor germination. Seedlings do not have enough stored energy to force through a heavy layer of soil before sprouting. Plant seeds twice as deep as the width of the seed. For example, plant an 1/8 inch (3 mm) seed 1/4 inch (6 mm) deep.



Once the radicle starts to grow, the seed is ready to plant into the substrate. When planted, gravity will direct root growth downward and light aboveground will provide energy to start photosynthesis. First a set of rounded cotyledon or seed leaves appear. Next, a pair of classic serrated cannabis leaves grow on the internode above cotyledons.

3

Transplant sprouted seeds when the white sprout is visible. I like to move the sprouted seed into a seedling block or mix soon after the white radicle becomes visible. The little white tap root, when long, is more difficult to keep evenly moist. Dangling rootlets are easy to damage and should not be exposed to air and light.

Transplant Sprouted Seeds into Growing Medium

Place germinated seed in a shallow planter, small seed pot, peat pellet, rooting cube or soilless mix. When starting more than a few seeds, use plug trays and fill with starter plugs, cubes, Sunshine® mix, Promix® or similar substrate. Plant germinated seeds in a heated or warm room to minimize any type of temperature stress.

1

Pre-moisten the fine planting mix, seed plugs and cubes. Fill plug trays with pre-moistened substrate. Plug trays are available in many sizes. Many different plug trays are available with numbers of contiguous planting cells. Larger plug “flats” can be cut down containing 6-12 cells.

2

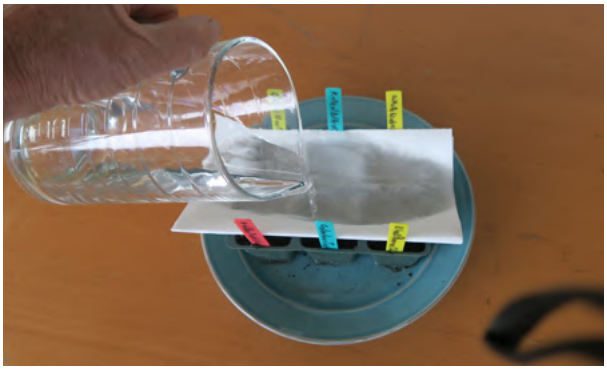
Use a pencil eraser to make a shallow hole 0.375-0.5-inch (1-2.5 cm) in the center of the mix of each cell of the plug tray.

Small growers can take the time to plant individual germinated seeds with tweezers. Avoid touching the little white rootlet with your dirty, rough hands. It is super delicate now and easy to damage.

3

Avoid touching, squeezing, scraping, fondling, etc. delicate rootlets with filthy hands to avoid injury. Move seeds with tweezers or shuffle them out of the paper towels into the planting hole to avoid disturbing rootlets. Or you can carefully pick up the fragile sprouted seeds with your clean fingers and plant them in a pre-drilled shallow hole in the soilless mix, small seed pot, peat pellet, rockwool rooting cube with the white root tip pointing down. Cover the germinated seed with a *very* light, 0.25–0.5-inch (1-2 cm) of moist soilless mix, peat or other substrate.

Lightly press down on the substrate to ensure it is in firm contact with the seed.



4

Cover planted containers, flats, and trays with a double layer of paper towels. Check under towels daily. Spray or sprinkle with water to keep the substrate surface moist if necessary. Remove the wet paper towel covering when the seedlings start to emerge. Some gardeners prefer to wait until half (50%) of the seedlings have emerged, especially if growing hundreds of seedlings.

5

Apply a very light dose of organic fertilizer once the cotyledons open. The small root system needs only water now. You may want to add a small dose of liquid kelp too. Keep the planting medium evenly moist until roots are established.

6

A small spoon works well to scoop regular and feminized seedlings out of plastic cell packs when the root system is small. Do not use this method for auto-flower seedlings because it will disturb roots and provoke flowering in most varieties. Peat pellets,

root cubes and other seed plugs may be transplanted in two to three weeks or when the roots can be seen through the sides.

Heat from grow lights warms the substrate surface and below. Keep an eye on soil moisture. Heat from the lamp can dry soil. More frequent watering may be required. A slight increase in substrate temperature speeds root growth.

A shallow flat or planter with a heat pad or heating cables underneath seedlings may require daily watering, while a deep, one-gallon (3 L) pot will need surface watering every few days. A properly watered flat of rockwool cubes needs water every 3-5 days when sprouting seeds. When the surface is dry (0.25-inch [7 mm] deep) it is time to water. Remember, there are few roots to absorb the water early in life and they are very delicate.

Place germinating seeds on a warm base – warm refrigerator, cable box, or soil heat pad and heating cables to keep temperature a little higher than the ambient air temperature. Bottom heat also helps avoid sudden fluctuations in temperature and moisture that shock seeds and slow germination.

Place a heat pad or soil heating cables below growing medium to speed germination. Cannabis seeds germinate and sprout quickest when the soil temperature is between 78-80°F (24-27.5°C) and the air temperature is 72-75°F (22-24°C). But stems will stretch between internodes if temperatures exceed 85°F (29°C) for several hours.

Semi-direct Seed Outdoors

Auto-flowering varieties grow well when sown semi-directly in soil. Roots have the chance to penetrate the soil and grow naturally. Sow auto-flowering varieties when the soil warms. Sow seeds up to a month earlier in raised beds and raised beds that warm sooner.

The root systems of auto-flowering varieties are very sensitive. Any time the root system is disrupted by movement or when the roots start to circle a container, the plant will start to flower. Undesirable untimely flowering adds up to puny plants that produce poorly.

These are the steps that Steve Rogers makes to plant auto-flowering cannabis seeds. First, he starts seeds in pots or plug trays. Once seedlings are strong and healthy, he transplants them outdoors.

1

Cover the plug tray soil with fine potting soil or soilless mix to fill all cells. Moisten the growing medium.

2

Make shallow planting holes with the end of a small stick about the size of a pencil eraser.

3

Drop a single seed in each hole.

4

Cover the planted growing medium with a very light fine layer of soilless mix. Smooth out the 0.25-inch (cm) layer of growing medium and lightly tamp it down.

5

Water the growing medium with a fine spray so that it is evenly moist.

6

Cover the planted growing medium with a layer of cardboard. Anchor the cardboard down so that it does not shift on the ground. Sprinkle the cardboard covering very lightly with water to add a little weight. Seeds should germinate and a sprout should pop through the soil after about three days.

7

Wait until half (50%) of the seeds have sprouted before removing the cardboard.

8

Once the seedlings start to sprout, keep them evenly moist and protected from slugs, snails, birds, and insects. Snail bait and a spun fiber covering will protect the tender seedlings until they grow tougher.

9

Feed with a dilute, quarter-strength organic fertilizer solution.

Planting Auto-flowering Cannabis Seedlings

Commercial grower, Steve Rogers (Singing Pig Farm, Inc.) loves growing auto-flowering cannabis. Rogers turned his green thumb into heavy harvests, "There is a persistent myth in the cannabis community that auto-flowers should not be transplanted. I use the transplant technique because it produces better and faster growth." Rogers is right, he has been transplanting auto-flowering seeds with almost 100% success. He continues "It's important to grow auto-flower plants quickly. If they begin to flower, there is no time to recover".

Steve Rogers' son, Ben, is sowing auto-flowering Blackberry Gum seeds in 1.75-inch (44 mm) Jiffy pellets that are set into 4-inch (10 cm) pots of seedling mix. The extra precaution with auto-flower seeds lets Ben transplant seedlings that have not fully developed root balls inside the Jiffy pellets. The extra 4-inch (10 cm) pot ensures that the roots that grow out the sides of the Jiffy pellet are disturbed as little as possible.

Auto-flowering varieties need to be babied during the first 4 weeks of life. Stress can cause plants to grow slowly and produce much less. Stressed autos develop less foliage, smaller flowers and low yields.

Minimize stress when transplanting. Keeping consistent levels of light, temperature, humidity, water, nutrients and growing medium chemistry will keep cannabis roots growing as fast and dense as possible. This is not possible when moving plants outdoors from an indoor garden. You can minimize the stress on cannabis plants by gradually introducing them to the new garden space. Both soil temperature and air temperature must be similar to an outdoor environment. If this is not possible, construct a makeshift greenhouse over the transplants and transplant them into raised beds.

If you are a new auto-flower grower, you may want to start auto-flowering sprouted seeds in a 5-gallon (20-L) root-pruning pot. The root-pruning container will hold the auto-flowering cannabis plant until harvest. Transplanting auto-flowering plants into their final container avoids extra work but diminishes container harvests. Outdoor crops benefit immensely using this transplanting technique.

This little plant was started from an auto-flowering seed.

Start auto-flowering plants in a Jiffy-pot, rockwool cubes, Ellepot, Rapid Rooter Plugs, Flora Root Plugs, etc. to transplant outdoors or to a larger container. The container must be rigid so that the root ball remains intact. Transplant autos as soon as cotyledon leaves start to emerge, or a day before they emerge. This will help guard against roots poking through the sides of the rigid container. I´m always amazed at how a little root movement will decrease yield.

Starting seeds directly in the soil outdoors and in a greenhouse is preferred by some growers. Planting seeds directly in Mother Earth allows the seed to become acclimated to soil life immediately. Direct-seeded cannabis develops a strong healthy tap root that penetrates much deeper into the soil than seeds started in containers indoors.

Start auto-flowering seeds in a plug such as an Ellepot" – a little paper tube filled with standard peat germination mix. Many different companies make similar paper-sleeve plugs. These plugs work great if you are planting 10-100s of seedlings. Many insert plugs will fit into a 1020 nursery flat that is easy to handle.

Do not use Styrofoam or hard plastic trays. Auto-flower roots suffer stress as soon tips hit the sides of the container or grow out the bottom of cells.

For best results, select a growing medium that is the same or almost identical to the one you plan to use in the next transplant phase. Keep the same substrate for all phases of growth and transplanting.

Optimize Auto-flower Cannabis Production

1 - Grow super-autos.

2 - Start seeds under lights indoors.

3 - Start super-autos in small cube, plug or container.

4 - Give seedlings 20 hours light and 4 hours darkness.

5 - Use low EC (<50 ppm) or clean Reverse Osmosis (RO) water.

6 - Water with 5:2 ratio of (5) humic acid to (2) kelp.

7 - Apply mycorrhizae fungi when planting and transplanting.

8 - Carefully transplant to 3-5-gallon (11-20 L) air-pruning containers.

9 - Fast-draining substrate.

10 - Trellis train plants to receive more light.

11 - Water and fertilize as needed.

12 - Harvest top flowers, wait 1-2 weeks harvest ripe lower flowers.

Cannabis Seedlings

The vibrant white roots on this seedling

These healthy seedlings have outgrown their small containers and must be transplanted.

These Colombian Jack from Kannabia Seeds are at the end of the seedling stage. Take a close look at the stem above and the cotyledon leaves and see how the stem "fattens up".

When a seed sprouts, the white taproot emerges and plows into the soil in search of nutrients. Soon afterward, the stem pushes out of the soil and cotyledons, also known as seed or seedling leaves, appear. The seed leaves spread out as the stem elongates.

The first true leaves appear within a few days and the little plantlet is now a seedling. The seedling growth stage lasts for three to six weeks. During seedling growth, a root system grows rapidly while green aboveground growth is slow. Water and heat are critical at this point of development. The new, fragile root system is very small and requires a small but constant supply of water and warmth. A fast-draining substrate that holds ample air is essential. Too much water will drown roots, often leading to root rot and damping-off. Lack of water will cause the infant root system to dry up. As the seedlings mature, some will grow faster, stronger and appear healthy in general. Once germinated, move seedlings to a slightly cooler growing area and increase light levels.

Some seeds sprout slowly and are weak and leggy. If possible, cull sickly, weak plants and focus attention on the remaining strong survivors. Seedlings should be big enough to thin out after 4-6 weeks of growth. If thinning out seedlings is too traumatic, you can continue to nurse the little seedlings along. In fact, Dr. Gary Yates advises, "I've found these often are the best cannabinoid producers! Don't cull the runts if you are

growing for yourself and yield is not important."

Over-watering and under-watering are the biggest obstacles most growers face when germinating seeds and growing seedlings. Keep the soil uniformly moist, not water-logged. Do not let the growing medium surface dry for long. Keep it evenly moist. Set root cubes and planting flats up on a grate to improve drainage.

The end of the seedling stage is over when rapid foliage growth starts. Rapid growth aboveground signals the beginning of the vegetative growth stage. Plants need more room to grow; transplanting into a larger container hastens development.

Photoperiods for Cannabis Seedlings

4/20 – 4 hours dark / 20 hours light.

Less intense light illuminates plants for more hours so that plants receive the total Daily Light Integral (DLI) they need to grow to maximum potential. This photoperiod works well for seedlings and vegetative growth stages for regular and feminized cannabis. Auto-flowering cannabis can be given this 4/20 photoperiod from seed to harvest.

6/18 – 6 hours dark / 18 hours light.

This is the standard photoperiod that indoor growers have found successful to promote vegetative growth in regular and feminized cannabis plants. Many growers use this photoperiod for auto-flowering cannabis too.

12/12 – 12 hours dark / 12 hours light.

Induce seedlings to flower when they are about 21 days from seed emergence with this photoperiod. Cannabis seedlings go directly into flowering. Grow a fast 90-day crop from regular seeds with this light schedule. Cannabis plants produce fewer and smaller flowers overall because of their short lifespan. Breeders use this technique to produce male pollen in less time.

0/24 – 0 dark / 24 hours light.

This schedule allows no rest for any plant processes.

Cannabis Needs Light, Air, Water, Nutrients & Soil (LAWNS)

- **Light Intensity for Seedlings**

Seedlings need at least 16 hours of low-intensity light daily. They grow well under fluorescent tubes and LEDs for the first two to three weeks. Fluorescent, CFL and HID grow lights can also be used. The compact fluorescent should be 12-18 inches (30-45 cm) and the HID 3-4 feet (90-120 cm) above seedlings for best growth.

Tender young seedlings need the low levels of light supplied by low-wattage fluorescent, CFL or LEDs. Fixtures typically supply 7,500-20,000 lux, the perfect intensity of light for seedlings.

Set the light fixture 4-5 inches (10-13) above the emerging seedlings. Once cotyledon and the first set of "true" cannabis leaves emerge, experiment by gradually moving the fixture as close as 2 inches (5 cm) from the top of seedlings. Each variety may react differently to light intensity. Move the light closer to increase intensity if stems start to stretch, a sure sign of light starvation. Back the light away to decrease light intensity if signs of light burn appear. Light burn causes tender leaves to contort somewhat and if intense may scar and discolor foliage. Too much light slows growth.

Many inexpensive bluetooth and WiFi-based environmental sensors (Temperature, humidity, moisture, etc.) that relay data to your mobile phone. The data is easy to analyze in real time in the chart and text readout on your mobile phone. The collected data can be used as a complete grow room history.

Keep a very close eye on the temperature and humidity. I like to set a maximum/minimum thermometer/hygrometer at seedling level. This gives me the most accurate readings.

Air

Avoid rapid changes in temperatures and humidity, especially with low light levels. The seedling temperature range 68-78ºF (20-25.5ºC) with an ideal at 75ºF (24ºC). Ideal seedling humidity range 60-70%.

Air (oxygen) content in substrates is essential. Do not let roots get too wet and cut off air.

Temperature range for seedlings.

Humidity range for seedlings.

Ideal temperature for seedlings.

Water

Seedlings need a constant supply of moisture. Seedling rooting plugs and cubes hold moisture for several days depending on conditions. A dilute nutrient solution is necessary for seedlings grown in inert substrates.

Nutrients

Start feeding after seedlings develop cotyledon leaves. Apply a very dilute quarter-strength nutrient solution. Organic soil may not need additional nutrients. If yellowing appears, give seedlings less water and less nutrients.. Be sparing with fertilizer when few roots exist. Increase the dosage as plants grow.

A nutrient solution must be added to inert substrates – coco coir, perlite, soilless mix, rockwool, expanded clay pellets, rooting plugs, etc. these inert substrates contain no nutrients of their own.

The first mild nutrient solution should be in the 6.2-6.4 pH range. Nutrient solution is acidic which will lower the pH. Keep the EC at or near 400 PPM. As seedlings grow bigger in 10-14 days increase the EC according to fertilizer manufacturer's instructions.

A dilute solution of humic acid (HA) and kelp in a 5:2 ratio is all that is needed in organic soil to really kickstart root growth according to Steve Rogers (Singing Pig Farm, Inc.). He uses this combination of HA and kelp in a 5:2 ratio which has shown to give a 50% increase in root mass over using either product alone. Rogers also adds a light dose of fish hydrolysate. He advises using a diluted solution more often rather than giving tender seedlings a big jolt.

Substrate

Soilless mixes and potting soils are often fortified with nutrients. This is especially true of seedling mixes. Instructions on the potting soil bag or manufacturer´s internet site will list the ingredients and instructions on use. If there are no instructions on the bag or internet site, think twice about purchasing the potting soil.

A little substrate heat now will help nurture small root systems to a strong start. The guidelines for substrate heat and ambient air temperature are the same as with seeds above. Remember, to keep an eye on the substrate moisture level. It tends to dry faster when warmer than ambient air.

How to Select Cannabis Seeds

Select seeds from mother plants that show the desirable traits you want. Grow clones of the super mothers to grow and harvest a garden like this.

Grow seedlings indoors under lights and move them into the greenhouse. Once cannabis seedlings acclimate to the slightly harsher greenhouse climate, strong bushy plants can be moved outdoors when weather warms.

Cannabis Seed / Clone Selection Criteria

Budget – ($ total cost) / seeds) = ($ cost each seed)

Genetic type – regular, feminized, auto-flower

Genetic background – male parent, female parent, 3-way cross, 4-way cross

Site – indoor, greenhouse, outdoor

Days to harvest – date from seed company – Actual date you harvest

Potency – (% CBD), (% THC) (% CBG)

Flavor/taste –sweet, earthy, citrus, vanilla, pine, berry, grape, etc.

Feeling/effect – happy, euphoric, alert, relaxed,

sleepy, munchies

Plant height – plant height inches/centimeters

Purpose – flowers, concentrates, vape cartridges, topical

Easy to cultivate – easy, medium, difficult

Easy to clone – easy, medium, difficult

Score – plant score (1-10)

Foto – Seeds labeled

Foto – Seedlings

Notes –

Here is a link to a seed selection guide,

The seeds in this seeded female are literally popping out of the seed bracts.

Seeds found in flowers often have an unknown male parent with a sordid history. The seeds may grow into plants with similar flowers but few are identical. The inconsistent growth pattern is accompanied by different cannabinoid profiles. There is a good possibility that intersex (hermaphrodite) tendencies will crop up. A few small male "bananas" (see foto above) on a female plant could pass on the intersex trait.

Acclimated cannabis seed performs best because it has been grown in the same area for several years. This is a good reason to produce and save seeds. Localized cannabis seed typically grows well when it is acclimated to a specific climate. You have probably seen huge 10-15-foot-tall 3-4.5 m) plants in photos from Humboldt county in Northern California. These plants have been grown in the same micro-climate for at least five years and they are acclimated to their environment. Of course, they are nurtured with great organic soil, expert gardening skills, and agreeable weather.

