THE UNIVERSITY OF MAINE
Cooperative Extension

Agronomics of CBD Hemp Production: Lessons from Maine and Colorado

13 December 2019

John Jemison
Extension Professor: Soil and Water Quality

Today's Presentation

- Discussion of hemp and hemp products
- Key criteria for growing high CBD hemp
- CBD hemp agronomy
  - first soil / soil management
  - second part – crop production
- NE production challenges
  - Western advantages / scale issues

April to October 2019

"Cannabatical" in the San Luis Valley

- Learn about soil and water management
  - Maine: 40 - 45" SLV - Colorado: 6 - 7"
- Learn about irrigation, technologies, and potato and hemp production

September 25, 2019

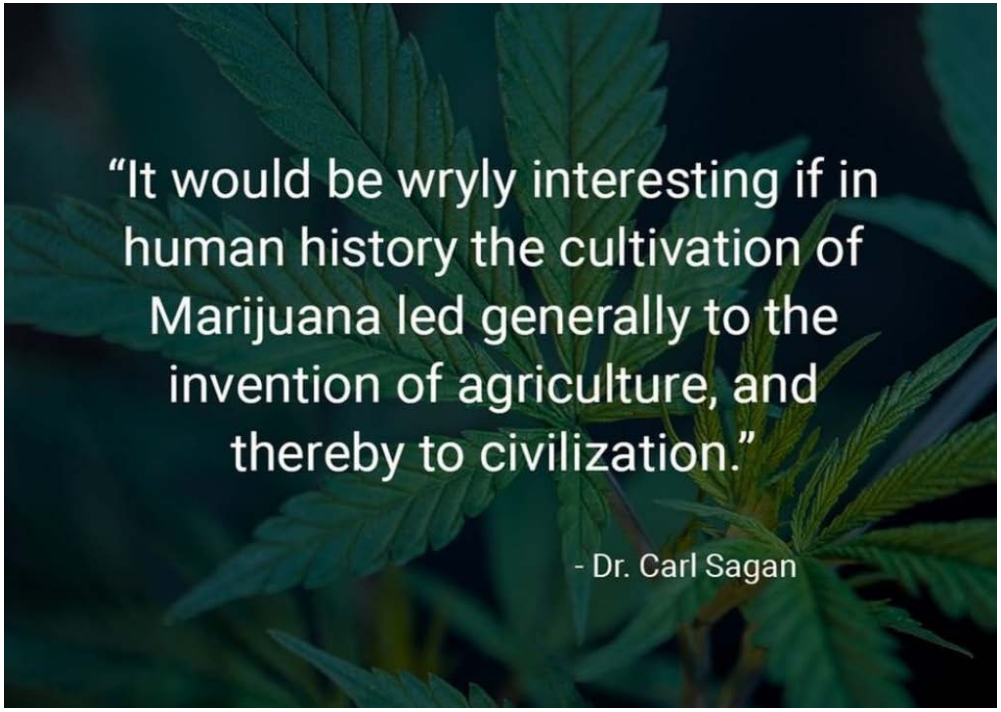
Circles – ¼ sections – 120 ac

August 23, 2019

Would I like to see this in Maine in August?

Cannabis: Industrial Hemp

- *Cannabis sativa* used for millennia … ?



Cannabis: Industrial Hemp

- *Cannabis sativa* used for >3000 years … ?
- Miracle plant? no
- Immune to the basic principles of crop management ? NO!
  - Sales up (Forbes – 700%)
  - Farmers see $ signs … reality?

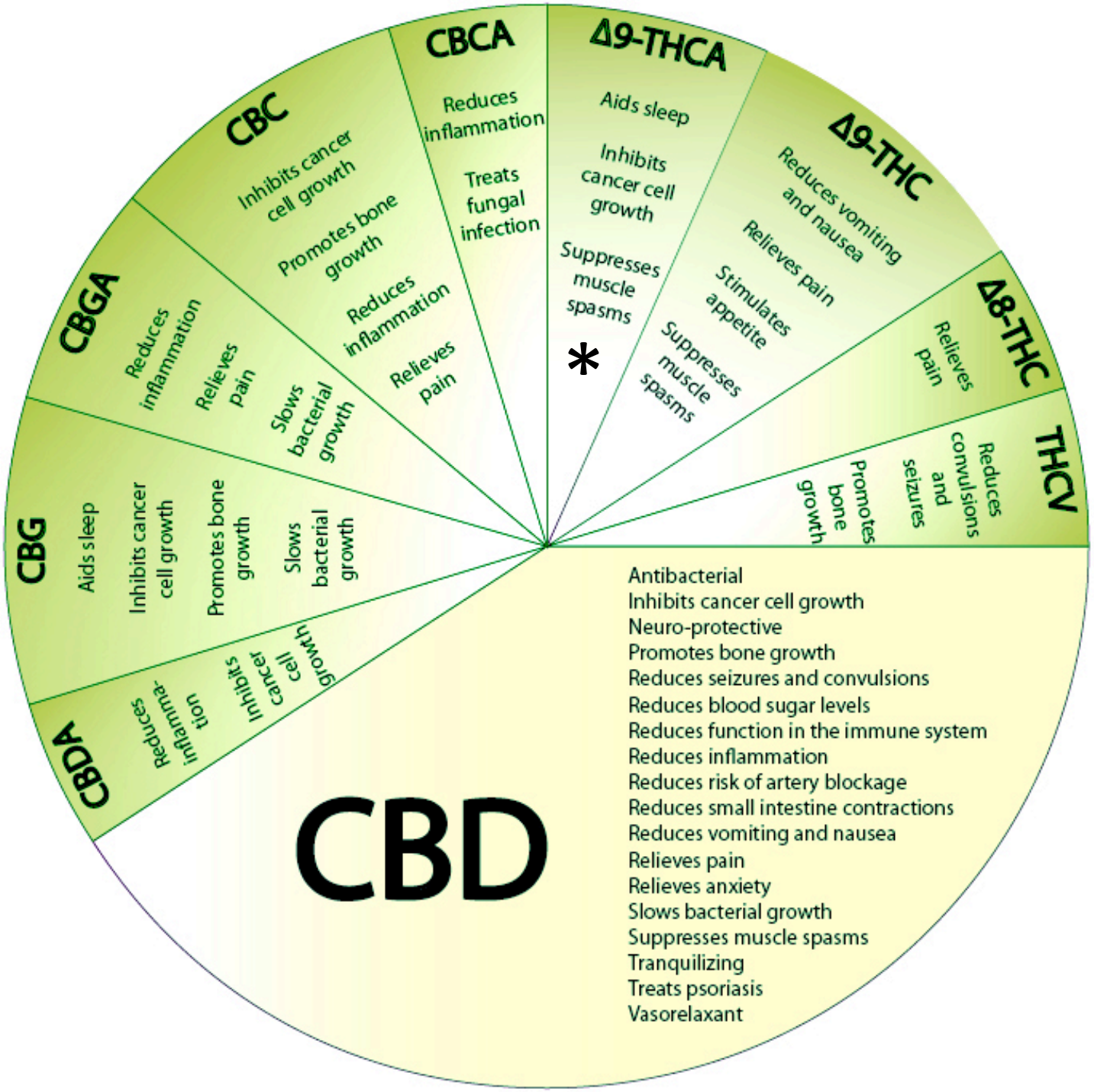
Both hemp and marijuana
are Cannabis sativa L.
If > 0.3% Total THC - marijuana

Bract is a modified leaf or scale, typically small, with a flower or flower cluster in its axil.

Trichomes

CBD / THC
Others
Terpines

Fat and
alcohol
soluble


CBCA
Reduces inflammation
Treats fungal infection
Δ9-THCA
Aids sleep
Inhibits cancer cell growth
Suppresses muscle spasms
*
Δ9-THC
Reduces vomiting and nausea
Relieves pain
Stimulates appetite
Suppresses muscle spasms
Δ8-THC
Relieves pain
THCV
Reduces convulsions and seizures
Promotes bone growth
CBC
Inhibits cancer cell growth
Promotes bone growth
Reduces inflammation
Relieves pain
CBGA
Reduces inflammation
Relieves pain
Slows bacterial growth
CBG
Aids sleep
Inhibits cancer cell growth
Promotes bone growth
Slows bacterial growth
CBDA
Reduces inflamma-tion
Inhibits cancer cell growth
CBD
Antibacterial
Inhibits cancer cell growth
Neuro-protective
Promotes bone growth
Reduces seizures and convulsions
Reduces blood sugar levels
Reduces function in the immune system
Reduces inflammation
Reduces risk of artery blockage
Reduces small intestine contractions
Reduces vomiting and nausea
Relieves pain
Relieves anxiety
Slows bacterial growth
Suppresses muscle spasms
Tranquilizing
Treats psoriasis
Vasorelaxant

How CBD cannabis is consumed

- Flower extracted – tinctures or oils
  - Sublingual dosing
- Edibles
- Smoke the "flower"
- Vaping**
  - Flower
  - Oils / concentrates

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Limited to no market today

Charlotte changed everything …

300 seizures a week to maybe 1/week…

Charlotte's web … first of many

low THC / high CBD cultivars

2016 Farm Bill:

- Opened the door to hemp production
- Farmers could do ”research” with universities
- Kentucky’s loose interpretation

2018 FARM BILL EFFECT

Under the 2018 Farm Bill, hemp has been removed from the Controlled Substances Act (CSA) and is now considered an agricultural product.

