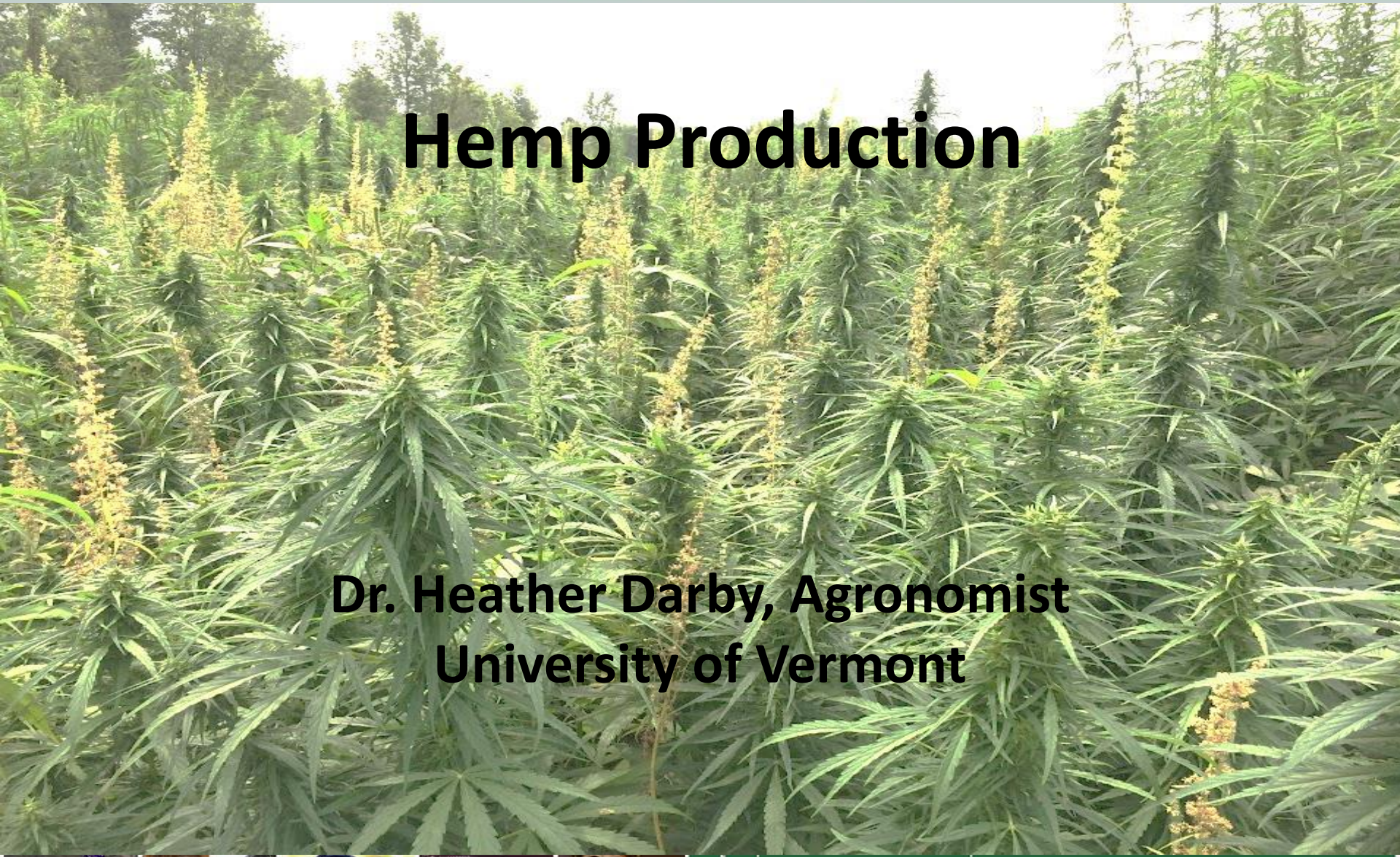
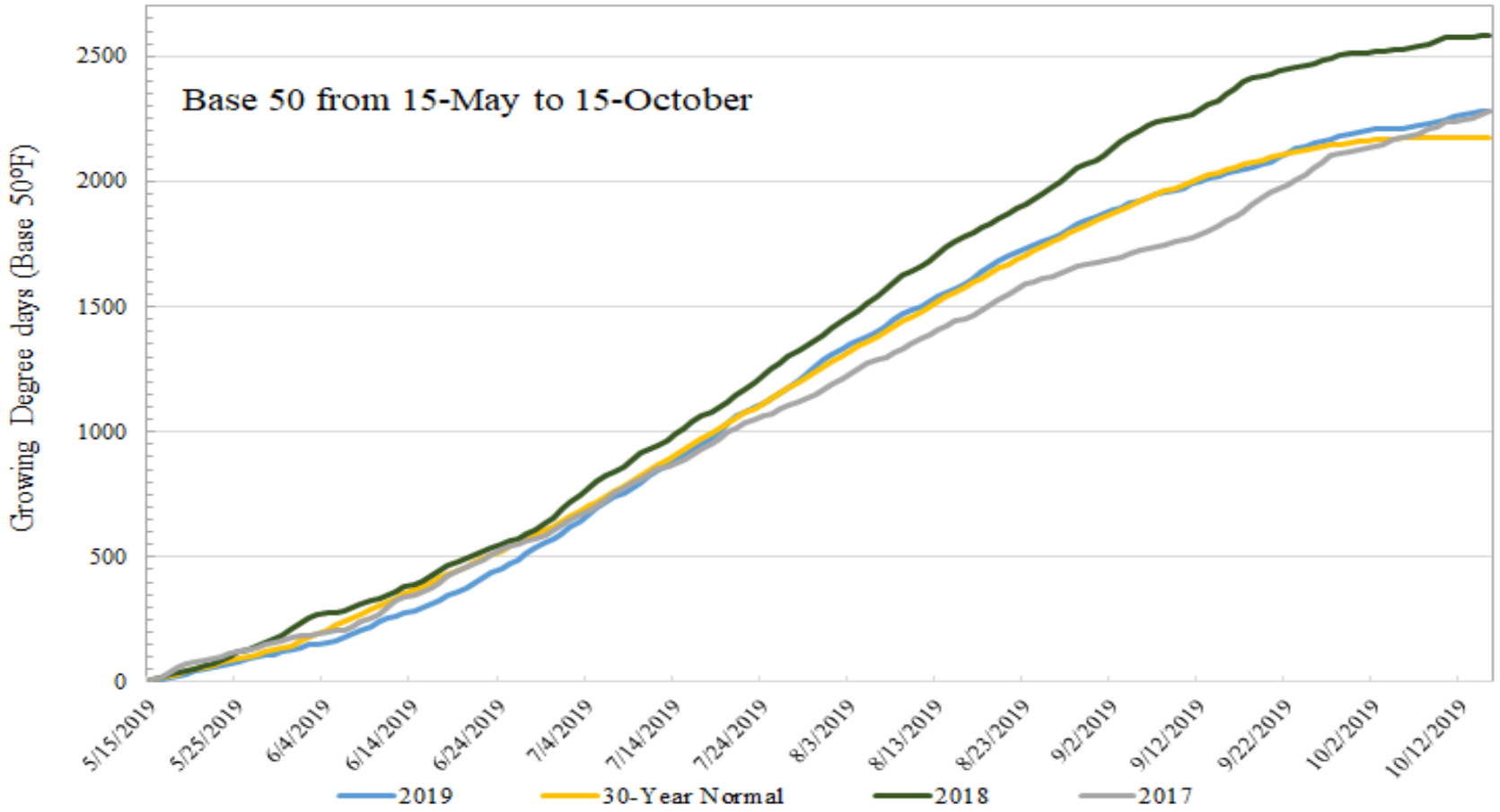


Hemp Production

Dr. Heather Darby, Agronomist
University of Vermont


Base 50 from 15-May to 15-October
Growing Degree days (Base 50°F)
2500
2000
1500
1000
500
0
5/15/2019
5/25/2019
6/4/2019
6/14/2019
6/24/2019
7/4/2019
7/14/2019
7/24/2019
8/3/2019
8/13/2019
8/23/2019
9/2/2019
9/12/2019
9/22/2019
10/2/2019
10/12/2019
2019
30-Year Normal
2018
2017

Soil Limitations

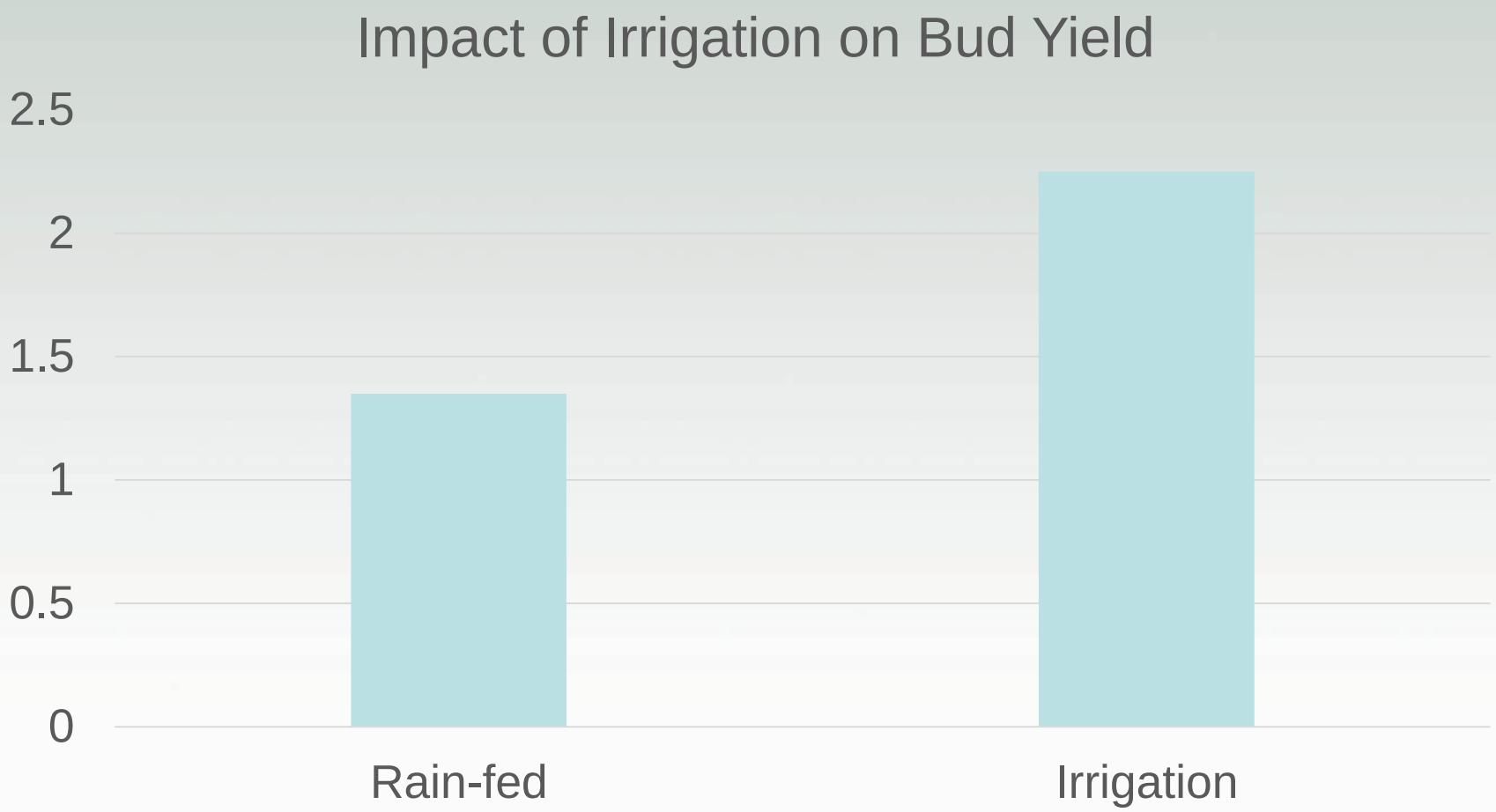
- Grows best on sandy loams.
- 40% or more clay not generally good.
- Does not tolerate water logged soils.
- Adequate pH – over 6.0 (requires calcium).

Water Requirements

- Hemp requires at least 20-30 inches of rainfall during the growing period
- Abundant moisture is needed during the germination period.
- The absorption of water increases until flowering begins. First 6 - 8 weeks of growth.
- Then the uptake of water decreases considerably, with a slight increase at late flowering and during seed formation.

We Should Water Because We Have Irrigation?

Irrigation?



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CULTIVATING HEALTHY COMMUNITIES

Fertility Requirements

Nitrogen (3.0 to 4.0%)

Potassium (2.0 to 3.0%)

65 – 70 lbs per acre

Phosphorus (0.5 – 0.6%)

50 to 70 lbs per acre

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CULTIVATING HEALTHY COMMUNITIES

Hemp Nitrogen Fertility

- High N can stimulate the formation of male flowers.
- Split applications of N are best to minimize over feeding at any one single stage.
- A deficiency of N causes the entire hemp plant to turn yellow (chlorosis).
- With deficiency growth and flowering are slowed, and the plants will be mostly male.

Whole Plant Analysis

Treatment lbs N ac^{-1}	Nitrogen %	Calcium %	Phosphorus %	Magnesium %	Potassium %
0	2.47 b	2.35 bc	0.625	0.238 c	2.21
75	2.63 b	2.10 c	0.540	0.258 bc	1.96
100	2.66 b	2.38 bc	0.610	0.283 ab	1.93
125	**3.25 a**	**2.83 a**	0.620	0.303 a	2.09
150	3.04 a	2.67 ab	0.548	**0.308 a**	2.10
LSD (<0.10) ‡	0.378	0.355	NS ¥	0.044	NS
Trial mean	2.81	2.47	0.589	0.278	2.06

†Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**
‡LSD – Least significant difference at p=0.10.
¥NS – No significant difference between treatments.

