



# CBD Hemp Production

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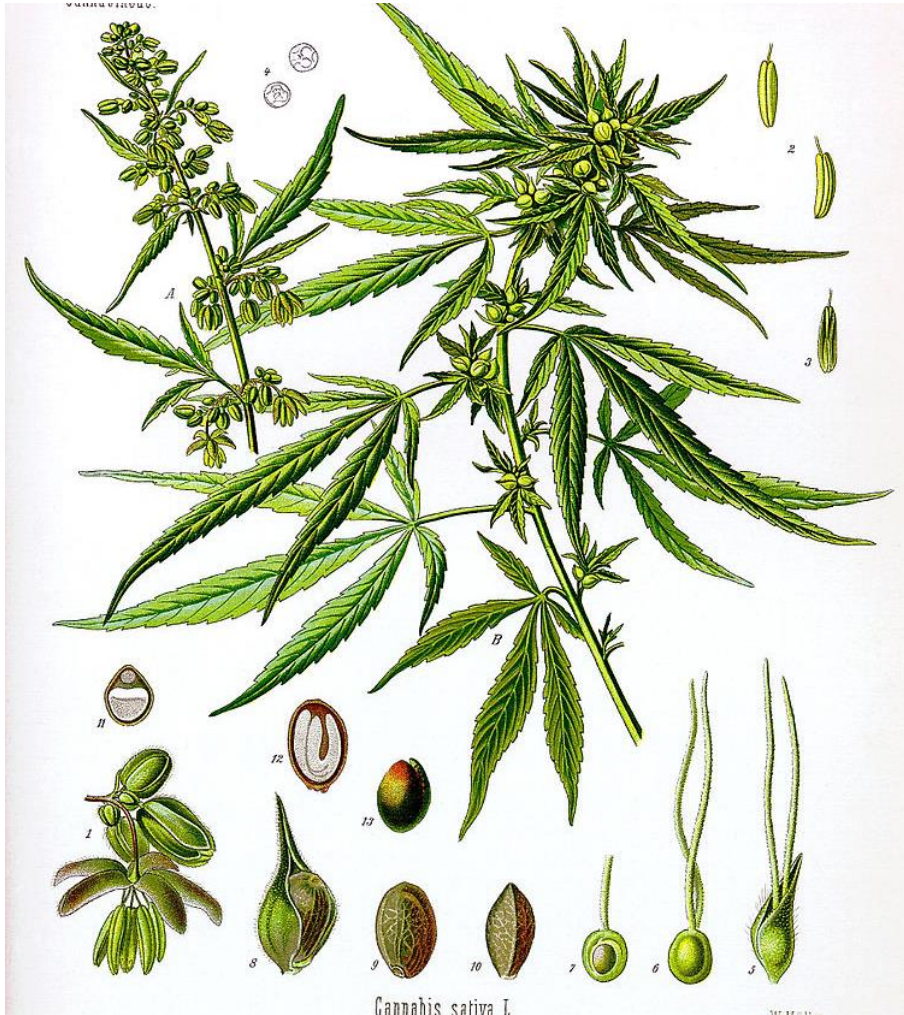
# Outline

- Introduction to CBD
- Planting material
- Planting considerations
- Mid-season considerations
- Flowering



