Hemp CBD Planting Guide

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“Though I do not believe that a plant will spring up where no seed has been, I have great faith in a seed. Convince me that you have a seed there, and I am prepared to expect wonders.” —Henry David Thoreau

Varieties

Cannabis producers should decide on varieties based on the desired end product: fiber, grain, grain/fiber, or cannabinoids. Every cannabis variety will have its own unique set of characteristics: short or tall, small or large seed, higher or lower cannabinoid content, different flowering times, and different nutrient requirements.

Cannabis cultivated for CBD-rich flower or biomass is generally more difficult to plant, upkeep, and harvest than cannabis varieties traditionally grown for grain and fiber. For this reason, this planting guide focuses on hemp (a cannabis variety containing less than 0.3 percent delta-9 THC) produced for Cannabidiol (CBD).

CBD-rich Variety

This includes cannabis varieties bred to exhibit high concentration of Cannabidiolic acid (CBDa). Only female hemp plants will produce flowers with high contents of cannabinoids.

Grain Variety

Grain varieties are bred to produce high yields of seeds that are food grade quality. Both male and female plants are needed to produce a grain crop.

Fiber Variety

Planted in high density, this cannabis variety is bred as a bast fiber crop. Fiber varieties are typically taller, and fibers are removed from the stalks after retting or softening of the fiber.

Grain/Fiber Variety

Cannabis can also be bred as monoecious (hermaphrodite) for dual purpose use. Dual purpose varieties are bred to produce both grain and fiber.

Hemp

The optimal temperature for cannabis seed germination is 65-70°F

Lower temperatures will delay emergence. It's best to plant after potential risk of late frost (e.g., mid-May or early June). Seed is best planted at a depth of 0.75-1 inch. For direct seeding, acceptable soil temperature at that depth for germination is 50°F.

Cannabis grows best on loose, well-drained, well-aerated soil with a pH of 6.0-7.0

Consistency in pH level will allow the plant to better absorb nutrients. If pH becomes too alkaline (above 7.5) or too acidic (below 5.5), it will cause deficiencies of nutrients. Cannabis does not do well in heavy clay soils due to higher calcium levels and greater water retention/saturation.

Cannabis generally prefers semi-humid conditions with temperatures between 60-80°F

Cannabis does not react well to over watering but requires ample moisture during early stages. Excess rainfall will stunt growth and lead to smaller yields. During the plant's life cycle, 10-14 inches of rainfall is optimal.

Germination (CBD)

Cannabis germinates best in a firm bed but is sensitive to soil compaction and soil crusting. Good soil moisture is necessary for seed germination. Cracked or dull-looking cannabis seeds are not likely to germinate.

Soaking

One method to encourage germination is to soften the seeds by soaking them in distilled water overnight (8-12 hours) at 65-70° F. After soaking, transfer seeds to a small 4"x4" pot or seedling tray. This method assumes transplanting after 2-3 weeks versus direct seeding outside.

Nutrients (CBD)

Cannabis has different nutritional needs based on the stage of its life cycle. Nitrogen is recommended during vegetative stage (e.g., NPK ratio of 3:1:2), while phosphorus and potassium are recommended for the flowering stage (e.g., NPK ratio of 1:3:4 then tapering off to 0:3:4).