To find varieties that fit your needs, decide which qualities you like – aroma, taste, effect, medicinal value. What is your criteria for seed selection? Do you base your selection on aroma and taste? Do you want a soaring high or a mellow relaxing effect? Do you want medicinal properties that will stimulate appetite, relieve pain and anxiety? Do you plan to make concentrates? Or do you want a combination of the above qualities? Many internet sites explain the qualities of different varieties.

Check out this "Seedfinder"

Decide if you want to grow CBD-rich, THC-rich or CBG-rich seeds that are regular, feminized, auto-flowering regular, auto-flowering feminized. See "Regular, Feminized & Auto-flowering Cannabis" chart above to help you make decisions.

Growing plants that grow well in your climate and that are acclimated to local growing conditions pays off with 5-10+ (2.25-5.5 kg) harvests of dried flowers.

Select varieties that grow well in your climate. Note that you can compensate for inclimate hot and cold weather by choosing the proper planting location. Extend the growing seasons by growing in raised beds and overcome harsh weather by growing in a greenhouse. Grow plants indoors and move containers outdoors when the weather permits and set up a small season-extending greenhouse. Remember to harden-off plants when moving outdoors.

Outdoor growers in cool alpine and northern climates will need to concentrate on varieties that ripen in the geographically demanding conditions brought on by a short cold growing season. Sativa lovers will need to choose varieties that are crossed with short-season indicas and auto-flowering cultivars. Cannabis plants that grow well outdoors in harsh desert conditions are few and far between. The image above was taken in Switzerland.

The Super Lemon Mango cannabis plants and other sativa-dominant varieties are being acclimated to the tropical climate in Thailand. According to the grower, Ryan Doran, "in my experience the indica-dominant, northern latitude, strains do excellent in northern Thailand and there is no reason to use acclimated strains in the winter. I have had great success with a wide variety of seeds that are typically bred in northern climates such as; Grand Daddy Purple, White Widow, Money Maker, OG Kush, Orange Punch, Critical OG, and Blue Dream."

Ryan continues, "Due to the short light cycles here in Thailand, with the longest day being 13.5 hours this (17-18º) northern latitude, indica, plants will flower anytime under natural sunlight, so they require supplemental lights for the veg stage. The quality of the flowers grown with these genetics outdoors is on par with the best flowers from California."

Climates with temperatures above 50ºF (10ºC) both day and night from April-September offer the widest latitude of possibilities. Such climates give you the opportunity to grow all kinds of cultivars. In fact, if you start plants indoors and move them out when they are two-feet-tall (60 cm) you can grow a couple of crops.

This grow tent image was taken 17 years ago. You can see why grow tents have become so popular!

Indoor growers can cultivate seed varieties that mature into plants from 3-4 feet tall (90-120 cm). Artificial light will not penetrate foliage of tall plants. Lower branches do not receive enough light and grow wispy small flowers. Indoor growers generally cultivate low profile pure indica, indica-sativa crosses or auto-flowering plants.

Auto-flower growers can move seedlings outdoors when nighttime temperatures are a minimum of 50ºF (10ºC). A small plastic greenhouse to protect autos at night will spur growth. Warmer soil in raised beds extends the outdoor season too. Autos need at least 6 hours of direct sunlight to yield a decent harvest. See "Planting Auto-flowering Cannabis" below for more information about growing autos.

Ordering Cannabis Seeds

Cannabis seed companies advertise on the internet and in magazines. Read their seed catalogs carefully and follow the guidelines they recommend for varieties to grow indoors, in greenhouses and outdoors.

Call the seed company to ask questions based on the description of the seeds. Speak to a qualified representative who will provide good answers to your questions. Companies with an e-mail address and web site are usually okay to order from, but make sure they answer your emails promptly. Do not be afraid to call several companies and ask them specific questions about the varieties (AKA strains) they sell.

No regulatory agency exists to uphold genetic standards in the cannabis seed industry. A variety that is produced by "seed company A "will not be the same as the same variety as from "seed company B". If you find a specific variety you like, take clones and keep it. Share the clones with friends so that you do not lose the variety.

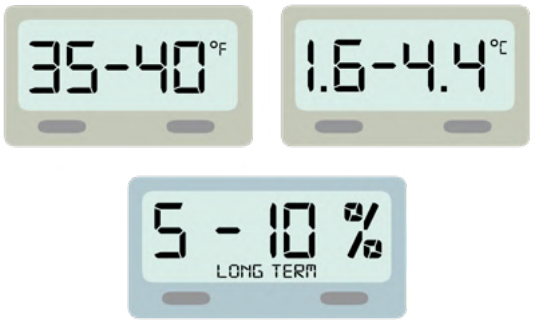
Growers buy seeds every year for several reasons. Growing feminized and auto-flower (feminized) plants produces a consumable harvest. Starting seeds saves you from having to make clones and you can grow the newest varieties. Regular seeds are more popular in the USA and other parts of the world than they are in Western Europe and surrounding countries.

Recessive genes do not appear until the F2 if you are saving seeds. This is another reason growers plant clones or purchase new seeds.

Air (oxygen), moisture and light are the three enemies of stored seeds. Quality seeds are packaged in airtight, impermeable, dark packets. I attempted to germinate 6-year-old improperly stored seeds from 12 different companies. The one company that packages their seeds in an airtight, impermeable dark envelope had a germination rate of 30%. None of the other seeds germinated.

Storing Cannabis Seeds

Store seeds in a dark, airtight container along with moisture-absorbent silica crystals. Remove seed every month and set silica crystals in a warm sunny location to dry out. Always label containers!



If storing seeds for a year or two, no need to employ a special "low humidity" refrigerator. If you require long-term storage, a low humidity refrigerator helps guarantee seeds remain viable.

Store seeds in a dry, cool, dark place. Make sure to label containers. Fresh seeds that you have grown and harvested will remain viable for up to five years or longer when stored properly using basic techniques. Low temperatures slow internal seed activity and are essential to preserve seeds. Low humidity is essential. Keep seeds in a low humidity environment. Keeping seeds in a refrigerator

When 50% of the stored seeds do not germinate, the average storage life is over. Old seeds often take longer to sprout and have a lower rate of germination.

Seeds with a hard outer cask are the most likely to sprout and grow well. Seeds with a thin, outer protective shell never truly go dormant, because moisture and air are always present within. This moisture and air cause hormone levels to slowly dissipate. Such seeds do not store well.

Seed hormones – ABA, cytokinins and gibberellins– are prompted into action when moisture signals germination to initiate.. Prevent moisture from signaling seeds to germinate by keeping them dry. Small amounts of condensed moisture can give seeds a false start on germination and cause them to expend all their stored energy too early. The seed will have no more stored energy to germinate properly. Avoid moisture levels above 5% if possible to help ensure viable seed long term, 5 years or more. Moisture levels above 5% will cause germination levels over time. Seal seed in an airtight container and place silica crystal packages in the container to absorb excess moisture. Keep seeds preserved longer and viable by vacuum-packing to remove oxygen.

Low-humidity refrigerators are expensive and beyond the needs of most gardeners. Saving seeds with conventional means should prove adequate and certainly more economical.

Seeds were germinated and nurtered properly to produce these strong seedlings. A perfect growing environment is created with LEDs.

CHAPTER FOUR

PLAN YOU GARDEN

Introduction

LED light fixtures illuminate this two-level indoor cannabis garden in California. Crops are harvested one day and replaced with new clones the next morning.

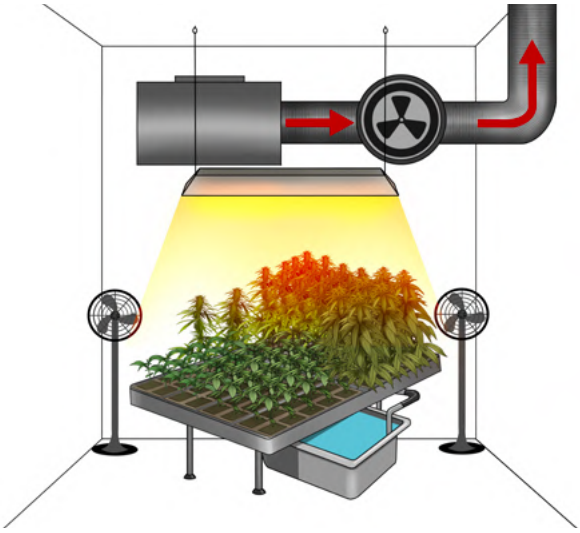
Plan your indoor garden on paper before investing any time or money. A few hours of planning and research on the internet will ensure a good start and increase your chances of success. What are your goals? Do you want to grow a single crop from seed to harvest? Do you want to grow a perpetual crop and harvest a few plants every week or two? Or do you want to harvest a crop every 2-3 months? Maybe you have designs on starting a big commercial garden. Are you an outdoor or greenhouse gardener who wants to get an early start on the growing season by starting plants indoors? Your decision will dictate the type of garden area you set up and the materials and supplies you will need.

Set a budget that fits your needs. A small area to start seeds that grow into plants a foot (30 cm) tall to transplant outdoors is inexpensive and requires a minor financial and time investment. Setting up a large space to produce several pounds (kg) per month requires a serious budget, planning and dedication. Remember that all gardens will require extra time to fine-tune the first few months. I have found that every time I set a budget for a project it always costs me more time and money than anticipated.

Site selection can limit the options for the type of indoor garden you can set up. Growing a few seedlings into plants that are 1-2 feet (30-60 cm) tall requires little space, electricity and ventilation. Large gardens require more space, electricity, water and ventilation. If you plan to grow a perpetual crop you will need at least two different rooms, one for seedling, clone and vegetative growth and a second room for flowering growth. Post-harvest drying and processing may require a completely separate room for larger crops.

Plan Your Garden

Single Crop



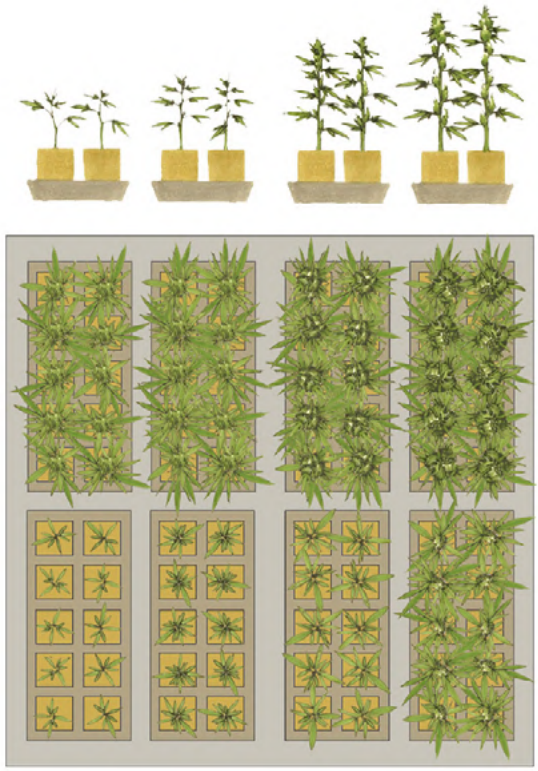
Growing in a single room is a good way to harvest a crop every 4-6 months. You can take the time to set up the garden properly and not be overwhelmed with growing plants when problems arise. Starting too many plants in a big room in a "get rich quick" scheme often results in a substandard harvest and in some cases, crop failure.

Purchase female clones legally at cannabis dispensaries or germinate seeds. Huddle small plants in containers under artificial light. Small plants in the vegetative growth stage need less intense light levels. Spread plants out and add more lights as their size increases. Set your timer to 18 hours of light and 6 hours of darkness for the vegetative growth stage. Induce flowering with an even 12 hours of darkness and 12 hours of light.

Set up a vegetative garden room. Apply the information in "Vegetative Room" below until plants are flowering size – 11-24 inches (30-60 cm) tall. Note: the room will need to be big enough to accommodate a flowering crop.

Induce flowering with a 12-hour day, 12-hour night photoperiod in the vegetative room. Apply the information in "Flowering Rooms" below.

Perpetual Crop



Two separate rooms are necessary to harvest a perpetual crop unless you are able to trust a clone vendor. The vegetative room should be about one quarter the size of the flowering room. This is a ratio of 1 to 4. Set up a vegetative room and a flowering room so that you can grow a perpetual crop. Take several clones from vegetative plants in the vegetative room every day or every week. Move the same number of plants to the flowering room daily or weekly. Harvest the same number of plants daily or weekly. Take clones of the same number of plants harvested. Actually, take 10-20% more clones to allow for mistakes.

Harvest a plant in the flowering room and move in a plant from the vegetative room into the flowering room.

Set up a vegetative garden room. Apply the information in the "Vegetative Room" below.

Set up a separate flowering room. Apply the information in the "Flowering Room" below.

Set up a separate post-harvest room. Apply the information in "Post-harvest Rooms" below.

Growth Stage	Time	Plants
Clone	2 weeks	30
Vegetative	2 weeks	10
Flower	8 weeks	30
Totals	12 weeks	

Big Gardens

Big gardens will require several rooms to nurture plants in each stage of life. Separate rooms for seedlings, clones and mothers are necessary to give each the exact conditions they

need. The seedling and clone rooms can be a part of a larger room as long as they are sectioned off so that temperature, humidity, ventilation and light levels can be controlled separately. The small plants use very little water and can be irrigated by hand. Small plants should be set up off the ground so that they can be visually monitored.

- Set up a separate seedling room. Apply the information in "Seedling Room" below.
- Set up a separate clone room. Apply the information in "Clone Room" below.
- Set up a separate mother room. Apply the information in "Mother Room" below.
- Set up a vegetative garden room. Apply the information in the "Vegetative Room" below.
- Set up a separate flowering room. Apply the information in the "Flowering Room" below.
- Set up a separate post-harvest room. Apply the information in the "Post-harvest Room" below.

Indoor, Greenhouse & Outdoor Crop

This outdoor garden in California started indoors under grow lights. Plants were transplanted into the greenhouse and the lights interrupted the nighttime dark cycle to maintain vegetative growth. The plastic you can see on the right is put back on the greenhouse at night to keep plants warm and protected.

Start seedlings and clones indoors under lights and move them into a greenhouse or outdoors. Grow small plants to 6-24 inches (15-60 cm) tall before transplanting outdoors. Small plants must be hardened-off when they leave the protected indoor environment before making the final move to harsher outdoor and greenhouse environments.

- Set up a separate seedling room. Apply the information in "Seedling Room" below.
- Set up a separate clone room. Apply the information in "Clone Room" below.

Seed and Seedling Room

Size and siting: A seedling room is usually small and can be as simple as an enclosed box with ventilation and adequate light. Unless you are growing vast quantities of seedlings, a small area is all that is needed. Avoid growing seedlings on a countertop in the bedroom, garage and protected corner of the garden room. These locations have their own climates – temperature, humidity, ventilation, lighting, etc. Seedlings will have to conform to this climate and often get a poor start in life. Seeds and seedlings are most fragile and vulnerable during their first few weeks of life. A slow start could haunt them all the way to harvest.

Lighting: Seeds need darkness to germinate. Provide them with warmth, humidity and air only. Once seeds are planted in a growing medium and sprout through the soil, they need low levels of light. A fluorescent lamp or indirect sunlight is all they need for the first week after sprouting through the soil. Increase light levels to filtered sunlight or move the

fluorescent lamp a little closer. You can add a low-wattage CFL bulb too.

Set timer to 16-hour days and 8-hour nights to promote more females and fewer males for regular seed varieties

Set timer to 18-hour days and 6-hour nights for feminized varieties and clones

Set timer to 20-hour days and 4-hour nights for auto-flowering varieties

Temperature: Seeds sprout best in a temperature range from 72-79ºF (22-26ºC). Warmer temperatures within this range usually speed sprouting. I like to keep temperatures at the ideal 75ºF (24ºC). Increasing bottom heat 2-3ºF (1-1.5ºC) speeds root growth.

Humidity: High humidity (90-100%) is necessary to moisten the outer shell to initiate germination. inside. Supply this humidity with a moist paper towel or similar material. Room humidity can be as low as 40-60%, but the moisture will evaporate quickly from the paper towel. Note: Seeds also need air, so do not soak them in water for more than 24 hours.

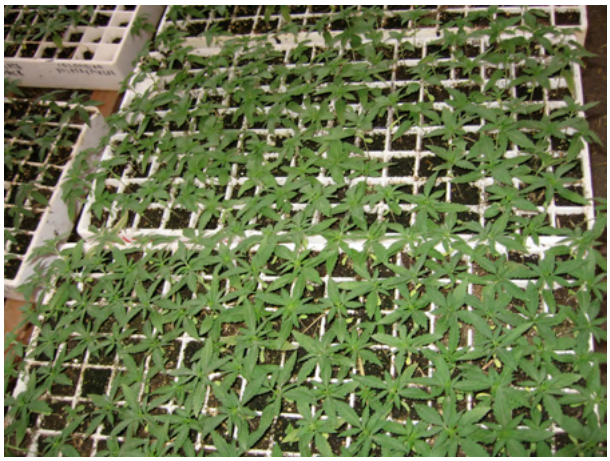
Air ventilation and circulation should be minimal during germination and seedling growth. Seedlings have a tiny fragile root system and are unable to withstand much wind. Air that moves a little and is not stagnant is perfect.

Rockwool rooting cubes hold a lot of air when saturated with water. They are easy to keep evenly moist for rapid seedling growth.

Water: Give germinating seeds and small seedlings distilled water or water with very low (<100 ppm) of dissolved solids and a pH between 6.0-7.0 for best results.

Nutrients: No nutrients are necessary for the first few weeks of growth. Some growers start fertilizing with a very mild nutrient solution after the third week of growth.

Growing medium: Transplant germinated seeds into a fine soil or soilless mix made for seedlings. These mixes hold a little more moisture to compensate for smaller growing containers, and the consistency allows roots to penetrate easily. Or transplant into preformed root cubes – Easy Plugs, Ellepots, Jiffy®, Oasis®, rockwool, etc. Use cubes that have similar water-holding-ability as the growing medium they will be transplanted into.



Containers: Small seed containers 1.5-2 inches (4-5 cm) across and 1.5-2 inches (4-5 cm) deep with a drainage hole are great if starting many seeds. Seedlings must be watered daily so the growing medium does not dry out. Grow in 4-inch (10 cm) pots if growing a few seedlings. Transplant germinated seeds into deep cell ((3 x 9 inches) 7-23 cm)) containers if you plan to transplant seedlings into Mother Earth outdoors or in a greenhouse.

Diseases and Pests: Damping-off rots seedlings at the soil line. Slugs, snails, and chewing insects are the main pests that attack seedlings. Seeds can carry diseases, and once germinated, diseases and pests can attack. Dip seedlings in a fungicide/pesticide solution when transplanting.

Commercial cannabis seeds must be shipped with a "phytosanitary certificate" that guarantees they are free of diseases and pests. Seed-producing females are often treated with fungicides so that they do not pass any pathogens along to seeds.