PC: Forrest Woolery

# *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)

**CBDA** (Cannabidiolic acid)

**CBCA** (Cannabichromenenic acid)

**CBGVA** (Cannabigerovarinic acid)

**THCVA** (Tetrahydrocannabivarinic acid)

**CBDVA** (Cannabidivarinic acid)

**CBCVA** (Cannabichromevarinic acid)

Heat



**CBG** (Cannabigerol)

**THC** ( $\Delta^9$ -tetrahydrocannabinol)

**CBD** (Cannabidiol)

**CBC** (Cannabichromene)

**CBGV** (Cannabigerivarin)

**THCV** (Tetrahydrocannabivarin)

**CBDV** (Cannabidivarin)

**CBCV** (Cannabichromevarin)

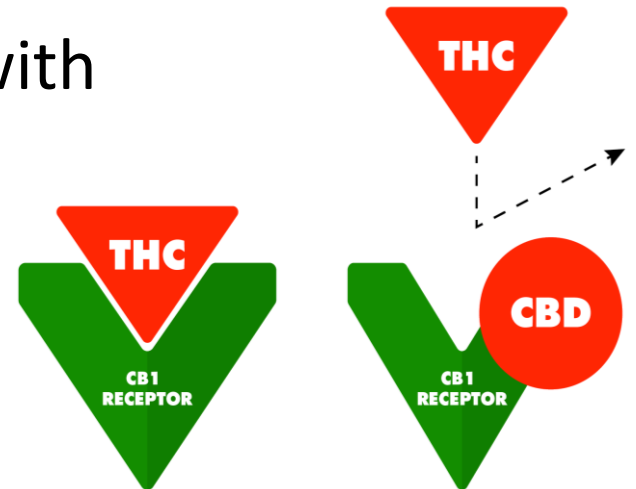
**THCA** and **CBDA** are usually the most abundant cannabinoids in Cannabis varieties.

# 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



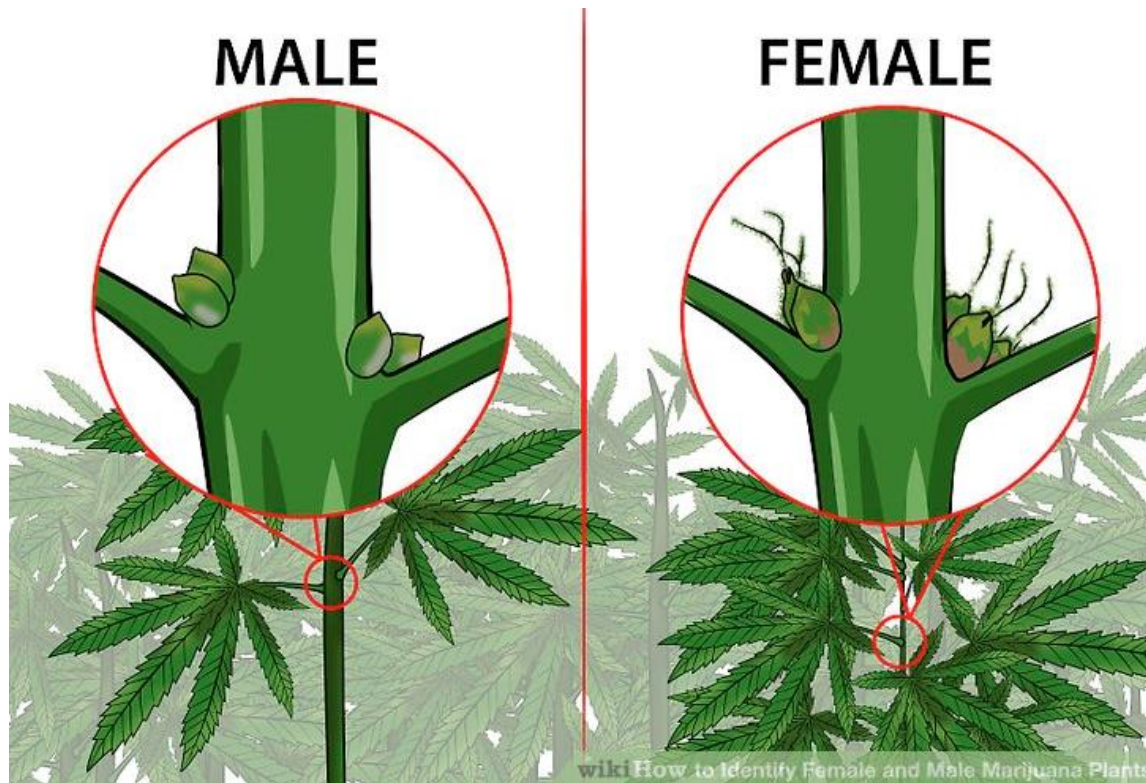
# Where does CBD come from?