Life Cycle

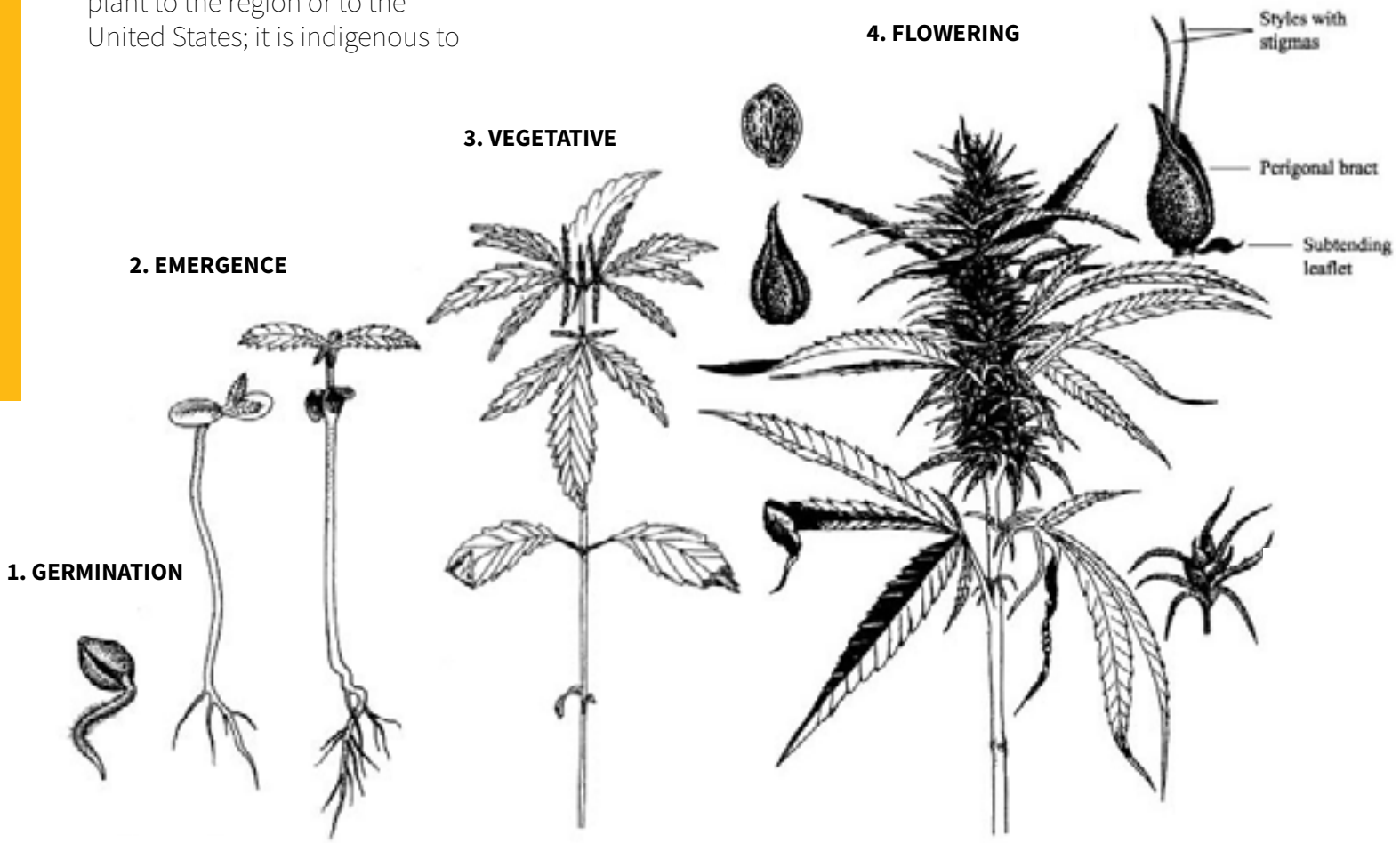
Cannabis is an annual plant belonging to the small family of flowering plants called Cannabaceae. The lifespan of cannabis grown outdoors is about 120 days: 30-60 days for vegetative growth and approximately 60 days for flowering time, varying by genetics.

Although cannabis will grow well in Midwest soil, it's important to note that cannabis is not a native plant to the region or to the United States; it is indigenous to central Asia and the East Indies. Cannabis has been cultivated mainly for fiber production in China, Russia, Italy, Czech Republic, Slovenia, Poland, Netherlands, Hungary, Germany, France, Japan, Canada, and more.

While Cannabis sativa is an important source of durable fibers, nutritious seeds, and medical extracts, the plant is poorly understood genetically.

Unfortunately, due to past U.S. prohibition of the cannabis plant almost no U.S.-based agronomic research existed until 2015.

With that said, the planting calendar and nutrient recommendations on the following page are for educational purposes only. Further fertility research will need to be completed to determine best practices.



Mediavilla, Vito, Manuel Jonquera, Ingrid Schmid-Slembrouck and Alberto Soldati 1998. A decimal code for growth stages of hemp (Cannabis sativa L.). Journal of the International Hemp Association

Example Planting Calendar (for CBD)