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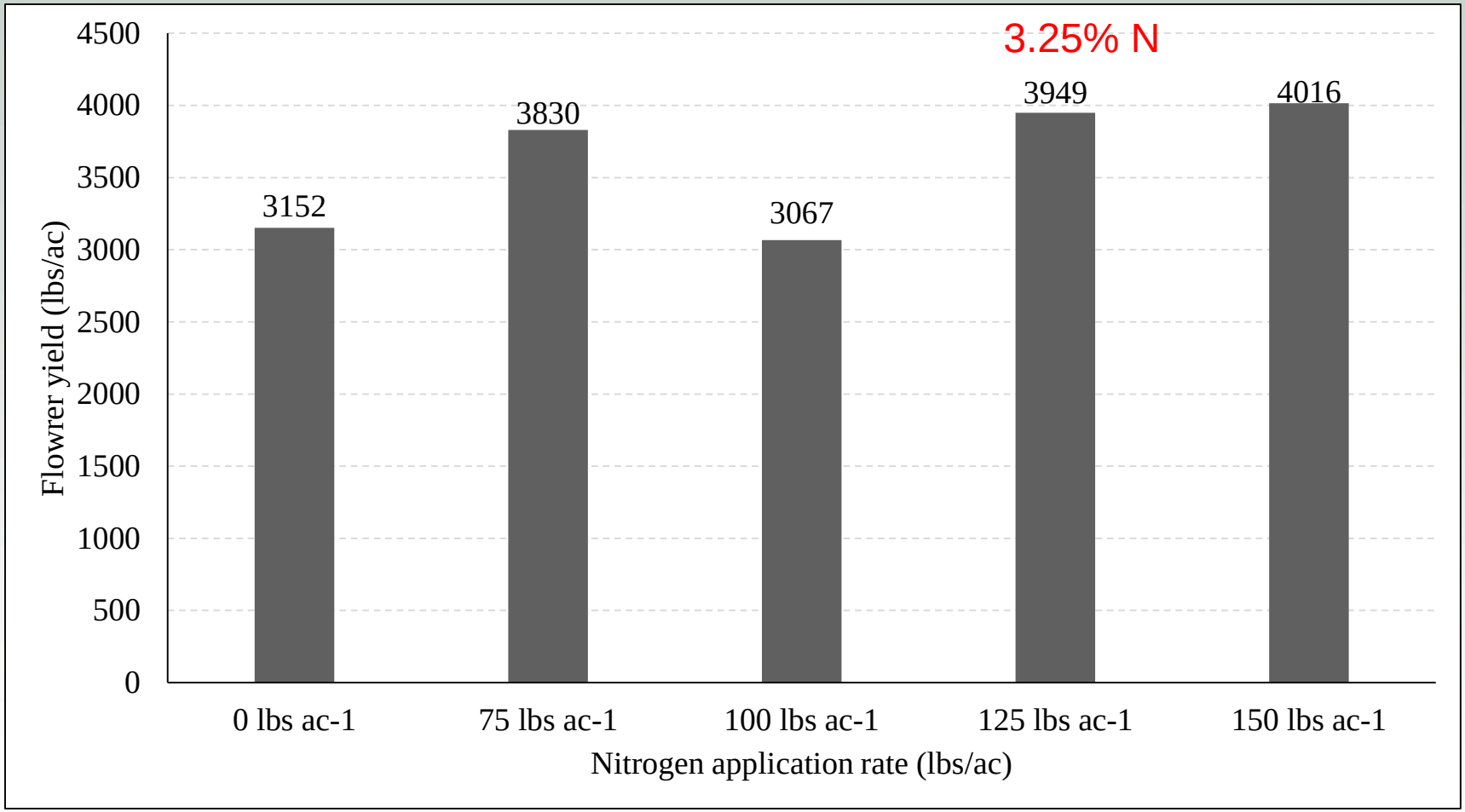
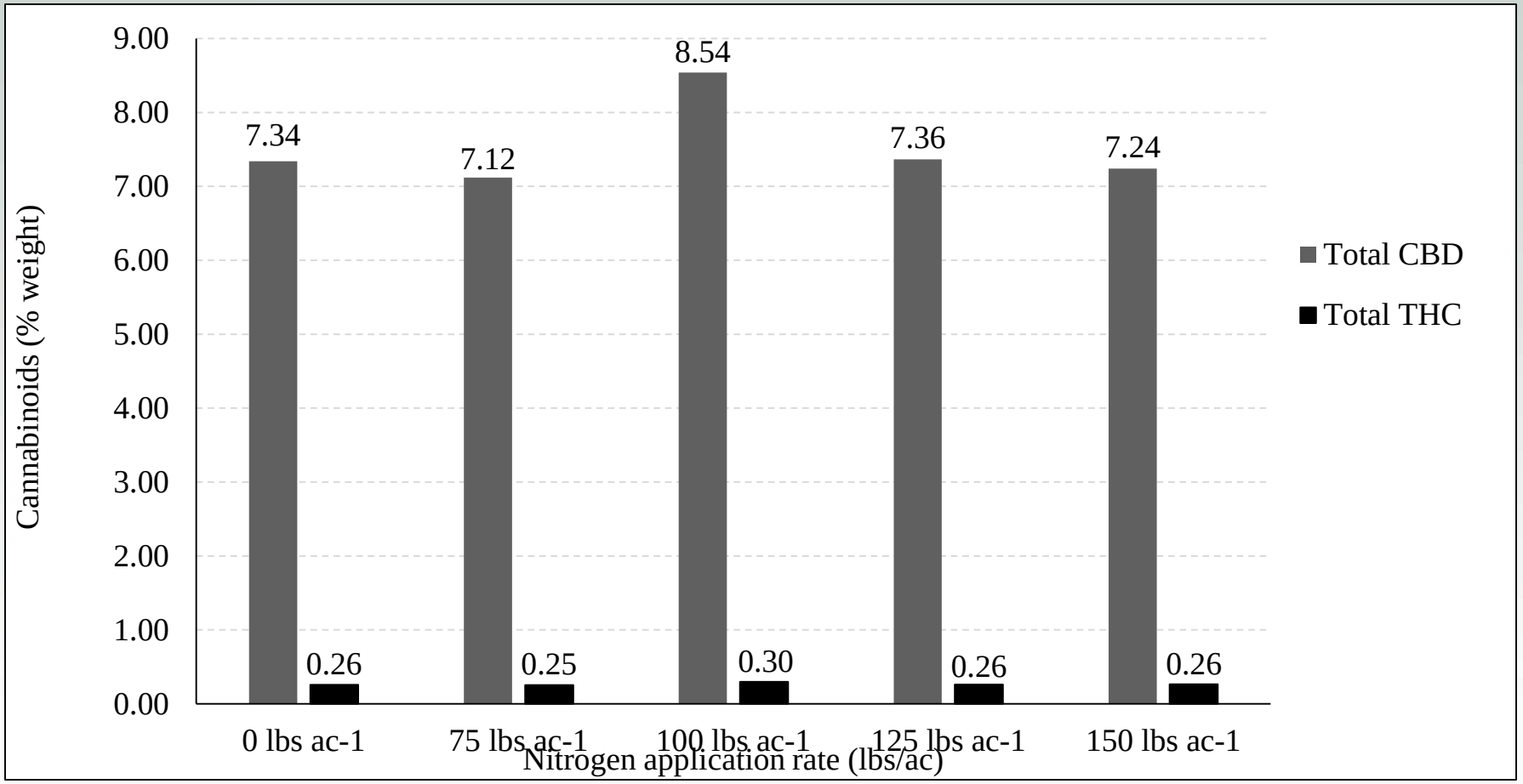
CULTIVATING HEALTHY COMMUNITIES

CBD Nitrogen Fertility - Yields



CBD Nitrogen fertility – Total CBD & Total THC



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Flower bud terpene profiles

Treatment	Alpha-pinene	Alpha-terpinene	Beta-myrcene	Beta-pinene	Camphene	Caryophyllene-oxide
	ppm	ppm	ppm	ppm	ppm	ppm
0	143 ab †	0.568 ab	593 b	48.5 b	2.82 ab	17.8 bc
75	**202 a**	0.593 ab	**972 a**	**70.3 a**	**3.82 a**	11.4 c
100	31.3 c	0.190 b	143 c	13.6 c	1.24 b	**48.0 a**
125	114 b	0.453 ab	480 b	40.0 b	2.45 ab	23.3 b
150	97.0 bc	**0.958 a**	464 b	40.3 b	3.75 a	15.1 bc
LSD (<0.10) ‡	78.3	0.638	308	21.1	1.58	11.8
Trial mean	118	0.552	530	42.5	2.82	23.1

Table 10. Total flower bud terpene profiles, Alburgh, VT, 2019†.

†Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**

‡LSD – Least significant difference at p=0.10.

¥NS – No significant difference between treatments.

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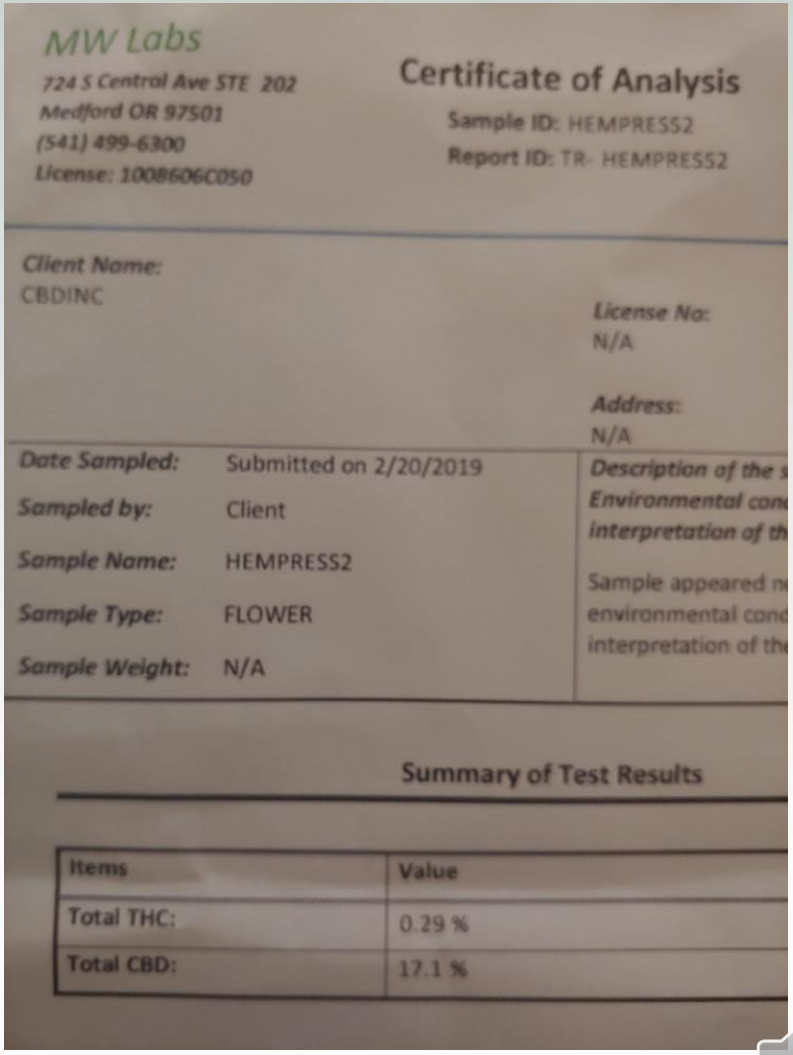
Seed Purchase - Buyer Beware

- Male/Female Seed
- High THC
- Mutants/Variation
- Poor Quality



MW Labs
724 S Central Ave STE 202
Medford OR 97501
(541) 499-6300
License: 1008606C050

Certificate of Analysis
Sample ID: HEMPRESS2
Report ID: TR- HEMPRESS2

Client Name:
CBDINC

License No:
N/A

Address:
N/A

Date Sampled:	Submitted on 2/20/2019
Sampled by:	Client
Sample Name:	HEMPRESS2
Sample Type:	FLOWER
Sample Weight:	N/A

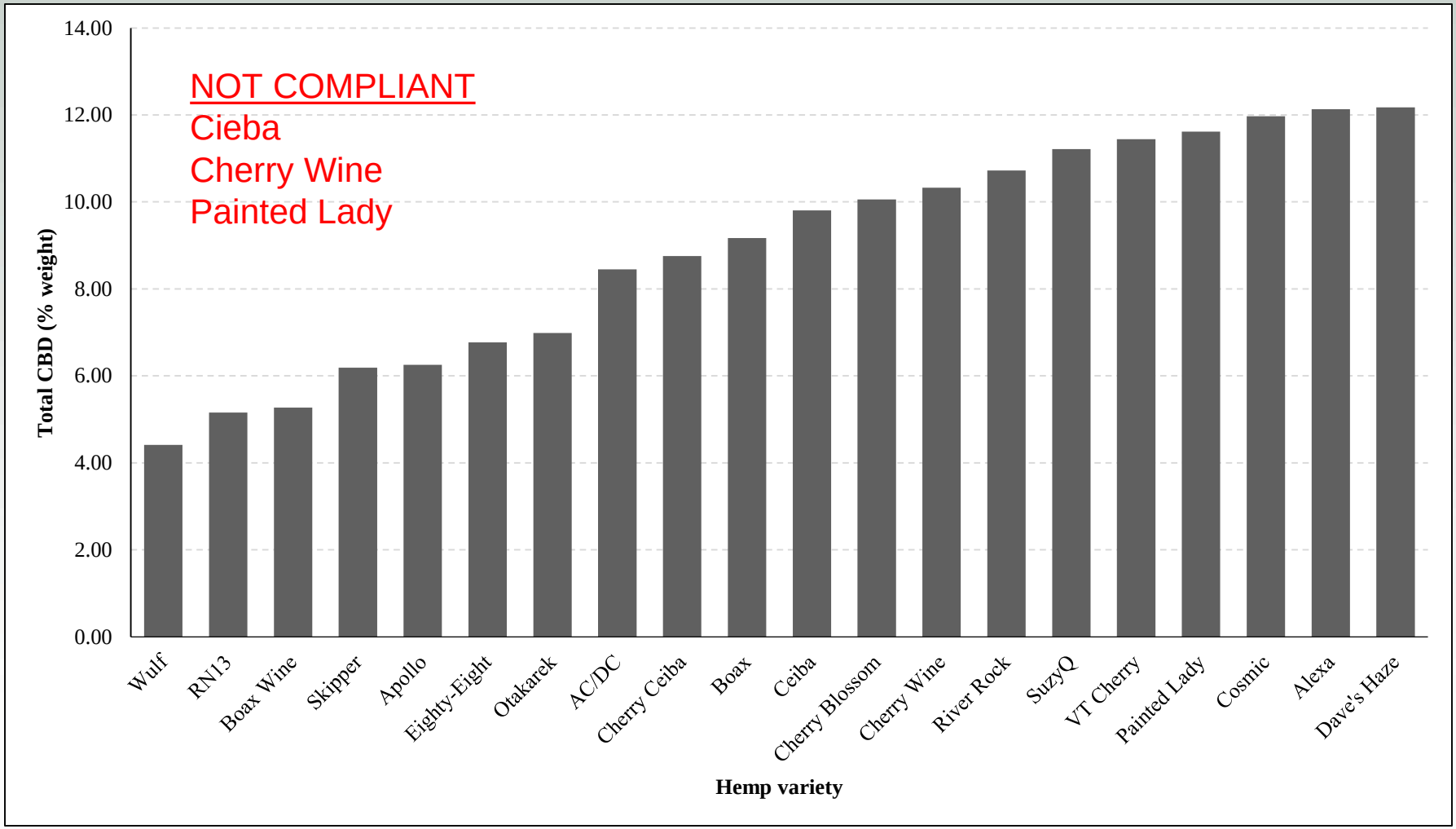
Description of the s
Environmental cond
interpretation of th