- 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

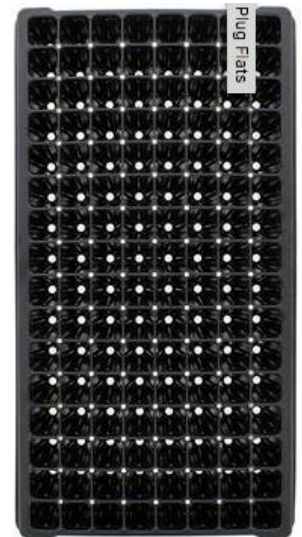
- Clones
  - Directly cut from a female mother plant
  - Guaranteed females (hopefully)
  - Need to be hardened off
- DATCP website currently has a list of approved varieties - <https://datcp.wi.gov/Documents/IHApprovedCBDVarieties.pdf>



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<sup>th</sup> May, transplanted 6<sup>th</sup> 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



<b>Planting date</b>	<b>Plant weight</b>	<b>Plant height</b>
	<b>lbs plant<sup>-1</sup></b>	<b>Cm</b>
<b>14-Jun</b>	<b>5.38a<sub>t</sub></b>	<b>82.1</b>
<b>21-Jun</b>	<b>4.83ab</b>	<b>80.5</b>
<b>27-Jun</b>	<b>4.20b</b>	<b>73.8</b>
<b>LSD (0.10)</b>	<b>0.734</b>	<b>NS</b>
<b>Trial mean</b>	<b>78.8</b>	<b>4.80</b>

(Darby et al., 2018)

Planting date	Dry matter flower yield†	Unmarketable dry matter flower yield	Dry matter flower yield	Unmarketable dry matter flower yield
	lbs plant <sup>-1</sup>	lbs plant <sup>-1</sup>	lbs ac <sup>-1</sup>	lbs ac <sup>-1</sup>
<b>14-Jun</b>	0.740	0.0151	2920	38.9
<b>21-Jun</b>	0.672	0.0223	3243	39.4
<b>27-Jun</b>	0.621	0.0149	2755	27.9
<b>LSD (0.10)</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>
<b>Trial mean</b>	<b>0.678</b>	<b>0.0174</b>	<b>2973</b>	<b>35.4</b>

† 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



<b>Plant spacing, ft x ft</b>	<b>Population*, plants ac<sup>-1</sup></b>
1 x 1	43,560
3 x 3	4,840
5 x 5	1,742

\*Population does not account for alleys or roads.

(Darby et al., 2018)

<b>Plant spacing</b>	<b>Dry matter flower yield†</b>	<b>Unmarketable dry matter flower yield†</b>	<b>Dry matter flower yield†</b>	<b>Unmarketable dry matter flower yield†</b>
<b>ft x ft</b>	<b>lbs plant<sup>-1</sup></b>	<b>lbs plant<sup>-1</sup></b>	<b>lbs ac<sup>-1</sup></b>	<b>lbs ac<sup>-1</sup></b>
1 x 1	0.084 <sup>ct</sup>	<b>0.00a</b>	<b>3669a</b>	<b>7.16a</b>
3 x 3	0.600 <sup>b</sup>	0.003 <sup>a</sup>	2894 <sup>b</sup>	12.4 <sup>a</sup>
5 x 5	<b>1.35a</b>	0.049 <sup>b</sup>	2354 <sup>c</sup>	86.6 <sup>b</sup>
<b>LSD (0.10)</b>	<b>0.093</b>	<b>0.019</b>	<b>411</b>	<b>35.9</b>
<b>Trial mean</b>	<b>0.678</b>	<b>0.017</b>	<b>2973</b>	<b>35.4</b>

(Darby et al., 2018)