HEMP-DERIVED CBD IS LEGAL

HEMP FARMERS CAN APPLY FOR CROP INSURANCE

BANKS WILL BE WILLING TO WORK WITH HEMP COMPANIES

$1.3 BILLION BY 2022

HEMP INDUSTRY GROWTH

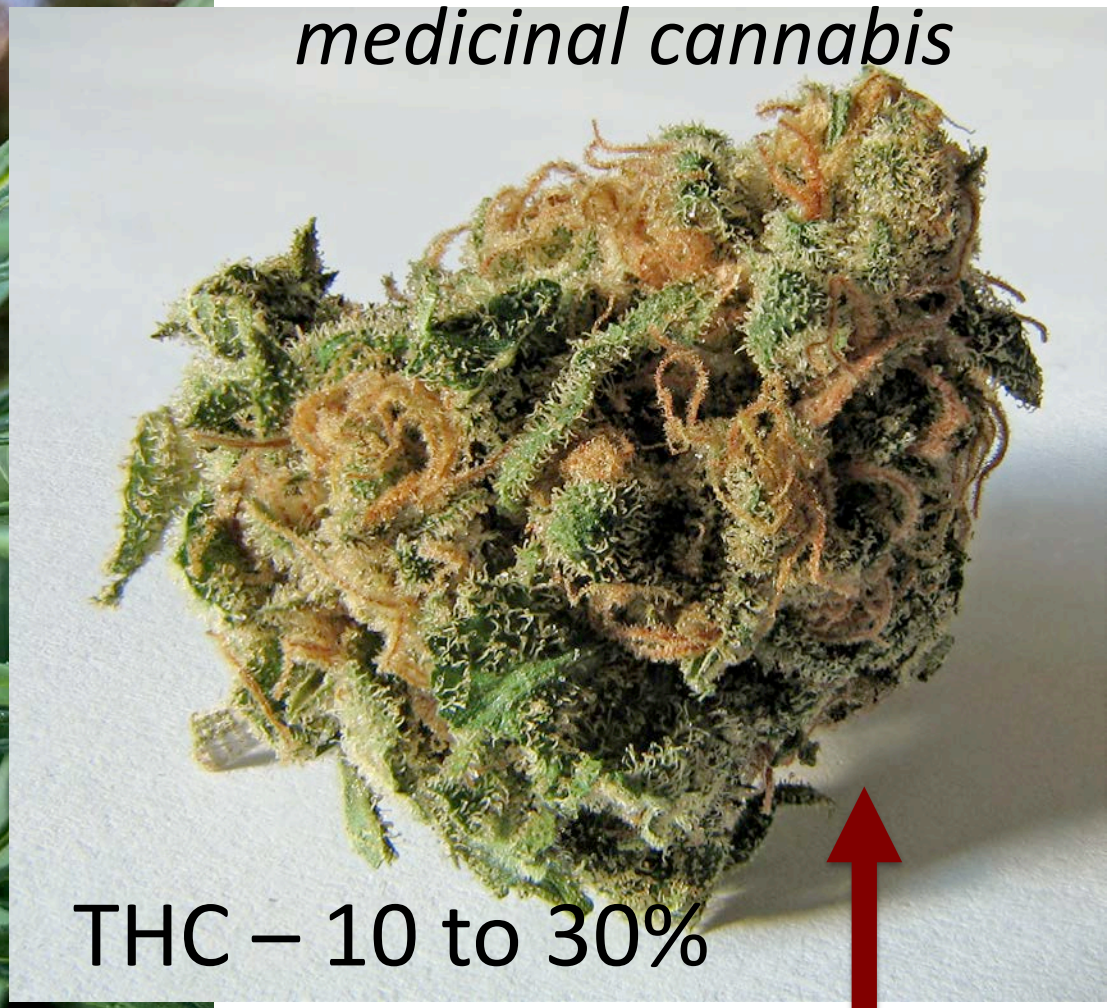
HEMP-DERIVED CBD PRODUCT SALES

© 2018 New Frontier Data | Source: Hemp Business Journal

New Frontier data

Removed hemp from Schedule 1

Both of these are *medicinal cannabis*



Still a schedule 1 drug

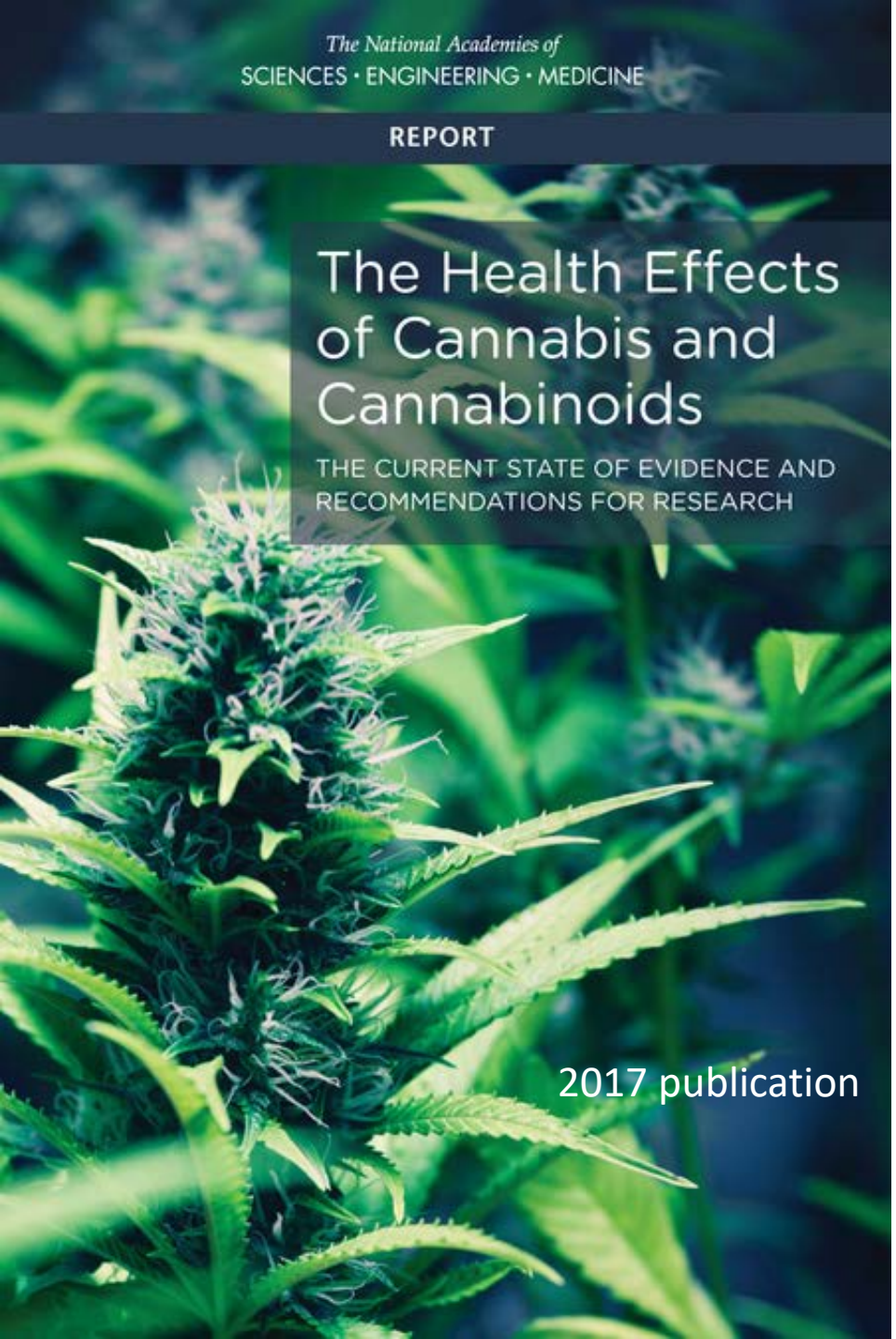
Example schedule 1 drugs:

Heroin,

Ecstacy,

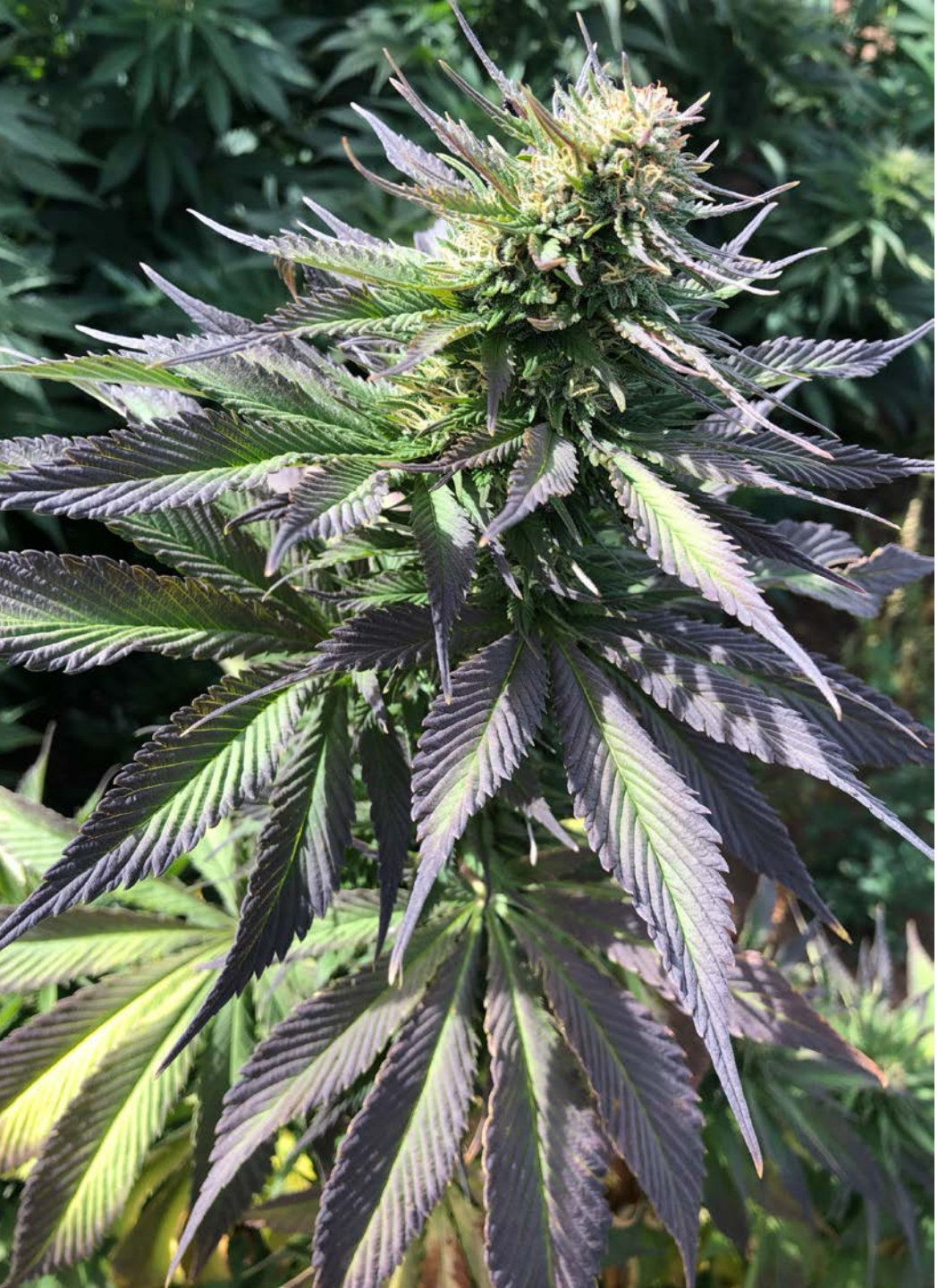
Peyote

High THC Cannabis?



Cannabis and cannabinoids

- Strong evidence:
  - control chronic pain
  - nausea from chemotherapy
  - spasticity – MS
- Moderate evidence:
  - improving sleep / apnea etc
- Some evidence:
  - improving appetite
  - decreasing weight loss
  - tourette's syndrome
  - anxiety
  - PTSD



Challenge #1

Your CBD cannabis
Exceeds 0.3% (+/-)

USDA says you are
growing marijuana
Schedule 1 drug

Must be destroyed

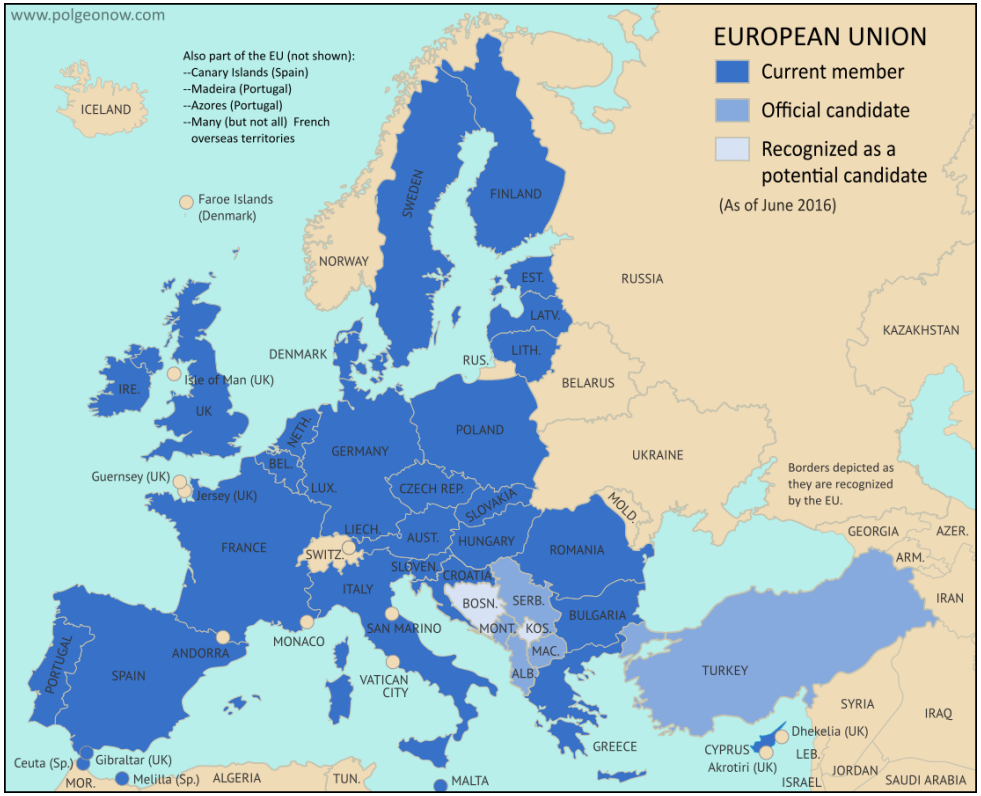
THC + 0.87 (THCa) < 0.3% +/- lab precision

Done on a *dry weight* basis!

Really no scientific basis for this …

>1% THC hemp to have psychoactivity

Small and Marcus, 2002.



EU countries - 2% THC

THC for hemp set at 0.2% in a "misguided effort aimed at preventing marijuana grows in industrial hemp fields."

Switzerland – 1% total THC

Thailand

<3% - designated hemp
3-9% - recreational cannabis
> 9% - medicinal cannabis

TESTED LABS

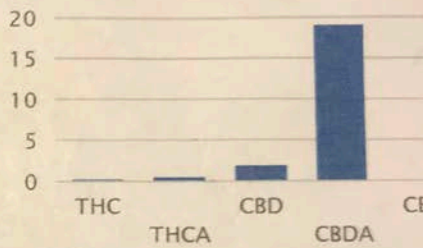
www.TestedLabs.com 207-618-9333
(http://www.TestedLabs.com)

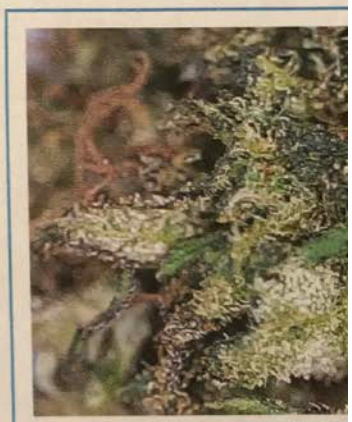
Cannabis Potency Resu

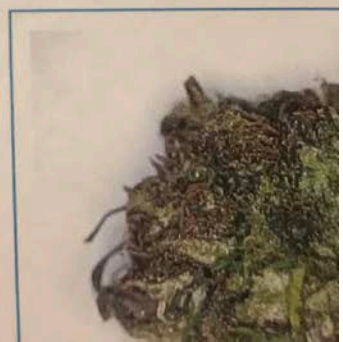
[redacted]

Sample: Mae's Cannatonic
Type: Concentrate
Notes:

Cannabinoid	Result
THC	0.27 %
THCA	0.5 %
CBD	1.91 %
CBDA	19.22 %
CBN	0.13 %
CBG	1.03 %
THCV	0.56 %
CBC	0.2 %
Total CBD (CBD+CBDA)	21.13 %
Max CBD *	18.77 %
Total THC (THC + THCA)	0.77 %
Max THC *	0.71 %
Total Cannabinoid Results	23.82 %







THC – 0.27%
THCa – 0.5%
CBD – 1.9%
CBDa – 19.1%

Not going to be able to have CBD get >8% and stay under 0.3% total THC

Should Farmers Produce Hemp?

- My line is … “Curb your enthusiasm …"
  - USDA rules: not farmer friendly
  - Extremely expensive crop to grow
  - Market is flooded right now
- Easy for processors to reject product
- Little research to support benefits / risks?

People are excited to grow hemp!

Who should do it?

CBD Cannabis: Flower Market

- "I've got some land - I want to grow hemp"
  - In active production? Drainage?
  - What kind of equipment / resources ?
    - Tractors, plastic layer, greenhouse?
- Plant production experience ?
  - Farmed several types of crops?
  - Grown medical / recreational cannabis?

CBD Cannabis: Other skill sets

- Good cultural pest management skills
  - IPM
  - Organic production experience
- Understand irrigation management

Cannabis: Industrial Hemp

- Investment backers?
  - 10ac CO farm - $180k in investments
- Basic business principles to follow!!
  - How big do you want to be …?
  - Raw biomass or value added products?
  - My advice – small/uber-organic/niche

“Value added products are going to be the saving grace for small farms.”