Sample appeared n
environmental cond
interpretation of the

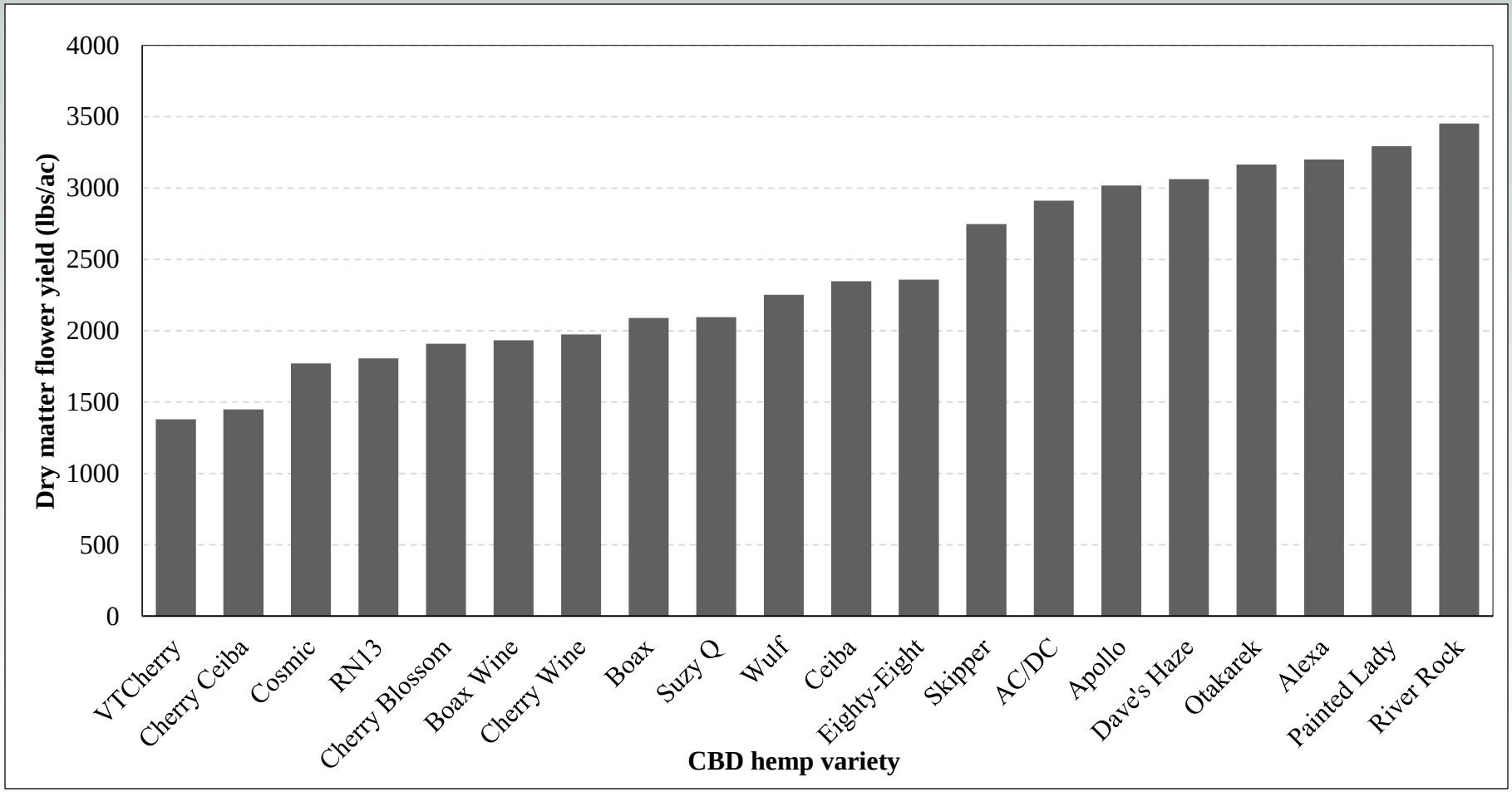
Summary of Test Results

Items	Value
Total THC:	0.29 %
Total CBD:	17.1 %

Seed Purchase – Buyer Beware



CBD Variety Trial - Yields



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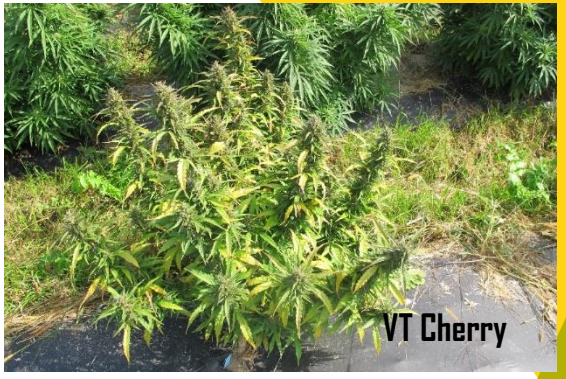
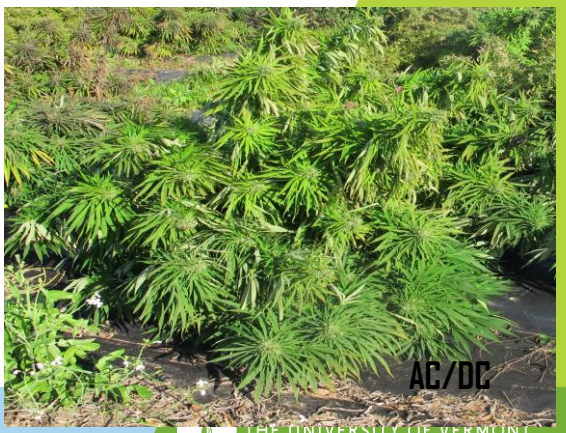
CULTIVATING HEALTHY COMMUNITIES

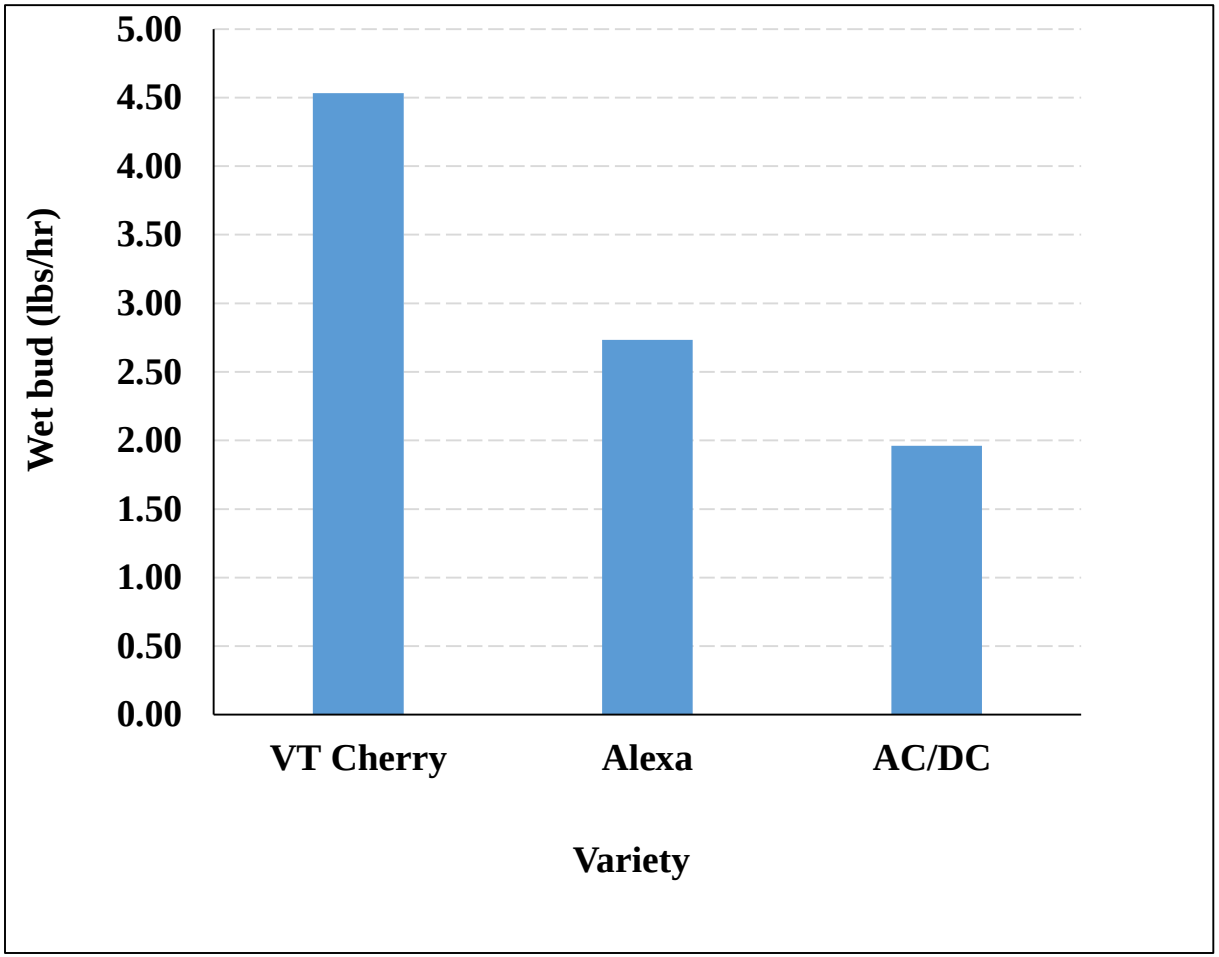
DOES SIZE MATTER?

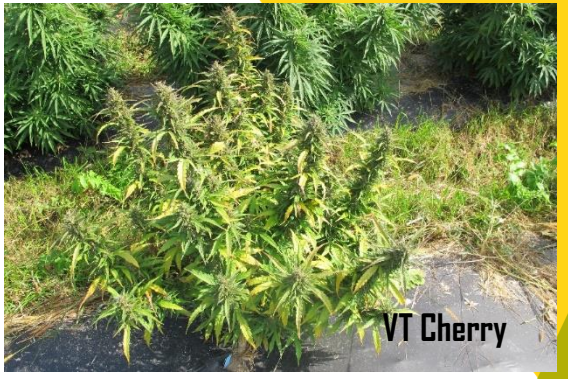
Variety	VT Cherry	Alexa	AC/DC
Hours	0.75	3	5
Whole plant (lbs)	5.4	13.2	21.2
Wet bud (lbs)	3.4	8.2	9.8
Dry bud (lbs)	0.8	2.0	2.2
Wet bud lbs/hour	4.53	2.73	1.96
Dry bud lbs/hour	1.07	0.67	0.44

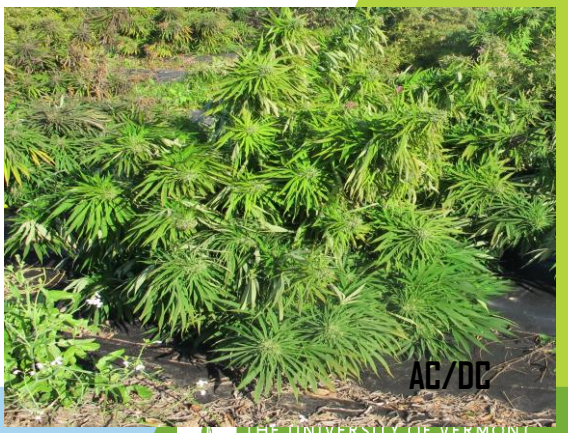




DOES SIZE MATTER?







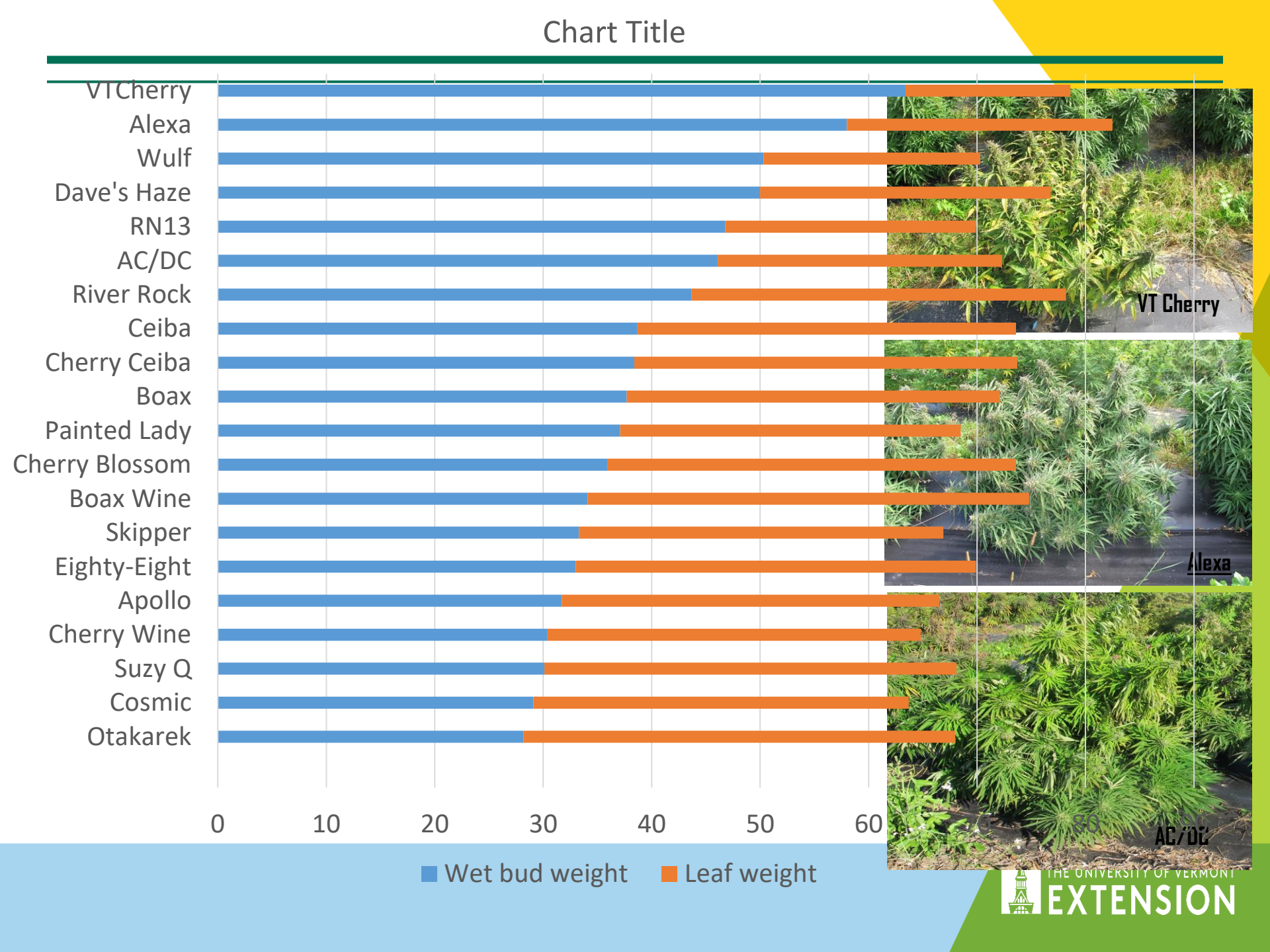


Chart Title
VTCherry
Alexa
Wulf
Dave's Haze
RN13
AC/DC
River Rock
Ceiba
Cherry Ceiba
Boax
Painted Lady
Cherry Blossom
Boax Wine
Skipper
Eighty-Eight
Apollo
Cherry Wine
Suzy Q
Cosmic
Otakarek
0
10
20
30
40
50
60
70
80
Wet bud weight
Leaf weight
VT Cherry
Alexa
AC/DC
THE UNIVERSITY OF VERMONT
EXTENSION