# Planting: Equipment

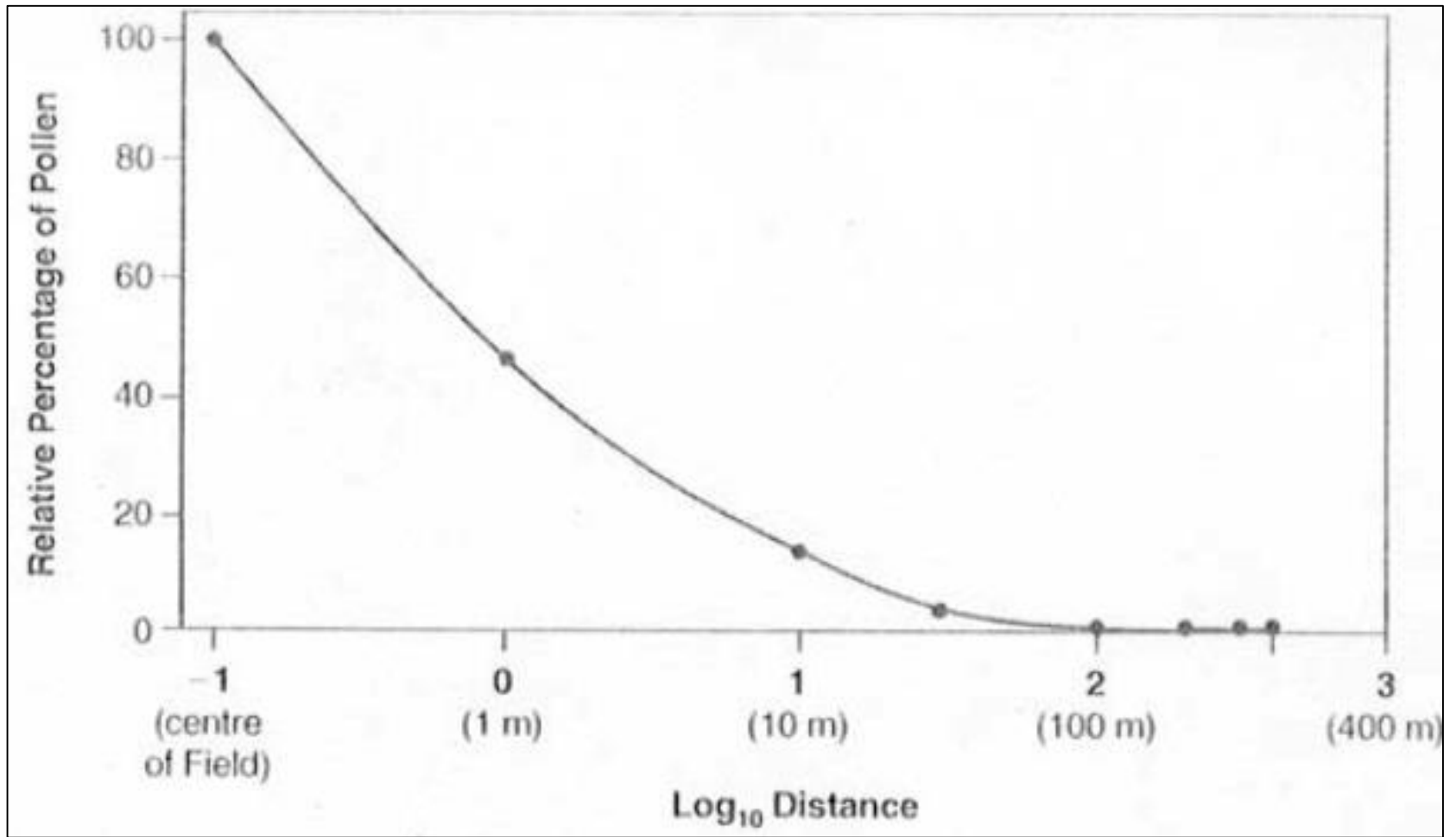
- Direct seeding
  - Planter – sorghum plate
- Transplants
- Into prepped beds, plastic beds, no-till cover
  - Water wheel
  - Closing wheel transplanter
  - 4 wheel tobacco setter
- Avoid root binding and more than 4 wks to reduce transplant shock