Wes O’roarke – Sol Mountain Farm

Product	Advertised CBD	Delivered CBD	% CBD Delivered	Delivery
Platinum X CBD Cherry Lollipops	"about 50 mg"	0.0 mg	0%	Edible
Hempzilla Berry Wild Gelato CBD Zilla Vape Pods	300 mg	0.8 mg	0%	Inhalation
Fresh Water CBD Beverage	No mg claimed	0.0 mg	0%	Water
CBD Living Water	10 mg	0.0 mg	0%	Water
Mountjoy Sparkling CBD Water	10 mg	0.0 mg	0%	Water
Hemp Bombs CBD e-Liquid - Sweet Mango Seduction	300 mg	26 mg	9%	Inhalation
MintedLeaf Pain Relief Cream *	150 mg	55 mg	37%	Topical
Charlotte's Web Hemp Infused Balm (Rite Aid) *	150 mg (Hemp Oil)	80 mg (CBD)	53%	Topical
NanoCraft CBD™ CBD Pain Salve Stick	100 mg	60 mg	60%	Topical
Just CBD Gummies	1000 mg/jar	620 mg/jar	62%	Edible
Cloud N9ne Vape Pen - Vanilla Ice Cream	200 mg	135 mg	68%	Inhalation
Herbal Springs CBD Infused Flavored Water - Blood Orange	10 mg	7 mg	70%	Water
Pure Hemp Farms Special Sauce CBD Prerolls	16.79% CBD	12% CBD	72%	Inhalation
Harmony Hemp HempBath Bomb	10 mg	7.4 mg	74%	Topical
Experience CBD Vape Oil	1000 mg	770 mg	77%	Inhalation
Thick Liq Canna Extract Pineapple Express	600 mg	465 mg	78%	Inhalation
CBDfx CBD Vape Juice - Blue Raspberry	250 mg	208 mg	83%	Inhalation
Sunday Scaries CBD Gummies	10 mg/gummy	8.4 mg/gummy	84%	Edible
Able CBD TriSleep Strips *	27.5 mg CBD and terpenes/strip	23 mg / strip	84%	Edible
CBD Lion Disposable Vape Pen - Jack Herer	50 mg	42 mg	84%	Inhalation
Life Bloom Organics 99% Pure CBD Sleep Intra Oral Spray	120 mg	102 mg	85%	Tincture
Se7en7h Sense Rest Easy	200 mg	171 mg	86%	Topical
PureKana CBD Vegan Gummies	25 mg/gummy	22 mg/gummy	88%	Edible
Lazarus Naturals CBD Tincture	225 mg	200 mg	89%	Tincture
Social CBD Revive Lemon Vape Pen	250 mg	225 mg	90%	Inhalation
Green Garden Gold Pure CBD Crystalline	500 mg	455 mg	91%	Crystalline isolate
CBDistillery Vegan CBD Gummies	30 mg/gummy	28 mg/gummy	93%	Edible
The Feels Peanut Butter Bars	15 mg	14 mg	93%	Edible
Tasty Hemp Oil Tasty Drops CBD Tincture - Spearmint	300 mg	279 mg	93%	Tincture
Bloom Farms Balance CBD Tincture	300 mg	283 mg	94%	Tincture
Ananda Hemp Spectrum Salve	125 mg	117 mg	94%	Topical
CBDmd Vanilla Flavor CBD Vape Oil	300 mg	285 mg	95%	Inhalation
Veritas Farms Full Spectrum Lip Balm *	25 mg (Hemp Extract)	24 mg	96%	Topical
Kushy CBD Freeze Roll On Gel	50 mg	48 mg	96%	Topical
Patriot Supreme CBD Oil	1000 mg	978 mg	98%	Tincture
California Grown CBD Gummies Napa Nectar	25 mg/gummy	25 mg/gummy	100%	Edible
Green Roads CBD Froggies	100 mg	104 mg	104%	Edible
Medterra CBD Tincture	500 mg	530 mg	106%	Tincture
CBDPure Hemp Oil	300 mg	324 mg	108%	Tincture
Manitoba Harvest Broad Spectrum CBD Softgels	15 mg/capsule	17 mg/capsule	113%	Capsule
OLEO Tangerine CBD Rooibos Tea Mix	25 mg	31 mg	124%	Edible
Sagely Naurals CBD Relief & Recovery Cream	25 mg	34 mg	136%	Topical
Solaray Leaf Therapeutics CBD Liquid VegCaps	15 mg/capsule	21 mg/capsule	140%	Capsule
Spruce Topical CBD Cream	300 mg	438 mg	146%	Topical
Procana CBD Balance Softgels	8 mg/capsule	12 mg/capsule	150%	Capsule
Karibo CBD Infused Moisturizing Cream	85 mg	129 mg	152%	Topical
Garden of Life Dr. Formulated CBD+ Turmeric	15 mg/capsule	23 mg/capsule	153%	Capsule
Products delivering within 20% of advertised CBD				
* Product advertised something other than just CBD, including				

47 tested CBD Products:

Only 1 had exactly what it was labeled to be!

Need more regulation!

Quality soil and good drainage …

Search

Enter Keywords Go

All NRCS Sites

Browse by Subject

- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Series Extent Explorer
- Geospatial Data Gateway
- eFOTG
- National Soil Characterization Data

The simple yet powerful way to access and use soil data.

START WSS

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Soil surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as soil quality assessments and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center at the following link: USDA Service Center or your NRCS State Soil Scientist at the following link: NRCS State Soil Scientist.

I Want To...

- Start Web Soil Survey (WSS)
- Know Web Soil Survey Requirements
- Know Web Soil Survey operation hours
- Find what areas of the U.S. have soil data
- Find information by topic
- Know how to hyperlink from other documents to Web Soil Survey
- Know the SSURGO data structure
- Use Web Soil Survey on a mobile device

Rogers Farm Soils Map #1

Prepared with assistance from USDA-Natural Resources Conservation Service

150 0 150 300 450 600 Feet

N

Bennoch
13B

Map Unit Description

Penobscot County, Maine, Southern Part

[Minor map unit components are excluded from this report]

Map unit: 13B - Pushaw-Boothbay complex, 3 to 8 percent slopes

Component: Pushaw (60%)

The Pushaw component makes up 60 percent of the map unit. Slopes are 3 to 6 percent. This component is on marine terraces on plains. The parent material consists of fine-silty glaciomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 11 inches during January, February, March, April, May, October, November, December. Organic matter content in the surface horizon is about 6 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Natural drainage class is somewhat poorly drained

Sandy loam river bottom ground perfect …

Cannabis: Drainage and Fertility

- Well drained soils – no crusting/wet feet
- No fields with history of wood ash/sludge
  - Concern over heavy metals - toxins
- Soil test your fields
  - UM soil test lab – 70 samples for hemp
  - Request a metals profile?

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AGRONOMIC CROPS

CODE NO.

101 Alfalfa (Over 50% stand) – Established
151 Alfalfa/Grass – new seeding

102 Clover (Over 50% stand) – Established
152 Clover/Grass – new seeding

104 Grass hay or haylage – 1 crop – Established
105 Grass hay or haylage – 2 crops – Established
154 Grass only (no Legumes) – new seeding

106 Pasture – Topdress

170 Conservation seeding or Wildlife food plot

125 Hops (commercial) – New or Established

130 Industrial Hemp (Licensed Commercial)

155 Oats only (without forage seeding) or oats underseeded with clover, plowed down next spring
156 Barley only (without forage seeding)
157 Spring Wheat only (without forage seeding)
167 Winter Wheat only (without forage seeding)
158 Winter Rye only (without forage seeding)
159 Buckwheat
160 Soybean/Lupin
161 Sudangrass or Sorghum-Sudan hybrids
163 Millet
164 Corn silage
166 Corn grain
165 Sunflower
175 Brassica Forage (rape turnip, typhon)
177 Canola

TURF

COMMERCIAL VEGETABLES (MORE THAN ONE ACRE)

CODE NO.
302 Bean – Dry or Snap
304 Beets
305 Broccoli or Cauliflower (transplants only)
335 Broccoli (direct seeded only)
336 Cauliflower (direct seeded only)
306 Brussell Sprout, Cabbage
308 Carrot, Parsnip
310 All Vines – Cucumber, Gourd, Muskmelon, Pumpkin, Squash, Watermelon
311 Niteshades – Eggplant, Pepper, Tomato
313 Lettuce
315 Alliums
317 Pea
322 Spinach
321 Radish, Rutabaga, Turnip
324 Sweet Corn
328 Roadside Stand (mix)
329 Asparagus (to be planted)
330 Asparagus (established bed)

NON-ORGANIC GARDENS (LESS THAN 1 ACRE) — CHEMICAL FERTILIZER

CODE NO.
391 Home garden vegetables, strawberry, and raspberry
393 Home tree fruit

ORGANIC GARDENS (COMMERCIAL & HOME) — NON-CHEMICAL FERTILIZER

CODE NO.
392 All vegetables, strawberry, raspberry, and flowers

COMMERCIAL FRUITS (MORE THAN ONE ACRE)

CODE NO.
401 Apple (new plantings only)
404 Raspberry / Grape – Established bed
405 Raspberry / Grape – To be planted
406 Strawberry – Established bed
407 Strawberry – To be planted
408 Stone fruit
409 Highbush Blueberry – To be planted
410 Highbush Blueberry – Established bed
411 Cranberry – To be planted

COMMERCIAL POTATOES

PROCESSING AND SEED POTATOES

CODE NO.