Stage	Germi-nation	Emergence/ Seedling	Early Vegetative Growth	Late Vegetative Growth	Pre-flowering	Sexing	Flowering	Ripening	Harvest
Date*	May 11 (48-72 hrs)	May 14 (2-3 weeks)	June 4 ~ June 21 (3 weeks)	June 22 ~ July 11 (2-3 weeks)	July 11 - July 18 (1 week)	July 11 (2 mo. after ger-mination)	July 18 ~Sept 23 (60-70 day flowering time)	Sept 23 ~ Oct 7 (2 weeks before harvest)	Oct 7
Approx. NPK ratio and ppm**	n/a	(2:1:2) 100-50-180	(3:1:2) 300-90-250	(3:1:2) 300-90-250	n/a	n/a	(1:3:5) 80-240-400	n/a	n/a
Nutrients (example per acre)***	n/a	N 200 lbs P 100 lbs K 360 lbs	N 600 lbs P 180 lbs K 500 lbs	N 600 lbs P 180 lbs K 500 lbs	n/a	n/a	N 160 lbs P 480 lbs K 800 lbs	n/a	n/a
Secondary Nutrients (approx. ppm)***	n/a	Ca 50 Mg 20 S 20	Ca 250 Mg 50 S 50	Ca 250 Mg 50 S 50	n/a	n/a	Ca 150 Mg 30 S 80	n/a	n/a
Micronu-trients (approx. ppm)******	n/a	Fe 25 Mn 20 B 5 Zn 5	Fe 50 Mn 25 B 25 Zn 15	Fe 50 Mn 25 B 25 Zn 15	n/a	n/a	Fe 125 Mn 50 B 20 Zn 30	n/a	n/a

* Time estimates only. Growth cycle will vary based on cannabis variety. Example assumes direct seeding, not transplanting.
** Nutrient levels should be tested before planting and adjusted accordingly. Assumes sample from the top 6 inches of soil.
*** Suggested maximums.

Nitrogen and potassium uptake are greatest during the first two months of growth. Higher rates of potassium and phosphorus are needed during the flowering stage. Sources of micronutrients include dead plant tissues, compost, and manure. The breakdown of organic matter (i.e. roots and leaves) will add nutrients back into the soil. No-till and holistic soil building practices are encouraged for creating fertile soil.

Male vs. Female

HEMP IS CANNABIS. ONLY FEMALE CANNABIS PLANTS WILL PRODUCE FLOWERS RICH IN CANNABINOIDS.

Cannabis pistils, which are often referred to as "hairs" of the cannabis bud, can help identify female plants early on. Female cannabis plants will continue to flower, forming fragrant buds until they are pollinated or harvested.

Contrary to popular belief, hemp plants are NOT male “marijuana” plants. Only female hemp plants will produce flowers rich in CBDa.

Cannabis grown for grain and stalks produces very little cannabinoid content— close to 0% THCa and 0% CBDa. However, the government classifies “hemp” as any cannabis plant containing less than 0.3% delta-9 THC. Therefore, breeders have been able to develop high-CBD, low-THC cannabis plants while falling under the legal classification, and social construct, of hemp.

The hemp plants, from which most CBD is extracted, is not your typical industrial cannabis grown for fiber or grain; genetically, they are different. Genes of the cannabis plant fight to convert the precursor cannabinoid CBGa to either THCa or CBDa, and plants can be bred to exhibit dominance in either cannabinoid.

Know the difference.

MALE

GRAIN | FIBER

Fiber and grain varieties will be grown from regular seeds, resulting in both male and female plants. While both male and female structures are needed to produce grain, a higher ratio of female plants is desirable to maximize the yield per acre. Only female plants live to mature seed stage.

There is no apparent difference in the fiber from male or female plants, but male plants will mature faster than female plants.

Producers looking to grow cannabinoid-rich flowers should beware of males from neighboring grain or fiber crop. Pollen can potentially travel miles, seeding female plants close by.

FEMALE

GRAIN | FIBER | CBD

Un-pollinated female flowers will produce higher concentrations of cannabinoids and terpenes than pollinated flowers.

When starting from regular seeds, male and female plants will occur almost equally but generally a higher ratio of females is desired. To limit the likelihood of producing male plants, CBD-rich varieties may be feminized, meaning the seeds were produced by female plants intentionally pollenated by another female (monoecious) plant.

Feminized seeds are generally more expensive, but they will result in little to no males in a field. Sinsemilla is an unnatural state for cannabis so plants should be monitored closely.

HERMAPHRODITE

GRAIN | FIBER

While cannabis plants are dioecious, having separate sexes, it's possible for female plants to grow pollen sacs which may then pollinate its own flower.

Inducing female plants to grow male sex organs is a common breeding technique to produce feminized seeds.

Monoecious or hermaphrodite plants may be desirable for seed production or dual purpose use. Dual purpose varieties are bred to produce both grain and fiber.