How Many Seeds/Plants

- 5 x 5 = 1,742
- 6 x 6 = 1,260
- 4 x 4 = 2,723
- 2 x 2 = 10,890

Genetics & Planting Stock – Large Expense

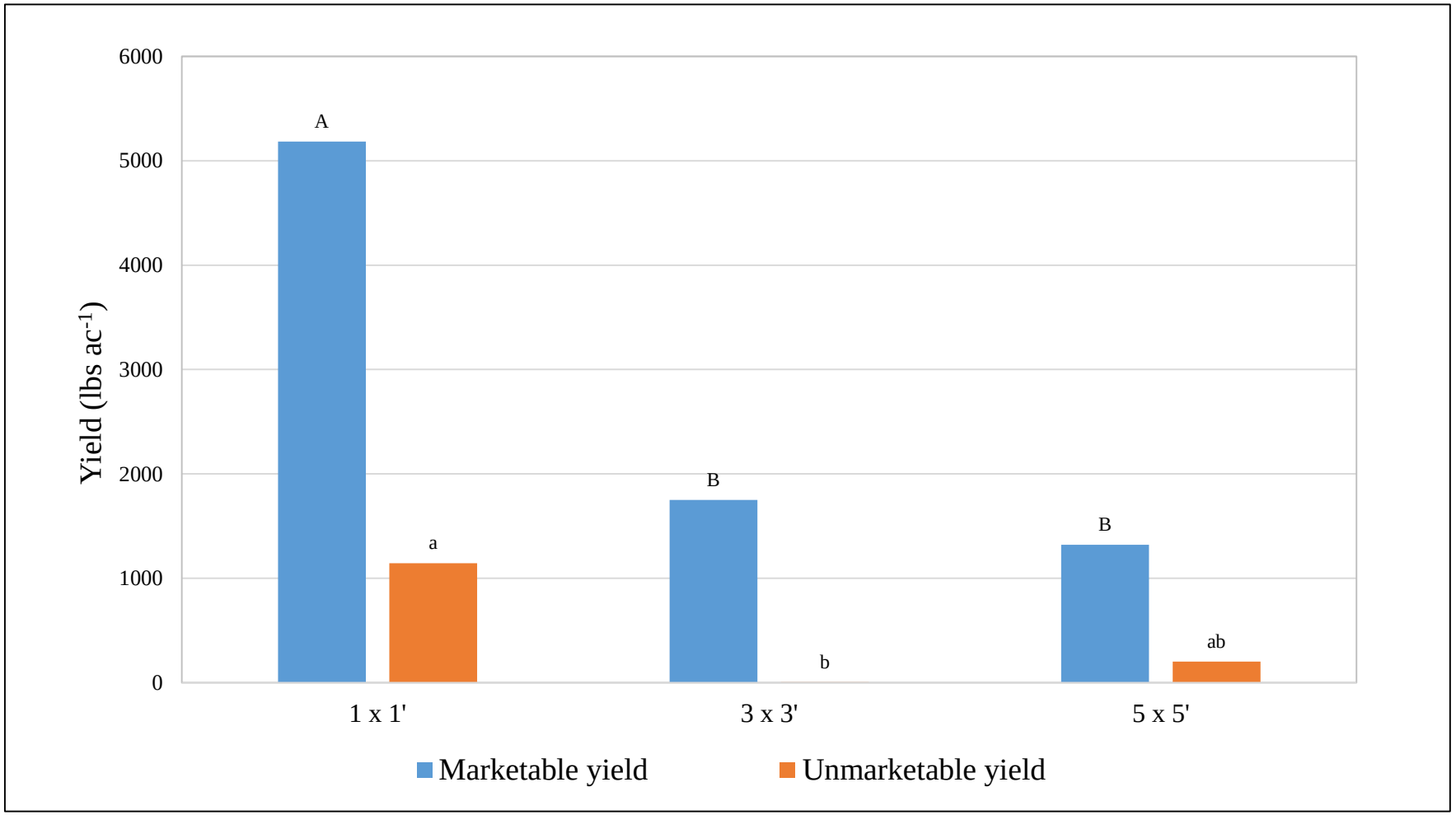
$1 to $2 per seed = $1,890/A

$ 3 to $8 per plant = $5,040/A

$ 4 to $8 per clone = $7,560/A

CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Marketable and unmarketable flower yields by spacing: per acre basis



Treatments with the same letter are statistically similar at the 0.10 level.

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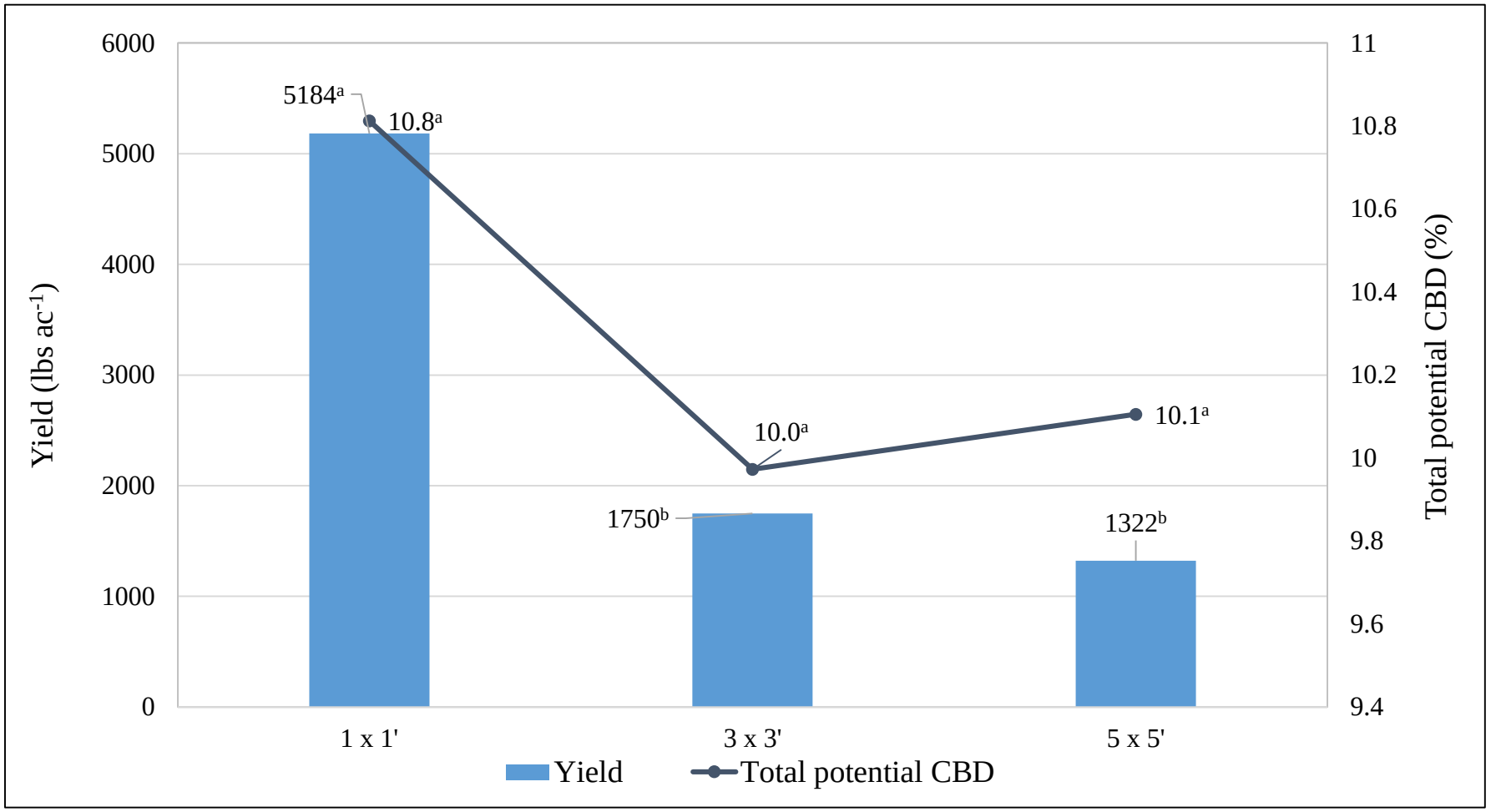
CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Flower dry matter yields and total potential CBD by plant spacing



Treatments with the same letter are statistically similar at the 0.10 level.

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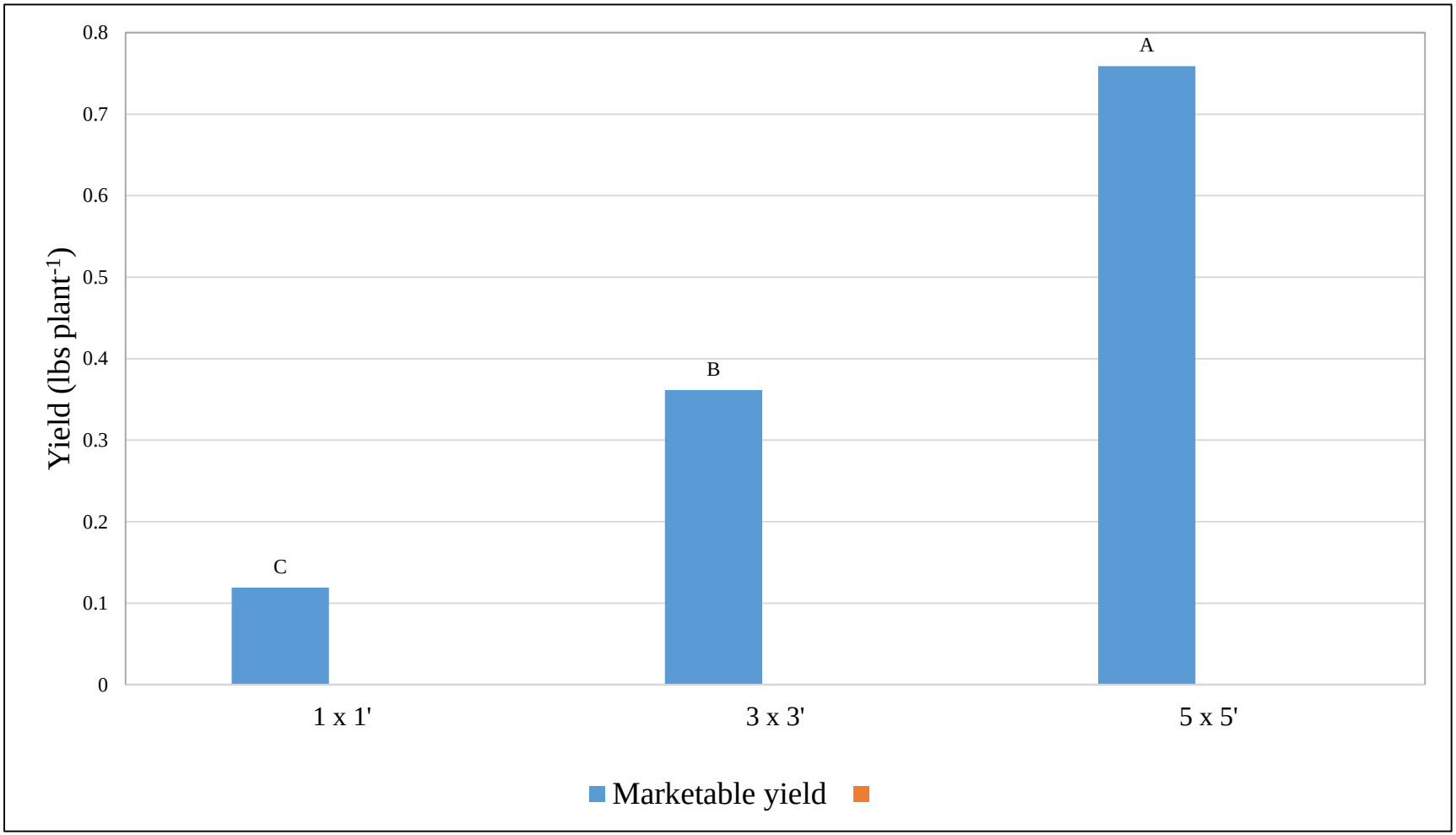
CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Marketable and unmarketable flower yields by spacing: per plant basis



Treatments with the same letter are statistically similar at the 0.10 level.

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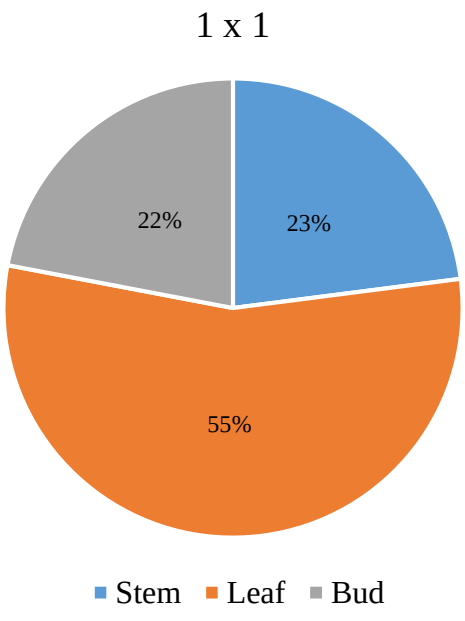
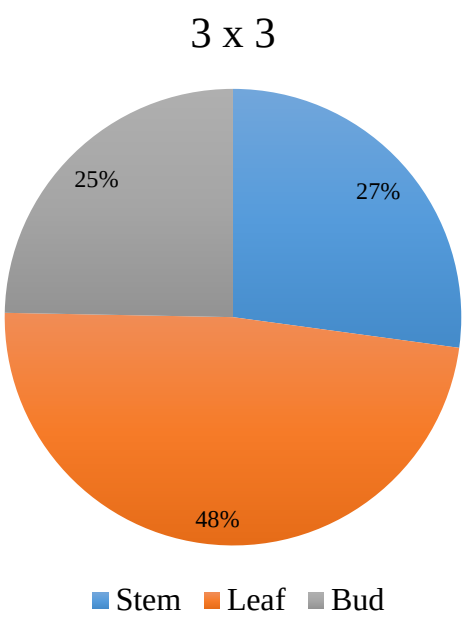
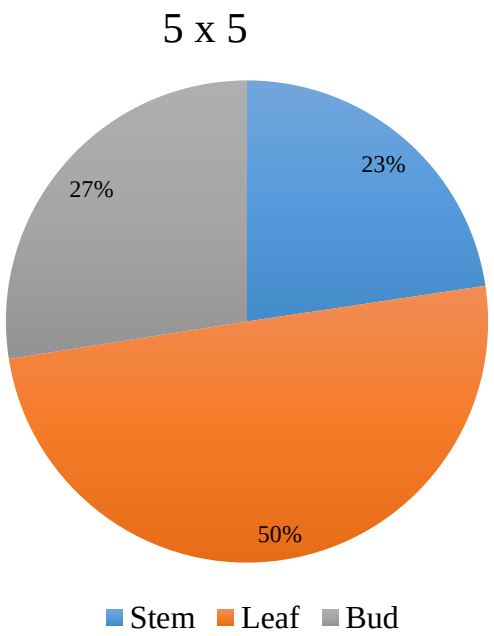
CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Biomass percentages by plant spacing







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Powdery mildew on a
1 x 1 spacing plant

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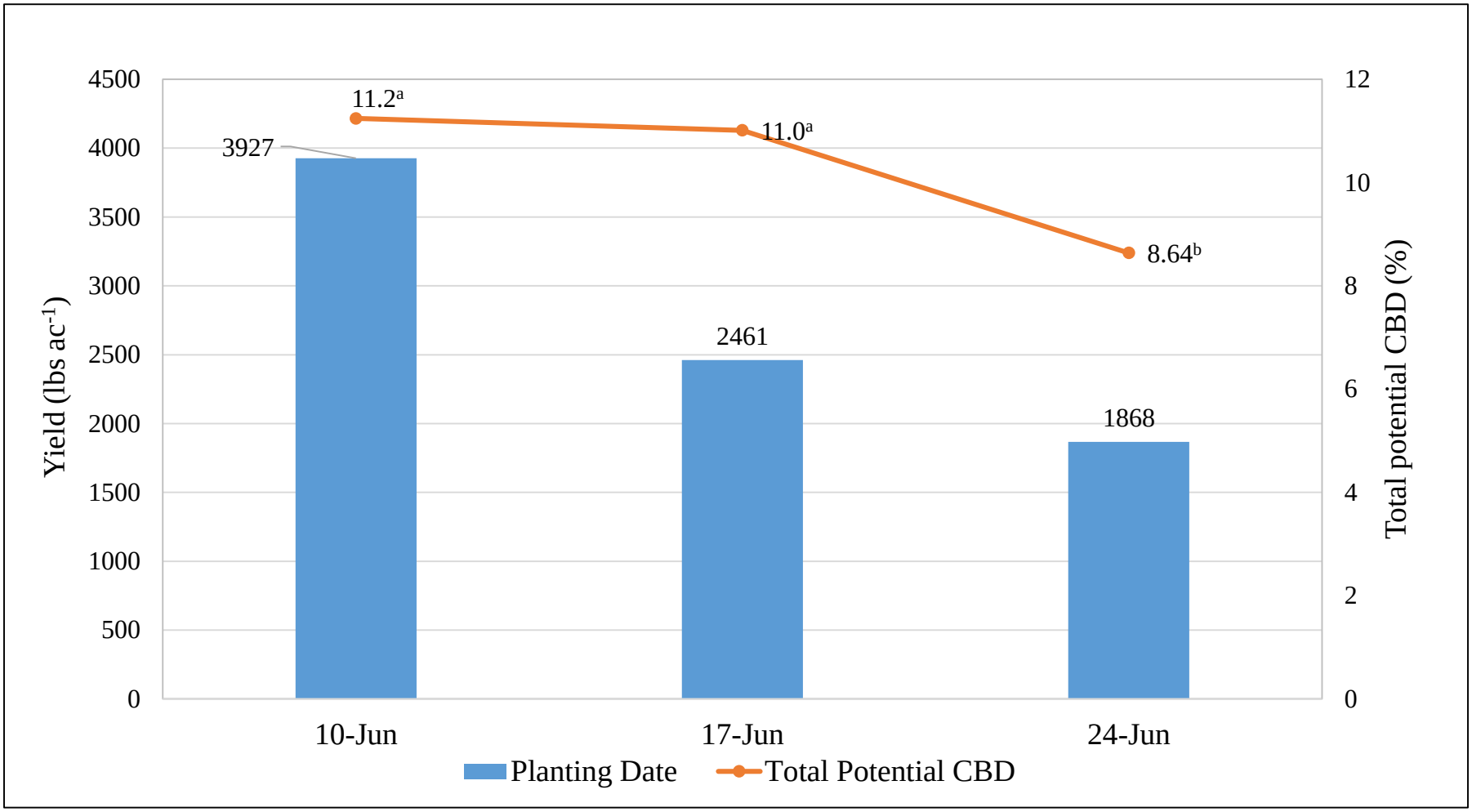
EXTENSION

CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Flower dry matter yields and total potential CBD by planting date



Treatments with the same letter are statistically similar at the 0.10 level.