Kill any latent pathogens on seeds with a hot water treatment or soak in dilute hydrogen peroxide (H2O2). Hydrogen peroxide breaks down the outer coating on the seed and kills pathogens too. It is a chemical scarification of the seed to prepare for fast germination.

https://www.elevatedbotanist.com/grow-basics/seedgermination

Clone Room

Size and siting: A small clone room is necessary for small home gardens, but a big room is a must to produce many clones on a regular basis. A small setup can be as simple as an enclosed area with ventilation and adequate light. Large dedicated rooms are a must

for serious clone production. You can section off a small portion of a vegetative or mother room to stick clones. The small separate area requires temperature, humidity, air circulation and ventilation and lighting control. Clones are most susceptible to drying out, disease and pests from the instant they are cut until they have developed a strong root system. As with seedlings, a slow start now can plague clones all the way to harvest.

T-5 fluorescent tubes are fading away and being replaced by LED fixtures.

Lighting: Clones need low levels of light to survive while they are striking roots. Fluorescent lamps, low levels of CFL, LED lighting and ambient or highly filtered sunlight are all clones need to carry on life processes until they grow a strong root system. Once they have developed a strong root system, clones can utilize more intense light. After transplant shock has passed, clones can process light necessary for vegetative growth.

Set light timer to 18-hour days and 6-hour nights

Temperature: Clones root best in a temperature range from 68-78ºF (20-25.5ºC). Warmer air temperatures may not speed rooting. Keep temperatures at the ideal 75ºF (24ºC) for best results. As with seedlings, increasing bottom heat 2-3ºF (1-1.5ºC) speeds root growth.

Humidity: High humidity (85-95%) is necessary for the first couple of days after cutting and sticking clones. Place clones in a humidity tent or humidity-controlled room. They can handle lower humidity (70-85%) after the first 3-4 days because they are more acclimated to the environment.

Clones need a little air circulation and ventilation. Usually a humidity dome with at least two adjustable vents located on either side supplies enough natural airflow to be sufficient.

Water: Give rooting clones distilled water or water with very low (<100 ppm) of dissolved solids and a pH between 6.0-7.0 for best results.

Nutrients: Clones do not need any nutrients until after they are transplanted. Some growers start fertilizing with a very mild nutrient solution just before transplanting.

Growing medium: Stick clones into Ellepots or Easyplugs or into preformed root cubes – Jiffy®, rockwool, etc. You can also use fine soil or soilless mix that holds a little more moisture and plenty of air. The substrate must have plenty of air for clones to grow a strong root system. Use cubes that have similar water-holding-ability as the growing medium clones will be transplanted into.

Containers: Small seed containers 1.5-2 inches (4-5 cm) across and 1.5-2 inches (4-5 cm) deep with a drainage hole are great if taking many clones. Keep an eye on the medium, do not let it dry out and be careful to not overwater. Grow in 4-inch (10 cm) pots if growing a few clones. Take clones or transplant into deep cell ((3 x 9 inches) 7 x 20 cm)) containers if you plan to move them into Mother Earth outdoors or into a greenhouse.

Diseases and Pests: Diseases such as powdery mildew and damping-off are the two main pathogens that attack clones. Mother plants with powdery mildew pass it on to clones. Damping-off is typically the result of an overly moist growing medium. Dip clones in a sterilizing solution when transplanting. Any diseases and pests mother plants have are passed on to clones. Always start with clean disease- and pest-free mothers.

Mother Room

Size and siting: Mother plants need plenty of space to grow and should not be crowded. They are pushed very hard and live 6 months or longer. The extra space will help them stay healthy and avoid diseases and pests. Grow large mothers on tables and smaller plants can be grown on the floor.

Lighting: Mother plants need adequate CMH, MH or LED light for rapid growth.

Set timer to 18-hour days and 6-hour nights for regular and feminized varieties

Temperature: Vegetative plants grow best within a temperature range from 55-80ºF (13-27ºC). Keep temperatures from climbing beyond 80ºF (27ºC) to avoid internodal stretching in some varieties. Do not let day and night temperatures fluctuate more than 10ºF (5ºC) to promote faster growth. Water and nutrient usage change when overall temperatures are higher or lower for more than one day.

Humidity: A humidity range of 50-70% is OK for mother plants. Avoid higher (70%) humidity because foliage tends to turn soft and supple. Soft stems with soft foliage grow roots more slowly. Soft foliage is more susceptible to diseases and pests.

This mother plant will produce several crops of clones before she is flowered and harvested.

Air ventilation and circulation: Plenty of air circulation and ventilation is essential for mothers to grow fast and stay healthy. Diseases and pests are discouraged by good air flow. See "Vegetative Room" below for more information.

Water: Mother plants need low ppm water (<300) and pH around 6.0 for fastest growth. d

Nutrients: Follow a regular nitrogen-rich nutrient application schedule. Nutrients must have all micronutrients AKA trace elements. Use the same brand or mix of nutrients throughout the crop. Change nutrient regimen only when deficiencies or excesses occur.

Growing medium: Mother plants love a substrate that drains quickly but holds plenty of moisture and air at the same time. Mothers stay in the growing medium 6 months or longer so compaction can be a problem. Add extra expanded clay pellets or perlite to the substrate to increase drainage and discourage compaction.

Containers: Grow mothers in air-pruning containers to promote a more profuse root system. More roots grow in a self-pruning container; smaller containers can grow bigger plants. Or grow mother plants in individual hydroponic containers so that they receive all the nutrients they need to keep them growing fast and strong.

Diseases and pests: Mother plants are in the ground 6 months or longer and are heavily abused by taking cuttings. Diseases, especially powdery mildew, and pests including spider mites, are common. Inspect mothers daily for disease and pest damage. Diseases and pests are passed on to clones when mothers are tainted.

Cultural problems: When a nutrient is deficient or the mother is sick, the malady is passed on to her clones. Keep mothers healthy by supplying her exact needs.

Vegetative Room

Size and siting: Vegetative plants are smaller and take up less space. The vegetative room should be about 0.25 (one quarter) the size of the flowering room. Allow enough space for plants to grow up to 3 feet (90 cm) tall if you plan to move them outdoors. Setting plants on the floor allows for more vertical growth and is less expensive than setting up on tables. Grow tables allow for easier plant maintenance and extra storage or growing space below tables. Reservoirs can also be set under tables.

Lighting: Vegetative plants need less light than flowering plants. CMH, MH and LED lamps all provide

adequate light for rapid vegetative growth.

Set timer to 18-hour days and 6-hour nights for regular and feminized varieties

Set timer to 20-hour days and 4-hour nights for auto-flowering varieties

Air ventilation and circulation: Plenty of air circulation and ventilation is essential for mothers to grow fast and stay healthy. Diseases and pests are discouraged by good air flow. See "Vegetative Room" below for more information.

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Growing medium: Mother plants love a substrate that drains quickly but holds plenty of moisture and air at the same time. Mothers stay in the growing medium 6 months or longer so compaction can be a problem. Add extra expanded clay pellets or perlite to the substrate to increase drainage and discourage compaction.

Large females in the foreground are leafing out and getting ready to move into the flowering room after providing several crops of clones. Small plants in the background will be moved outdoors in 30 days.

Containers: Grow mothers in air-pruning containers to promote a more profuse root system. More roots grow in a self-pruning container; smaller containers can grow bigger plants. Or grow mother plants in individual hydroponic containers so that they receive all the nutrients they need to keep them growing fast and strong.

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Cultural problems: When a nutrient is deficient or the mother is sick, the malady is passed on to her clones. Keep mothers healthy by supplying her exact needs.

Flowering Room

Size and siting: The flowering room should be about four times larger than vegetative room. Flowering plants will put on more foliage during the first 3-4 weeks of flowering especially when they are given more intense light. You can calculate 40 x 40 inches (100 x 100 cm) square per flowering plant that is 4 feet (120 cm) tall including the container. This flowering room gains double the space by stacking plants on two levels.

Lighting: Ideally you are using LED grow lights. New LEDs are substantially more efficient than all other grow lights

including HIDs and CFLs. Add a HPS bulb if you are using a CMH or MH bulb. Add one 600w HPS for each 315 CMH. Add one 1000w HPS for each 630w CMH or 1000w MH bulb. Or change out your MH for a HPS of equal or greater wattage.

Set timer to 12-hour days and 12-hour nights to induce flowering for regular and feminized varieties.

Set timer to 18-hour days and 4-hour nights for auto-flowering varieties.

Temperature: Flowering cannabis grows best with 55-80ºF (13-27ºC), with the ideal at 75ºF (24ºC). Drastic temperature fluctuations cause stress and slow growth.

Humidity: Flowering cannabis loves a humidity range from 40-60%. This range keeps most mold and diseases at bay. Remember charcoal filters clog and stop filtering out fragrances when relative humidity climbs above 80%. Humidity climbs at night when lights go out. Extra venting is often necessary.

Air ventilation and circulation: Air movement keeps CO2-rich air available around foliage. Ventilation carries off fragrant CO2-depleted air and brings in new CO2-rich air to grow big flowers. Changing the air every minute in grow rooms keeps fragrance under control too.

Water: – Flowering plants use a lot of clean water. Check plants daily and irrigate as needed. Use a moisture meter to check for dry soil pockets.

Nutrients: Follow a regular phosphorus- and potassium-rich nutrient application schedule. Bottled-nutrient formulas must have all micronutrients AKA trace elements. Use the same brand or mix nutrients throughout the crop. Change nutrient regimen only when deficiencies or excesses occur.

Growing medium: Use the same growing medium as for vegetative plants.

Containers: Use the same containers as for vegetative plants. Do not transplant plants when moving from vegetative room to the flowering room.

Diseases and pests: Kill or stop any and all diseases on flowering plants as soon as they are noticed. Always use the least toxic way to control plagues. Inspect flowers and other foliage daily carefully so that you catch all problems immediately.

Cultural problems can get out of hand easily during flowering. Be very careful during vegetative growth to solve all cultural problems. Cultural problems that carry on into flowering are well entrenched and may take longer to remedy.

Post-harvest Room

Size and siting: Hanging plants and branches take up the most space. Hang branches 2-3 levels high if space and access permits. Hanging net baskets make most efficient use of space. Each hanging net shelf can hold about a half pound (230 gms) of manicured flowers. Site drying room in a cool location that is easy to regulate the temperature.

Lighting: Minimal lighting is necessary in a drying room. Plants do not need light to dry. Bright light and heat degrade drying cannabis. If trimming tables are located in the drying room, use small directional lights to illuminate the manicuring area.

Hanging cannabis branches and complete from drying lines is a simple low-tech method that takes more space.

Temperature: Cannabis dries best in a temperature range of 55-70ºF (18-21ºC). Cannabis dries too fast at temperatures above this range. Higher temperatures also liberate more of the fragrances. Lower temperatures cause it to dry too slowly.

Humidity: The ideal humidity range to dry cannabis is 55%. This humidity range will let it dry quickly enough to remove moisture, pigments, and other substances from stems, flowers and foliage. Fungus can become a problem in humid rooms. Adequate air ventilation and circulation are essential. The room may need a dehumidifier if ventilation is inadequate.

Modern drying practices have a low humidity (40%) for the first few days, to draw moisture from thick foliage and stems. Then humidity is ramped up to 65%, during the next 2-3 weeks. And reduced once again to 40% to finish the drying process.

Air ventilation and circulation: Constant air ventilation and air circulation 24/7 are necessary.

If fragrance becomes an issue, set up a charcoal filter fan to clean the air before expelling.

Diseases and pests: Fungus is the main disease that attacks drying cannabis. Avoid problems by following temperature and humidity recommendations above. Caterpillars and insects will drop to the floor from hanging plants. Corral them below hanging plants with sticky traps or spray the floor intermittently. Smear the ends of drying lines with sticky traps to contain spider mites and other insects. They bunch up at the end of the lines. You can smash them all at once every couple of days. Most pests are not interested in attacking drying cannabis.

Drying: Hang branches or in the worst case scenario, entire plants, from drying lines. Allow plenty of air in between hanging branches for air circulation. Hang net shelves to dry manicured buds. Hanging net shelves make the absolute best use of drying space. Two- and three-foot-wide shelves can hang closely together. Turn flowers on net shelves daily so that they dry evenly and do not have a "flat" side.

Manicuring: Set up folding manicuring tables and chairs as needed. Set tables up outside the drying room if possible.

Storage: Designate a clean, cool, dry, dark, place to set storage containers. Keep the storage area temperature below 60°F (15.5°C) and humidity as close to 40-50% as possible. Store harvested cannabis in labeled airtight containers. Label with name of variety and date harvested. Include any other pertinent details on the label too.

Clean up before planting the next crop. Harvest should be well-planned so that ripe plants are cut and removed from the garden area for processing. Remove all debris on the floor and on growing beds. Containers full of growing medium should be removed and separated. Scrub containers with soap and water. Compost used soil. Once the growing area is completely clean, move in new seedlings or clones.

Jaime Carrion, breeder of Cannatonic, displays medicinal cannabis plants he grew with Golden Triangle Group in Thailand.

CHAPTER FIVE

GROW ROOM SETUP

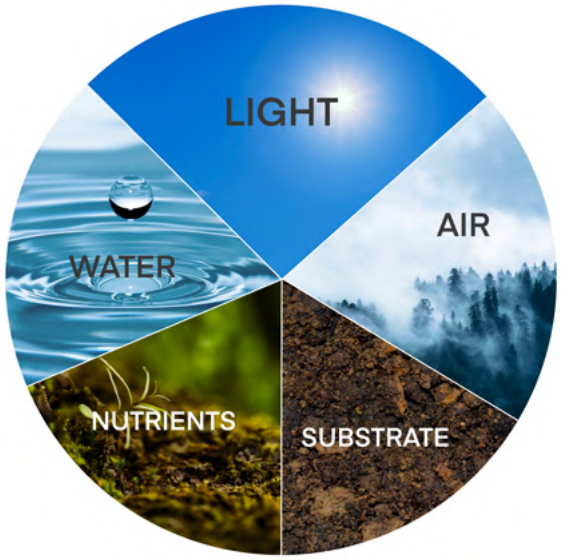
Introduction

Your goal as an indoor gardener is to supply your cannabis garden with the maximum proportions of light, air, water, nutrients and a substrate. Cannabis can grow to its fullest potential when given all of these essentials.

Each and every element, light, air, water, nutrients and growing medium must be functioning at 100% efficiency. If one element does not perform at 100%, all suffer. For example, if air is working at 80%, ALL elements suffer and cannot break the 80% barrier.

Keep these basics – light, air, water, nutrients and growing medium – in mind when setting up your grow room so that you can use all the natural advantages available. Site the grow room where it stays naturally cool with easy outlets for air ventilation. Nearby electrical outlets for lights, fans, timers, etc. are essential. A water source attached to a hose will save much manual labor. Setting up a low maintenance grow room will keep both you and your garden healthy and happy.

This chapter shows you how to set up your grow room so that lights, fans, water, nutrients and substrate function properly. They supply light, air, water, nutrients and a substrate to anchor cannabis plants for maximum growth.



Remember these five (05) essential variables with the acronym "LAWNS" – Light, Air, Water, Nutrients, Substrate. You must control each of these essentials to harvest a heavy cannabis crop.

Light 20%
Photoperiod
Intensity
Color spectrum

Air 20%
Temperature
Humidity
CO2 content

Water 20%
pH
EC
Oxygen content
Temperature

Nutrients 20%
Composition
Purity

Substrate 20%
Structure
Moisture content
Air content

Each and every element, air, light, water, nutrients and growing medium must be functioning at 100% efficiency for photosynthesis to occur in cannabis. If one element does not perform at 100%, all suffer. For example, if air is working at 80%, ALL elements suffer and cannot break the 80% barrier.

Site Garden Rooms and Post-harvest Room

Small garden rooms can be located in an easy-to-access sunroom or windowsill if growing seedlings or clones will move outdoors. Larger garden rooms are typically sited in an out-of-the-way space with little or no traffic. A corner of the basement or a spare bedroom that is not frequented by children, pets and other people, is perfect. Enclosed rooms are easiest to control. The room will need an entrance and exit for ventilation and electric service. A water source and floor drain will add much convenience and lower setup expenses. A door that locks will keep out unwanted people and pests.

Post-harvest drying and processing rooms need electric service and ventilation capabilities.

Windowsills and sunrooms are excellent spaces to start plants that will be moved outdoors. Plants must receive 5 hours of direct sunlight to grow well. A small sunny space is all you need to set small plants so that they can grow big enough to move outdoors.

Grow tents offer a simple and easy grow space. There are a few details

Grow tents or closets are a great value for many indoor and outdoor home gardeners. Grow closets are relatively inexpensive and they can be shipped directly to your home. They are freestanding and can be set up in any room in or near the house. When you figure the cost of grow room construction in your home and the cost of a grow closet, the closet is usually more economical. You will still need electricity, openings in the room for ventilation in and out. A water source will also save you time and energy.

Basements are often a perfect location for a garden room. Temperatures are easy to keep constant in an underground, earth and concrete insulated grow room. Usually equipped with water supply and drainage. In hot climates, a subterranean room may be the only place you are able to

grow. The basement must be clean and dry. Dank humidity-laden basements require extra ventilation to expel moist air. Patch all cracks in walls and floor. Paint walls with a waterproof paint so that moisture does not bleed through walls. Premium paints are epoxy-based and manufactured with a fungus inhibitor. A quick internet search for "anti-damp paint" will turn up many options.

Main floor grow rooms are usually plumbed for heating with hot air vents. Some homes may have central air conditioning. A window in the room provides a ready-made opening for air ventilation. Locate the main floor grow rooms next to a bathroom, laundry room or kitchen so water source is readily accessible. Always site the garden in the coolest room in home to minimize temperature fluctuations.

Outbuildings, including garages, workshops and barns, not attached to homes may need to be insulated to keep the temperature constant. The room will need openings for ventilation, a water source and water draining capabilities. Electrical service is essential. A water source will lower the workload. You can grow plants on a trailer and move it out into the sunshine during the day. This is an excellent way to harden-off clones and seedlings that will move outdoors.

Conex containers make great grow rooms and drying rooms. Steel containers are less expensive, but they get hot in direct sunlight and very cold when outdoor temperatures freeze. Burying the container will keep temperatures more consistent but add expense of burying. Aluminum conex containers were used to move perishables and are insulated. Temperatures are easier and less expensive to regulate in an aluminum conex. Both aluminum and steel containers have wooden floors. You can drill holes in the sides and floor to fasten shelves and partitions. Inspect containers before purchasing for holes. Conex containers are easy to sell too.

Used mobile homes are insulated and inexpensive. They already have electrical service, heating and cooling ducting, and plumbing. Moving an old mobile home requires a Highway Department permit. Contract a professional moving company about moving details. They get the permit, park it where you want, are insured and possess the required truck and special tools for the job. Older models may not comply with local electricity standards. You can gut the inside and assemble grow rooms. Standard widths are 8, 12 and 14 feet (0.90, 3.5, 4 m) wide. Double-wide mobile homes can be up to 28 feet (8.5 m) wide. Make sure to get the necessary permits and inspections before setting up your legal garden.

Attic garden rooms are a last resort if no other space is available. Typically, attic rooms are difficult to access and have no piped in water supply or drainage. Attics are usually hot during the summer when sunlight hits the roof and cold during the winter, especially when snow accumulates outside. If you have something to hide, grow in the attic.