WHY IS CANNABIS WITH LESS THAN 0.3% THC CONSIDERED "HEMP?"

Why is cannabis with less than 0.3% THC considered hemp? This classification is based on the work of plant scientists Ernest Small and Arthur Cronquist.

In 1976, the two scientists calculated a dividing line of 0.3 percent THC to be the concentration that naturally best separated "non-drug" cannabis from "drug" cannabis. According to Dr. Ernest Small, the level of 0.3 percent is well under the concentration of 0.9 percent THC considered minimal for psychotropic effects by some authorities.

Hence, 0.3 percent THC is more of an arbitrary dividing line, based on 1970s science, which classified cannabis sativa as "non-drug" type and cannabis indica as "drug" type. It is not necessarily the threshold for causing intoxication, nor is it the best figure to maximize hemp's potential in the U.S. The threshold could be increased to 0.6 percent, lowering risk for farmers and making U.S. hemp more competitive, without posing a threat to safety.

Transplanting & Cloning

If you are anticipating a longer flowering period on a particular variety but have limited time due to seasonal changes, starting from clones can be a good way to get ahead, skipping the germination and seedling phase. Growing from clones can also be a way to catch up if you are starting later in the season (i.e. late June or early July). Cloning can save time but also can ensure that your crop will be genetically identical to the mother plant.

When starting from clones, there will be transplanting involved. Transplanting is also a popular method when starting seedlings indoors earlier in the season when outdoor temperatures are not yet suitable for planting (below 60°F).

Starting from clones can be advantageous when growing CBD-rich varieties. Cloning essentially takes the guess work out of sexing plants and improves the odds of a hemp plant not "going hot", or exhibiting a concentration of delta-9 THC higher than 0.3 percent.

The difference between hemp and recreational or medical cannabis is distinguishable by two separate genes which are tightly linked and fight to convert the precursor cannabinoid, CBGa, to either THCa or CBDa—the acidic forms of THC and CBD. Consequently, higher levels of CBDa imply higher levels of THCa.

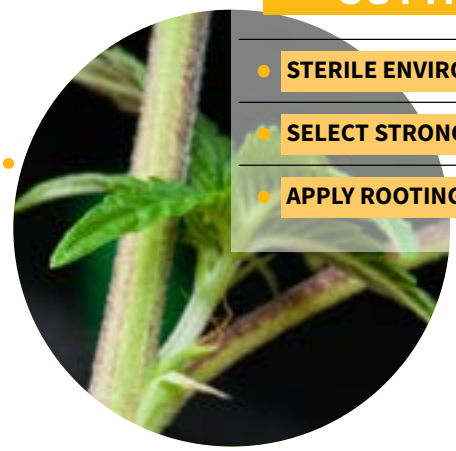
When THC production genes are turned "on" and CBD is turned "off," plants are THC dominant, psychoactive, and are considered recreational and medical. When both CBD and THC genes are turned "on," plants are moderately psychoactive (as CBD potentially lessens the psychoactivity of THC) and are considered medical. When CBD production genes are turned "on" and THC is "off," plants are considered industrial or food product.

Whether cannabis varieties bred to produce high concentration of CBDa and low concentration of THCa will be more or less likely to go "hot" in more fertile soil is yet to be studied. Therefore, clones of mother plants grown in local conditions or perhaps well-adapted to the local environment pose the least risk.

MOTHER PLANT

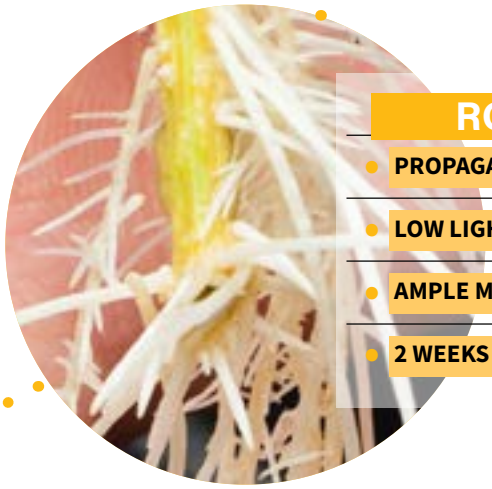
- TYPICALLY INDOORS
- ONLY FEMALE PLANTS
- EXTENDED VEGETATIVE STAGE

CUTTINGS



- STERILE ENVIRONMENT
- SELECT STRONG NODES
- APPLY ROOTING SOLUTION

ROOTING



- PROPAGATION TRAY
- LOW LIGHT
- AMPLE MOISTURE
- 2 WEEKS

TRANSPLANT

- 4”X 4” SOIL OR COCO POT (2-3 WEEKS)
- TRANSFER TO 1 GAL. SOIL POT (OPTIONAL)
- TRANSPLANT OUTDOORS WHEN READY
- STRONG ROOTS MINIMIZE PLANT SHOCK