After heavy red clover or alfalfa green manure
501 Early and low-nitrogen varieties
504 Mid-season varieties (includes Shepody)
502 Russet Burbank
503 Late-season varieties

After underseeded grains, non-legume green manures, broccoli, or old sod
506 Early and low-nitrogen varieties
509 Mid-season varieties (includes Shepody)
507 Russet Burbank
508 Late-season varieties

After grains (no underseeding), or replanted potatoes
511 Early and low-nitrogen varieties
514 Mid-season varieties (includes Shepody)
512 Russet Burbank
513 Late-season varieties

TABLE STOCK POTATOES

CODE NO.

After heavy red clover or alfalfa green manure
516 Early and low-nitrogen varieties
519 Mid-season varieties
517 Russet Burbank, Russet Norkotah, Superior
518 Late-season varieties

After underseeded grains, non-legume green manures, broccoli, or old sod
526 Early and low-nitrogen varieties
520 Mid-season varieties
527 Russet Burbank, Russet Norkotah, Superior
528 Late-season varieties

After grains (no underseeding), or replanted potatoes
529 Early and low-nitrogen varieties
521 Mid-season varieties
530 Russet Burbank, Russet Norkotah, Superior
531 Late-season varieties

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125 Hops (commercial) – New or Established

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Soil Test Parameter	Average	Lowest	Highest
Soil pH	5.9	5.1	7.9
Soil OM (%)	5.7	1.0	21.0**

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Soil Test Parameter	Average (lb/ac)	Lowest (lb/ac)	Highest (lb/ac)
P	46	3	1803
K	242	50	650
P rec	50	0	70
K rec	116	0	150
Lime Rq pH 6.5	3750	0	7500

Cannabis: Industrial Hemp

- Basic Agronomic Principles to follow!!
  - Don’t treat your soil like dirt

Cannabis: Industrial Hemp

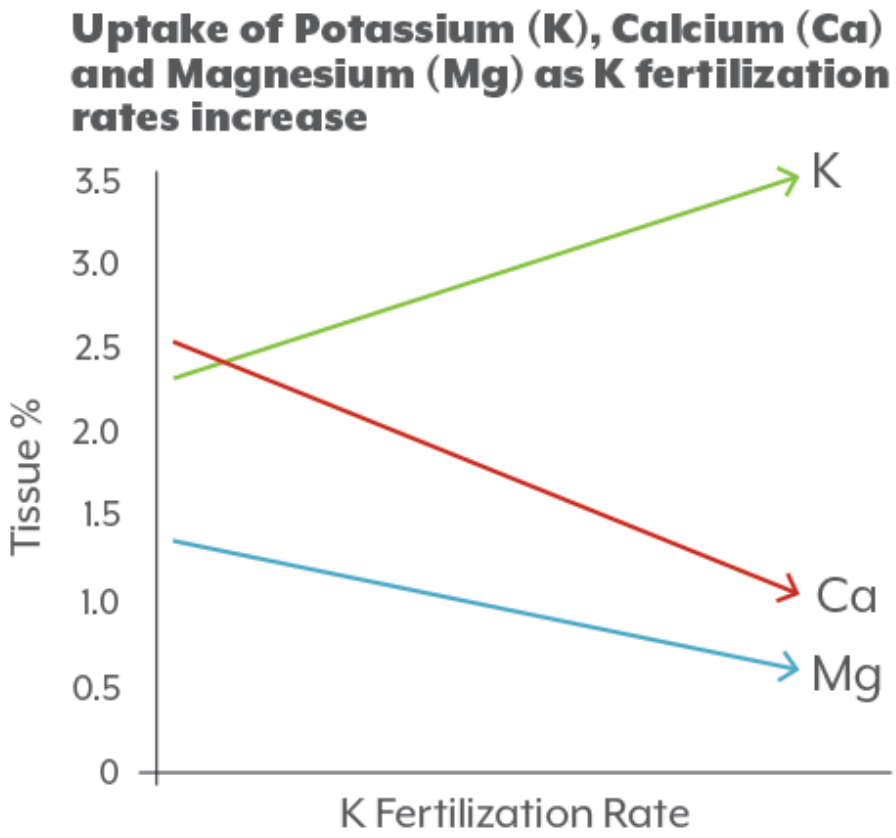
- Basic Agronomic Principles to follow!!
  - Don’t treat your soil like dirt
- Convert a hay field to cannabis?
  - Start in the fall / not the “spring”!

July 11, 2018

If turning under a sod …

- Soil test the field !
- Apply lime if needed
  - Dolomitic lime / $CaCO_3$ and $MgCO_3$

Soil Test Determined



Antagonism of excess K leading to Ca and Mg deficiency
vice / versa too … excessive Ca / Mg … K deficiency

If turning under a sod …

- Soil test the field !
- Apply lime if needed
- Apply manure ?
- Plow the sod in September / October
- Allow to break down over winter
- Spring: chisel and disk twice

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Solid or liquid manure …
what nutrients do you get?

Manure Analysis

Solid manure contains:

- 10 pounds total N/ton (mostly organic N)
- 6 pounds P_2O_5
- 10 pounds K_20
- 72% water

Manure Analysis

1000 gallons of this manure contains:

- 28 pounds TKN
- 14 pounds organic Nitrogen
- 14 pounds NH_4-N
- 13 pounds P_2O_5
- 34 pounds K_20
- 90-93% water

Cannabis: Fertility Regime

- Fertility – Soil test recommendations
  - Lime: minimum pH 6.0 – max 7.0
  - P_2O_5/K_2O - apply 50 / 100 lbs
  - Nitrogen – flat rec – 150 lbs/ac … ???
  - N:P through growth cycle …
    - N growth early/fade …
    - Abundant P at flowering/harvest

Cannabis: Nutrition

- Fascinating plant but not “mystical”
  - Requires same essential 17 nutrients
- Hobby vs. serious grower
  - Hobby grower – its a ”weed”
  - Prepared/savy grower needs to recognize issues – nutrient/pest ???

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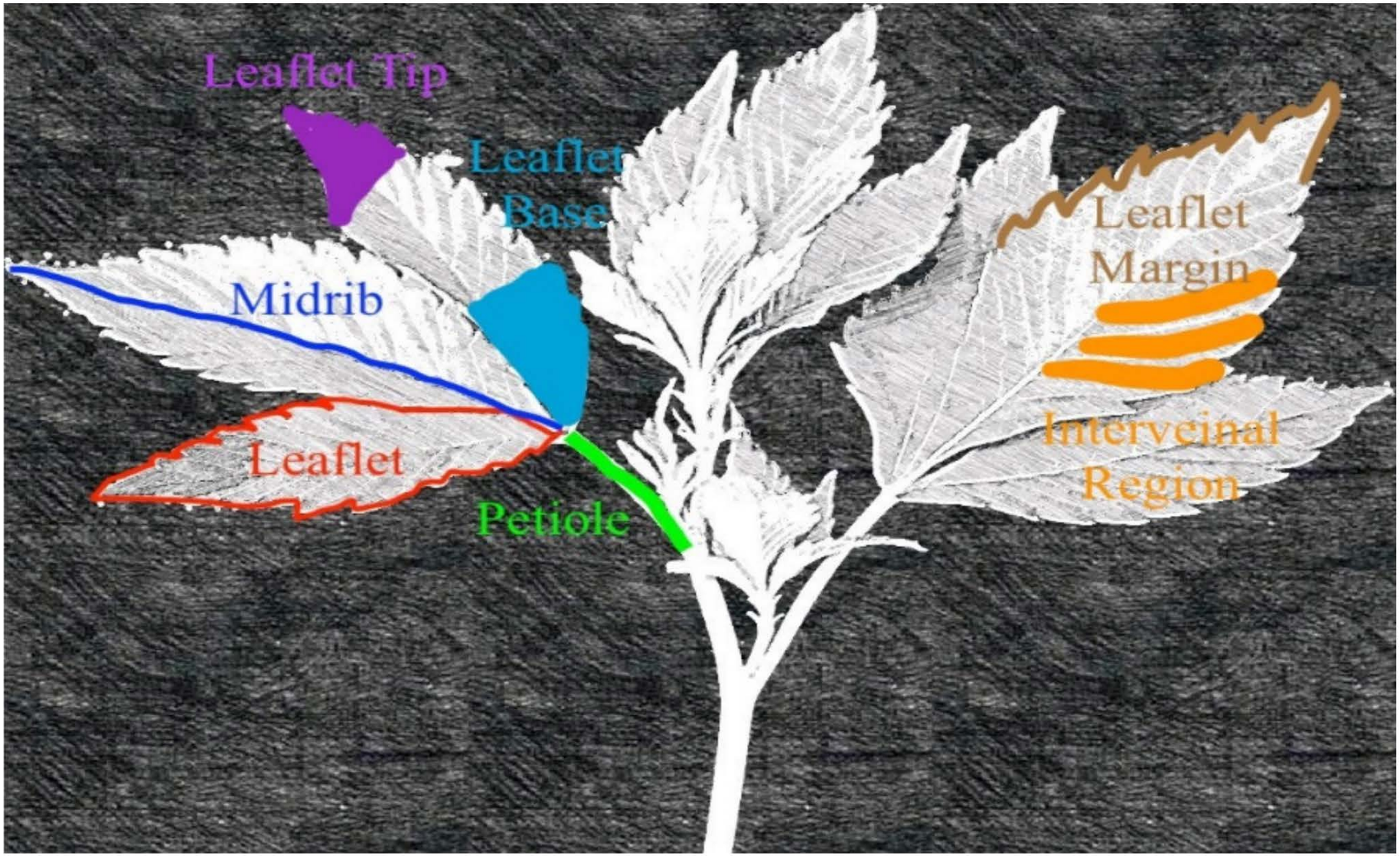