Enclose the Garden Area

Remove everything that does not pertain to the garden. Furniture, curtains, books, etc. will accumulate moisture and could harbor diseases and pests. An enclosed room allows easy, precise control of everything and everyone that enters or exits, as well as who and what goes on inside. You can enclose the room by framing some plywood or even fabricating white plastic walls in the designated area. Turn on a light inside the room and check for cracks – light leaking outside the room. Insulate windows so that the temperature is easier to keep constant in the room. I have done several YouTube videos that show how to enclose and construct a grow room.

Prefabricated grow closets are a convenient alternative to spending time and energy constructing a grow room. A quick internet search for "grow closet" will net millions of results. Make sure to read the reviews and all the details about grow closets before investing.

White-out Walls, Ceiling and Cover Floor

Cover walls, ceiling, floor–everything–with a highly reflective material like flat white paint or reflective Mylar. The more reflection, the more light energy available to plants. Good reflective light will allow effective coverage of grow light to increase from 10% or more, just by putting a few dollars worth of paint on the walls. Reflective white Visqueen® plastic is inexpensive and protects walls and floors.

Ideally, the floor should be concrete or a smooth surface that can be swept and washed down. A floor drain is very handy. In grow rooms with carpet or wood floors, a large, white painter's drop cloth or thick, white Visqueen® plastic, will protect floors from moisture. Trays placed beneath each container add protection and convenience.

Specially designed paints for damp conditions contain a fungicide and are attracted by moisture. When applied to a damp, cracked wall, the paint is drawn into the moist crack to seal it off, preventing moisture from entering. An internet search for "moisture resistant paint" and "paint for moist basement" will show you available products. Wash walls with a 5% bleach solution to ensure they are clean.

Lighting and Electricity

Fluence LEDs illuminate this super productive indoor cannabis garden at Shango Farms in Portland, Oregon. Casey Rivero and head grower Josh are leading the tour.

Typically, hobby growers spend $100-$500 for a single grow light fixture that covers a 3 x 3-foot (90 x 90 cm) or a 4 x 4-foot (120 x 120 cm) area. Mounting heights vary from 1-3 feet (30-90 cm) depending upon the design of the LED fixture. The fixture must supply adequate amounts of usable light for cannabis growth over the entire garden canopy. Start with the highest rated PPFD (µmols/m2/second) LED light fixture you can afford. Look for µmols/m2/second above 2.0 for best results.

Measuring usable light for cannabis growth can become complex and confusing. To simplify a few complex measurements, I have condensed this information so that it is easy to understand. You will need to know the active growing area of your grow room, the height of the grow light fixture, the efficiency of the fixture and the hours the light is on.

Area - Square feet (m2) of grow room - length x width, light footprint - the physical area covered by light

Height of fixture - 1, 2, 3 feet (30, 60, 90 cm)

Watts of electricity – LEDs use 40% less electricity than HID, CFL, etc.

Grow light efficiency – measured in PAR, PPFD of 2-2.7 µmol/J for your grow

Hours of light – Photoperiod 18/6 veg, 12/12, 13.5/10.5 flower, Auto-flower 20/4 veg & flower

Many manufacturers, like www.MIGRO.com provide all the information you need – area, mounting height, usable light for plant growth and wattage of grow light fixture. The manufacturer will provide the correct mounting height for the area covered to illuminate the area with the optimum amount of light for plant growth. The information below summarizes the main points you need to know.

Area – Measure the square feet or m2 (length x width = sq ft (m2)) of the active garden area to be illuminated by grow lights. This is the area to be illuminated by the grow lights. Light that does not fall on plant foliage – walls and floor – is wasted.

Height of fixture – Hobby LED grow light fixtures are usually designed to be mounted at 1, 2 or 3 feet (30, 60, 90 cm) above the garden. When mounted at 1 ft. (30 cm) light reaching the canopy of the garden is bright, but the footprint is fairly small. As the mounting height increases, light coverage (footprint) increases and light intensity decreases.

Grow light fixture efficiency – measures how much usable light for cannabis growth a grow light fixture produces per watt of electricity. The fixture must throw an even footprint of intense light over the entire

garden area. Usable light for plant growth emitted from individual LEDs, HIDs, CFLs, etc. is expressed as "Photosynthetic Active Radiation" (PAR) watts. Light emitted by the entire grow light fixture that actually reaches the canopy of the actively growing garden is expressed as photosynthetic photon flux density (PPFD).

Measuring PAR

The best way to ensure cannabis plants receive enough usable light for growth is to measure it. A quantum sensor (AKA PAR meter) accurately measures Photosynthetically Active Radiation (PAR). Quantum sensors cost a minimum of $300. A quantum sensor measures individual photons in the PAR range at a single point. The measurement is recorded as Photosynthetic photon flux density (PPFD).

Smartphone apps for IOS and Android are accurate to a range of about 10% at measuring PAR/PPFD. Inexpensive lux and foot candle meters can also be used with a conversion factor. You can find the conversion factor charts at *www.migrolight.com*.

Photosynthetic photon flux (PPF) is the amount of PAR (number of photons between 400 and 700 nm) emitted from a lamp per second. The unit is micromoles (µmol) per second (s), abbreviated µmol•s-1 or µmol/s. This value is usually measured in a lab with an integrated sphere, which measures the total photons emitted from a lamp.

Photosynthetic photon flux density (PPFD) is the PPF incident upon a square meter (m2) with units of µmol•m-2•s-1 or µmol/m2-s. The PPF and PPFD are often used interchangeably and debate continues among plant scientists and engineers about which term is "correct." To avoid ambiguity, concentrate on the unit; if m2 is included, then the value refers to the intensity of PAR at a surface, which is usually measured at the top of a plant canopy. If m2 is not included, then that refers to the total amount of light emitted from a lamp (the PPF) and not the intensity at a particular location (the PPFD).

Hours of light – Photoperiod cannabis plants require 12-13.5 hours of light to induce and maintain flowering. You must use more intense grow light so supply all of the necessary light for rapid growth. Auto-flower cannabis can be given 20 hours of light during flowering. You can give auto-flowering cannabis less intense light for more hours to fulfill the Daily Light Integral (DLI) so that big fat flowers form. More hours of light pro.

Watts of electricity – High quality LED grow light fixtures produce almost twice as much light as High Intensity Discharge (HID) lights for the same amount of electricity consumed. Once PPFD is determined, watts-per-square-foot (Wm2) are a useful unit of measurement.

If your grow space is not a standard size you can calculate the area and the corresponding wattage to provide the PAR intensity with the table in the section 'grow light wattage guide'.

Recommended PAR intensity

Seedling stage

Both auto-flower and photoperiod cannabis seedlings (under three weeks old) need low-PAR intensity of about 250 µmols/m2/second. A lower PAR intensity prevents fragile plants from being damaged by bright light.

Vegetative stage

For photoperiod plants older than the seedling stage or about 3 weeks we recommend a PAR intensity of about 500µmols/m2/second and increase evenly through the vegetative stage up to 900 µmols/m2/second when switching over to flowering.

Auto-flower older than the seedling stage or about 3 weeks old we recommend PAR intensity to about 300µmols/m2/second and increase through the vegetative stage up to 550 µmols/m2/second when switching over to flowering.

Flowering stage

Photoperiod flowering cannabis illuminated 12 hours per day needs to receive 500-1000 µmols of PAR light for every m2 (PPFD) to flower properly, lower levels of PAR light slow rapid growth. Higher PAR intensity does not increase growth rates enough to justify the extra energy cost.

Auto-flowering cannabis needs a lower maximum PAR intensity of about 550µmols/m2/second. This is explained and detailed later in this chapter.

Head grower, Josh from Shango Farms in Portland Oregon demonstrates high PAR value of Fluence LED grow lights.

Daily Light Integral or DLI

Daily light integral (DLI) describes the number of photosynthetically active photons (individual particles of light in the 400-700 nm range) that are delivered to a specific area over a 24-hour period and is measured in moles of light (mol photons) per square meter (m−2) per day (d−1), or: mol·m−2·d−1

An average PAR intensity of 900 µmols/m2/second will deliver 900 x 60 seconds x 60 minutes x 12 hours = 34.56 Mols/m2/day.

Overall, the maximum PAR most plants can absorb in a day is about 50 mols. Above 40 mols, growth rate decreases. However using elevated CO2 can enable more efficient absorption of high PAR intensity above about 45 Mols.

PAR intensity for Autos and Photoperiod plants

Photoperiod flowering cannabis that receives only 12 hours of light per day must take in the entire DLI necessary in 12 hours. This requires very high PAR levels of light. The average PAR of up to 900 µmols/m2/second is necessary to maximise the potential yield.

Auto-flowering cannabis can flower under 20 hours of light per day. Auto-flowering plants require lower levels of light during flowering to reach their DLI. The average PAR of up to 550 µmols/m2/second is necessary to maximise the potential yield.

Grow Light Wattage Guide

Photoperiod flowering cannabis requires 900 PAR to achieve a DLI of 40 In 12 hours. Photoperiod and feminized cannabis plants require 12 hours or more of uninterrupted darkness to flower. This leaves only 12 hours of daylight or artificial light to supply the DLI.

Regular - 12-hour days

Grow Light	Efficiency	Target PAR	DLI 12 hrs	Watts/m2	Watts/sq ft
White Red LEDs	2,4	900	40	330	30
White LEDs	2	900	40	400	35
Blurple LED	1,4	900	40	600	50
HPS	1,4	900	40	600	50
Fluorescent	0,7	900	40	1150	100

Auto-Flower - 20-hour days

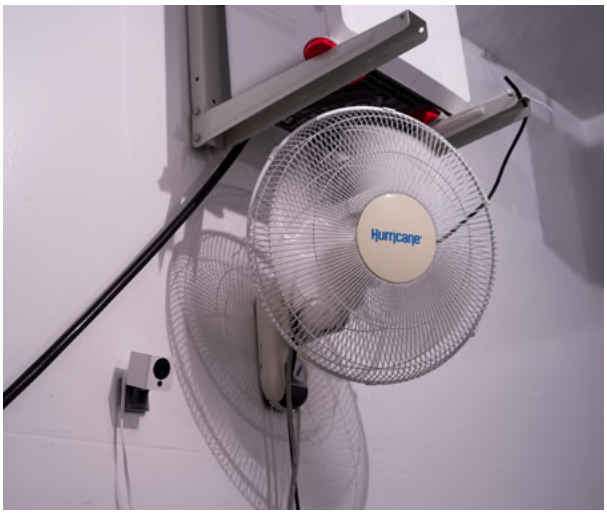
Grow Light	Efficiency	Target PAR	DLI 20 hrs	Watts/m2	Watts/sq ft
White Red LEDs	2,4	550	40	230	20
White LEDs	2	550	40	280	25
Blurple LED	1,4	550	40	400	35
HPS	1,4	550	40	400	35
Fluorescent	0,7	550	40	800	75

Measuring grow light intensity at the canopy of the garden will tell you exactly how much light is available for plant growth.

Air Ventilation and Circulation

Air ventilation and circulation: Good air flow inside the room is essential to keep air from stratifying in the room and around foliage. Adequate air circulation also discourages diseases and pests. Changing the air in the room is essential to allow a fresh supply of CO2 and to expel stale used air. Ideally, the air in a small-to-medium-size grow room should be replaced every minute or two.

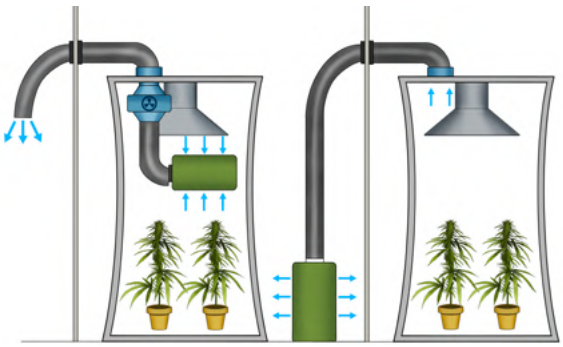
Constant air circulation and a supply of fresh air are essential but often inadequate. There should be at least one fresh-air vent in every grow room. Vents can be an open door, window, or duct vented to the outside. An exhaust fan vented outdoors usually creates an adequate flow of air. An oscillating fan works well to circulate air. When installing such a fan, make sure it is not set in a fixed position and blow too hard on tender plants. It could cause windburn and dry out plants, especially small seedlings and clones. If the room contains a heat vent, it may be opened to supply extra heat or air circulation. Read "Setting Up the Vent Fan" below for more information.



Wall-mounted oscillating fans circulate grow room air and are up out of the way during maintenance.

The temperature in the grow room tends to stay the same, top to bottom, when the air is circulated with an oscillating fan(s). In an enclosed grow room, HID lamps and ballasts radiate heat, often enough to heat the room. Fluorescent and CFL fixtures radiate less heat, and LEDs emit the least amount of heat of all grow lights. A remote ballast placed near the floor on a shelf or a stand also helps break up air stratification by radiating heat upward. Grow rooms in cool climates stay warm during the day when the outdoor temperature peaks, but often cool off too much at night when cold temperatures set in. To compensate, turn on grow lights at night to help heat the room but leave it off during the day.

Intake air is supplied in some garden rooms and small greenhouses via cracks and holes, but most enclosed rooms need a designated intake vent. Sealed grow areas require an intake vent or fan to draw in new fresh air. An intake vent allows air to passively flow into an enclosed area. An intake fan blows fresh air into the garden room or greenhouse. Airflow through ducting is impaired.



The concave walls show the negative pressure in the room. The negative pressure makes life very difficult for diseases and pests.

Negative pressure in the grow room makes life difficult for diseases and pests to live. Negative pressure helps keep the atmosphere inside the grow room stable and isolates the fragrance of growing cannabis too. A simple way to check for negative pressure in a grow room is to open the door. The door should open and close easily when intake and vent fans are turned off. When the intake and vent fans are turned on and create negative pressure in the room, the door should be difficult to open. An air entrance/exit ratio of 1:4 (a 20% differential) will create negative pressure in the grow room, for example a 100 cfm [m3/h] incoming fan and a 400 cfm [m3/h] exhaust fan will give the room negative pressure.

This carbon filter mounted directly to an efficient in-line extraction fan evacuates air efficiently out of the grow room. The filtered air keeps the fragrance of cannabis inside the grow room. The outer dust and particulate filter is easy to remove and clean.

Heating and Cooling

An oscillating circulation fan distributes cool air from an air conditioner.

An electric heater in the greenhouse can keep the temperature warm so that plants do not suffer.

Sometimes it is too cold for lamps and ballasts to maintain satisfactory room temperatures. Grow rooms located in homes are usually equipped with a central heating and/or air conditioning vent. The vent is usually controlled by a central thermostat that regulates the temperature of the home. By adjusting the thermostat to 68ºF (20ºC) and opening the door to the grow room, it can stay a cozy 68ºF (20º C). However, using so much power is expensive. Keeping the thermostat between 60-65º F (15-18ºC), coupled with the heat from the light, may be enough to sustain 68ºF (20º C) temperatures. Other supplemental heat sources such as electric heaters are somewhat expensive and draw extra electricity, but they provide instant heat that is easy to regulate. Avoid diesel and wood heat unless it is vented properly. Propane and natural gas heaters increase temperatures and burn oxygen from the air, creating CO2 water vapor as by-products. This dual advantage makes using a CO2 generator economical and practical.

If temperatures drop more than 10ºF (5ºC) when the lights go out in a grow room, relative humidity climbs quickly. The humid air must be evacuated so that it does not condense.

HIDs lamps and ballasts radiate heat, which lowers humidity. Fluorescents and CFL fixtures radiate less heat than a HID system. LED fixtures emit the least amount of heat. Heat from the grow light fixture and a vent fan on a thermostat/humidistat are all the humidity control necessary for most garden rooms. Dry heat sources that lower humidity include hot air vented from a furnace or wood stove. Do not direct piped-in warm dry air to blow directly on foliage. Hot dry air dehydrates cannabis plants quickly.

Increase humidity by misting the air in clone rooms, garden rooms and greenhouses with water or set out buckets of water to evaporate into the air in small enclosed gardens. Usually irrigation water evaporating from the soil surface adds more than enough humidity to the enclosed area.

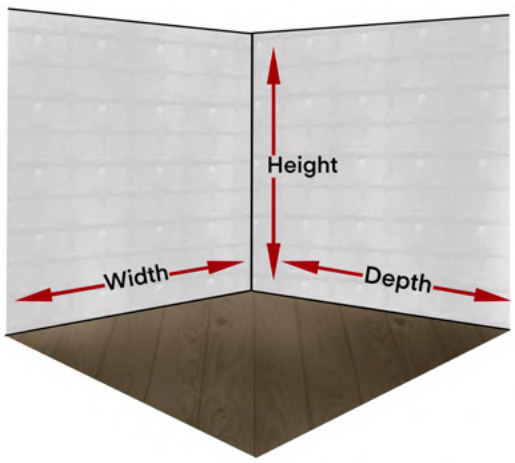
A humidifier is convenient and relatively inexpensive. Humidifiers evaporate water into the air to increase relative humidity. Set the humidifier control to a specific humidity level. This level of humidity is achieved when enough water evaporates into the air. A humidifier is not necessary unless there is an extreme problem with the grow room drying out. More often than not, high humidity results as a byproduct of irrigation and transpiration.

A dehumidifier removes moisture in a room by condensing it from the air. Once the water is separated from the air, it is captured in a removable container, piped into a container or directed down a drain. Interestingly enough, the expelled water carries a strong enough fragrance of cannabis that can be detected by a sniffer dog. Use the collected water for irrigation, it has a neutral pH and low ppm value. You may be amazed at the amount of water in the air. For example, a dehumidifier will remove about 10 ounces (30 cl) of water in a 10 × 10 × 8-foot (21.5 m2 room when the temperature drops just 10ºF (5ºC).

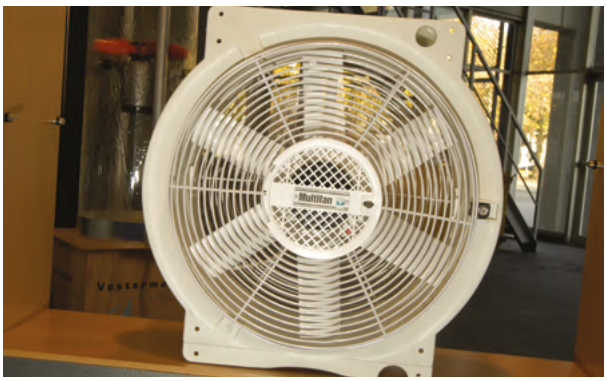
Dehumidifiers are often used to discourage fungi. Relative humidity control is an integral part of insect and fungus prevention and control. Humidity above 80% discourages spider mites but promotes fungus as well as root and stem rot. Humidity levels below 60% reduce the chances of fungus and rot. Lowering relative humidity during flowering to about 50% keeps plants growing strong and healthy.

Dehumidifiers are more expensive and use more electricity than humidifiers. Air conditioners, although expensive to operate, dehumidify the air. Install an air conditioner in warm climates to cool and dehumidify the enclosed area.