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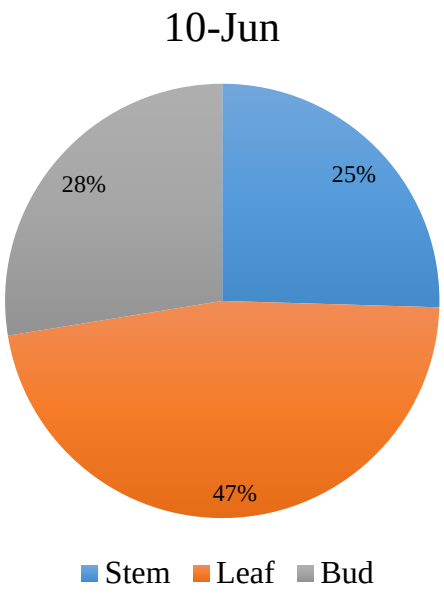
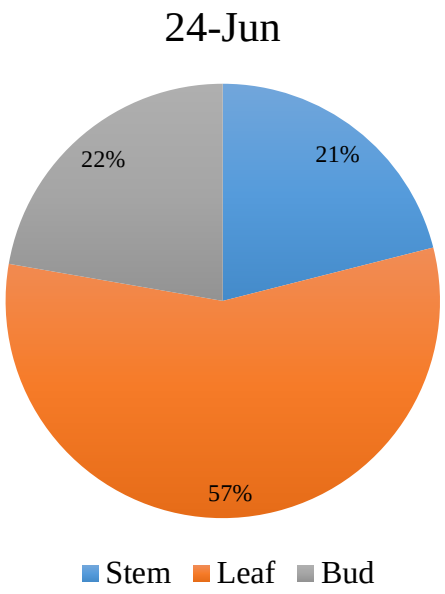
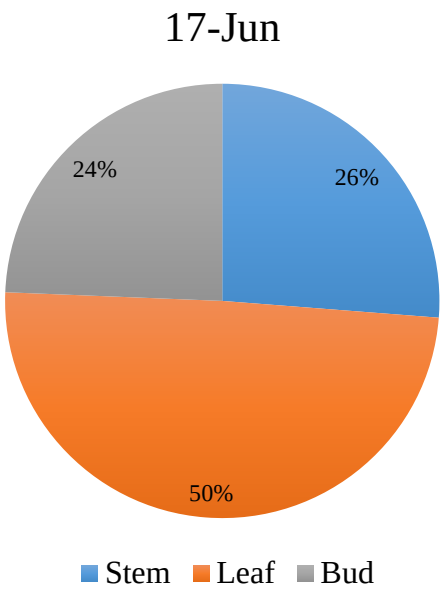
CBD Plant Spacing x Planting Date Trial (var. Ceiba)

Biomass percentages by planting date







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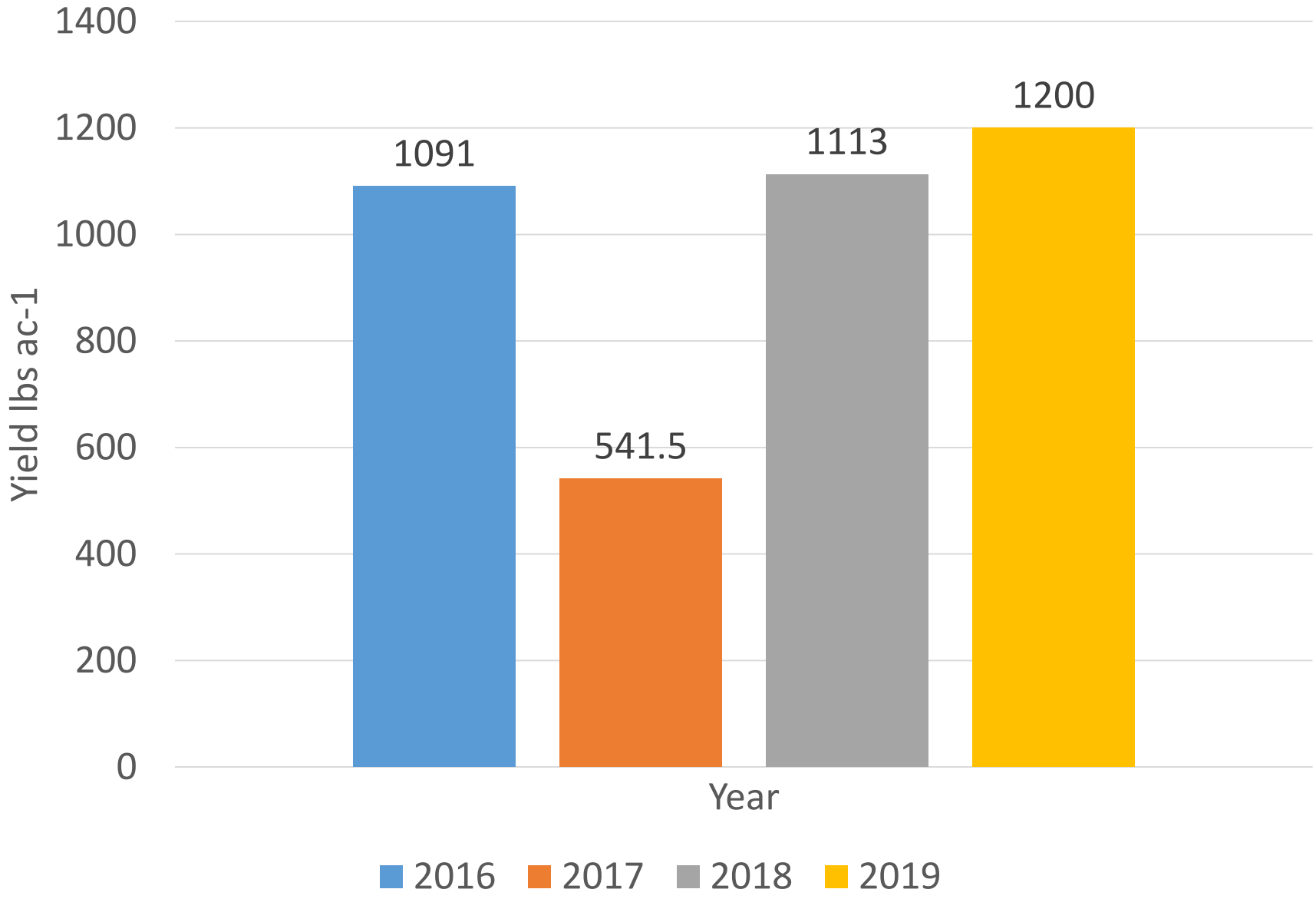
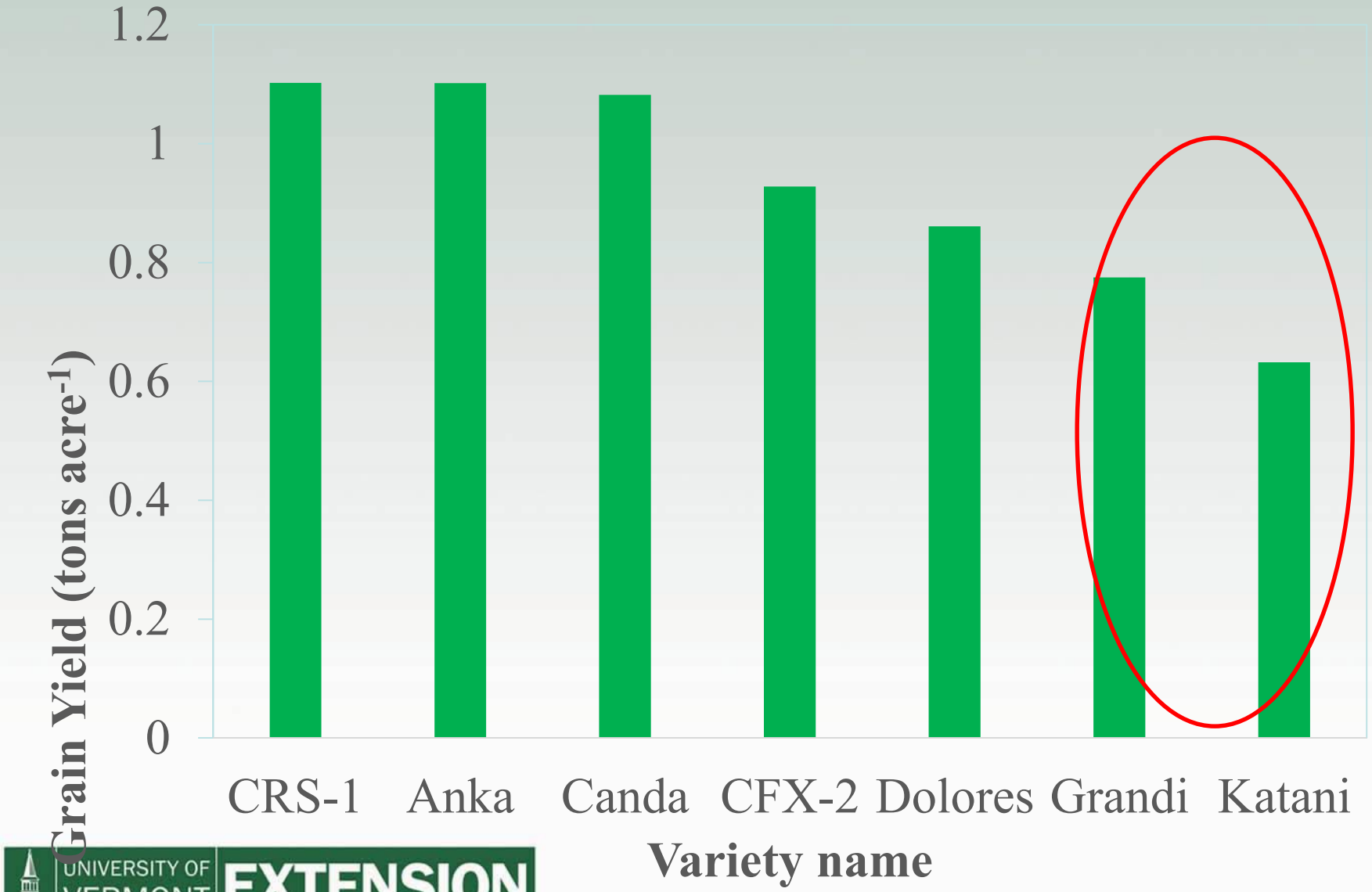
Grain Yields in Vermont



Grain Varieties



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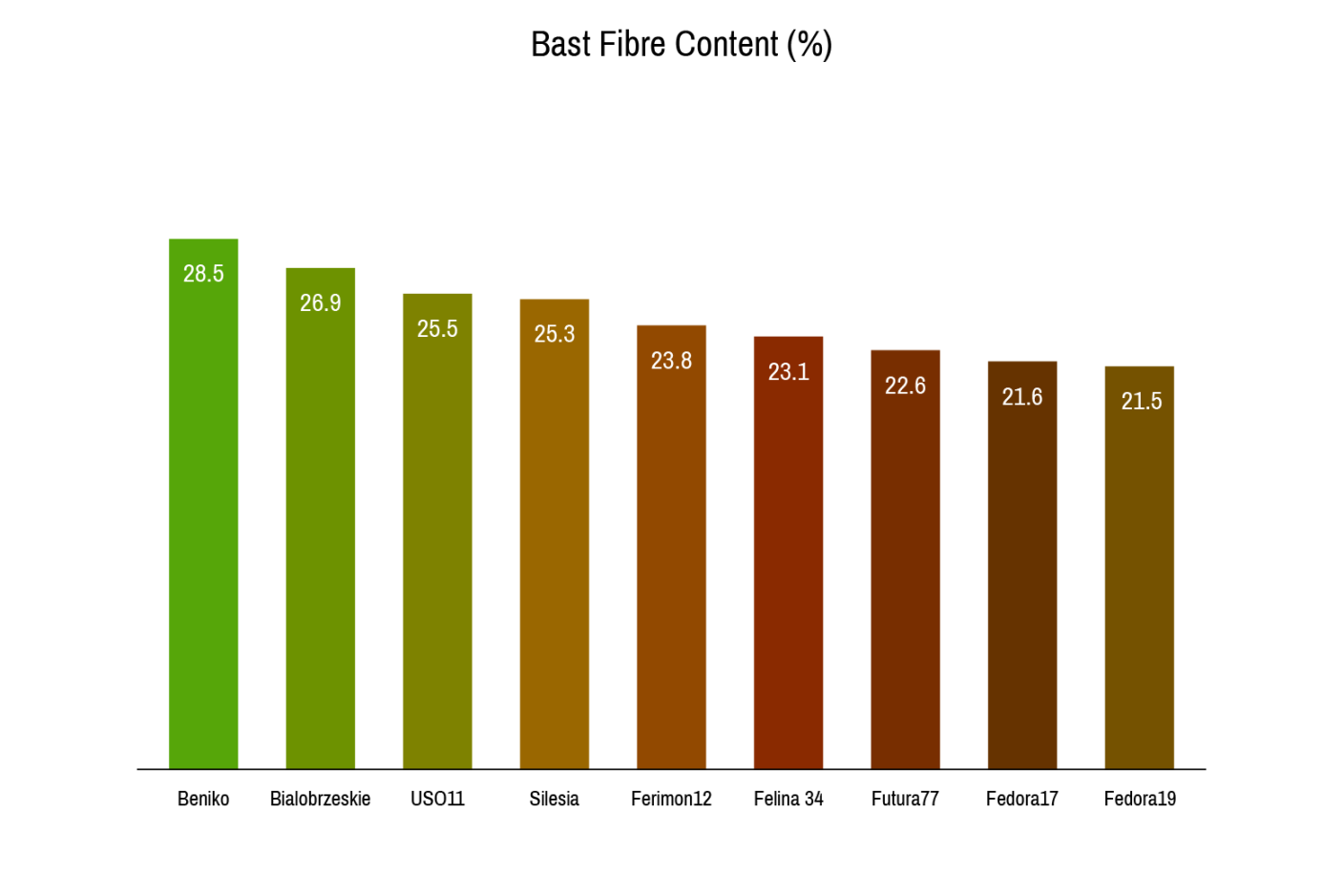
CULTIVATING HEALTHY COMMUNITIES