Nitrogen

- Highly mobile
- Key role in dozens of plant processes
- Energy compounds (ATP, ADP)
- Genetic compounds
- Amino acids
- Chlorophyll
- Enzymes
- 3.5-4.5% in leaf tissue

Plant Nitrogen Sources

- Organic Matter
  - 2 - 8% in soil
  - Supplies N, P, S, Ca, Mg (5%, 2%, 1%)
  - Likely supplies 20-30% of crop N uptake
- Fertilizers - supply NH_4^+ or NO_3^-
- Manure: NH_4^+ and organic N
- Fish emulsion … (2-4-1)

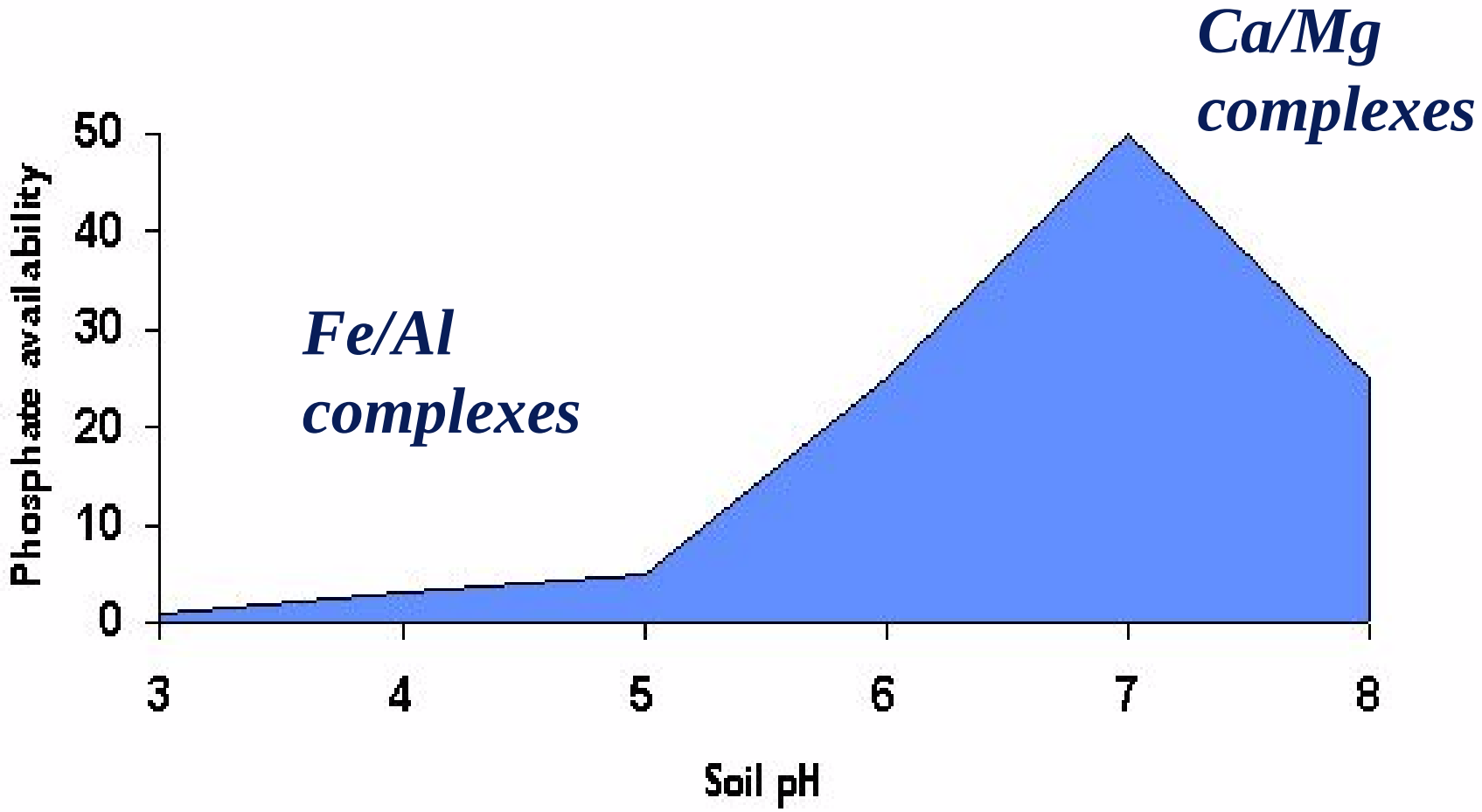
Macronutrient Mobility in Plants

- N: leaf chlorosis
  - mobile in plant (where to look?)
  - mobile in soils
    - move to plant by mass flow

Phosphorus

- Immobile in soils
- Somewhat mobile
- Important for root development
- Flower and seed development
  - ensure that you have sufficient P at flowering
- Sufficiency (0.3 – 0.5%)

Phosphate Availablity

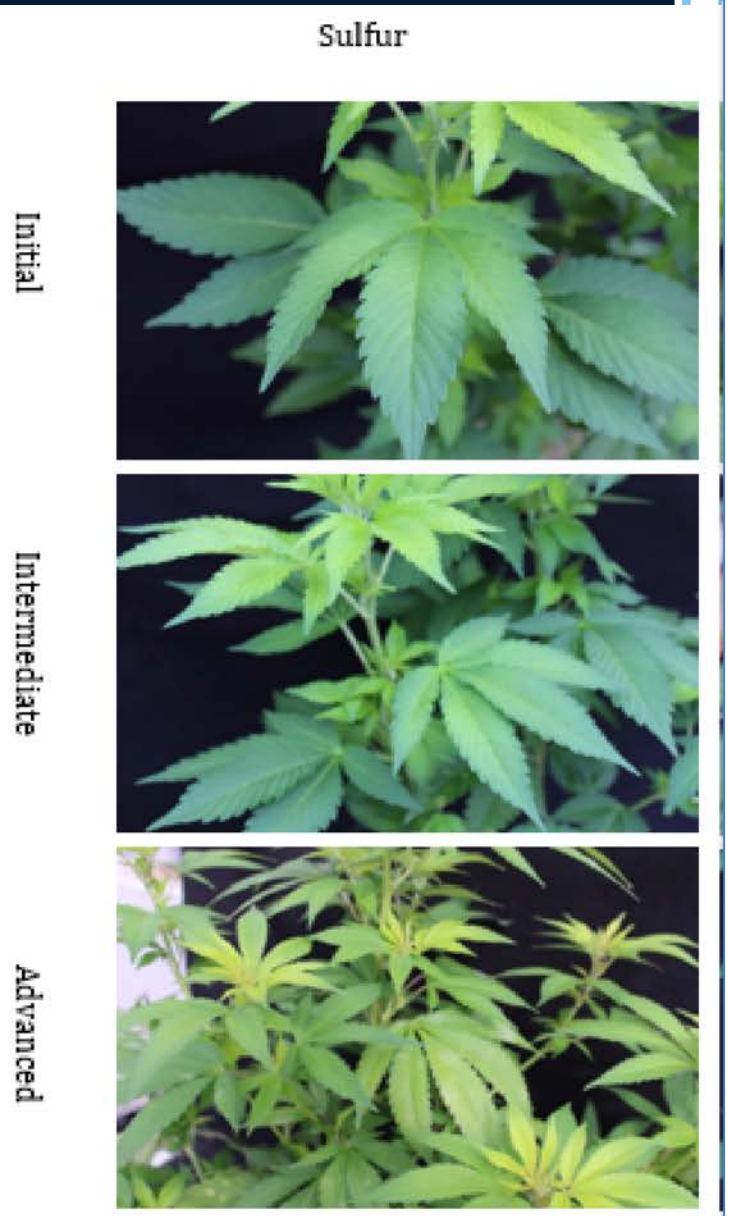


Phosphorus Deficiency

- Look generally on lower/mid plant
- Advanced deficiency
  - wetted area on leaf ?
- Poorer flower development
- Delayed maturity / Reduced yields

Potassium

- Large requirement (K)
- Moving sugars / WR
- Mobile in plant
- Burning along leaf edges
- Need high levels at flowering
- Often confused with leaf hopper burn …
- Sufficiency: 1.8 – 2.5%



Sulfur in Cannabis

- Amino acid formation
- Organic products …
- Sulfate form absorbed
- 5:1 ratio N:S
- Relatively immobile in plants – look at new leaves for chlorosis
- Sufficiency: 0.2 – 0.4%

Magnesium

Magnesium in Hemp

- Chlorophyll
- Interveinal chlorosis
- K:Ca/Mg interference
- Important in low levels throughout growth
- Highly mobile in plant
- Sufficiency: 0.4 – 0.8%

Micronutrients

- Metals (Fe, Mn, Zn, Cu, Ni)
  - Important for chlorophyll, reactions, stress management, etc.
  - Fe and Mn concentrations higher than Zn
    - Want compact plant with no seeds; low auxin
  - Chelates or sulfate forms
- B, Mo, Cl
  - trace amounts required

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Micronutrients in Cannabis

	Manganese Toxicity	Boron Toxicity
Initial		
Intermediate		
Advanced		

Lets take a stretch break

Let's Grow Some CBD Hemp …

- Do I plant CBD from seed or transplants
- Plant biology…

  want only female plants

Female plant - initiating flowering

Need Feminized Seed?