IN SOIL

Planting

OUTDOOR

CBD BIOMASS

Opportunities for outdoor cultivation can substantially lower startup costs, but harvesting CBD-rich cannabis is laborsome. Small hemp farms may need extra farmhands to harvest the crop in time. Proper spacing supports efficient harvesting.

Rows are typically 4' x 4' with 6-8 feet between rows depending on the variety. Cannabis cultivated outdoors for CBD purposes will mainly be processed into biomass to produce CBD extracts.

Preemptive measures should be taken to reduce the risk of contamination, e.g., pesticide blow over, heavy metal contamination, or microbial contamination.

OUTDOOR

GRAIN | FIBER

Grain and fiber varieties are typically planted in 6-7 inch rows, resulting in about 400,000-600,000 grain plants per acre and 800,000-1,000,000 fiber plants per acre. Fiber varieties should be planted more densely to prevent branching while grain varieties will need more space to produce flowers.

Fiber and grain varieties will both start from regular seeds. Grain varieties will need about 25 pounds of seed per acre (approx. 25,000-27,000 seeds per pound), accounting for 70-80 percent germination rate. Fiber varieties will need up to 100 pounds per acre.

INDOOR

CBD FLOWER

Indoor cultivation facilities offer more control over the growing environment but can be more capital-intensive when using artificial lighting. However, indoor cultivation also includes sun-grown cannabis in greenhouses or enclosed hoop houses.

SUNGROWN

CBD FLOWER

Most of the hemp currently being grown in the U.S. is used for CBD extract purposes. Growing for fiber and grain requires growing at larger scale and is more capital intensive. You can grow CBD-rich hemp on 1-2 acres and still make a decent profit which is great for small farms.

Hemp CBD

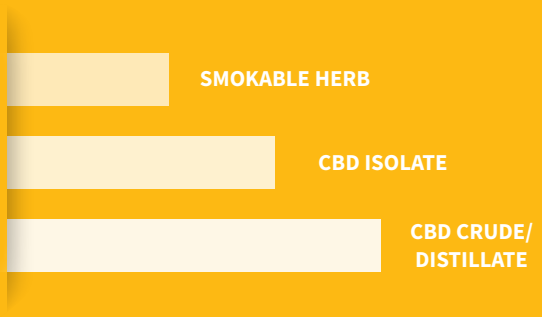
While many industrial farms are preparing to grow hemp at large scale, there are many advantages to small-scale production. First, failing small is better than failing big. Cannabis cultivated for CBD-rich flower or biomass is generally more difficult to plant, upkeep, and harvest. Growing at large scale while maintaining high-quality will be challenging.

Levels of pesticides that we are used to seeing in food, which are considered tolerable, are not likely to be attractive or even acceptable to processors and consumers of hemp CBD products. Soil testing before planting is a great idea.

Depending on the type of extract and level of refinement, you may see low levels of pesticides become concentrated at higher levels no longer suitable for human consumption without proper remediation. Remediation adds more cost to processing. For this reason, cannabis grown in organic soil using holistic management practices will be in higher demand.

- **TEST SOIL FERTILITY ($30)**
- **TEST SOIL FOR PESTICIDE RESIDUE ($300)**
- **TEST SOIL FOR HEAVY METALS ($60)**
- **AVOID ROTATIONS WITH CORN AND SOYBEANS**
- **REDUCE WATER SATURATION WITH PROPER RUNOFF**
- **REMOVE WEAK OR DISEASED PLANTS**
- **USE STERILE, CLEAN EQUIPMENT**
- **MANAGE PESTS BEFORE FLOWERING**

