CBD Hemp Production

Shelby Ellison, PhD & Leah Sandler, PhD
Outline

• Introduction to CBD
• Planting material
• Planting considerations
• Mid-season considerations
• Flowering
Cannabis sativa L.

- Annual
- Dioecious
  - Males and female flowers are typically on separate plants
- Wind pollinated
- Cannabis > 0.3% THC
  - Medicinal or recreational use
- Cannabis <0.3% THC
  - Industrial Hemp
    - Seed
    - Fiber
    - CBD
What is CBD?

- 8 Major Cannabinoid Acids Naturally Produced by Cannabis

**CBGA** (Cannabigerolic acid)
**THCA** ($\Delta^9$-tetrahydrocannabinolic acid)
**CBDCA** (Cannabidiolic acid)
**CBCA** (Cannabichromene acid)
**CBGVA** (Cannabigerоваринic acid)
**THCVA** (Tetrahydrocanabivarvinic acid)
**CBDVA** (Cannabidivarvinic acid)
**CBCVA** (Cannabichromevarin acid)

**CBG** (Cannabigerol)
**THC** ($\Delta9$-tetrahydrocannabinol)
**CBD** (Cannabidiol)
**CBC** (Cannabichromene)
**CBGV** (Cannabigerivarin)
**THCV** (Tetrahydrocanabivarvin)
**CBDV** (Cannabidivarvin)
**CBCV** (Cannabichromevarin)

Heat

**THCA** and **CBDCA** are usually the most abundant cannabinoids in Cannabis varieties.
How does CBD work?

• CBD interacts with the body’s endocannabinoid system

• Almost every organ of your body contains cannabinoid receptors
  – Particularly in brain and central nervous system.

• The endocannabinoid system has four primary purposes
  – neuroprotection, stress relief, immune response, and regulating the body’s general state of balance.
How does CBD work?

• The human body has two primary cannabinoid receptors (CB1 and CB2).

• Unlike THC, CBD does not interact with these receptors.
  – This is why CBD does not cause any psychoactive effect.

• CBD inhibits the break down of endocannabinoids, leading to an increase in your body’s naturally-produced cannabinoids. *Leafly
Medicinal uses of CBD

• Anti-seizure
• Anti-inflammatory
• Analgesic
• Anti-tumor effects
• Anti-psychotic
• Inflammatory bowel disease
• Depression
Where does CBD come from?

- The highest concentrations of CBDA are found on trichomes of an unpollinated female flower
- Trichomes are glandular hairs found on the surface of plants
- Trichomes also produce terpenes and flavonoids which contribute to a plant’s aroma and flavor profile
Determining sex

- Cannabis plants have pre-flowers at their nodes (where leaves and branches extend from the stalk).
- By the sixth week, you should be able to find the pre-flowers and confidently determine the sex of your plant.
- Remove male plants as well as hermaphroditic plants that show both sex types.
Female and male pre-flowers

Female pre-flower
Male pre-flower
Mature female and male flowers

Female flower

Male flower
Planting materials

- What will do well in Wisconsin?
- CO, OR, CA cultivars – different climates (drier)
- Ditchweed left over from 40s and 50s
Planting materials

- **Seed**
  - Typically more hearty than clones
  - Non-feminized means will have both males and females, in which case you’ll need to get rid of the males
  - A lot of beginning growers start with feminized seeds
  - Start in greenhouse and transplant (hardened off)
Planting materials

• Clones
  – Directly cut from a female mother plant
  – Guaranteed females (hopefully)
  – Need to be hardened off

• DATCP website currently has a list of approved varieties - https://datcp.wi.gov/Documents/IHApprovedCBDVarieties.pdf

PC: Forrest Woolery
Starting seeds

• Cells – 144’s, deep cell
• Conscious of tap root and transplant shock
• Potting mix
• Adequate water – careful to avoid overwater
  – Flood tables
• 0.5” depth
Greenhouse protocol

• No longer than 4 weeks in greenhouse
• Cuttings take approx. 10 days to start rooting
• Harden off before transplant – shade cloth
  – Particularly if using lights – UV rays
CBD agronomic disclaimer

- Optimum agronomic protocols for CBD production in field-scale systems has not been defined by replicated research methods.
- Much of what is practiced today is extrapolated from *Cannabis* production systems in U.S. states where it is legal and/or from other countries.

(Williams & Mundell, 2015)
Planting: Time of year

• Transplants – clones or seedlings
  – No longer than 4 weeks in greenhouse
• VT started 14\textsuperscript{th} May, transplanted 6\textsuperscript{th} July
  – Or throughout month of June
• NY July 6 and 9
• Can start in late May- through mid June
• Day length sensitivity; will start to flower want good vegetative growth to support flowering
• Direct seed - mid May to early June
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<thead>
<tr>
<th>Planting date</th>
<th>Plant weight</th>
<th>Plant height</th>
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<td></td>
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<td>Cm</td>
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<td>14-Jun</td>
<td>5.38a(\d)</td>
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<tr>
<td>21-Jun</td>
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<td>LSD (0.10)</td>
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(Darby et al., 2018)
<table>
<thead>
<tr>
<th>Planting date</th>
<th>Dry matter flower yield†</th>
<th>Unmarketable dry matter flower yield</th>
<th>Dry matter flower yield</th>
<th>Unmarketable dry matter flower yield</th>
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<td>lbs plant⁻¹</td>
<td>lbs ac⁻¹</td>
<td>lbs ac⁻¹</td>
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<tr>
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<td>0.0223</td>
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<td>LSD (0.10)</td>
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<tr>
<td>Trial mean</td>
<td>0.678</td>
<td>0.0174</td>
<td>2973</td>
<td>35.4</td>
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</table>

† Dry matter is at 0% moisture.