Setting Up the Vent Fan

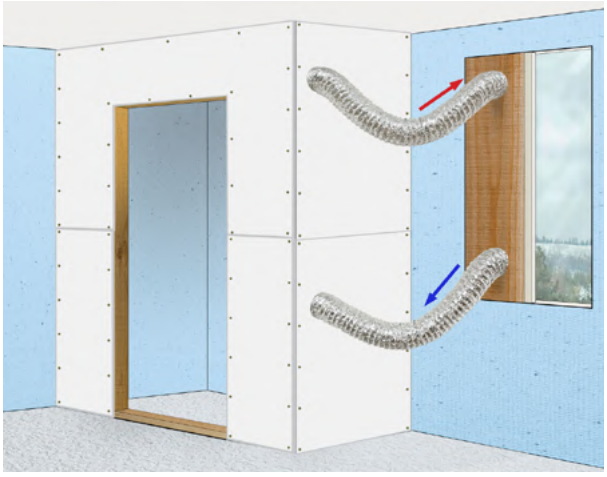


Step One: Calculate the total volume of the enclosed garden room. Length × width × height = total volume. For example, a grow room that is 10 × 10 × 8 feet (21.5 m2) has a total volume of 800 cubic feet)10 x 10 x 8 feet = 800 cubic feet, 3.04 m x 3.04 m = 9.24 cubic meters (m3).



Step Two: Use a vent fan that will remove the total volume of air in the room in 1-5 minutes. Vent fans are rated in cubic feet per minute (CFM) (M2/min) that they can move. Look for a fan with a high enough CFM (M2/min) to evacuate your grow room in 1-5 minutes. Buy a fan that can easily be mounted on the wall or "in-line" in a ducting pipe. Quality "in line" fans move large volumes of air quietly and efficiently. It's worth spending the extra money on an in-line fan. Small rooms can use a fan that can be attached to a flexible 4-inch (12 cm) dryer hose. Many stores sell special ducting to connect high-speed squirrel blowers with the 4-inch (12 cm) ducting. Ideally you can mount a vent fan like the one above to move air directly outdoors. Extracting air with no ducting is the absolute best way to air out of the garden room efficiently.

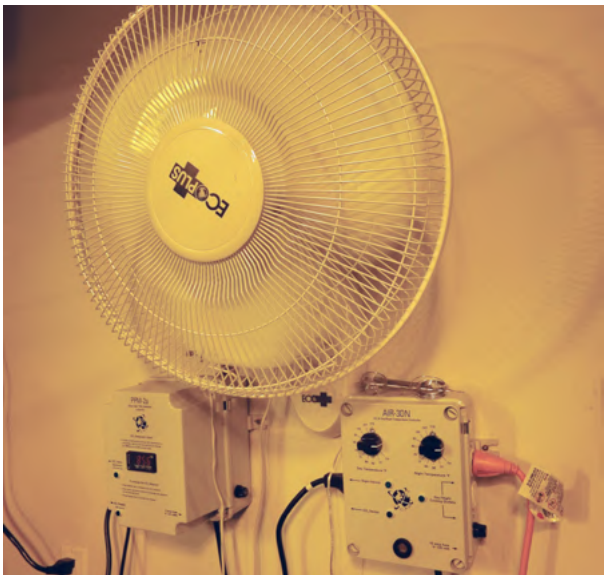
Step Three: Place the fan high on a wall or near the ceiling of the grow room so that it vents off the hottest, most humid air. If possible, cut a hole in the wall and secure the fan in place over the hole so that no ducting is needed. Most locations require special installation. See: Steps 4-8 below.



Step Four: To place a fan in a window, cut a 0.5-inch (1.5 mm) piece of plywood to fit the window frame. Cover the window with a light proof dark-colored paint or similar covering. Mount the fan near the top of the plywood so it vents air out of the grow room. Secure the plywood and fan in the windowsill with sheet rock screws. Open the window from the bottom.

Step Five: Another option to make a light-proof vent is to use 4-inch (12 cm) flexible dryer ducting. Vent the hose outdoors and attach a small squirrel cage fan to the other end of the ducting. Make sure there is an airtight connection between the fan and hose by using a large hose clamp or duct tape. Stretch the flexible ducting so it is as

Timers for fans, pumps and lights are inexpensive and easy-to-use.



Step Six: Or attach the vent fan to a timer and run it for a specific length of time. This is the method used with CO2 enrichment. Set the fan to turn on and vent out used CO2-depleted air just before new CO2-rich air is injected.

Water

Gardens need more water as plants grow bigger. A 10 × 10-foot (3 x 3 m) garden may need more than 50 gallons (190 L)

per week. Carrying water is hard, regular work. One gallon (3.8 L) of water weighs eight pounds (3.6 kg); 50 × 8 = 400 pounds (180 kg) of water a week! It is much easier to run in a hose with an on/off valve or install a hose bib in the room than to schlep water. A three-foot (90 cm) watering wand attached to the hose on/off valve makes watering easier and saves branches from being broken when watering in dense foliage. Hook up the hose to a hot and cold water source so the temperature is easy to regulate.

A drain in the floor is the most convenient way to remove excess irrigation water. If no floor drain is available, you can lay down a swimming pool liner or some impermeable cover on the floor. Run a lip up the walls about 4 inches (10 cm) to contain any water spills. The covering will contain excess irrigation water but it will not drain. Have a mop and bucket handy to clean up standing water on the floor.

Fertilizer

Nutrient concentrations typically appear prominently on the face of the commercial fertilizer packages in a "guaranteed analysis." The N-P-K numbers on the label give the percentages of nitrogen, phosphorus and potassium. Nitrogen is listed as total combined elemental. Most hydroponic fertilizers break nitrogen into fast-acting nitrate that is immediately available. Ammonium and urea go through a nitrification process to turn into nitrate, which a plant can use. Ammonium and urea are slower acting because the nitrification process takes a little time. Phosphoric anhydride (P_2O_5) is listed as the form of phosphorus, but this figure understates phosphorus content by 44%. The balance (56%) of the phosphorus molecule is oxygen. Twenty percent P_2O_5 is 8.8% actual phosphorus. Potassium (K) is listed in the potash form of potassium oxide (K_2O) of which 83% of the stated value is actually elemental potassium.

The rest of the mineral nutrients are listed in their elemental form that represents the actual content. Most often, the mineral elements used in fertilizer formulas are listed in chemical compounds on the label. Look at the fertilizer labels to ensure that the elements, especially non-soluble trace elements, are chelated and readily available for root absorption.

Nutrients in most parts of the world are measured in parts-per-million (ppm), even though they are expressed as a percentage concentration on the label. The ppm scale is simple and finite–almost. The basics are simple: one part per million is one (1) part of 1,000,000, so divide by one million to find parts per million. To convert percentages into ppm, multiply by 10,000. For example: 2% equals 20,000 ppm. For more information on ppm and Electrical Conductivity, see chapter eighteen, Container Culture & Hydroponics.

Fertilizers are either water-soluble or partially soluble (gradual-release). Both soluble and gradual-release fertilizers can be organic or chemical.

Soluble Chemical Fertilizers

Soluble salts fertilizers are an excellent choice for container cultivation. Water soluble fertilizers applied in solution make controlling growing medium nutrient levels more precise. Soluble fertilizers dissolve in water and are easy to control. They can be easily added or leached out of the growing medium. In general, hydroponic fertilizers that use soluble food-grade nutrients cause few problems. Avoid low-quality fertilizers that do not list all necessary micronutrients on the label.

Slow-release chemical granular fertilizers such as Osmocote™ work well but are easy to over-apply in containers. They are almost impossible to leach from growing medium fast enough to save plants in containers. These time-release chemical fertilizers are used by many plant nurseries because they are easy to apply and only require one application every few months. Using this type of fertilizer on your outdoor cannabis garden is convenient. In a container exacting control is lost. Osmocote-type fertilizers are best suited for perennial and annual plants where labor costs and uniform growth are the main concerns.

Organic Fertilizers

Pre-packaged organic fertilizers, although often expensive, are convenient and preferred by most home gardeners growing cannabis in containers. Concentrated soluble organic fertilizers are available from many manufacturers. See the new digital Sixth Edition of Marijuana Horticulture for more information about commercial.

Organically grown cannabis has a sweeter taste and creates a small carbon footprint. Outdoor gardens naturally lend themselves to organic principals to build the soil. Container gardens contain a limited amount of soil and the necessity for sanitation must be considered when growing organically. Outdoors, organic gardening is easy because all of the forces of nature are available to harness. Indoors and in greenhouses only few of the natural phenomena are free and easy. The nature of growing in containers does not lend itself to long-term organic soil management, but some organic techniques have been practiced with amazing success.

Organic container gardens typically use soil that contains worm castings, peat, manure, leaf mold, compost, etc. In a container, there is little space to build the soil by mixing compost and organic amendments. Even if it were possible to build the soil in a container, organic activity consumes months of valuable growing time. Diseases and pests also enter the equation. It is easier and safer to throw old, depleted soil outdoors and start new plants with fresh organic soil.

Organic nutrients work very well to increase the soil nutrient content, but nutrients are released and available at different rates. The nutrient availability may be difficult to calculate, but it is fairly difficult to over-apply organic fertilizers. Organic nutrients are typically available more consistently when used in combination with one another. Growers often mix up to 20% worm castings with other organic agents to get a strong, readily available nitrogen base. They fertilize with bat guano, the organic super bloom, during flowering.

A greenhouse using raised beds allows true organic methods to function properly. The raised beds have enough soil to hold the nutrients and promote organic activity. When managed properly organic soil will provide the bulk of nutrients.

Outdoor organic gardens are easy to implement and maintain organic practices. Using compost teas, compost, manures, and big, bulky amendments is easy outdoors. Organic amendments and fertilizers can be heavy and bulky. Make sure to allow enough space to store and move them easily.

Compost and Compost Teas

Compost and compost teas are used by many organic gardeners as both an amendment to build soil and to supply nutrients to cannabis. Compost is inexpensive, abundant, and works wonders to increase water retention and drainage. Biological activity within the pile also increases nutrient uptake in plants. Indoors, compost is not as practical to use in containers unless it has been hot composted and is free of pests and diseases. Unfinished compost could have unwanted guests. I do not advise using compost in indoor gardens because it could harbor unwanted diseases and pests.

Mix nutrients in a sink or an area that can withstand water and nutrient solution spills. Keep nutrients in a cool dry place outside of the grow room to avoid degradation. Keep a written record and calendar of your irrigation and nutrient application schedule. I like to take photos of the garden and specific plants every week. Weekly images are a great way to keep track of growth and progress.

Substrates

Growing in containers is completely different than growing in Mother Earth outdoors or in a greenhouse. Container culture and hydroponics require that all nutrients are delivered to a relatively small volume of substrate. The substrate must provide the proper environment to anchor the plant and have plenty of air (oxygen) and the proper available nutrients in solution ready for uptake. Controlling the substrate environment requires basic knowledge about the qualities of the substrate and how to prepare it for cultivation and maintenance. Each substrate requires different preparation and maintenance. Get the most from substrates by choosing the proper growing and irrigation system. Some substrates are most effective when mixed together.

Substrates are the materials in which cannabis roots grow in containers. Healthy, vigorous growth and flower production all starts with the roots. The substrate you choose for container cultivation will have a profound effect on your crop. The reason for this is that the substrate may provide any or all of the following five functions:

1

Physically support the plant.

2

Water retention in an available form for uptake the plant.

3

Allow the gas exchange between the root zone and the atmosphere.

4

Provide the plants with essential nutrients.

5

Sustain the root zone swelling microbes critical for nutrient cycles, and the suppression of pests and diseases.

Total pore space

Pore space is a very important quality of a substrate. Pore space has a profound effect on both air and water retention and, therefore, a profound effect on root health. The substrates most commonly used for containerized cannabis production have a typical pore space in the range of 75% to 90%. Where your substrate falls in this range depends on your choice of substrate material and the proportions of the aggregates that are in your mix. The key point is that most of the volume of the substrate in your container is the pore spaces between the solid particles. Even more important than total pore space is the size of the pore spaces. The critical properties of water retention and air-filled pore space are determined by not only the size but the amount of different sizes of pore spaces your substrate contains.

Air-filled pore space

When a container is watered to the point of runoff, the pores of a substrate are saturated. When allowed to drain, the larger pore spaces can't hold the water against the force of gravity, and they become air-filled. The substrate is now holding the maximum amount of water possible. This is referred to as "container capacity". Air-filled pore spaces are what make the gas exchange between roots and atmosphere possible. Gas exchange is critical for providing the roots with needed oxygen for respiration. Too little air-filled pore space increases the chance of root rot and the root zone may become anaerobic. Anaerobic conditions cause the buildup of ethanol, ethylene and hydrogen sulfide gas. Air-filled pore space of 10%-20% is recommended for container growing. To illustrate, an 80% sphagnum peat and 20% perlite mix has an air-filled pore space of 10% to 13% in a 4 inch container. The air-filled pore space may be increased by the addition of materials such as perlite, water resistant rockwool granules, pumice, etc.

Air-filled pore space and container capacity define the condition of the substrate after drainage in a specific size container. Container height has a big effect on the water retention and air-filled pore space of a substrate. These important physical properties vary as the height of the container changes. When discussing air-filled pore space and water retention keep in mind that it is always relative to container size.

Water-holding capacity

A substrate's most important function is retaining water and fertilizer solution available for uptake by the roots. If the water-holding capacity of the substrate is too high, then too many of the pores are retaining water and might result in insufficient air-filled pore space. This can lead to increased disease and pest pressure. Also a substrate that retains too much water requires less frequent irrigation which results in reduced fertigation. You are then faced with the choice 0f either nutrient deficiencies from inadequate fertigation or overwatering in order to give your crop enough nutrients. A substrate lacking in water-holding capacity requires frequent irrigation and the plants will be prone to water stress.

Water retained by a substrate is not completely available to the roots for uptake into the plant. There is easily available water which is held at a low tension in the substrate. There is available water, some of which can be held at a much higher tension than easily available water. The plants need to work a little harder to access this water. Some water is held tightly by the forces of cohesion and adhesion on the fine particles of the substrate and are unavailable for use by the plants.

Water-holding capacity and air-filled pore space are influenced not only by the aggregates that are mixed to create a substrate, the size and shape of the container also determines water and air retention. A tall 5-gallon bucket will hold less water and more air that a shorter, wider 5-gallon container filled with the identical substrate. This happens due to the force of gravity which causes a layer of water saturation to form at the bottom of the container. This is called a perched water table. A given substrate always has a constant height of perched water table. A shorter container with a larger diameter has a larger volume of substrate within the perched water table zone and so it holds a larger volume of water and less air than a taller, narrower container.

This is important because a root substrate that works well in a tall container, may have too high of a water-holding capacity and too low of an air-filled pore space when placed in a short container. Therefore, the container in which the substrate is being placed should be considered when designing a substrate."

Several substrates– coco coir, coco coir/perlite mix, rockwool, soilless mix and expanded clay pellets are the most commonly used by container and hydroponic growers. Each substrate is unique and has distinct strengths and weaknesses. Each has different requirements for preparation and maintenance. You must prepare and maintain each substrate according to specific parameters so that you can harvest a heavy cannabis crop.

Coco Coir is very popular. Once prepared, coco coir holds air even when saturated for short times and it allows the maximum amount of nutrients in solution to be available for roots to uptake. It is more work to prepare for cultivation and requires daily monitoring of the nutrient solution. Coco coir is perfect for top-feed container systems. Hand-watering is difficult because coco coir must be watered at least once every day. Automatic fertigation systems work best. Dry coco is lightweight to ship and handle. Different grades of coco are available in compressed dehydrated bricks or in uncompressed plastic bags. Cost per cubic foot – Brick, $13, Washed, $15.

Coco/perlite mix is super popular and a very economical substrate. Adding perlite to coco coir improves drainage, increases the air-holding ability, and cuts the cost of the substrate immensely. Coco coir/perlite 50/50% mix costs $9.00 per cubic foot.

Perlite is a lightweight inexpensive additive that increases drainage and air-holding ability. It is problematic when used as a standalone substrate. Mix perlite with other substrates

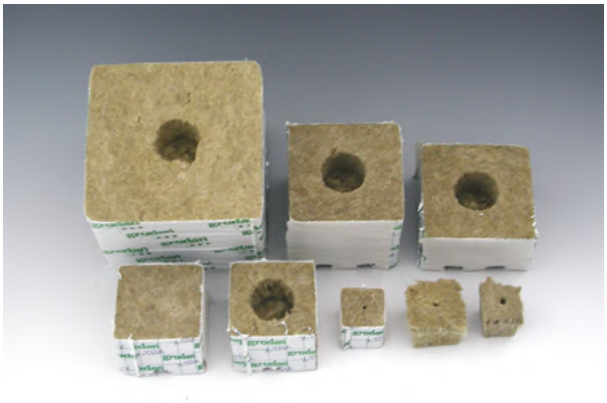
including coco coir, soilless mix, and potting soil to increase drainage and air-holding ability. Also enjoy the cost cutting benefits when you add perlite to other substrates.

Peat moss contributes to half or more of soilless mixes and is included too. Vermiculite is included but with less information. Other substrates such as scrounged items, foam, milpito, washed gravel, rice hulls, sand, sawdust, etc. are low-cost substrates that come with their own set of complications and are covered at the end.

Sphagnum moss and sphagnum "peat" moss have been common potting soil and soilless mix ingredients for decades. Peat moss is the most commonly available sphagnum moss. Both grow in wetlands in northern climates. Peat holds plenty of water and air. It is mixed with perlite and other amendments to make potting soils and soilless mixes. Peat tends to break down after a crop and has special requirements for mixing, watering, and reusing.

Soilless Mix works well in top-feed containers. It is relatively inexpensive and lightweight. You supply all of the nutrients via the nutrient solution which makes control easy. Soilless mix is low-maintenance and can be irrigated by hand or automatically.

Rooting cubes and plugs are outstanding. Rockwool cubes, Jiffy cubes, and polymer-bound plugs save time and energy. Each one has specific qualities.



Rockwool, AKA stone wool and mineral wool, works great to germinate seeds and root clones. Small cubes are relatively economical and easy to maintain the proper root zone nutrient solution to air ratio. Cubes also transplant into other growing mediums easily with little or no root damage.

Available in cubes, slabs, and granules, this sterile substrate has the ability to hold 20% air and 80% nutrient solution. Rockwool must be conditioned and buffered, to lower pH and add a nutrient solution. Cubes are easy to hand-water, an automatic watering system – flood and drain, or top feed – must be set up to keep roots in large cubes, slabs and loose rockwool bathing in nutrient solution.

Expand Clay Aggregate (LECA) are porous clay pellets that hold air and nutrient solution on their surface and within it´s internal structure. They are pH-neutral and must be kept moist so that roots do not dry out. LECA can be mixed with other substrates including coco coir, soilless mix and potting soil to improve aeration. Reusable many times but washing away red dust that sheds and sterilizing is a bit of a messy job.

Potting Soil is great for top-feed containers. Although expensive, potting soil is naturally forgiving and requires less care than other substrates. Potting soil requires fertigation less often so that nutrients have plenty of oxygen in the substrate to become available.

Custom Potting Soil Mixes are made with grower Tender Loving Care (TLC). Please take a look at some successful soil recipes near the end of the chapter.