- Feminized seed production
- Done primarily in greenhouses
- Spray female plants with chemicals
  - Colloidal silver, silver nitrate, others
  - Female plants produce male flowers
  - Pollinate – offspring is female
  - Why seed costs $0.85-$5.00/seed

Produce

Feminized seed …

Good to start inside

Much better germination

Hard to make a lot
and keep healthy!

May 28, 2019

Advantages to Clones?

a) All females
b) All same genetics
c) Should be healthy
d) Less likely to change sex

Cannabis: Industrial Hemp

- Basic Agronomic Principles!!
- Drilling … poor germination is common!

- Bomaragra - Selling transplanter -
  - Going to drill everything … ???

Cannabis: Industrial Hemp

- Basic Agronomic Principles!!
- Plant spacing
  - 3x2 spacing - 7260 plants/ac
  - 3x3 spacing - 4840 plants/ac
  - 5x5 spacing - 1740 plants/ac

Plant Spacing – ME vs. CO

- CO … goal is efficiency / weed control
  - 3 x 2 spacing -
  - Center pivot irrigation
- ME … goal is large plants – air flow
  - 4x4 minimum spacing (5x5 and 6x6)
  - Black plastic .. Drip irrigation

Plant Spacing – ME vs. CO

- 1740 plants/ac vs. 4840/7260 plants/ac
  - Hard to compete w/West
  - Way less labor intensive
  - Lower cost of production!
- ME … air flow
  - Disease prevention is key - lollipop
  - Monitor for disease …

Darby et al., 2018
Alburgh VT

Evaluated
Planting date
Spacing effects
On yield / quality

Heather's UVM Research

- 1x1, 3x3, and 5x5 spacing
  - 1x1 – 43,560 plants/acre
  - 3x3 – 4840 plants/ac
  - 5x5 - 1740 plants/ac
- No black plastic or drip irrigation

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Plant Spacing Effect on Plant Growth

Spacing	Weight	Height
Foot x Foot	Lbs/plant	cm
1x1	0.6a	76
3x3	4.7b	81
5x5	9.1c	79
LSD 0.1	0.7	NS

H. Darby - 2018 - Grown at Borderview Farm – Alburgh, VT

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Plant Spacing Effect on Plant Growth

Spacing	Flower Dry Weight (lb/plant)	Loss*	Flower Dry Weight (lbs/ac)	Loss
1x1	0.08c	0.000a	3669a	7.2a
3x3	0.6b	0.003a	2894b	12.4a
5x5	1.35a	0.05b	2354c	86.6b
LSD	0.09	0.02	411	35.9

* Loss was soil tainted lower buds that were not useable

H. Darby 2018 - Grown at Borderview Farm – Alburgh, VT

Wide spacing
For disease control!

Why lollipop plants?

Other diseases:
fusarium,

3-4% of plants with curly beet top

Figure 1. ***Sclerotinia sclerotium*** **infection on industrial hemp, Alburgh, VT, 2016.**

Cannabis: Industrial Hemp

- Basic Agronomic Principles to follow!
- Have a crop rotation strategy!!!
  - "Why I've only grown one year?"
  - Don't wait until you have a problem

Cannabis: Industrial Hemp

- Basic Agronomic Principles!!
- Plastic mulch?

Weed control !

Early July

Weed management

Start with a stale seedbed

Till soil / weeds emerge

Till again / plant hemp

Cannabis: Industrial Hemp

- Basic Agronomic Principles to follow!!
- Water management

Cannabis Water Needs

- 9 ac in of water
- Not deep rooted
- Little information

Cannabis: Industrial Hemp

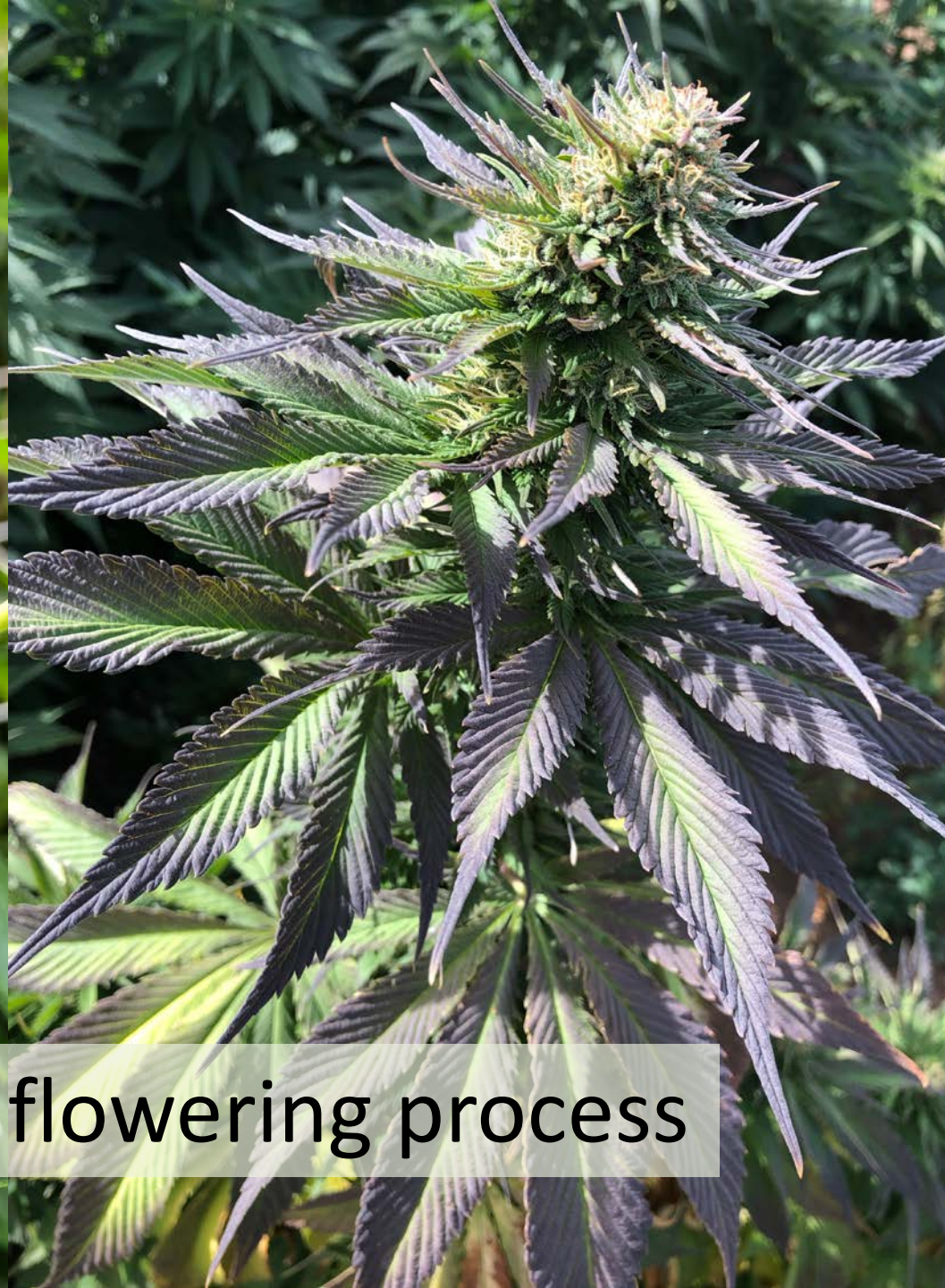
- Water management – Colorado
- 9 acre inches = 32,700 ft3 = 244,400 gal
- How many plants? 4500
- 54 gallons water per plant per season
- Need roughly ½ gal water per day per cannabis plant -

Cannabis: Industrial Hemp

- Water management – Maine / NE
- Crap shoot?
- How many plants? 1750 plants/ac
- 3 – 4 inches of rainfall / month
- Black plastic – ¼ gallon early – root system
- Flowering - ½ gallon/day if dry

Hemp Production Process

- Daylength drives flowering process



ME: 7 to 8-wk flowering process

9/27/18

Process

- Grow plant from seed, clone, or transplant
- Daylength drives flowering process
- Harvest

Colorado: Potato Conference - 2018

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Maine: mostly high labor harvesting

Process

- Grow plant from seed, clone, or transplant
- Daylength drives flowering process
- Harvest
- Dry

Need drying and storage

Process

- Grow plant from seed, clone, or transplant
- Daylength drives flowering process
- Harvest
- Dry
- Cure? / extract