Variety Selection



Varieties Developed for Fiber

- Fiber varieties increase bast fibers from 40 to 60%

- Landrace varieties & marijuana types – 10 to 15% bark

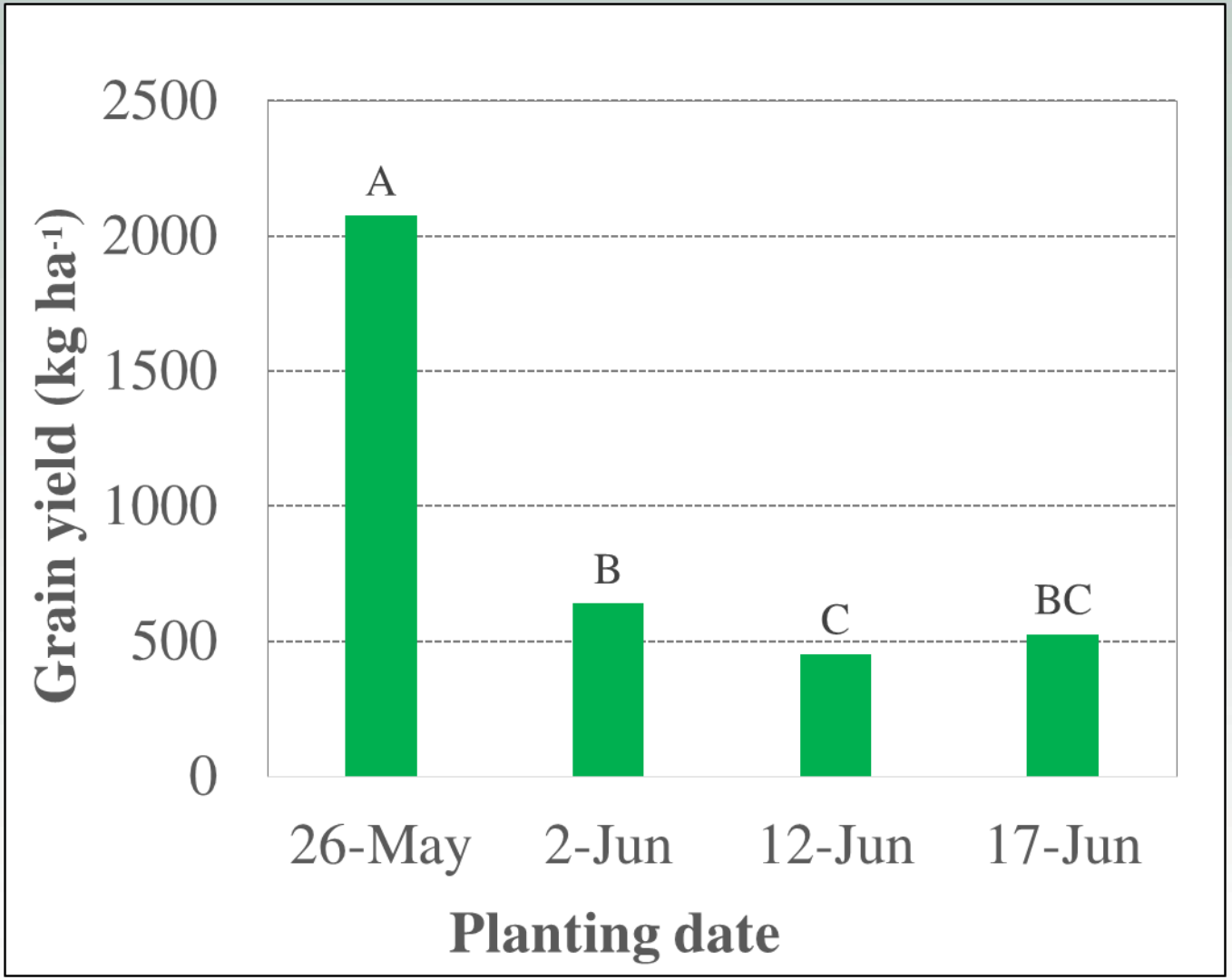


Figure 3. Yield of hemp planted from 26-May to 17-Jun. Columns with the same letter were not significantly different from each other, $p < 0.0001$).

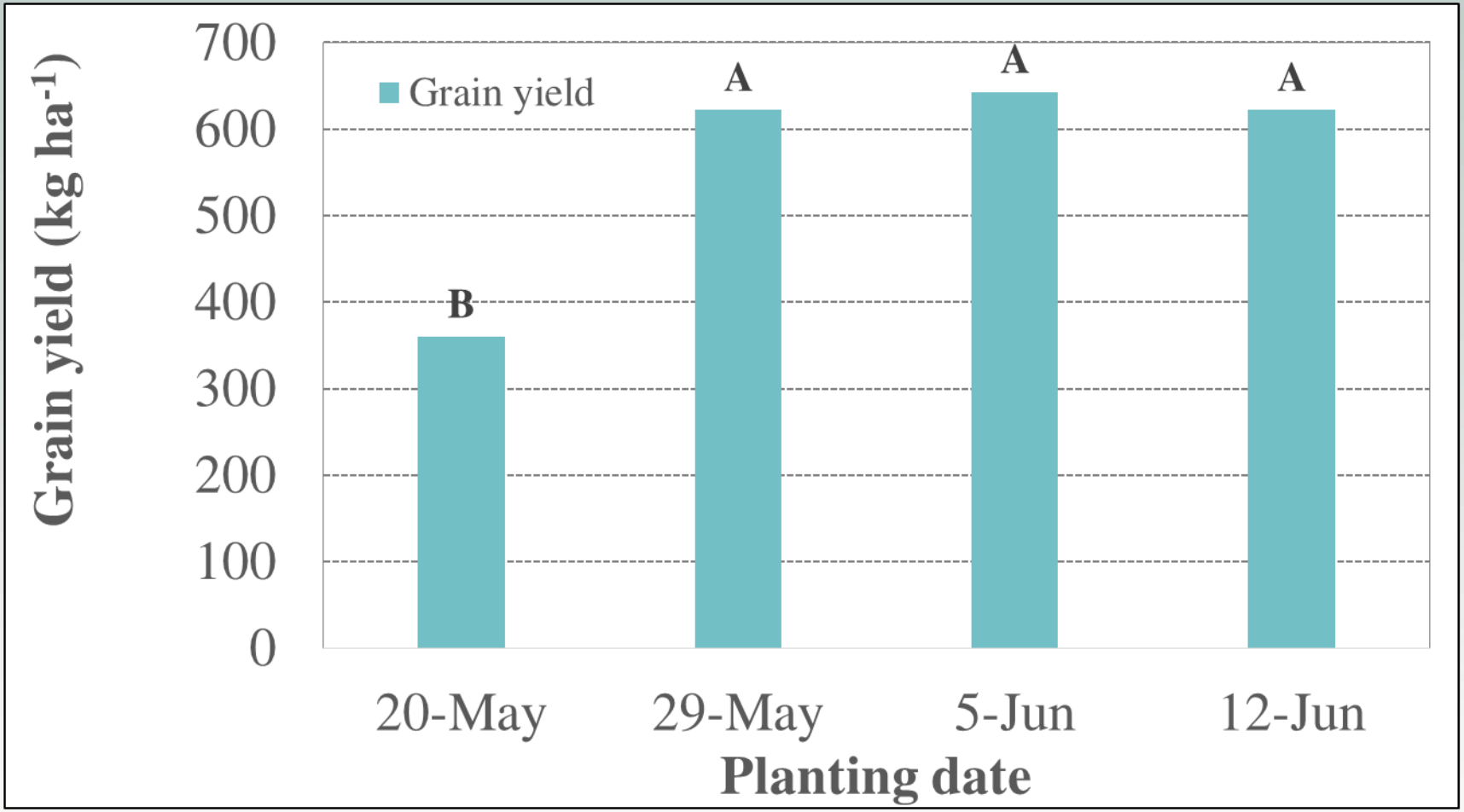
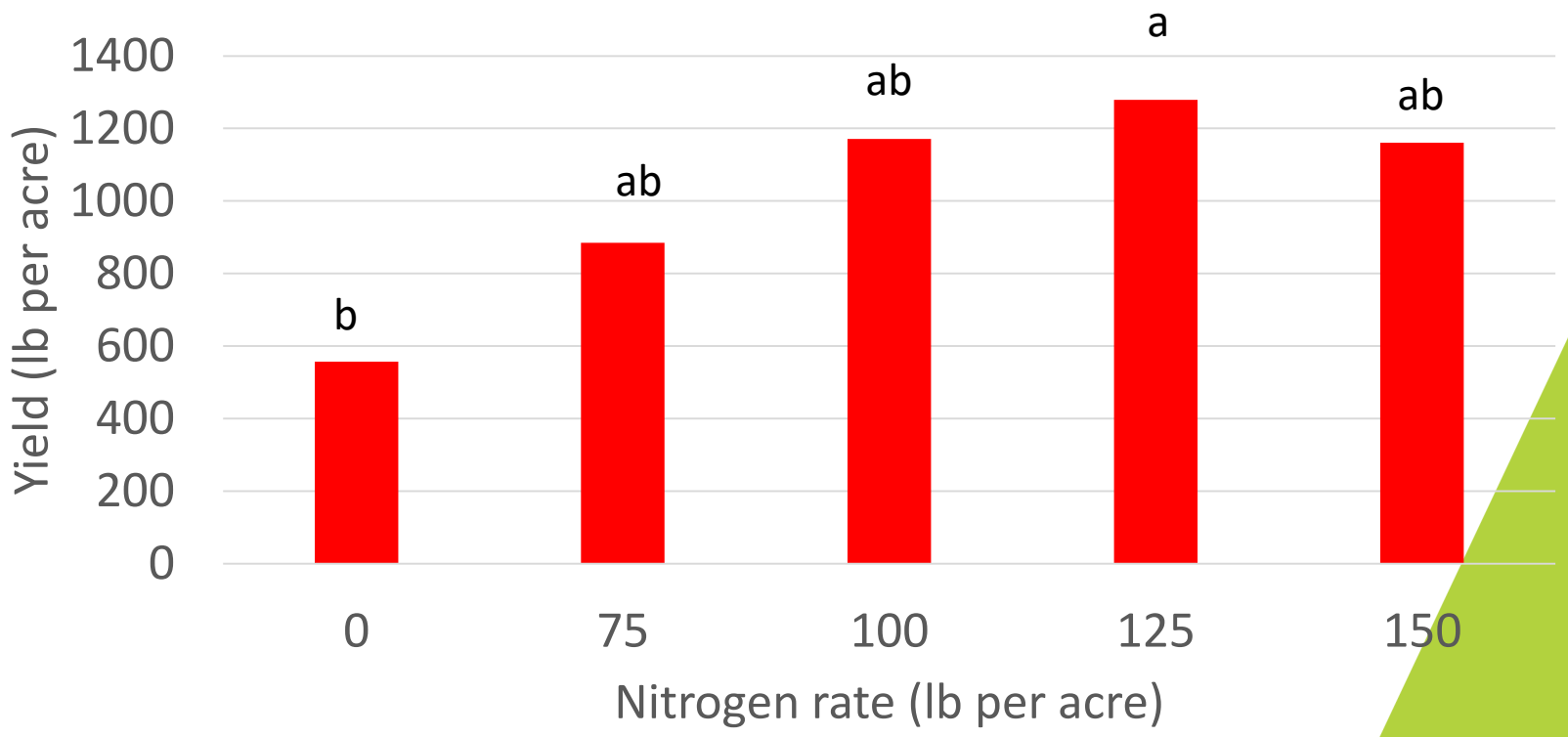


Figure 7. Hemp grain yields from four planting dates. Columns with the same letter are not significantly different from each other, LSD (0.10) = 179, p = 0.0075).

Nitrogen Fertility and Grain Hemp



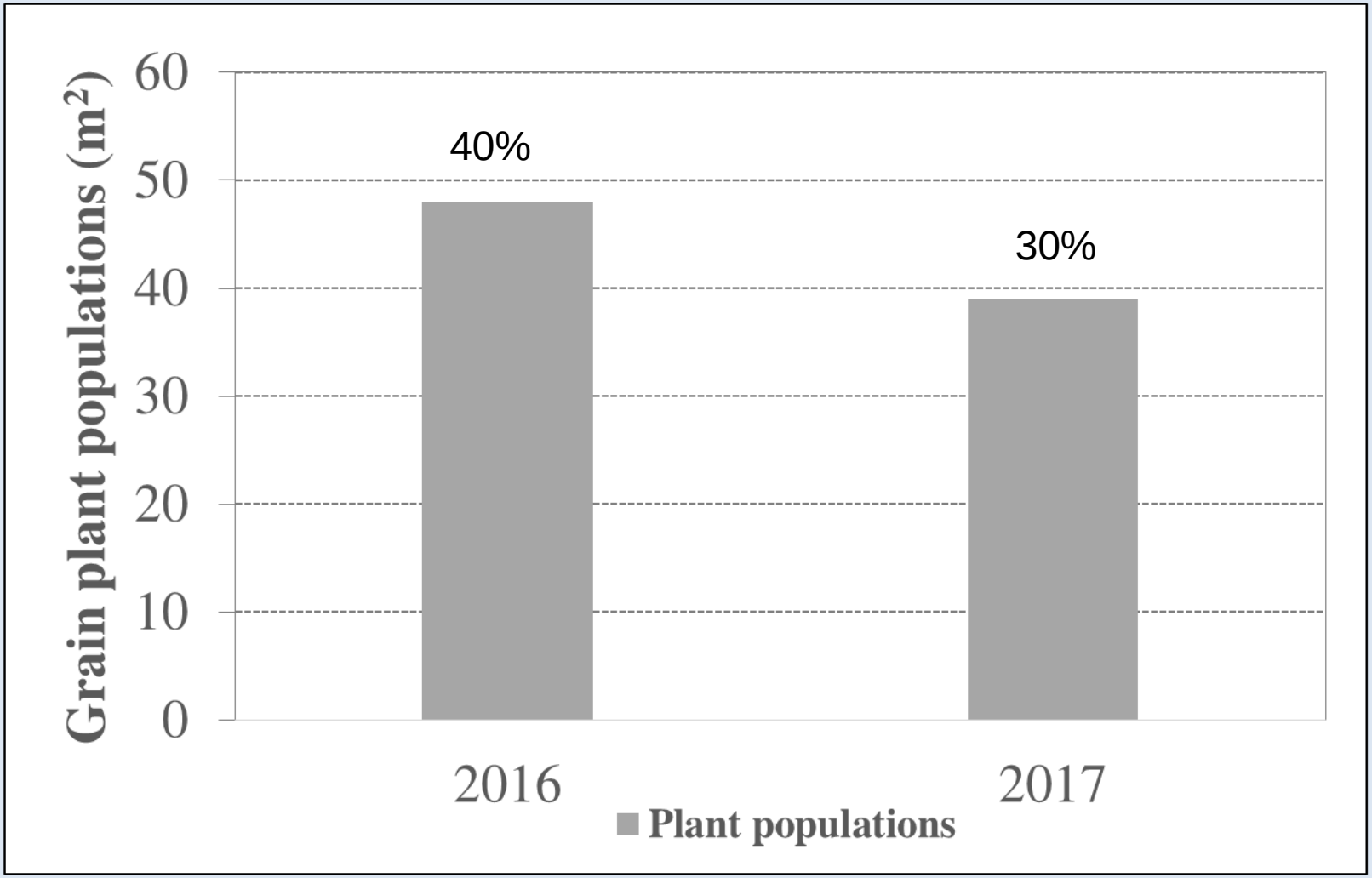


Figure 2. Average hemp grain population comparisons from the 2016 and 2017 variety trials.