Grow Room Construction Tools & Supplies

Construction Tools

Measuring tape to layout garden
Electric drill and drill bits
Electric circular saw
Stapler + staples
Hardware (hooks, screws, chain, etc.)
Screwdrivers, hammer, wrenches
3-inch paint brush, paint roller and paint pan

Construction Supplies

White paint
White Visqueen® plastic
Ducting pipe Aluminum tape or duct tape for ducts
Clamps for ducts
Filters for intake ducts
Carbon Filter to clean air
Ratchets for rope
Security camera – battery-powered, time-lapse

Electrical Components

Air –Thermometer/hygrometer max/min
Air – Thermostat/humidistat –
Timers – Number of timers
Controller (Controls Lights, temp, humid, CO2)
Air – Fans – Extraction –Inline, blower, propeller, CFM/metric, Number extraction fans
Air – Circulation fans –Oscillating, Wall-mount, Size – inch diameter, Number circulation fans

Container/Hydroponic Garden Setup

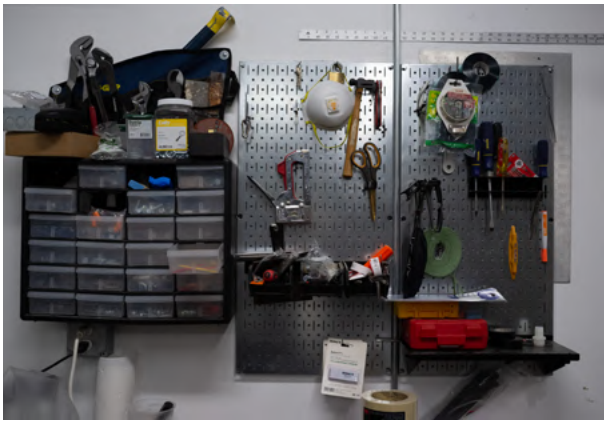
System –wick, fill/drain, top feed pots, top feed slabs
Containers – Size – gallons/liters, Number, Root-pruning, Plastic, Bags
Irrigation System – hand, drip, sprinkler, flood/drain, constant flow
CO2 – emitter, generator
Air Filter – size
Reservoir – Size – gallons/liters, Single reservoir, A and B reservoir, On/off valve, Autofill valve
Water pump – GPH/metric, Submersible, Exterior
Air pump – volume, Air stone
Timers – Water pump, Air pump
Substrate – Rooting cubes, Coco, Coco/perlite mix, Soilless mix, Rockwool, Clay pellets, Soil, Other

Garden Tools

Scale weighs up to 30 gms
Scale weighs up to 20 pounds
Moisture meter
Measuring cup & spoons – imperial/metric
Liquid biodegradable soap spray
Soap spray bottle, pump-up sprayer
Pruners
Hand trowel – plastic
Garden hose cut to length ½ inch or ¾ inch
Water wand with breaker/shower head
Water can with breaker/shower head
Automatic irrigation – drip, sprinkler, flood, gravity
Hose-end venturi sprayer
Security camera – battery-powered, time-lapse
pH meter
EC/PPM meter
Light meter
30X hand-held microscope battery-powered light
UVB flashlight to see slimy trails, poo, fluids
Leather gloves
Rubber gloves
Respiration mask
Protective goggles
Broom, dustpan, mop, bucket
Camera on smartphone

Growing Supplies

Cloning/seedling Supplies – Rooting hormone – powder, liquid, gel, humidity dome
Containers – Self-pruning, rigid, grow bags
Soil – Choose from list of popular soils
Substrate – Rooting cubes, Coco, Coco/perlite mix, Soilless mix, Rockwool, Clay pellets, Soil, Other
Nutrients – Organic or salt-base – vegetative and flowering formulas. Some brands sell micronutrients separately.



There are some tools an indoor gardener must have and a few extra tools that make indoor horticulture much more precise and cost effective. Procure all the tools before bringing plants into the room.

If you check your garden room daily and precision growing is not necessary, you will need few of the listed tools

Move In Seedlings and Clones

Move in seedlings or clones once the grow room is set up with everything in place. Huddle them closely together under the lamp. Make sure that the grow light is the proper distance from tender seedlings. HIDs emit heat along with light. Position 400-watt lamps 18 inches (45 cm) above seedlings and clones. Place a 600-watt lamp 24 inches (60 cm) away and a 1000-watt lamp 30 inches (75 cm) away. Fluorescent, CFL and LED grow light fixtures can be placed much closer. Follow manufacturer's guidelines for mounting height.

Gardens with elevated growing beds often waste light on walkways. Overcome wasted aisle space with rolling beds.

This grow room was set up with precision LEDs, climate, nutrients, and substrate.

CHAPTER SIX

12-WEEK GARDEN

Introduction

This 12-week Grow Scenario is presented in a week-by-week format so that it is easy to follow. Once seedlings are potted up into a 4-inch (55 cl) container, well-rooted and growing aboveground, they are ready to move into the vegetative grow room and start the 12-week Grow Scenario.

A maintenance schedule is included to help you stay on track and avoid common problems. The schedule will give you a base starting point so that you can fine-tune your garden to fit your specific needs.

See chapter Five, Grow Room Setup, for complete information on setting up lights, fans, water, nutrients and substrate so that they are most efficient.

Garden Calendar

Seedlings

Important Dates	Date
Start germination	
Emersion	
Stage end	
Transplant	

Container, Hydroponic & Reservoir Gardens

Growth Stage	Light Level
Seedling	250 µmols/m2/second
Photoperiod Vegetative	500 µmols/m2/second
Auto Vegetative	300 µmols/m2/second
Photoperiod Flowering	500-1000 µmols/m2/second
Auto-flowering	550µmols/m2/second

Air	Day	Night
Air - Temp Range		
Air - Humid Range		
Air Circulation (1-10 scale)		
Air Ventilation (1-10 scale)		
CO2 Level (PPM)		

Water Application/Hand/Automattic	Day	Week
Water Dose (gallons/liters)		
Frequency (daily/weekly)		

Fertilizer	Daily	Weekly
Dose (ml/L)		
Frequency (day/week)		
Additive (ml/L)		
Frequency (day/week)		
pH - Reservoirs		
pH - Substrate		
pH - Runoff		
PPM/EC - Reservoirs		
PPM/EC - Substrate		
PPM/EC - Runoff		

Substrate	Daily	Weekly
pH		

JORGE CERVANTES

Temperature		
Container Temperature		
Temperature Alarm (degrees)		
Moisture 1-10		

Troubleshooting	Daily	Weekly
Inspect - culture		
Inspect - Nutrient Def/Excess		
Inspect - Disease & Pest		
Preventive Apply AACT		

Seedlings get off to a slow start, but once established, growth is very rapid.

12-week Cannabis Garden Schedule

Transplant clones or seedlings in 1-pint (55 cl) 4-inch pots into the room. Plants should be about 4–6 inches (10–15 cm) tall. Grow seedlings that will be transplanted outdoors for a few weeks indoors before moving outdoors.

Week One: First Week of Vegetative Growth

Light
Photoperiod: 18 hours day, 6 hours night
Intensity: 250 µmols/m2/second
Auto-flower: 20 hours day, 4 hours night
Intensity: 300 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 50-70%
Ideal: 60%
CO2: 1,000ppm

Water:
pH: 5.5-6.5
EC: <50
Irrigation:
Keep growing medium evenly moist so that roots stay wet but still have enough air to take in nutrients. Be very careful not to overwater the limited number of roots or let tender roots dry out. Irrigate with enough water so that 10%–20% flows out the bottom of the container. Do not let plants sit in standing water. Do: Keep growing medium evenly moist. Don't: Overwater and make soggy substrate.

Nutrients
EC: 1.4-1.8 / PPM 1,400-1,800
Use your favorite "grow" nutrients for seedlings and use as per manufacturer's instructions. Use any additives suggested by the manufacturer. See feeding chart from manufacturer.

Soil/Substrate
pH
Soil: 6.0–6.5
Hydroponics: 5.5

Strong root systems.

Growth Characteristics: During the first week of vegetative growth, plants develop a strong root system. You will see signs of upward green growth too. Now it is very important to keep plants from suffering water and temperature stress.

Green growth aboveground should be strong and resilient.

Week Two: Second Week of Vegetative Growth

Light
Photoperiod: 18 hours day, 6 hours night
Intensity: 500 µmols/m2/second
Auto-flower: 20 hours day, 4 hours night
Intensity: 500 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 50-70%
Ideal: 60%
CO2: 1,000ppm

Water:
pH: 5.5-6.5
EC: <50 ppm
Irrigation: Plants need a little more water now. Keep growing medium evenly moist. Be very careful not to overwater or let tender roots dry out. Plants need a little more water now.

Nutrients
EC: 1.4-1.8 / PPM 1,400-1,800
Fertilizer: Use your favorite "grow" nutrients with higher levels of nitrogen for green growth as per instructions.

Soil/Substrate
pH:
Soil: 6.0–6.5
Hydroponics: 5.5

Growth Characteristics: During the second week of vegetative growth plants plants should be about 6–8 inches (15–20 cm) tall. They will continue to develop strong root systems, and green leafy growth increases notably. Now it is very important to keep plants from suffering water and temperature stress.

Week Three: Third Week of Vegetative Growth

If you are moving photoperiod seedlings into a greenhouse or outdoors, simply extend the vegetative growth period. You can also keep seedlings in the vegetative growth stage longer so that they are bigger when you induce flowering with a 12/12 day/night light schedule.

If photoperiod seedlings are not big enough (10-12 inches (25-30 cm)) to induce flowering now, wait until they are a bit bigger. Many growers wait until seedlings are 20-24 inches (50-60 cm) tall.

If light does not penetrate foliage, and bottom leaves yellow as plants grow taller, remove them. Remove the bottom pair of leaves especially if they show signs of weak growth.

Light
Photoperiod: 18 hours day, 6 hours night
Intensity: 500 µmols/m2/second
Auto-flower: 20 hours day, 4 hours night
Intensity: 500 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 50-70%
Ideal: 60%
CO2: 1,000ppm

Water:
pH: 5.5-6.5

EC: <50 ppm
Irrigation: Plants need 16 ounces (500 ml) or more of water per week. Keep growing medium evenly moist. Continue to monitor water levels carefully to avoid overwatering and underwatering. Leaching substrate now will help remove any built-up nutrient salts.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "grow" nutrients with higher levels of nitrogen for green growth as per instructions.

Soil/Substrate
pH:
Soil: 6.0–6.5
Hydroponics: 5.5

Growth Characteristics: During the third week of vegetative growth, seedlings should be about 10–12 inches (25–30 cm) tall. They will continue to develop strong root systems, and green leafy growth increases substantially.

Transplant clones and seedlings into 3-gallon (11 L) containers. Transplant just before lights go out so plants have all night to recover from shock. Move lights up to 24 inches (61 cm) or more above plants for a day or two until transplant shock is over.

Week Four: First Week of Flowering

Order Seeds for next crop at seedsman

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80°F (13-27°C)
Ideal: 75°F (24°C)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 25 ounces (75 cl) or more of water each week. Keep growing medium evenly moist so that roots stay wet but still have enough air to take in nutrients. Continue to monitor water levels carefully to avoid overwatering and underwatering.

Plants may need irrigation less often this week because they are in larger pots.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Switch to your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth; use per manufacturer's instructions. Pay special attention to the dosage calendar.

Soil/Substrate
pH:
Soil: 6–6.5
Hydroponics: 5.5

CAUTION:

Stress symptoms will be more evident now and appear in the form of slow growth, yellow and discolored foliage and burned leaf tips. Most often stress is brought on by (1) over-watering, (2) over-fertilization – a build-up of nutrients in the substrate, (3) lack of light, (4) temperatures too hot, cold or fluctuate too much, (5) humidity too high or low, (6) poor drainage. See "Misdiagnosed Disorders" in Chapter Eight, Diseases, Pests & Problems.

Growth Characteristics: The first week of flowering growth, seedlings should be about 14 inches (36 cm) tall. They will recover from transplanting and develop roots and green leafy growth. Stems start to elongate as plants start to prepare to flower.

Diseases and pests may rear their ugly heads now. Inspect foliage and soil surface for signs of the two most common problems, fungus (powdery mildew & gray mold), and spider mites. See Chapter Eight, Diseases, Pests & Problems. Inspect for all the diseases and pests listed in Chapter Eight. Switch to flowering nutrients.

Week Five: Second Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigate: Plants need one quart (1 L) or more of water each week. Avoid overwatering and underwatering.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company, such as PK 13/14 below. P=potassium and K=phosphorus, 13/14 are the percentages of each.
Add PK 13/14 or a similar product. On Friday add PK 13/14 again. This product is packed with more potassium (P) and phosphorus (K) for bigger, denser buds.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: The second week of flowering growth seedlings should be about 16 inches (41 cm) tall. They will continue to develop root systems and green leafy growth increases. Fast-growing roots could start to poke out container drainage holes. Stems will elongate more this week, stretching upward.

White, fuzzy, hairlike pistils sticking out of seed bracts should be visible on female plants.

CAUTION:

Stress symptoms will be more evident now and appear in the form of slow growth, yellow and discolored foliage, and burned leaf tips. Control temperature, humidity, and moisture. Flush system and change nutrient solution.

Remove male plants. Check for male flowers.

Diseases and pests will continue to become more of a problem if the room is not kept clean. Weak under-fertilized and under-watered plants like this are a target for pests and diseases. Inspect foliage for signs of spider mites and other pests. Check soil surface for signs of fungus gnats.

White pistils on female plants appear now.

Remove all male plants as soon as they are identified.

Male plants will start to show first signs of flowering pollen sacks.

Stems will elongate more this week.

Week Six: Third Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night

Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 1.5 quarts (1.5 L) or more of water a week. Keep growing medium moist. Avoid overwatering and underwatering. But if growing in soil, you may need to water every other day or when the soil surface is dry about an inch (3 cm) deep.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company.

Wednesday add PK 13/14 or a similar product.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: The third week of flowering growth seedlings should be about 18 inches (45 cm) tall. They will continue to develop roots and green leafy growth increases. Stem elongation continues but at a slower rate now. White fuzzy pistils on female plants will multiply and become more and more prominent. Remove plants with male flowers. The California Orange plant in the image was grown in British Columbia, Canada.

Weed out male plants!

Take clones now to pre-grow them for the next 8-week crop.

CAUTION:

Stress symptoms will be more evident now and appear in the form of slow growth, yellow and discolored foliage, and burned leaf tips. Control stress by adjusting the environment to ideal conditions, and flush soil or change hydroponic nutrient solution in reservoirs.

Diseases and pests will continue to become more of a problem if the room is not kept clean. Inspect foliage for spider mites. Check soil surface for signs of fungus gnats. See Chapter Eight, Diseases, Pests & Problems, for control measures.

Week Seven: Fourth Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)

Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 2 quarts (2 L) or more of water per week. Keep growing medium evenly moist. Monitor water levels carefully. Growing medium could start to dry out daily from now on. On Friday, flush plants with 3 times the volume of water as the volume of growing medium to wash out any built-up nitrogen in the growing medium. For example, flush a 3-gallon (11 L) container with 9 gallons (33 L) of water.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Most manufacturers advise to increase fertilizer dosage this week. Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: During the fourth week of flowering, seedlings should be about 20 inches (51 cm) tall. They will continue to develop roots but much more energy is put into flower/bud formation. You can see why Big Bud (pictured) is a favorite to grow. Elongation continues but at a very slow rate. Calyxes with pistils continue to develop and buds fill in and growing really starts to get exciting now!

Plant seeds for the next crop.

CAUTION:

Stress symptoms will become apparent now and appear in the form of slow growth, yellow and discolored foliage, and burned leaf tips. Control stress by adjusting the environment to ideal conditions, and flush soil or change hydroponic nutrient solution in reservoirs.

Diseases and pests will become problematic if the room is not kept clean. Inspect foliage for spider mites and other pests. Check soil surface for signs of fungus gnats. See Chapter Eight, Diseases, Pests & Problems for control methods.

Week Eight: Fifth Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 2.5 quarts (2.5 L) or more of

water a week. Keep growing medium evenly moist. Watch water levels carefully and avoid overwatering and underwatering.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: This Nebula female is in the fifth week of flowering, seedlings should be about 22 inches (56 cm) tall. Plants will develop roots but much more energy is put into flower/bud formation. Stem elongation continues but at a very slow rate. Calyxes continue to develop, and buds continue to fill in.

CAUTION:

The unmistakable fragrance of fresh marijuana should start to become very prevalent this week. You will need to take measures to remove or filter it out with a carbon filter.

Carbon filter

Take clones for the next crop.

CAUTION:

Stress symptoms will slow growth, yellow and discolor foliage, and burn leaf tips. See Chapter Eight, Diseases, Pests & Problems, for more information.

Diseases and pests will become problematic if the room is not kept clean. Inspect foliage for spider mites and other pests. See Chapter Eight, Diseases, Pests & Problems, for more details.

Week Nine: Sixth Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 2.5 quarts (2.5 L) or more per week. Keep growing medium evenly moist. Monitor water levels carefully to avoid overwatering and underwatering.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: This is the sixth week of flowering growth. Seedlings should be about 22 inches (60 cm) tall. Plants put much energy into flower/bud formation. Stem elongation continues but very, very slowly. Calyxes with white fuzzy pistils continue to develop, and buds start to put on weight. Larger leaves may yellow and discolor.

Remove bottom branches that impair air circulation between plants to guard against fungus. Do not remove, the growth is relatively strong and productive.

CAUTION:

Stress will slow growth, yellow and discolor foliage, and burn leaf tips.

CAUTION:

The unmistakable fragrance of fresh marijuana will be more and more dominant this week. You must remove or filter it out before expelling outdoors.

Diseases and pests will become problematic if the room is not kept clean. Inspect foliage for spider mites and other pests and diseases. Check soil surface for signs of fungus gnats. See Chapter Eight, Diseases, Pests & Problems, for control methods.

Week Ten: Seventh Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night

Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%
CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need 2.5 quarts (2.5 L) or more of water a week. Keep growing medium evenly moist. Watch water levels carefully to avoid overwatering and underwatering.

Nutrients
EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Use your favorite "bloom" nutrients with higher levels of potassium and phosphorus to stimulate bud growth as per instructions. Add any additives suggested by the company.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: During the seventh week of flowering growth, seedlings should be about 24 inches (61 cm) tall. They put energy into flower/ bud formation. Stem elongation virtually stops. Calyxes continue to develop, and buds really pack on weight; buds start to get hard and plump! Large leaves continue to yellow and discolor. Leaves around buds may show burned tips and become brittle, especially if given high doses of fertilizer.

Stress will slow growth, yellow and discolor foliage, and burn leaf tips.

CAUTION:

The fragrance of fresh marijuana will be very strong this week if growing potent strains. Take measures to remove or filter it out. Check the filter for efficiency.

Diseases and pests will continue if the room is not kept clean. Inspect foliage for spider mites and other pests and diseases. Check soil surface for signs of fungus gnats. Check for bud mold (botrytis) See Chapter Eight, Diseases, Pests & Problems, for control methods

Stop all spraying this week.