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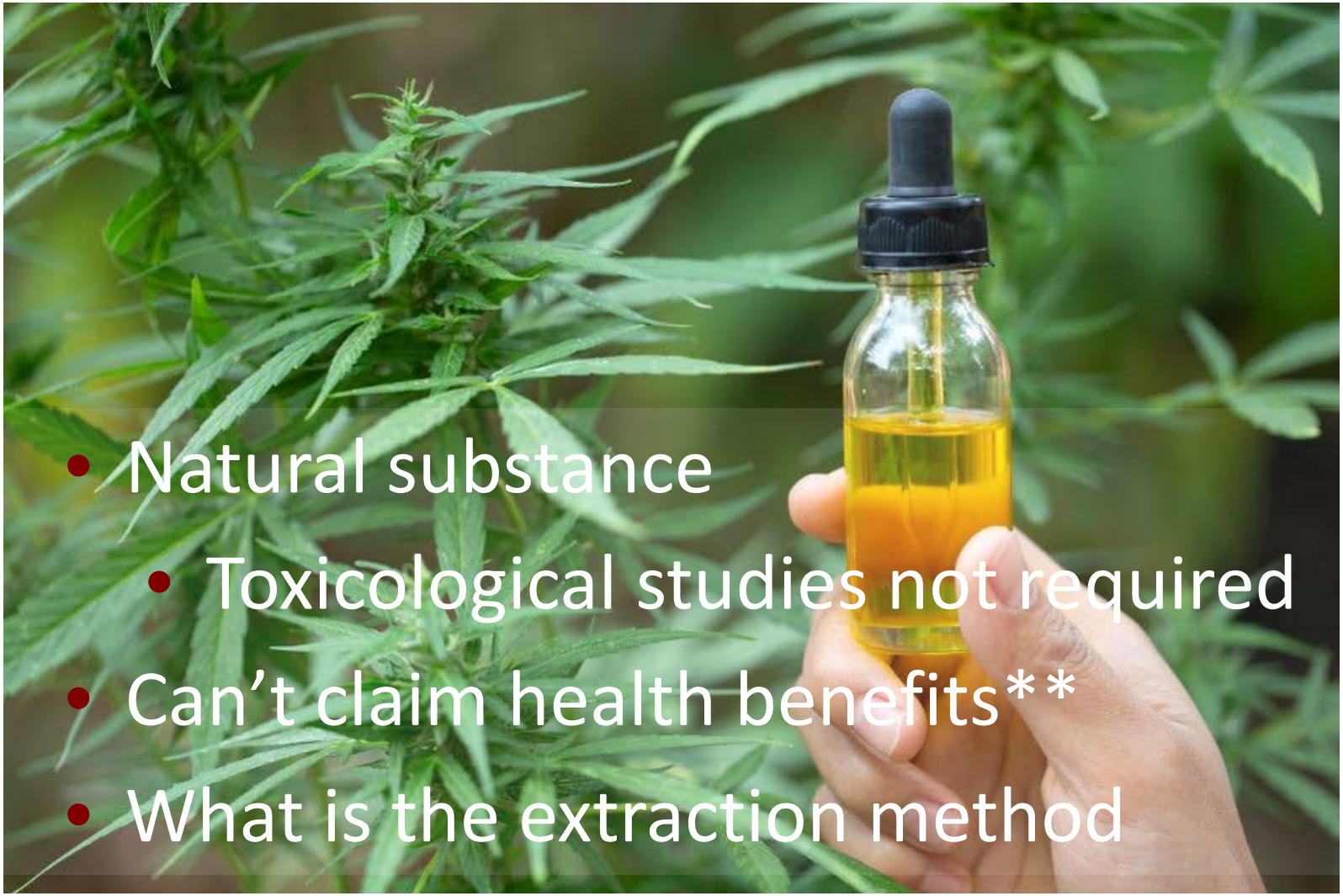

- Natural substance
  - Toxicological studies not required
- Can’t claim health benefits**
- What is the extraction method

EVERCLEAR
EVERCLEAR
95% Alc. By Vol. (190 Proof)
GRAIN ALCOHOL
DISTILLED FROM 100% SELECTED GRAINS

John’s Sour Cherry CBD Edibles

1.2 mg/large edible … (~20%CBD x 15% efficiency)

0.02 mg/kg dose ***

500+ acres of CBD hemp

Cannabidiol for Seizure Control

- FDA has approved one CBD drug Epidiolex

5-20 mg/kg/day

FDA drug approval
99% pure CBD

Controls, testing, consistent product …

Barely approved due to side-effects - liver

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Hepatotoxicity of a Cannabidiol-Rich Cannabis Extract in the Mouse Model

Ewing et al., 2019 – J. Molecules
https://doi.org/10.3390/molecules24091694

- CBD formulation was flower extracted
- Single dose or 10-day treatment
- Found hepatotoxicity in mice

Extremely high doses …

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Marijuana (THC) May Protect the Liver from Alcohol — But Experts Urge Caution

GENETIC AND METABOLIC LIVER DISEASE

Cannabis use is associated with reduced prevalence of progressive stages of alcoholic liver disease

Adeyinka C. Adejumo
Tokunbo O. Ajayi
Oluwole M. Adegbala
Kelechi L. Adejumo

First published: 17 January 2018
https://doi.org/10.1111/liv.13696

Key Need #2 – Realistic health studies

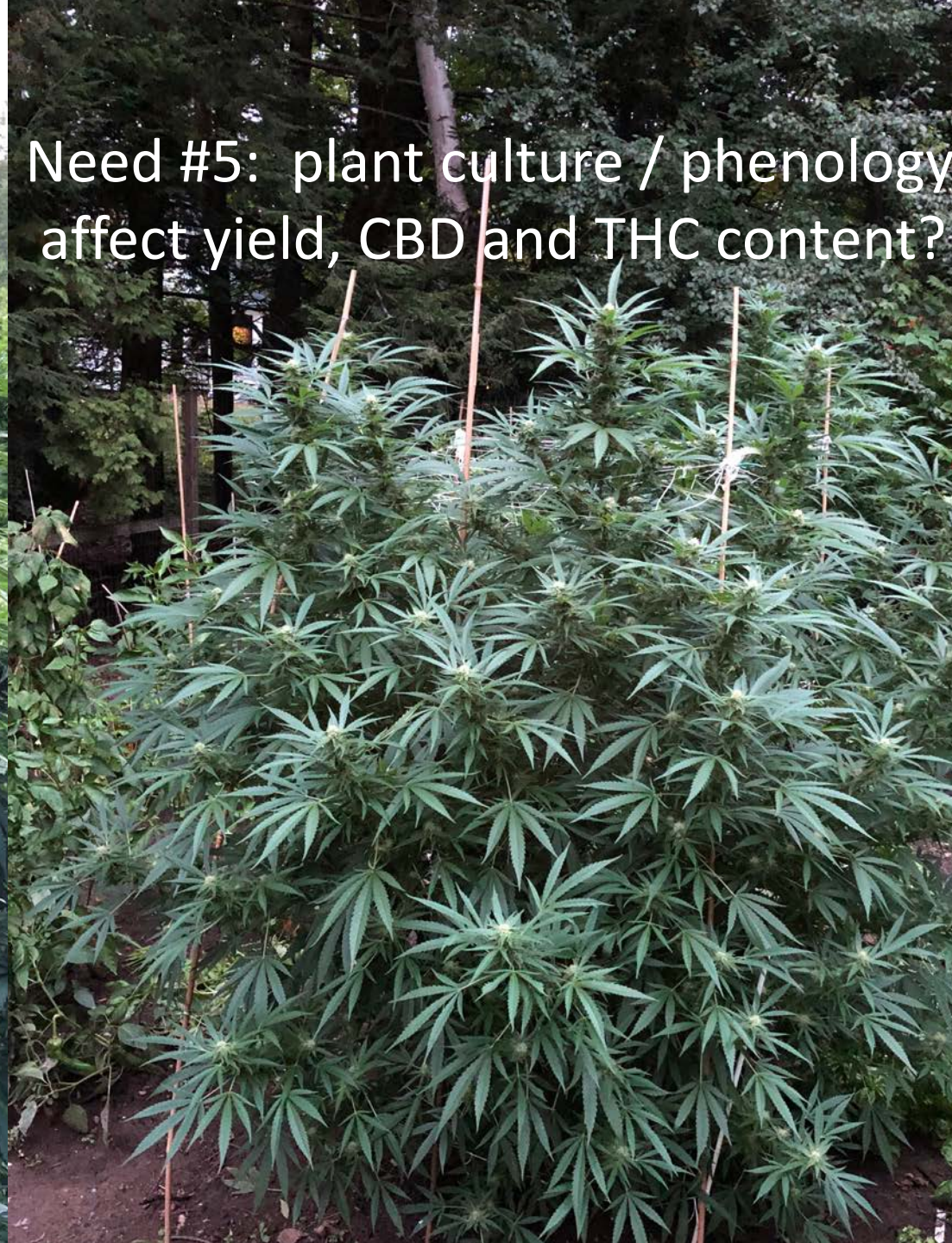
- Need to do mice/rat research
  - 1 to 10 mg (0.02 – 0.2 mg/kg) dosages
  - Conduct over longer period of time
- Human studies … people consuming CBD, CBD/THC mixes and THC alone over a longer period of time.
- Better understand THC interact with CBD

Key Need #3 – Production oversight

- More studies into safety of solvents
  - Propane, Butane, Hexane?
- Pesticide use
  - Colorado list of approved products
- Required testing ... contaminants
  - Microbial, pesticide, heavy metals, etc.

Key Need #4.

- Need to understand how plant stress affect THC and THCa levels in plants
  - Varieties (Stormy Danielz, TT, cherry)
  - Water management by variety
  - Fertility status by variety
  - Pest susceptibility by variety
    - insects – fungi – weeds



Need #5: plant culture / phenology affect yield, CBD and THC content?

So … growers ask should I grow?

- Expensive crop to grow / USDA rules?
- Over-planted – prices are falling
- Difficult to compete with the west
- Lack of well-researched CBD studies
- Tread lightly – “Curb your enthusiasm”

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Thoughts, comments, questions?