Weed control trial

- Standard row – Average height 177 cm, significantly lower than other treatments.
- Weed cover ranged from 7.03 – 17.1%, no significant differences.
- No significant yield differences, 1444 kg/ha.

Percent weed cover assessment in industrial hemp, Alburgh, VT, 2016

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CULTIVATING HEALTHY COMMUNITIES

Weed Control trial

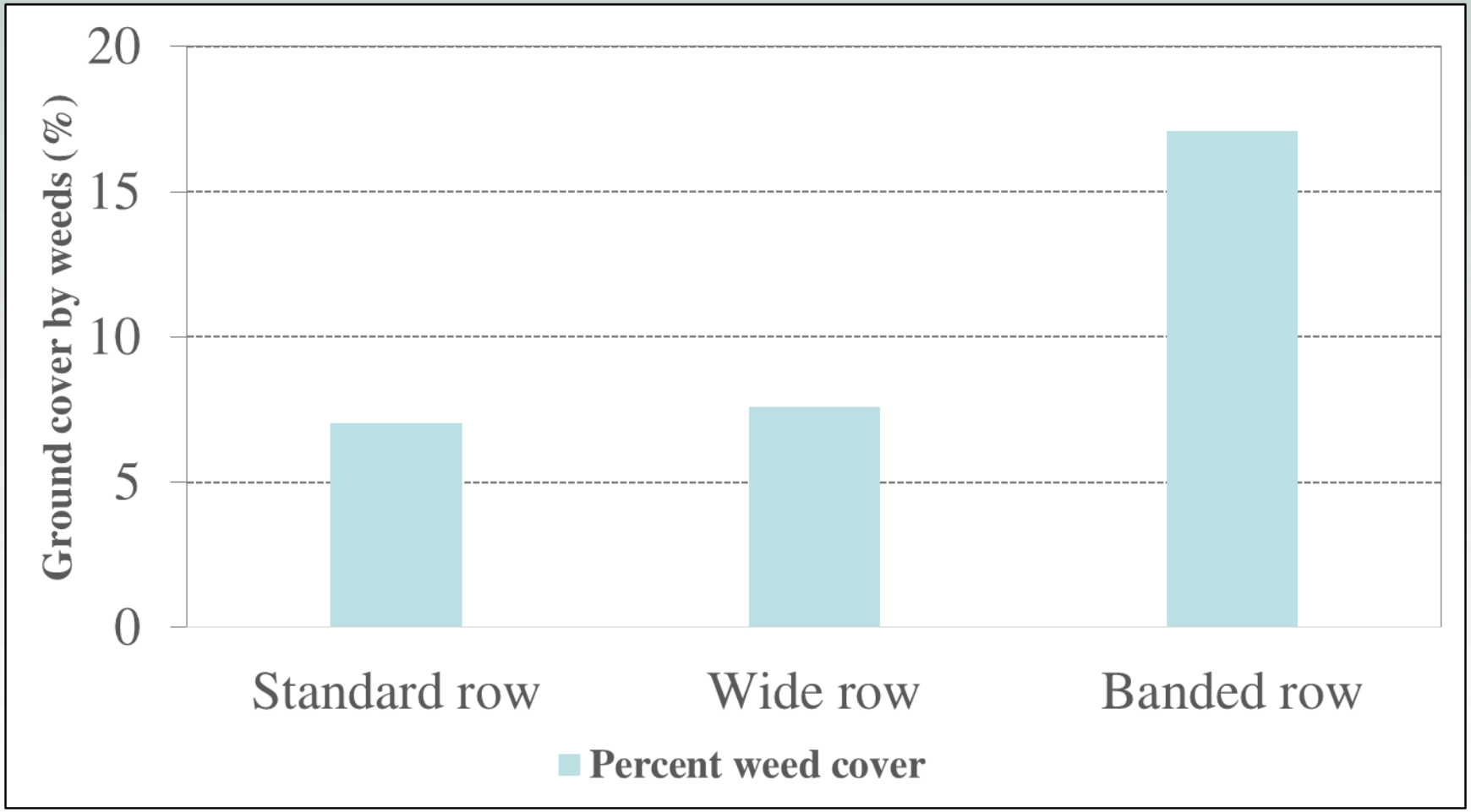

Figure 9. Row spacing effect on percent of ground covered by weeds. No significant difference

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CULTIVATING HEALTHY COMMUNITIES

Growth stages

Staminate, male flower

Pistillate, female flower

Seed development

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CULTIVATING HEALTHY COMMUNITIES

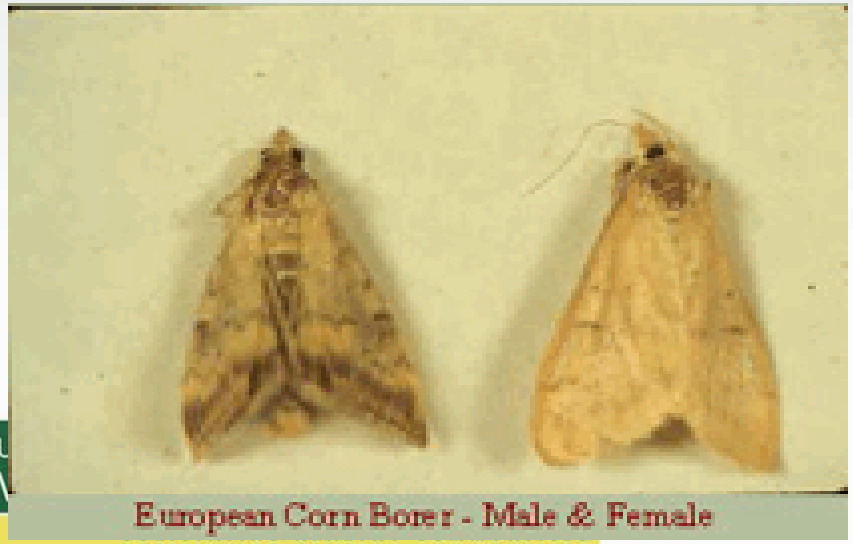

University

Corn borer

ECB found in hemp; Left-ECB in grain hemp (Photo credit: Marguerite Bolt, Purdue Extension, 8-Aug 2019) Right-ECB in CBD hemp (Alburgh, VT, 2019)

ECB damage in corn

Corn Borer

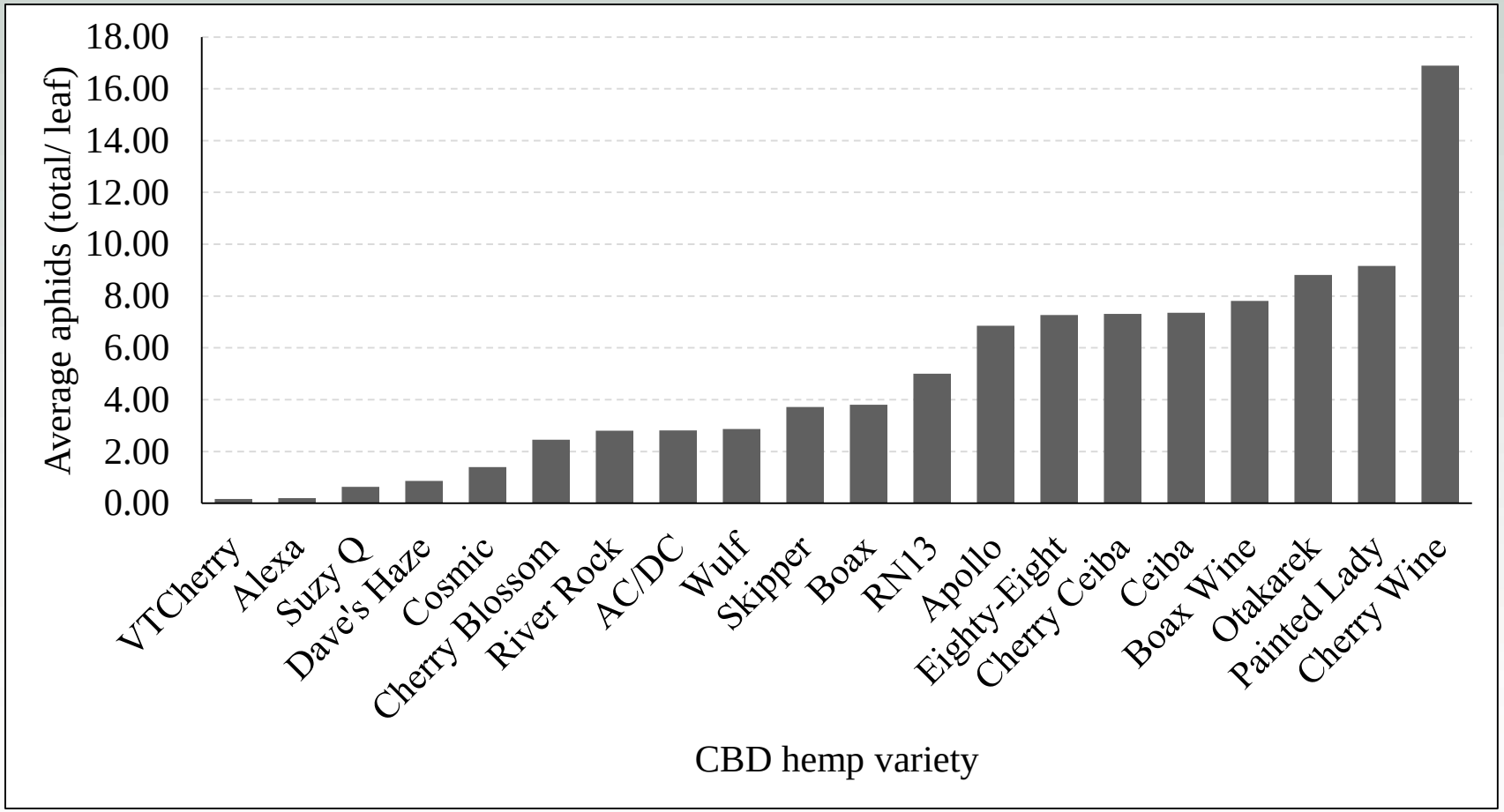


- 2 flights per year
- June little damage
- July/August more damage

- Traps
  - Pheremone traps
- Beneficial release
  - Trichogramma wasps
- Sprays

Aphids

CBD Variety Trial – Aphid populations



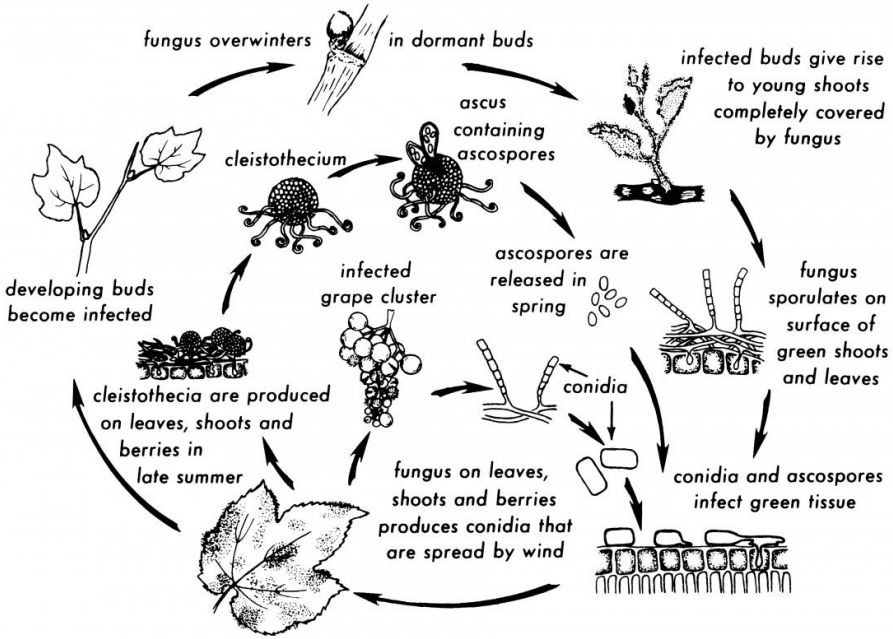
Diseases in Hemp

Botrytis cinerea

Sclerotinia sclerotiorum

Sphaerotheca macularis

Powdery Mildew



Lifecycle of powdery mildew in grape vines; New York State Agricultural Experiment Station (2008)

Powdery mildew in hemp

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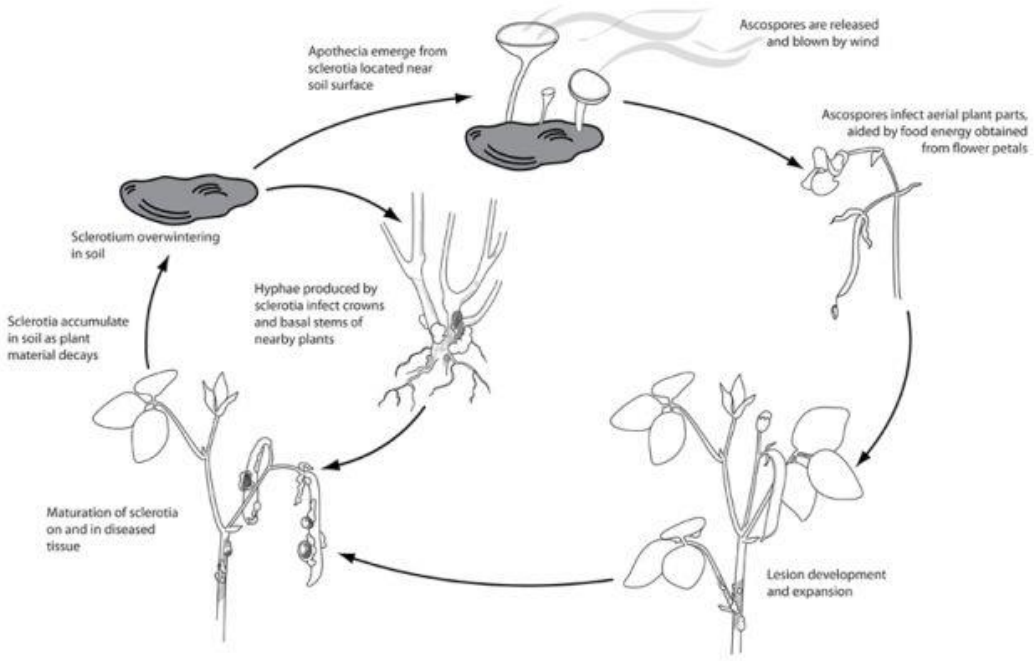
Sclerotinia white mold



Lifecycle of white mold (Sclerotinia) (provided by the American Phytopathological Society (APS) 2012)

Sclerotinia sclerotiorum **on hemp. Alburgh, VT.**

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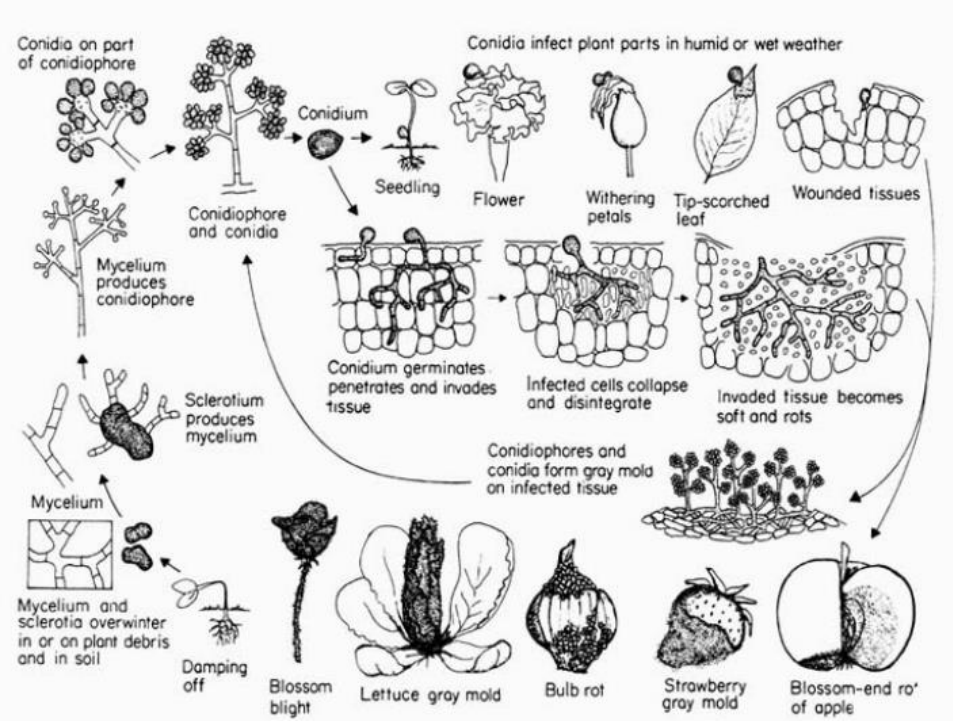
Botrytis



Lifecycle of botrytis grey mold disease (provided by George Agrios, Plant Pathology 4th edition)

***Botrytis cinerea* in hemp, Alburgh, VT**

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Crop Rotation

- Hemp is susceptible to many diseases.
- Hemp should be rotated ideally to a new spot every 1 to 2 years.
- To minimize disease build-up would recommend a 4 to 6 year rotation.