Week Eleven: Eighth Week of Flowering

Light
LED + UV
1,000 umol/m2/s
Photoperiod: 12/12 day/night
Intensity: 700 µmols/m2/second
Auto-flower: 20/4 day/night
Intensity: 550 µmols/m2/second

Air
Temperature
Min/Max: 55-80ºF (13-27ºC)
Ideal: 75ºF (24ºC)
Humidity
Min/Max: 40-60%
Ideal: 50%

CO2: 1,400

Water:
pH: 5.5-6.5
EC: <50
Irrigation: Plants need progressively more water, 2.5 quarts (2.5 L) or more per week. Stop watering 3 days before harvest to start removing water from growing medium, and plants will dry faster.

On Monday, flush plants with 3 times the volume of water as the volume of growing medium to wash out any built-up nitrogen in the growing medium. For example, flush a 1-gallon (4 L) container with 3 gallons (12 L) of water. You might want to use a "clearing agent" such as Final Flush.

Nutrients

EC: 2.0-2.4 / PPM: 2,000-2,400
Fertilizer: Stop fertilizing this week and apply plain water to wash out built-up fertilizer from growing medium. Some growers stop fertilizing 10 days before harvest to allow plants to use all the fertilizer so that buds, when smoked, do not taste like fertilizer.

Soil/Substrate
pH:
Soil: 6–6.5 pH
Hydroponics: 5.5 pH

Growth Characteristics: This is harvest week! During the eighth week of flowering plants should be about 24 inches (61 cm) tall. They will continue to develop roots but much more energy is put into flower/bud formation. Calyxes with pistils continue to develop, and buds put on more and more weight until harvest. Large leaves will be yellow, and smaller leaves could be discolored with dark tips.

CAUTION:

Stress symptoms will become very apparent now, appearing in the form of slow growth, yellow and discolored foliage, and burned leaf tips.

Diseases and pests: Cut out any bud mold you find. Nothing can be done for latent spider mites and other pests. They will bunch up at the top of buds or escape out the end of the drying line.

CAUTION:

The fragrance of fresh marijuana will be the strongest this week if growing potent strains. Take measures to remove or filter out fragrance.

Week Twelve: Harvest

Light
Photoperiod: 12 hours day, 12 hours night
Intensity: 1000 µmols/m2/second
Auto-flower: 20 hours day, 4 hours night
Intensity: 550 µmols/m2/second

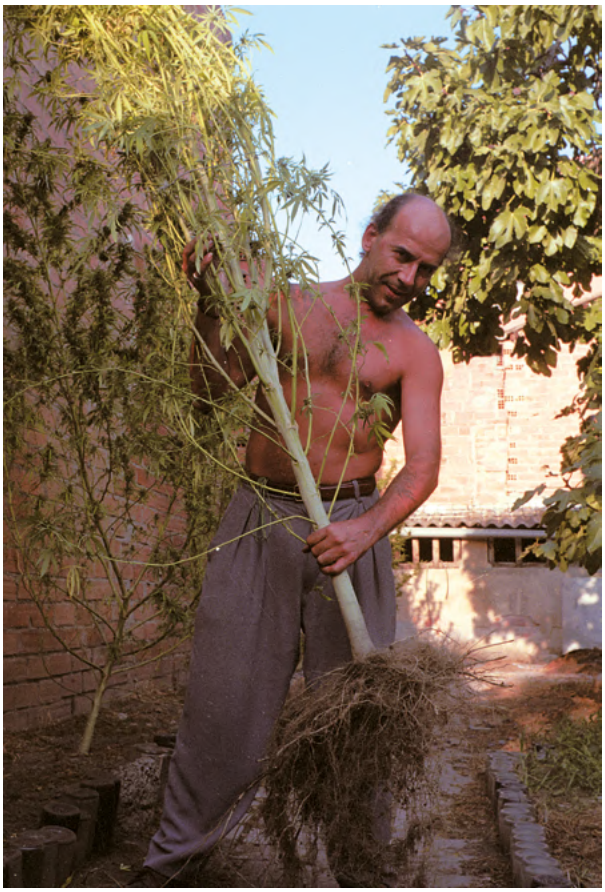
Air
Temperature
Min/Max: 55-70ºF (13-21ºC)
Ideal: 60ºF (15.5ºC)
Humidity
Day: 50%
Night: 50% night

Cut plants at base to harvest. Remove individual branches afterward to manicure.

Beautiful crop started indoors is ready to harvest.

Peter from the Cannabis College (1997) in Amsterdam inspects for peak ripeness.

Harvesting in Morocco 1998.



Good friend Xus (RIP) harvesting crop in 1999.

Experience the joy of your harvest!

A Mexican friend poses in a “lucha libre” mask with an illegalharvest in the early 2000s.

CHAPTER SEVEN

HARVESTING CANNABIS

Introduction

Harvest when plants are at peak ripeness. Harvest timing is critical. The peak harvest window is open for roughly 5–7 days. Most growers manicure harvested buds before drying them slowly and evenly, so THC is preserved. After drying, buds must cure so that full aroma and flavor develop. Like a fine wine, aging (curing) improves taste and fragrance. Once cured, proper storage will ensure buds retain all of their essential qualities.

Pungent marijuana odors are often a problem around harvest time. To minimize odors keep the drying and trimming room well ventilated so fragrances do not linger. Keep rooms cool, below 70°F (21°C) so essential cannabis oils release few pungent aromas. An air conditioner works well to keep odors to a minimum in sealed rooms. A carbon filter will remove odors in the drying/ manicuring room and will also treat expelled air.

Before Harvest

Irrigate with plain water. Give plants plain water the last 7–10 days before harvest. Make sure to let 10–20% of the water drain out the bottom of containers.

Do not water for 1–2 days before harvest, so plants are pre-dried at harvest. Let the soil dry out but do not let the plants wilt.

Harvest

At harvest all plant growth and THC production stop. THC content cannot increase after harvest. In fact, it can only decline. Slow THC decomposition by keeping harvested buds out of extended exposure to light and warm temperatures (above 80°F [27°C]); jostling and bruising from handling; and damp, humid environments.

Mind-bending psychoactive THC (tetrahydrocannabinol) is located in leaves, flower buds, and trichomes. The majority of THC is found on female (sinsemilla) plants in the resin glands or trichomes on flower tops. Stalked trichomes look like a small post with a ball on top. These trichomes develop most heavily on buds and small leaves. THC is most concentrated where the stalk meets the ball of the resin gland.

Large female leaves like the Yumboldt at right and male plants contain fewer resin glands and much less mind-altering THC. The THC content found in stems and roots is virtually non-existent. Male plants, stems, and large leaves hold low levels of THC and are most efficiently used to make hash, concentrated resin.

Harvest Leaves

Remove large leaves while plants are still in the ground. Cut or pluck off the entire leaf and leaf stem. Once the large leaves are fully formed, THC potency has generally peaked. Smaller leaves around buds continue to develop resin until buds are ripe. Peak potency is retained as long as leaves are healthy and green. Harvest yellow and diseased leaves and dispose of them.

Toss leaves into a paper bag, not a plastic bag. Paper bags breathe well and can be closed by folding over the top.

Keep the paper bag in a closet or area with 55-60% humidity and 65°–75°F (18°– 24°C) temperature. Reach into the bag once or twice a day and turn leaves so the moist leaves mix with drier leaves. Leaves will be dry to the touch in 5–7 days. Once dry, place leaves in the freezer so they are ready to make hash.

Male Harvest

Male plant in early flowering. The white spots are drops of water.

Harvest male plants before they disperse pollen. Most growers remove them from the garden as soon as they are spotted at pre-flowering, near the end of vegetative growth. Male flowers produce visible pollen sacks with viable pollen 2–4 weeks after lights are set to a 12-hour day/night photoperiod.

Put a plastic bag over any male plants that might disperse pollen before cutting the main trunk off at the base. Shake the plant as little as possible to minimize any pollen dissemination. See Marijuana Horticulture: The Indoor/Outdoor Medical Grower's Bible for complete information on breeding.

Sinsemilla Harvest

Harvest sinsemilla plants 6–12 weeks after inducing flowering with the 12/12 day/night photoperiod. Harvest at the point when THC production is at its peak, before it starts to degrade. Most plants that receive the same amount of light throughout are ready to harvest at the same time. Lower buds that receive less light often take a few more days to mature.

In general, *indica* and *indica*-dominant strains are ripe 6–8 weeks after initiating flowering. Sativa and sativa-dominant strains are ready to harvest in 8–12 weeks. Too often growers harvest too early because they are excited to have a crop.

Test for ripeness by removing a small piece of a mature bud. Put it in a microwave oven or conventional oven. Set the microwave on a low power setting and turn on in 10- second bursts until it is dry enough to burn. Place a little bit of the dry bud in a single-hit pipe and sample. The dry, raspy taste will be from fast drying, but you will be able to tell how potent the pot is.

Too Early!

This bud is weeks from harvest. Wait at least 6 weeks before testing buds for harvest. Many growers harvest lightweight buds before THC develops to full potential.

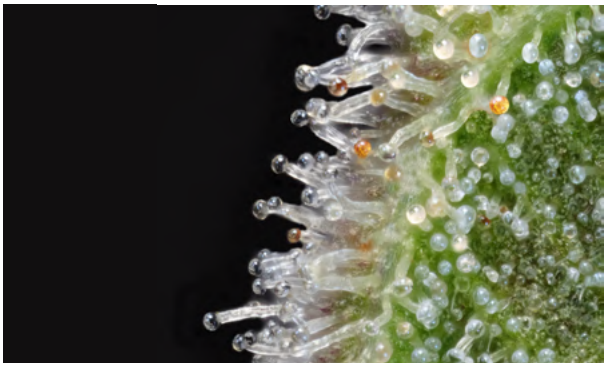
Early Harvest

This bud is still a couple weeks from harvest. The healthy, white fuzzy pistils are still growing and the resin is really starting to accumulate. After a couple of weeks, this bud will be packed with resin. Buds harvested now will yield up to 30% less weight.

Small clear capitate-stalked trichomes are developing on this cannabis flower. Note the stigmas are vibrant white, rather than dying back. Both clear new trichomes and white fuzzy female stigmas tell you that harvest is a few weeks away.

Peak Harvest

Resin gland formation slows. Trichomes are starting to degrade faster than they develop. THC production has peaked out. Now is the best time to harvest.



Harvest when THC levels are at their peak for maximum mind-bending effects. This close up of trichomes shows you what to look for at the time of peak maturity.

Late Harvest

Trichomes start to degrade faster and faster. Harvest now for a heavier high.

White stigmas turn brownish-red as buds continue to ripen. In some strains, peak potency is when half of the pistils are white and the other half have turned brown. This test is only a general guide to peak potency.

The most accurate way to tell peak potency is to look at resin glands on growing plants with a 10X–50X magnifier. My favorite is a 30X handheld microscope with a battery-powered light. You can quickly check several buds daily for peak potency.

Amber capitate-stalked resin glands signify late flowering. This is the point that resin becomes more delicate and degrades more quickly. Harvest plants before the heads of resin glands start to break off.

Look at the capitate stalked trichomes, the ones with a ball on top of the stalk. They develop clear to translucent resinous trichomes. More and more well-formed trichomes continue to appear as they reach peak potency. Harvest when these resin glands form more slowly than they degrade. Bulbous tops and stalks start to deform when they degrade. Handling buds will bruise and deform resin glands. Such damaged resin glands should not be confused with naturally deteriorating ones.

Often resin glands on strains change colors and deteriorate as plants ripen. The trichomes turn from clear to translucent to amber. All glands do not change color at the same time.

Hair-like cystolith trichomes contain no THC. They are visible with the naked eye and with magnification. Find these protective trichomes on tops and bottoms of leaves, stems, and buds. They exude substances that repel pests and protect foliage from diseases.

Step-by-Step: Harvest

Step One

How to tell when fertilizer will affect taste

- Leaf tips and fringes re burned
- Leaves are brittle at harvest
- Buds crackle when burning
- Buds smell like chemicals
- Buds taste like fertilizer

Stop fertilization 7-10 days before harvest. This will allow plants to use built-up nutrients in foliage.

Step Two

Do not spray plants during harvest week so there are no unwanted residues on foliage at harvest. Sprays can also linger in dense buds, which may attract bud mold.

Step Three

Cut or pluck off large leaves and leaf stems a day or two before harvest. This will speed the rest of the harvest process, and it does not diminish harvest.

Step Four

Use pruners to cut plants at the base or remove one branch at a time. Cut branches into lengths of 6–24 inches. Do not remove the root ball, it contains absolutely no THC.

Step Five

Manicure buds right after harvesting. Trim off smaller leaves around buds that show little resin. Use small, pointed scissors to get into tight spaces in buds. See “Manicuring” later in this chapter.

Step Six

Save all trimmed leaves in a paper bag so they can be made into hash later.

Step Seven

Hang manicured branches from drying lines or place on drying racks. Keep the temperature at 65°–75°F (18°–24°C) with the humidity about 55%. Feel buds to check for dryness. They should be dry enough to cure in four to seven days.

Step Eight

Once buds appear to be dry, they are ready for the final drying or curing.

Manicuring Cannabis

After harvest the crop must be manicured, dried and cured

Manicuring buds is time-consuming. Budget 4–6 hours to manicure a single pound (454 gm) by hand with scissors. An automatic trimmer will cut manicuring time to 1–2 hours.

Manicure over a fine silkscreen, glass, or slick-surfaced table. Scrape up fallen resin glands on the table or under the screen. This potent resin can be smoked immediately or pressed into blocks of hash.

Use small easy-to-maneuverer pointed scissors to reach

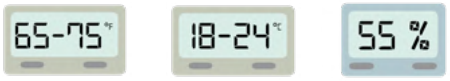
into crevices in buds. Have 2 or 3 different pairs of scissors available. Switch scissors when your hands fatigue.

Wear inexpensive rubber gloves to collect "finger hash." After trimming, remove accumulated finger hash on gloves with rubbing alcohol. Set the hash-laden alcohol on the counter overnight to evaporate. Scrape up the remaining hash after all the alcohol has evaporated. Or put the rubber gloves in a freezer for a few hours. Cooling will make it easier to scrape and rub the accumulated hash from the gloves.

Scrape accumulated resin from scissors when it clogs blades. Use a small knife to remove built-up resin from blades. Ball up small bits of scraped resin by rubbing it together between fingers. The ball of hash will grow as manicuring progresses.

Drying Cannabis

Fresh green marijuana is not very potent. Drying converts a little of THCA into its psychoactive form, THC, and removes about 75% of the moisture from freshly harvested plants. Moisture evaporates evenly when plants are dried slowly over 5–7 days or longer. Buds are dry throughout so will taste sweet and smoke smoothly. Buds dried too quickly retain chlorophyll and other substances within foliage. Such poorly dried cannabis tastes "green," burns unevenly, and tastes bad.



The ideal temperature in the drying room is between 65° and 75°F (18°– 24°C) and humidity about 55%. Temperatures below 65°F (18°C) slow drying, and humidity is more difficult to control. Humidity above 80% slows drying and increases the chances of mold attacks. Temperatures above 75°F (24°C) may cause buds to dry too fast, and humidity can also fall below the ideal 50% level more easily. Always use an accurate maximum/minimum thermometer and hygrometer to ensure temperature and humidity are kept in the ideal range.

Small harvests can be dried easily in a closet, cabinet, or a cardboard box that is a fraction of the growing area's size. Large harvests require much more room. See Marijuana Horticulture: The Indoor/Outdoor Medical Grower's Bible for more information.

Use a small circulation fan to keep air moving in the drying room, but do not train the fan directly on buds or they will dry unevenly. A ventilation fan may also be necessary to help control temperature and humidity. Use an air conditioner or heater to control extreme humidity and temperatures.

Bending and breaking cannabis plant stems is an indicator of dryness, but not an absolute measure. Dry buds burn well when rolled into a joint. Once dry, buds are ready to cure. Curing is essential!

Check for dryness by bending a stem. The stem should snap rather than fold when bent. The bud should be dry to touch, but not brittle.

Cannabis Curing and Storage

Once the buds are dry, they are ready for curing. The curing process lets buds dry evenly so they smoke smooth and taste sweet. When properly cured, all unnecessary moisture is removed and THC reaches its most psychoactive potential. Proper curing ensures buds are completely dry and much less susceptible to mold when stored.

To cure buds, gently pack them into sealable airtight containers. Moisture will move from stems to drier foliage. Place the containers in a cool, dry, dark place. Open the container after 2–4 hours to let humid air escape. Leave the top off for 5–10 minutes so moisture evacuates. Close the container. Open the container for a few minutes every few hours to release excess moisture before closing the lid again. Depending upon moisture content, buds should be totally dry in a few days to 2 weeks. Gently squeeze buds to feel if they are less pliable and moist than they were a few hours before. Once they are evenly dry, they are ready to smoke or seal in an airtight container for storage.

Store packaged buds in a cool, dry, dark place. The owner of this Volkswagen Beetle stored buds in a cool, dry place, but he forgot to keep it dark. Buds stored in the refrigerator will stay fresh a few months longer. Make sure buds are in an airtight container when stored in the refrigerator to prevent moisture from entering the container.

CHAPTER EIGHT

DISEASES, PESTS & PROBLEMS

Introduction

Cleanliness is the secret to disease and pest prevention. Keep the floor, ground, and substrate surface clean. Dirty tools often carry microscopic pests and diseases. Wearing clean clothes and using clean tools will reduce problems. A separate set of indoor tools is easy to keep clean.

Wash your hands if you touch diseased plants. Pay attention to simple hygiene. Do not work in the dirty outdoor garden and then visit the indoor garden. Even walking across a lawn or brushing up against outdoor plants could carry pests and diseases to your indoor garden. Stay away from dogs, cats, and other pets that have been outdoors, and don't let them in the garden. Houseplants can also help spread pests and disease.

Keep all debris off the floor. Clean the garden area regularly.

Dip tools in alcohol to disinfect.

Wash your hands to avoid transmitting insects and diseases from other plants.

Grow insect- and fungus-resistant strains like Power Plant and keep the garden strong and healthy. Keep air well-circulated and fresh. Keep humidity around 50% and maintain the temperature at about 75°F (24°C) during the day and about 5°F (3°C) cooler at night.

Keep the temperature and humidity at the proper levels to avoid cultural, pest, and disease problems.

Make sure there is plenty of ventilation and air circulation.

Misdiagnosed Disorders

Avoid most common ailments by keeping light, temperature, and humidity at the proper levels. Use clean water, the proper complete nutrient solution, maintain EC and pH at the correct levels, and change the nutrient solution every week. Fine-tune these vital factors before deciding that plants are nutrient deficient.

Many problems in containerized gardens and to a lesser degree outdoor gardens, are misdiagnosed as a lack or excess of fertilizer. Inexperienced growers tend to solve nutrient concerns by adding fertilizer rather than learning the cause of the problem and solving it. Often, adding more fertilizer compounds and complicates cultivation problems.

Once a plant demonstrates symptoms, it has already undergone stress. It will take time for it to resume vigorous growth. Correct identification of each symptom as soon as it occurs is essential to help plants retain vigor. Indoor, greenhouse and some outdoor marijuana crops live a short three or four months and are harvested so fast that plants do not have time to recover from nutrient imbalances. One small imbalance could retard growth by a week or more and diminish harvest.