(Darby et al., 2018)
Planting: Types of soil

• Non-marginal land
• Well draining – does not like excessive moisture
• Loamy
  – Deep tap root will help stabilize, clay or compaction hard on roots
  – Nutrient heavy – soils that can hold nutrients but not bind them
• pH 5.9- 6.5 up to 7.5
Planting: Field Prep - tillage

• No till
  • Plant into strips of clover, rye, green mats

• Tilled soil with cover planted at same time
  – Hit twice – let weed flush come up and then hit it again right before transplant or seeding

• Black plastic

• Don’t recommend straw due to moisture and mold
Planting: Field Prep-Fertility

• High nutrient use crop
• 100-120 N lbs/acre at planting
  – NPK – 2:1:2 – K is important, but largely added N
• Additional N approx. month later, before flowering (50 lbs/acre)
• Clover additional N
• Think about spacing - fertilizing a lot of unused soil
  – Fertilize when laying plastic
  – Plant cover to hold nutrients
  – High grow facilities may use fertigation
Planting: Spacing

• Different recommendations
• Direct seeding – 30 in. centers, 12-16 in row
  – 24,000 seeds/lb, 1/2lb per acre at 50/50
• Pulling males may increase spacing can go closer if non feminized
• Transplants – 1x1ft all the way to 6x6ft
  – 1,500 to 4,000 plants an acre
• Again may be pulling males
<table>
<thead>
<tr>
<th>Plant spacing, ft x ft</th>
<th>Population* , plants ac⁻¹</th>
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<tr>
<td>5 x 5</td>
<td>1,742</td>
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*Population does not account for alleys or roads.

(Darby et al., 2018)
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<th>Unmarketable dry matter flower yield†</th>
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<tr>
<td>ft x ft</td>
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<td>lbs plant⁻¹</td>
<td>lbs ac⁻¹</td>
<td>lbs ac⁻¹</td>
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<td>0.017</td>
<td>2973</td>
<td>35.4</td>
</tr>
</tbody>
</table>

(Darby et al., 2018)
Planting: Equipment

• Direct seeding
  • Planter – sorghum plate

• Transplants

• Into prepped beds, plastic beds, no-till cover
  – Water wheel
  – Closing wheel transplanter
  – 4 wheel tobacco setter

• Avoid root binding and more than 4 wks to reduce transplant shock
Managing males

• Non-feminized Seed – 50/50
• Feminized – not always a guarantee
• Need to be on constant lookout for males
  – Your own plants
  – Nearby feral hemp (“ditch weed”)
  – Remove as soon as possible
• Pollen is incredibly prolific
  – Experts recommend 10 miles between CBD hemp and fiber/grain hemp
(Small & Antle, 2003)
Total CBD Concentrations as a Function of Pollination and Bud Location

(Williams, Chappell, Pauly)
Indoor production

• Trellis plants – netting, drop down
• Remove bottom branching for air flow (10”)
• Additional pruning can be done to provide greater airflow and potentially reduce fungal infections
  – promote more flowering branches and increase yields
Water management

• 12-15 in (hemp), 25-30 in (marijuana)—research from CSU

• Approx. 6 gallons per plant a week - CO

• Drip tape

• Linear or center pivot irrigation

• Traveling gun
Nutrient management - N

• Pre-plant applications
• In season N
  – Most nitrogen hungry at flowering
• 1,674 to 4,209 kg ha\(^{-1}\) from 0 - 200 kg N
• Grower in KT – 125-200 lb/acre N, pre plant and over top application in July
Nutrient management - K

- Keep potassium levels in medium to high range of > 250 ppm range
- K is mostly in stalk and vegetation – greatest uptake at the start of flowering
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Total Plant (kg/ha)</th>
<th>Grain (kg/ha)</th>
<th>Uptake</th>
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<tbody>
<tr>
<td></td>
<td>Hemp*</td>
<td>Canola**</td>
<td>Hemp*</td>
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<tr>
<td>N</td>
<td>200</td>
<td>120</td>
<td>40</td>
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<tr>
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<tr>
<td>K</td>
<td>211</td>
<td>75</td>
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<td>S</td>
<td>14</td>
<td>20</td>
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*Source Canola: Canadian Fertilizer Institute
Weed Management

• No labeled herbicides or pesticides
• Black plastic
• Cover – clover, rye
  – Large enough spacing to mow
• Row cultivation or hoes
Pest Management - insects

• Aphids (Cannabis aphid), mites, thrips
• Insects that chew leaves of the plant (defoliators) – caterpillars, beetles, grasshoppers
• Stalk borers- European corn borer, Eurasian corn borer in CO
• Corn earworm
Pest Management - insects

- https://hempinsects.agsci.colostate.edu
- JM Parkland
Pest Management - insects

- Biopesticides, soaps, and oils – state approved least-toxic pesticides
- Monitor visually and with sticky traps
- Infested plants pruned
- Caterpillars, etc. removed by hand picking
- Insectary plants grown around the perimeter can provide beneficial insects – green lacewings, syrphid flies, collops beetle, damsel bugs
Pest Management - disease

- More humid climate than west - will be a challenge
- Powdery mildew (*Podosphaera macularis*) and gray mold (*Botrytis cinerea*)
- Botryis – “bud rot”, inside flowers causing rot from inside out
- Powdery mildew - first appears white and powdery sports on leaf tops, will then spread
  – Downy mildew similar
Pest Management - disease

- May respond to oils, potassium bicarbonate, and induced systemic materials such as potassium phosphate
Pest Management - vertebrates

- Deer like to graze
- Fences and other barriers
- Traps for rabbits, mice, moles
Thank you!

Questions?

Shelby Ellison – slrepinski@wisc.edu
Leah Sandler – lsandler@michaelfields.org