USES OF CBD-RICH FLOWER



CBD PROCESSING

CRUDE

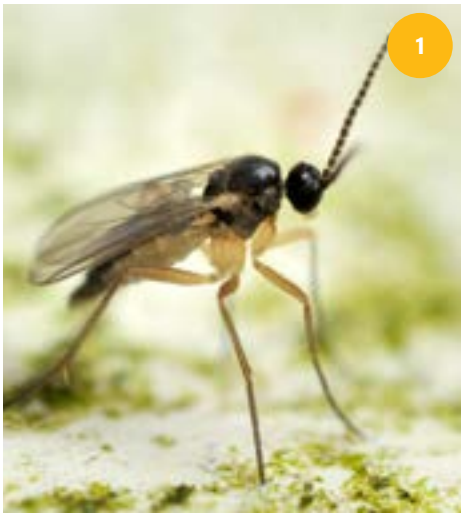
Crude oil refers to extract that closely resembles the cannabinoid/terpene profile of the original plant. CBD concentration tends to be between 40-50%. Crude oil is extracted via ethanol or supercritical CO2.

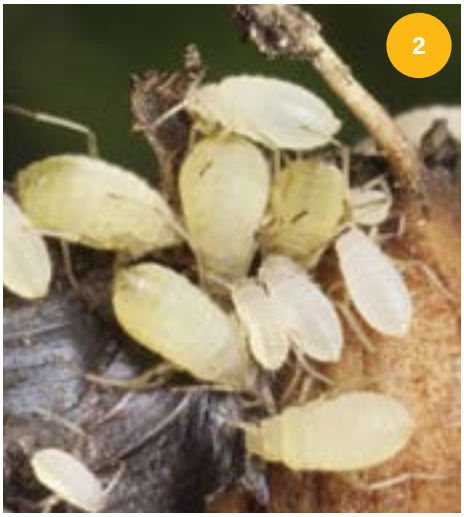
DISTILLATE

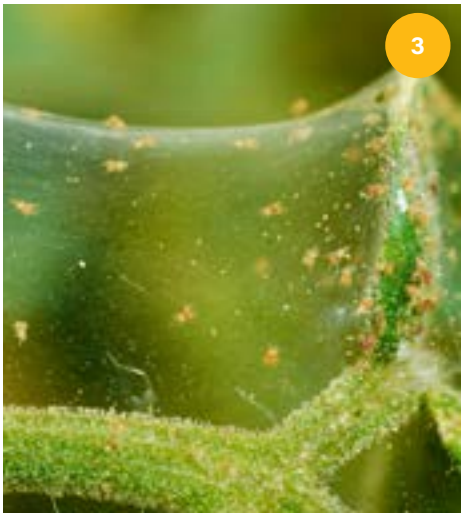
Distillate with a higher concentration of cannabinoid content is produced using fractional distillation. Most terpenes and minor cannabinoids are lost in the refinement process.

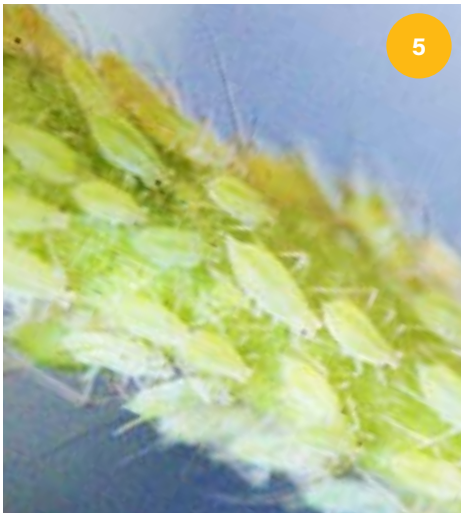
ISOLATE

98-100% pure CBD. CBD must be isolated from decarboxylated, full spectrum plant material to create THC-free CBD products. CBD isolate is flavorless and water soluble.









1. Fungus Gnats
2. Root Aphids
3. Spider Mites
4. FlowerThrips
5. Foliar Aphids

Pests

Organic standards prohibit the use of most synthetic substances—including most pesticides used in conventional agriculture—for at least three years prior to the harvest of an organic crop. However, USDA organic regulations allow residues of prohibited pesticides up to 5 percent of the EPA tolerance.

Some cannabis producers will focus on producing as much biomass as possible without necessarily thinking about the environmental impact of pesticide, insecticide, and herbicide use. Most industrial farmers are used to spraying crops to prevent pests and disease. However, by using methods such as companion planting, mulching, composting, and Integrated Pest Management, producers of cannabis can help improve biodiversity and soil biology.