# Managing males

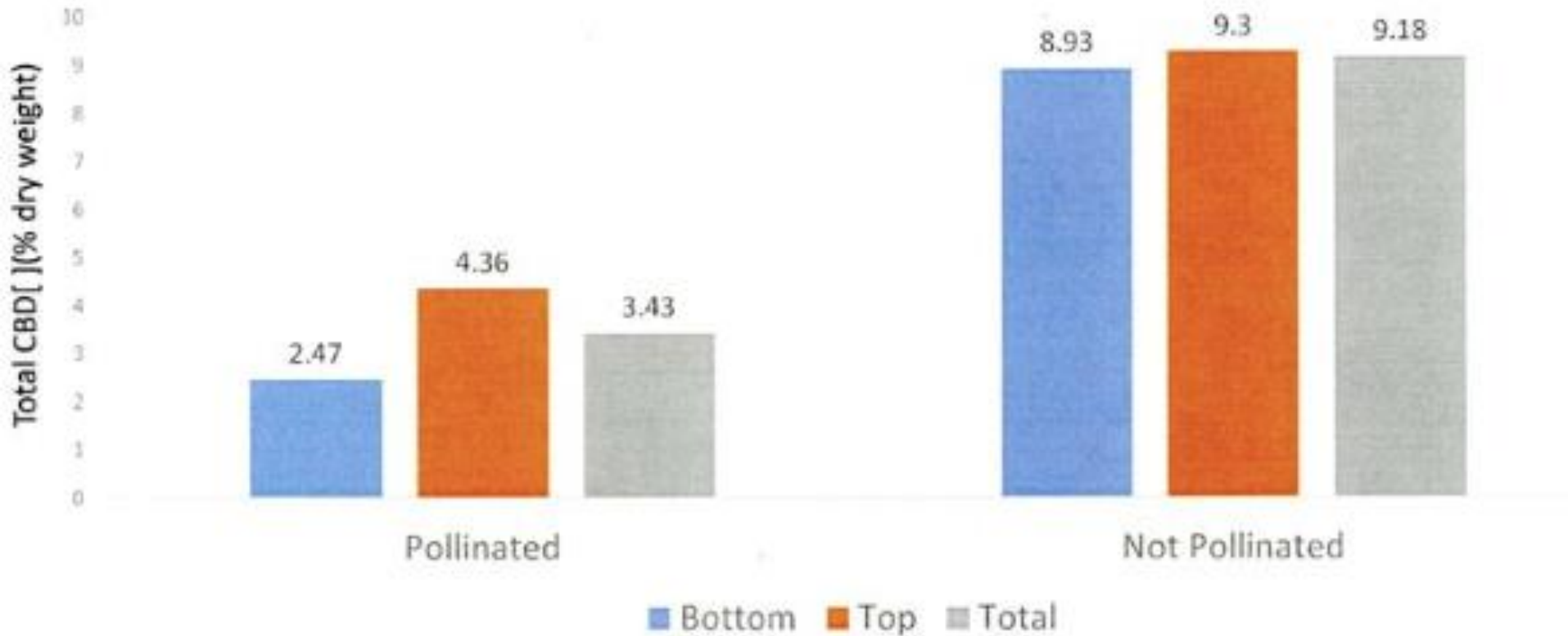
- Non-feminized Seed – 50/50
- Feminized – not always a guarantee
- Need to be on constant lookout for males
  - Your own plants
  - Nearby feral hemp (“ditch weed”)
  - Remove as soon as possible
- Pollen is incredibly prolific
  - Experts recommend 10 miles between CBD hemp and fiber/grain hemp