Products

- **Actinovate** (Novozymes BioAg Inc., EPA Reg. No. 73314-1) - *Streptomyces lydicus*

  Suppress or control foliar fungal, root rot, and damping off pathogens. This product is labeled for use against downy mildew and other pathogens. Works best if it is used prior to disease onset.

- **Cease** (Bioworks Inc., EPA Reg. No. 264-1155-68539) - *Bacillus subtilis*

  This product can be used to control a variety of fungal pathogens and bacterial diseases and is I intended for use as both a foliar spray and a soil drench. Cease is to be used at the onset of favorable disease conditions prior to the onset of symptoms.

- **Regalia** (Marrone Bio Innovations, EPA Reg. No. 84059-3) – *Fallopia sachalinensis* (giant knotweed)

  Is a broad-spectrum bio-fungicide that is active against soil borne and foliar pathogens..Regalia works by stimulating the plant's natural defenses and has antifungal and antibacterial properties.

- **Trifecta** Crop Control (Trifecta LLC, EPA/FIFRA exempt (25b) insecticide/fungicide)

  A nano-emulsified essential oil based multi-purpose mold, mildew and pest control. The active ingredients include soap, isopropyl alcohol, thyme oil, clove oil, garlic oil, vinegar, peppermint oil, corn oil, geraniol, citric acid and rosemary oil. Trifecta uses the various essential oils to act as a repellent, suffocant, reproductive inhibitor, and fungicide and can be applied directly to foliage or as a soil drench depending on target pest.

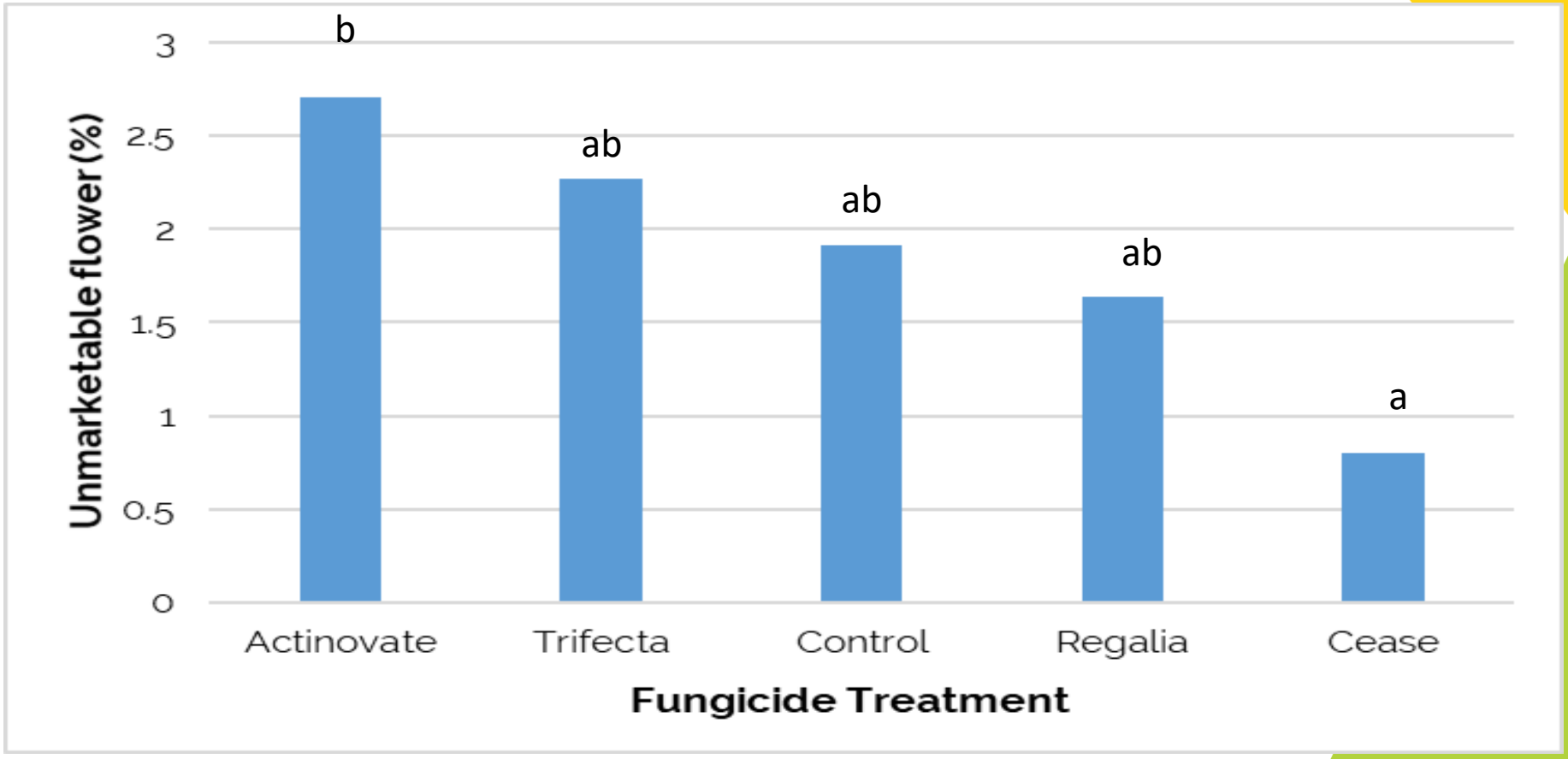


Figure 1. Unmarketable flower (%) at harvest by fungicide treatment, Alburgh, VT, 2019.

Cover crops

Indoor vs outdoor

Treatment	Flower dry matter	Dry matter flower yield		Yield at 8% moisture	Unmarketable flower yield	
	%	lbs plant^{-1}	lbs acre^{-1}	lbs acre^{-1}	lbs plant^{-1}	lbs acre^{-1}
Indoor	21.1	1.67	**2910**	**3163**	0.125	218.5
Outdoor	18.9	1.29	2255	2451	0.209	364.6
LSD (0.10)	NS	0.36	628	683	NS	NS
Trial mean	20.0	1.48	2582	2807	0.180	292

The top performing treatment (p=0.10) is shown in **bold.**
NS – There was no statistical difference between treatments in a particular column (p=0.10).
† Dry matter yield is reported at 0% moisture.

EXTENSION

Indoor vs outdoor

There is a significant correlation between soil moisture and cannabinoid content. THC & CBD indicated to increase with decreasing moisture and humidity. (Latta and Eaton, 1975; Sikors et al., 2011)

Treatment	Total potential CBD % weight	Total potential THC ‡ % weight
Indoor	16.8	**0.614**
Outdoor	13.9	0.482
LSD (0.10)	NS	0.120
Trial mean	15.3	0.548

The top performing treatment (p=0.10) is shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

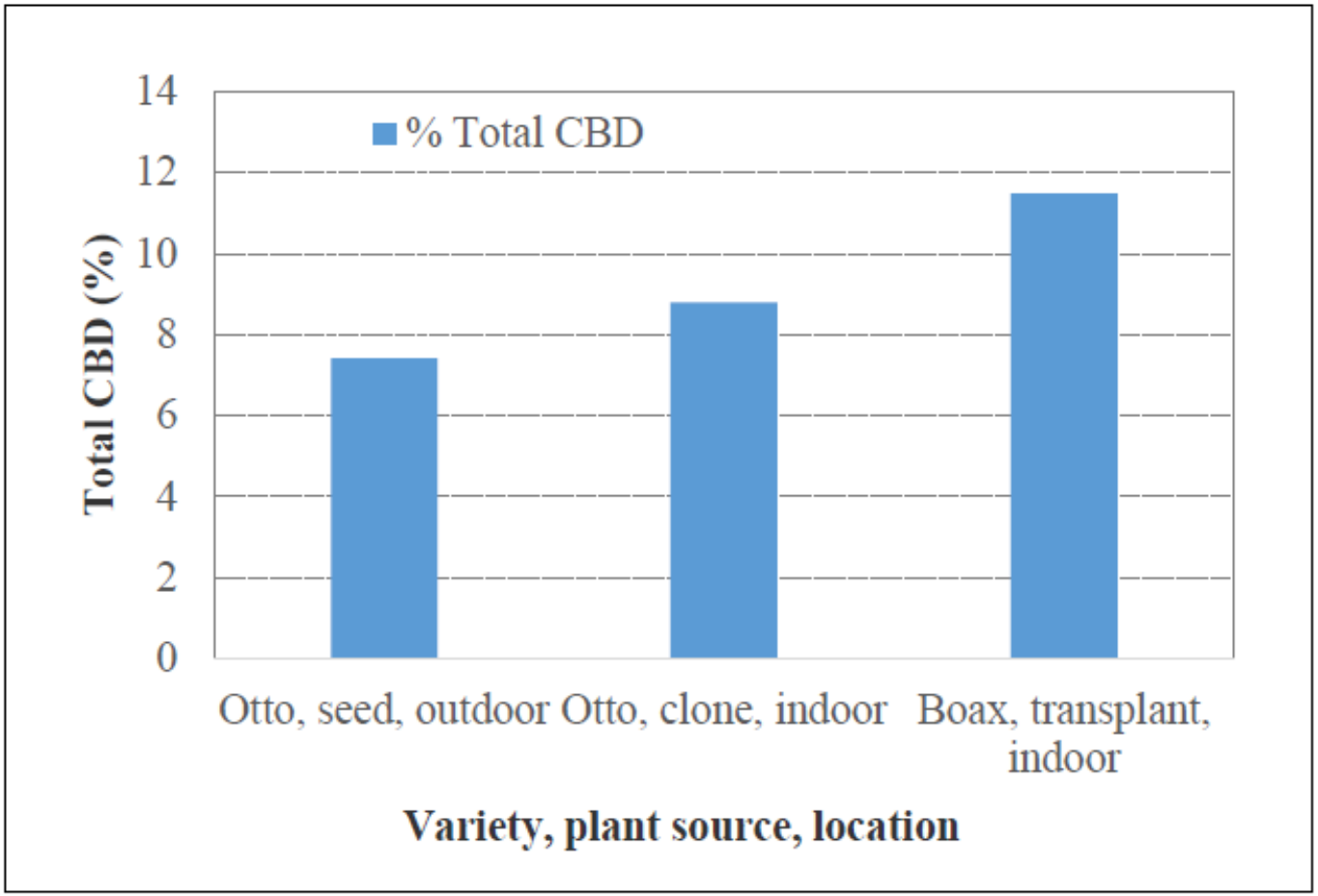
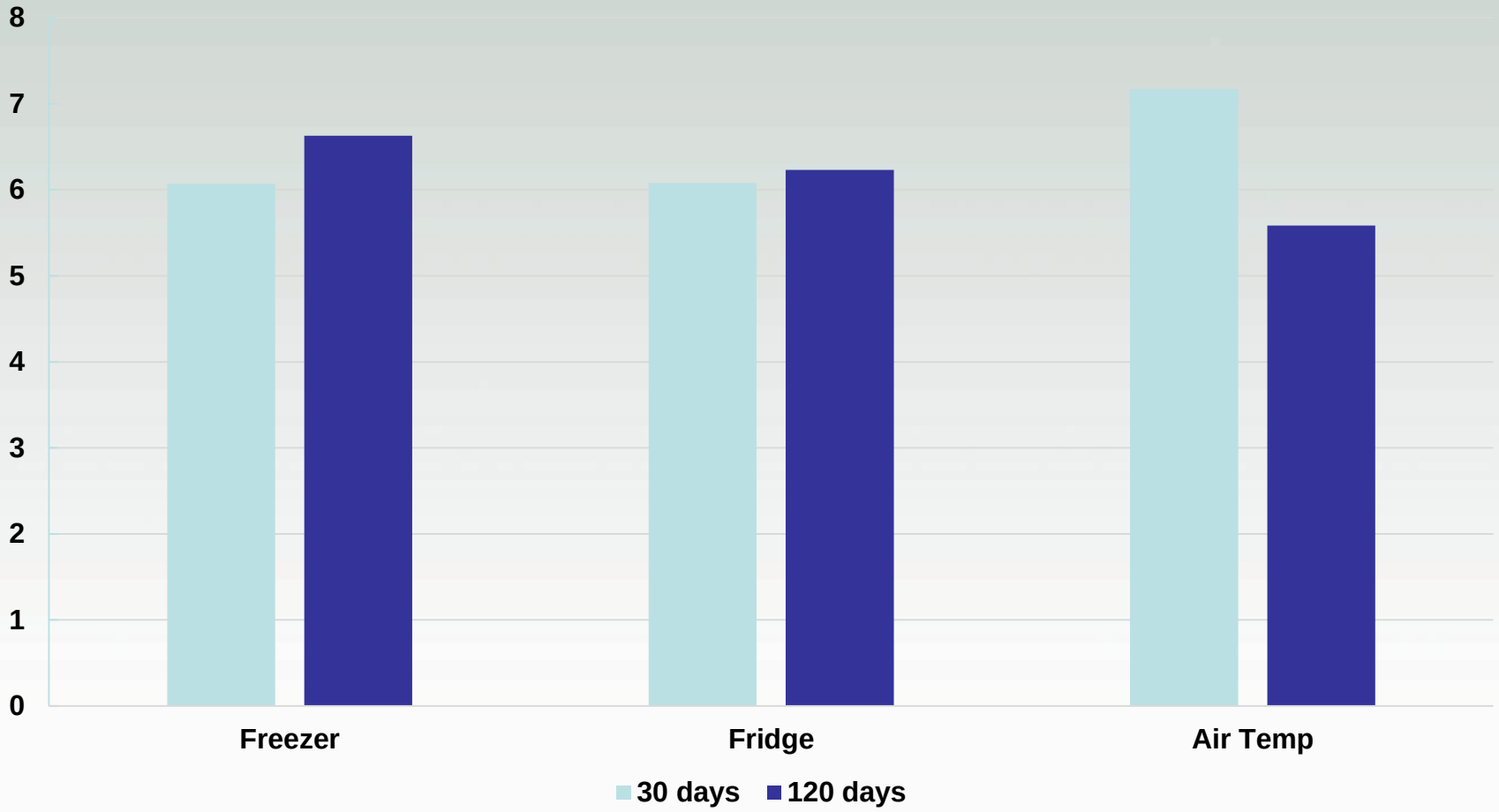


Figure 2. Average cannabidiol (CBD) concentration of Boax and Otto, Alburgh, VT, 2017.

Storage Temperature



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