Pesticides, insecticides, and herbicides used in conventional farming practices will deter beneficial insects and microbes that would otherwise aid in pest and disease control. Integrated Pest Management (IPM) practices in conjunction with holistic methods that allow beneficial microbes to thrive are recommended when producing cannabis for human consumption.

IPM is an environmentally sensitive approach to pest management using proactive methods that support healthy soil.

Integrated Pest Management

LADYBUG

APHIDS | MITES

Ladybugs are a popular, beneficial insect that mainly prey on aphids and mites. A single ladybug can eat up to 50 aphids per day or 5,000 in its lifespan.

It's important to use the right species of ladybugs. Harmonia axyridis, or the Asian lady beetle, and Coccinella septempunctata, sevenspotted lady beetle, are commonly used for aphid control.

Consider planting flowers that ladybugs are attracted to: yarrow, marigold, dill, fennel, and dandelion to name a few.

PRAYING MANTIS

APHIDS | GNATS

Similar to ladybugs, the praying mantis is attracted to fragrant, colorful plants. However, praying mantises will eat both pests and beneficial insects.

Other beneficial insects may include predatory mites, wasps, and beetles.

Consider planting flowers and culinary herbs like holy basil, thyme, oregano, yarrow, chamomile, calendula, clover, dandelion, aster, nettle, fennel, and marigolds as a cover crop.

GREEN LACEWING

APHIDS | MITES | THRIPS

Green lacewings work well as a general predator. Consider planting dill, coriander, fennel, and dandelion to attract lacewings.

PREDATORY MITES

BROAD| RUSSET | SPIDER

Predatory mites target two-spotted spider mites, broad mites, russet mites, cyclamen mites, and other mite species.

GRAY MOLD AND POWDERY MILDEW ARE THE MOST COMMON DISEASES CAUSED BY HUMID CONDITIONS AND EXCESS MOISTURE.

Diseases

Humidity, water saturation, lack of airflow, and excess foliage are likely to cause fungal diseases and microbial contamination. Cannabis infected by mold, powdery mildew, and other fungi pose a potential threat to cannabis consumers. Mold should not be confused with the plant's trichomes or the resinous glands that produce cannabinoids and terpenes.

Preventative measures include planting in areas with proper drainage and runoff (i.e. mounded rows), providing ample spacing for plants to grow and to improve air circulation, and proactively pruning plants to remove excess foliage. After harvesting, proper drying and storage of cannabis flowers to control humidity levels is extremely important.

Excess water may also cause root rot. In the Midwest, plasticulture is likely not necessary. With heavy rainfalls, raised beds with plastic ground cover are bound to cause over saturation and lead to beds drying too slowly.

Resources

- GROWING INDUSTRIAL HEMP IN ONTARIO
- INDUSTRIAL HEMP FACTSHEET, VOTE HEMP
- BAST FIBER APPLICATIONS FOR COMPOSITES
- THE WORLD'S MAJOR FIBRE CROPS - THEIR CULTIVATION AND MANURING
- UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF PLANT INDUSTRY - CIRCULAR NO. 57.
- 1913 YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
- AN INTRODUCTION TO INDUSTRIAL HEMP AND HEMP AGRONOMY
- HEMP HISTORY AND AGRONOMY 2018, UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE
- INDUSTRIAL HEMP PRODUCTION, UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE
- HEMP PRODUCTION, PURDUE UNIVERSITY
- DECIMAL CODE FOR GROWTH STAGES OF HEMP (CANNABIS SATIVA L.)
- INDUSTRIAL HEMP OPPORTUNITIES AND CHALLENGES, NORTH CAROLINA STATE UNIVERSITY
- 2018 HEMP TRIALS FOR NEW YORK STATE GRAIN, DUAL PURPOSE, AND FIBER PRODUCTION, CORNELL UNIVERSITY
- MICRONUTRIENTS: FUNCTIONS, SOURCES AND APPLICATION METHODS
- INDUSTRIAL HEMP HARVEST AND STORAGE BEST MANAGEMENT PRACTICES
- UNDERSTANDING THE NUMBERS ON YOUR SOIL TEST REPORT, UNIVERSITY OF ARKANSAS
- INDUSTRIAL HEMP VARIETY PERFORMANCE IN NORTH DAKOTA, NDSU
- INDUSTRIAL HEMP PRODUCTION 101, MONTANA FARMERS UNION
- INDUSTRIAL HEMP: FROM SEED TO MARKET, CORNELL UNIVERSITY
- FEMINIZED SEED WHITE PAPER, OREGON CBD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