(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



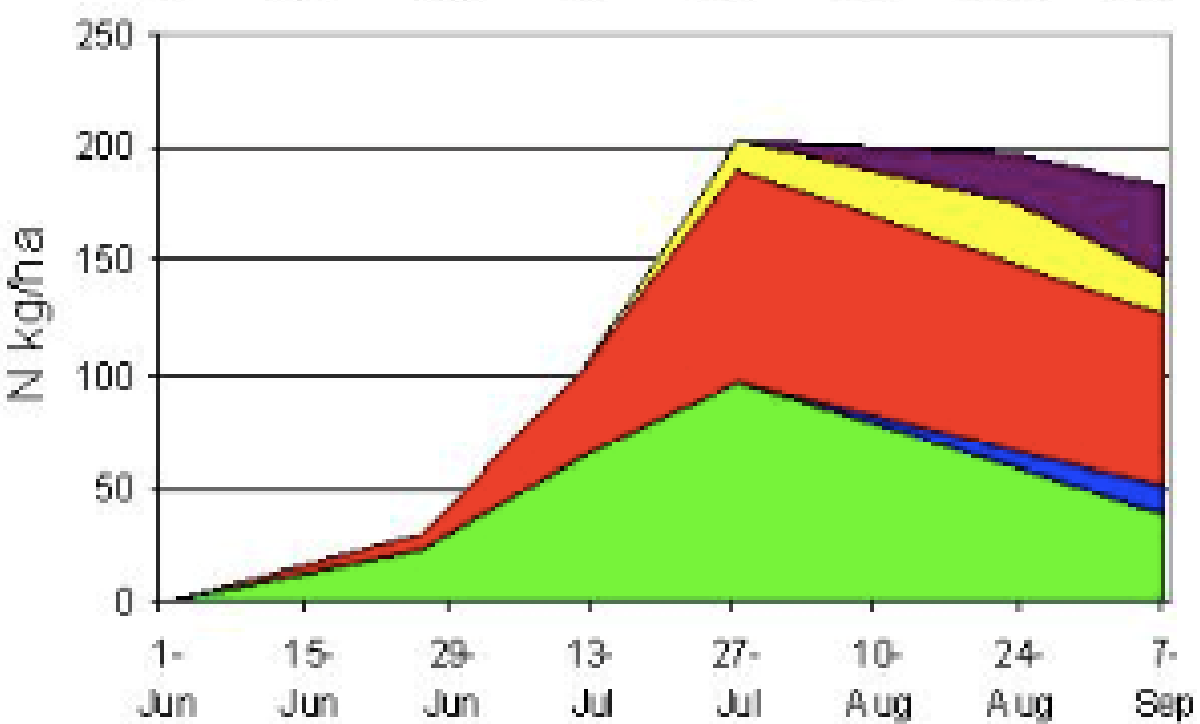
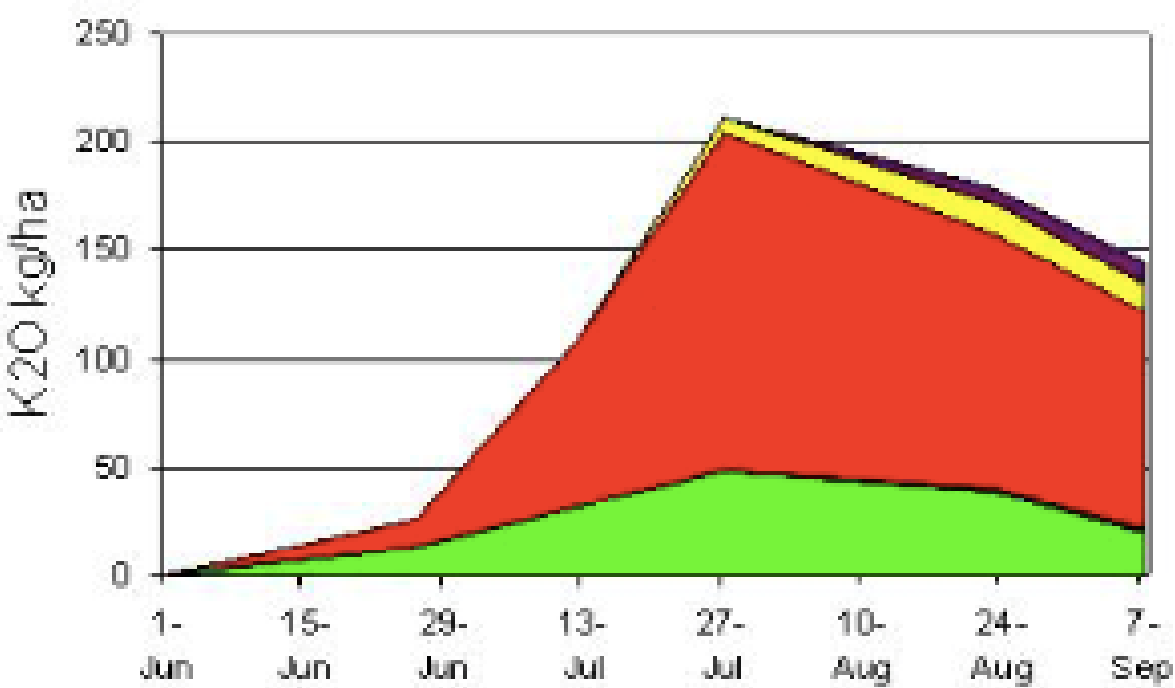
# Nutrient management - N

- Pre-plant applications
- In season N
  - Most nitrogen hungry at flowering
- 1,674 to 4,209 kg ha<sup>-1</sup> 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





- Seed
- Flower
- Stem
- Fallen leaf
- Leaf

## Nutrient Uptake and Removal of Field Crops (kg/ha)

	Total Plant (kg/ha)		Grain (kg/ha)		Uptake
Nutrient	Hemp*	Canola**	Hemp*	Canola*	Hemp/day**
<b>N</b>	200	120	40	65	6.7
<b>P</b>	47	50	19	35	1.56
<b>K</b>	211	75	10	17	6
<b>S</b>	14	20	3	12	

\*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*)
- Botrytis – “bud rot”, inside flowers causing rot from inside out
- Powdery mildew- first appears white and powdery spots 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?

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