Light is often a problem indoors. Low levels of light and light of the wrong color spectrum causes slow growth. When growth is slow, diseases and pests tend to attack weaker plants. Nutrient deficiencies and excesses also tend to develop quickly.

Indoors, the proper LED lights supply the perfect spectrum and intensity for cannabis growth. Mounting height of the light fixture and even coverage of intense light are essential. Check with light manufacturers for mounting height and light coverage.

Too much light is seldom a problem. Intense light from HID lights radiates a good deal of heat. When mounted at the proper height the light footprint spreads evenly.

Air temperature and humidity also influence growth. Keep the temperature in the range of 70°–75°F (21°–24°C) day and about 65°–70°F (18°–21°C) night. Keep relative humidity 55–65% vegetative room and 50% flowering room. The humidity climbs at night when the lights go out and temperatures drop. Typically, venting moist air out of the room will keep humidity in the proper range.

Circulation fans keep the air from stratifying, hot air rises and cooler air lays near the ground. Circulating air moves foliage and creates a more difficult to attack plant.

Ventilation fans keep air changing in the grow room. Control heat and humidity with ventilation. Turn the ventilation fan on to evacuate hot humid air. New fresh air will replace old stale air to keep plants healthy.

Water quality – Raw input water with a dissolved salt reading greater than 300 ppm is often treated with a Reverse Osmosis (RO) device to remove the excess salts. RO-treated water is ideal because it has virtually no dissolved salts. You add all the nutrient salts to form a perfect nutrient solution. RO devices also remove sodium from the water. Excess sodium (more than 50 ppm) in the water supply restricts water and nutrients from being absorbed by the roots.

Over-watering is a common problem. Too often gardeners kill containerized plants with kindness, too much water and often fertilizer. Use a moisture meter with a probe to check substrate moisture levels.

Underwatering occurs when the substrate is not completely wet. Water never reaches the dry substrate. A moisture meter will help avoid under-watering and help you find dry soil pockets that do not get watered in the container.

An imbalanced pH causes problems. The pH of input water can be about 7.0 because fertilizers are acidic and drop the pH of the final nutrient solution. Keep the pH adjusted in the range of 5.5–6.5, in hydroponics, and 6–6.5 in soil gardens to allow nutrients to be chemically available.

The optimum pH range for cannabis growth is 5.8-6.2. But cannabis plants will grow within a pH range of 5.5-6.5. Within this range, nutrients are chemically available in solution; above or below this range, several nutrients become less available. And, different substrates, coco coir, rockwool, soilless mix, expanded clay pellets, all have specific air and moisture needs to ensure nutrients are available. In soil, a pH below 6.5 may cause a deficiency in calcium, which causes root tips to burn and leaves become subject to fungal infections and dead spots on foliage. A pH above 7.0 could slow down the plant's iron intake and result in chlorotic leaves causing veins to yellow. Adding more calcium and iron will not solve the problems.

Nutrient deficiencies and excesses can also be confused with disease and pest damage. For example, Hemp Russet mites cause slow growth and small deformed flower growth. Inexperienced growers may confuse this with a nutrient problem.

Over-fertilizing is common. Adding too much fertilizer without sufficient runoff causes nutrient salts to build up in the substrate, creating toxic conditions. Nutrient excesses and nutrient deficiencies occur that are caused by toxic levels of fertilizer in the substrate.

Under-fertilizing is less common. But using the wrong measuring scale/container or misinterpreting the mixing formula is somewhat common. Always double check the proportions of nutrients to be mixed into solution.

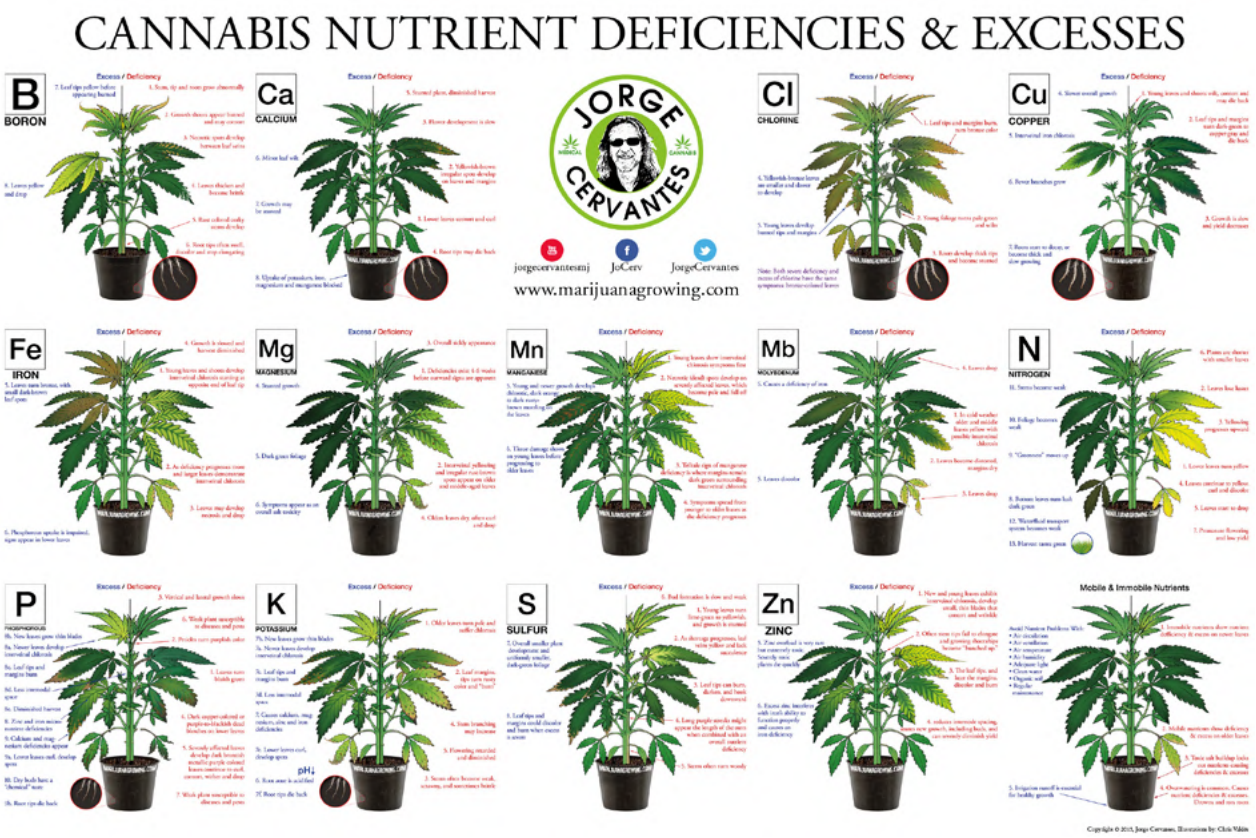
Poor drainage, cold, soggy soil impairs nutrient uptake and leads to root rot. Tell tale signs of these conditions include weak, supple, discolored, and super green foliage.

Soil temperature should be kept below 65ºF (18ºC) so that nutrients are readily available for uptake. Hot soil impairs nutrient uptake by roots and causes excessive water consumption. Outward signs include discolored foliage, dry foliage and hot soil.

Damage from cultural practices

Cultural Practice	Symptom
Lack of light	slow, spindly growth and stretching between internodes
Light burn	burned patches on leaves
Lack of ventilation to the plant	slow growth and curled-down leaves
High humidity	slow growth and curled-down leaves
Low humidity	seldom a problem and plants use more water
High temperature	slow growth and drooping leaves
Low temperature	slow growth, purpling, and no flowers
Over-watering	slow growth, disease and nutrient deficiencies
Under-watering	wilting, slow growth, disease and nutrient deficiencies
Nutrient pH	slow growth, poor nutrient uptake, discolored foliage
Nutrient overdose	slow growth, dry foliage, burned and discolored foliage
Soil has nutrient buildup	slow growth, burned and discolored foliage
Poor drainage	slow growth, curled down leaves
Indoor air pollution	slow growth and sickly appearance
Spray application damage	burned spots

Nutrient Deficiencies & Excesses



You may have seen this infographic before. I made it about 10 years ago for the Cannabis Encyclopedia. Since then, it has been copied many, many times. If you should decide to copy it, please copy "as is" without removing my name and website. Thanks!

Diseases & Pests

This section covers the most common pests and diseases that attack cannabis plants in a grow room. The descriptions and methods of control are simple and straightforward. If you have more questions about pests and diseases not answered in this book, please consult *Marijuana Horticulture: The Indoor/Outdoor Medical Grower's Bible*, which covers in much more detail solutions to controlling just about any pest and disease that attacks cannabis.

Controlling diseases and pests requires a multifaceted approach.

1

Keep all debris off the floor. Clean the garden area regularly.

2

Wash your hands to avoid transmitting insects and diseases from other plants.

3

Dip tools in alcohol to disinfect.

4

Grow insect- and fungus-resistant strains and keep the garden strong and healthy.

5

Keep air well-circulated and fresh.

6

Keep humidity around 50% and maintain the temperature at about 75°F (24°C) during the day and about 5°F (3°C) cooler at night.

7

Inspect plants every day/week for signs of diseases and pests.

Spider Mites

Spider mites are common indoors. Find spider mites on leaf undersides, sucking plant fluids. They look like tiny specks and cause yellowish-white spots on the tops of leaves. If infested, spider webs may be seen when misted with water. A 10X–30X magnifying glass helps to identify the yellow, white, two-spotted, brown,

or red mites and their translucent eggs.

Control spider mites by:

- Cleaning up regularly
- Raising humidity and lowering temperature
- Smearing sticky trap such as Tanglefoot™ around the pot lip and stems
- Dipping small plants and spraying large ones with pyrethrum or neem oil
- Introducing predatory mites

Stipples caused by mites.

Mites on leaf underside.

Spider mite infestation! Parts of this plant are completely covered with spider mite webbing. It is better to remove an infested plant from the garden so that it does not contaminate other plants.

Whiteflies

Whiteflies flutter from under leaves when disturbed. They look like a small, white moth about one millimeter long. Adults have wings. Eggs are also found on leaf undersides. Whiteflies cause whitish speckles, stipples, on the tops of leaves. Attract and kill adults with bright yellow sticky traps that are placed among plants. The wasp Encarsia formosa is the most effective whitefly parasite. Kill with insecticidal soap or pyrethrum applied at five- to ten-day intervals.

Whiteflies are between yellowish aphids. The dark spots are honeydew that has attracted mold.

Fungus Gnats

Dark specks are fungus gnats. Larvae grow four to five millimeters long with translucent bodies and black heads. Winged adults are gray to black with long legs. Pests infest

growing mediums and roots, eating and scarring roots. Plants lose vigor, foliage pales, and wounds invite disease. Control with Vectobac®, Gnatrol® and Bt-i. Use neem or insecticidal soap as a soil drench. Predatory soil mites are also available.

Gray Mold (Botrytis)

Gray mold (aka bud mold and bud rot) flourishes in moist, temperate climates and can be fatal. Botrytis appears hairlike, similar to laundry lint, and later turns slimy but can appear as dark, brownish spots on stems and flowers in arid climates. It attacks stems, leaves, and seeds, and can cause damping-off.

Once it starts, gray mold is fatal. If on buds, cut buds off one inch (3 cm) below infestation. Prevent gray mold by increasing air circulation and ventilation. Use fresh, clean growing medium. Remove infected foliage with alcohol-sterilized pruners and destroy it. Wash your hands and tools.

Gray mold on bud

Botrytis damage

This bud is gone!

Damping-off

Rotten stem

Damaged stem and roots

Damping-off is fatal. It prevents sprouted seeds from emerging. Seedlings and cuttings rot at the soil line. Foliage in older plants yellows and stems rot. First, the stem loses girth at the soil line, grows dark, and finally falls over.

Once it starts, damping-off kills plants. Avoid by controlling growing-medium moisture. Dust seeds with fungicide.

Damping-off rots seedlings and cuttings at the soil line.

Green Algae

Green algae grow in light and nutrient-rich environments. Avoid algae by covering growing mediums.

Slimy, green algae need nutrients, light, and a moist surface to grow. Algae grow on moist rockwool and other moist-growing mediums exposed to light. Algae cause little damage, but attract fungus gnats and other pests and diseases.

Prevent by covering moist-growing mediums to exclude light. Control by adding an algaecide to the nutrient solution.

Downy Mildew

Sometimes called "false mildew," downy mildew affects vegetative and flowering plants. It appears as whitish-yellow spots on top of leaves, creating pale patches. Greyish mycelium spawn is on leaf undersides, opposite the pale patches.

Control with cleanliness! Use a sterile growing medium. Remove and destroy affected plants, not just foliage. Kill with biological Serenade® and the Bordeaux mixture (copper sulphate and hydrated lime) is also somewhat effective.

Root Rot

Root rot causes roots to turn brown and slimy.

Root rot turns roots dark brown, slows growth, leaves discolor, older foliage and later the entire plant wilts. Root rot is caused by lack of air and soggy substrate.

Root rot causes roots to turn brown and slimy.

Prevent root rot by using fresh, sterile growing medium and keeping the garden clean. Keep calcium

levels adequate and avoid excess nitrogen. Keep pH above 6.0 in hydroponic units, and use Bio-Fungus® or RootShield®. Root rot causes roots to turn brown and slimy.

Spraying Cannabis

Small pump hand sprayers are convenient and economical.

Pests and diseases can often be avoided by making sure the garden area is clean. Inspect foliage and roots regularly for signs of pests and diseases.

Control the growing environment to ensure plants are strong and healthy. Sometimes even with the best intentions, pests and diseases get a grip in the garden and must be removed.

Once you have determined you must spray, assess the damage and identify the pest or disease. Once identified, you can take cultural measures or purchase the proper product to rid the garden of the plague.

- Use only contact sprays approved for edible fruits and vegetables
- Do not use toxic systemic chemicals!
- Read the entire label on all sprays and follow Directions
- Mix pesticides and fungicides just before using
- Safely dispose of unused spray
- Organic and natural-based sprays are also toxic and should be used sparingly
- Spray both sides of leaves and stems
- Rinse leaves on both sides with plain water 24 to 48 hours after spraying
- Use protective gear, including a facemask, when spraying, especially if using an aerosol/fogger
- Raise lamps up and out of the way

Small pump hand sprayers are convenient and economical.

Jorge Cervantes (left) wore disguise for 20 years to avoid arrest. Today, Jorge waves to you from a legal garden in Southern Oregon.

JORGE CERVANTES

TOP 12 STRAINS FOR BEGINNERS

(No particular order)

Selected from Seedsman, Great for Beginners Category page.
Based on USA warehouse and sorting by most popular and Dr Gary recommended.

Purple Ghost Candy (Seedsman)

Click on the icon to buy the seed at seedsman

Pure Kush (Greenhouse Seed Co)

Click on the icon to buy the seed at seedsman

Green Crack Auto (Seedsman)

Click on the icon to buy the seed at seedsman

Blue Sunset Sherbert (Barney's Farm)

Click on the icon to buy the seed at seedsman

Northern Lights Auto (Seedsman)

Click on the icon to buy the seed at seedsman

Purple Punch Auto (RQS)

Click on the icon to buy the seed at seedsman

Gelat.OG (Seedsman)

Click on the icon to buy the seed at seedsman

Orange Bud (Dutch Passion)

Click on the icon to buy the seed at seedsman

Amnesia Fast (Seedsman)

Click on the icon to buy the seed at seedsman

Top Gun Auto

Click on the icon to buy the seed at seedsman

Vanilla Frosting (Humbolt Seed Company)

Click on the icon to buy the seed at seedsman

Banana Kush

Click on the icon to buy the seed at seedsman

SUGGESTED RESOURCES AND USEFUL LINKS

Make sure you sign up to Jorge's newsletter on marijuanagrowing.com

https://marijuanagrowing.com/

MjBiz:

https://mjbizconference.com/

Seedsman blog - beginner cultivation:

https://www.seedsman.com/blog/category/cultivation/beginner-cultivation/

MjUnpacked:

https://mjunpacked.com/

The Cannigma: evidence-based approach to every issue surrounding cannabis:

https://cannigma.com/

Cáñamo magazine:

https://canamo.net/

Respect my region

https://www.respectmyregion.com/

Soft secrets:

https://softsecrets.com/es-ES

CannaTrade:

https://www.cannatrade.ch/en/

Atlas Seeds:

https://softsecrets.com/es-ES

Spannabis:

https://spannabis.es/

The IACM Patient Council is an international coalition of patients' organizations:

https://iacmpatients.com/

JORGE CERVANTES

VISIT JORGE'S WEBSITE

FOLLOW JORGE'S NEWS ON SOCIAL MEDIA

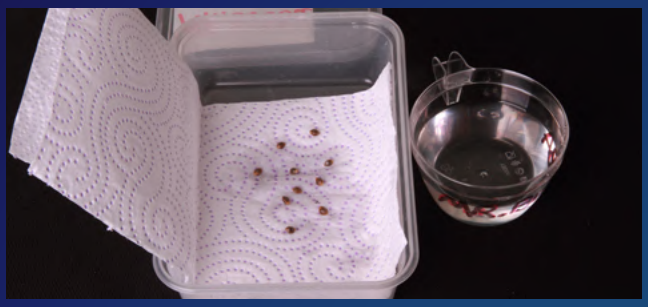
“

BOOKS, WHETHER PRINTED OR DIGITAL, HAVE LONG PROVIDED GROWERS WITH THE INSPIRATION, INSTRUCTION, AND TOOLS THEY NEED TO FLOURISH IN THE FACE OF ADVERSITY. HAVING YOU AS A READER AND FRIEND FOR THE PAST 40 YEARS HAS BEEN INVALUABLE TO ME. THANK YOU FOR HELPING ME SHAPE MY LIFE. TO BE CONTINUED...

”

JORGE CERVANTES

co-author Stefan Martin Meyer using the AI platform *midjourney.com*



EASY-TO-USE ON SMARTPHONE

Jorge's comprehensive guide to cannabis cultivation shares the best cannabis introductory tips and practices. This easy-to-use cannabis grower's guide includes everything you need to know to setup and grow a 12-week indoor garden or grow seedlings and clones to move to a greenhouse or outdoors. The easy-to-understand text is is illustrated with more than 270 color images, charts and graphs. The layout and design of this 100-page book make discovering the rewards of cultivating your own cannabis garden fun and trouble-free.

ANSWERS ARE A CLICK AWAY

You will be turning to mini-Grow Bible again and again. Download *We Grow Cannabis* to your smartphone so that you can carry a copy with you always. Take advantage of Jorge's 40-year wealth of cannabis cultivation knowledge and experience. You can look up anything you want to know when you need to know it with a few clicks on your smartphone, tablet or computer. Jorge gives you his personal guarantee that all information is current and correct.

INFORMATIVE AND DETAILED

We Grow Cannabis details essential information on cannabis botany, life cycle, seed selection, garden planning, grow room setup, growing, harvesting, drying, curing and storage. A great chapter on problem-solving, diseases and pests will keep your garden healthy to ensure a heavy harvest.

GROW AND LEARN TOGETHER

Every harvest will be heavy using Jorge's tried and true tips and techniques. Join Jorge's world-wide community of growers he has helped grow more and better cannabis. Grow with Jorge and enjoy big fat cannabis flowers from your own garden today!