



# How to Increase Cannabinoids and Terpenoids in Cannabis Through Horticultural Management

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# *Cannabis sativa* L.

- Annual, herbaceous species
- Dioecious (male and female plants)
- Cannabinoids – secondary metabolites
  - Trichomes on female flowers
  - Over 100 identified [1–3]
  - Unique physiological effects on animals
  - Decarboxylation (e.g. THCA vs. THC)
- Terpenoids = flavours and aromas



# Introduction to Drought Stress

- Intermittent drought = high levels of essential oils [4]

## Summer Savory [5]

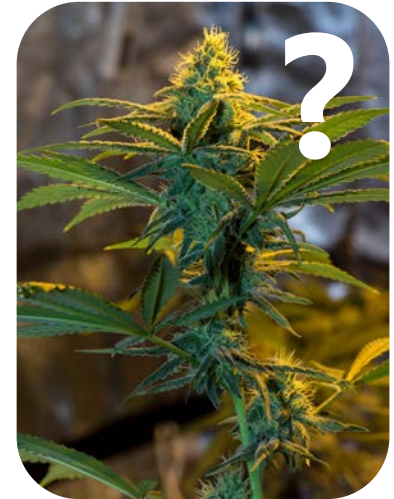


[www.rareseeds.com](http://www.rareseeds.com)

## Sage [6]



[www.medicalnewstoday.com](http://www.medicalnewstoday.com)



- Drought generally reduces growth [7-9]

# Research Objectives

Evaluate the effects of drought stress timing and frequency on cannabinoid and terpenoid content in cannabis.

## Two trials:



Drought applied once during the flowering stage



Drought timing and intermittent drought

# Methods: Drought Stress

## Drought Stress Trial

**Treatment:** Drought + well-watered control

**Drought timing:** Week 7

**Drought threshold:** Mid-day plant water potential (WP) between -1.4 and -1.5 MPa

**Experimental design:** Completely randomized

**Replication:** 4 for drought treatment and control

**Pot volume:** 11 L

**Measurements:** Only cannabinoids

## Drought Stress Timing Trial

**Treatments:** Six + well-watered control

**Drought timing:** Weeks 4, 5, 6, and 7 + two intermittent treatments

**Drought threshold:** Leaf angle increase of  $\approx 50\%$

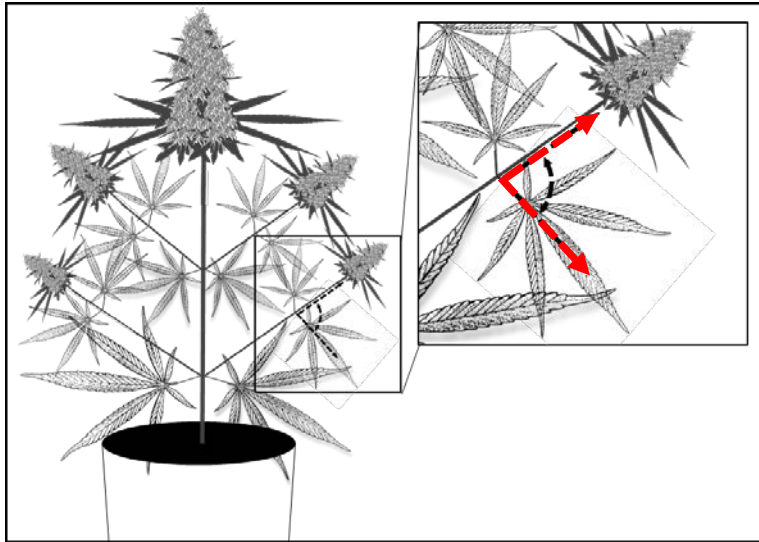
**Experimental design:** Completely randomized

**Replication:** 7 for each drought treatment and the control

**Pot volume:** 6 L

**Measurements:** Cannabinoids and terpenoids

# Drought Indicators



Location for leaf angle measurement to indicate degree of wilting in cannabis.



Stem Psychrometer data

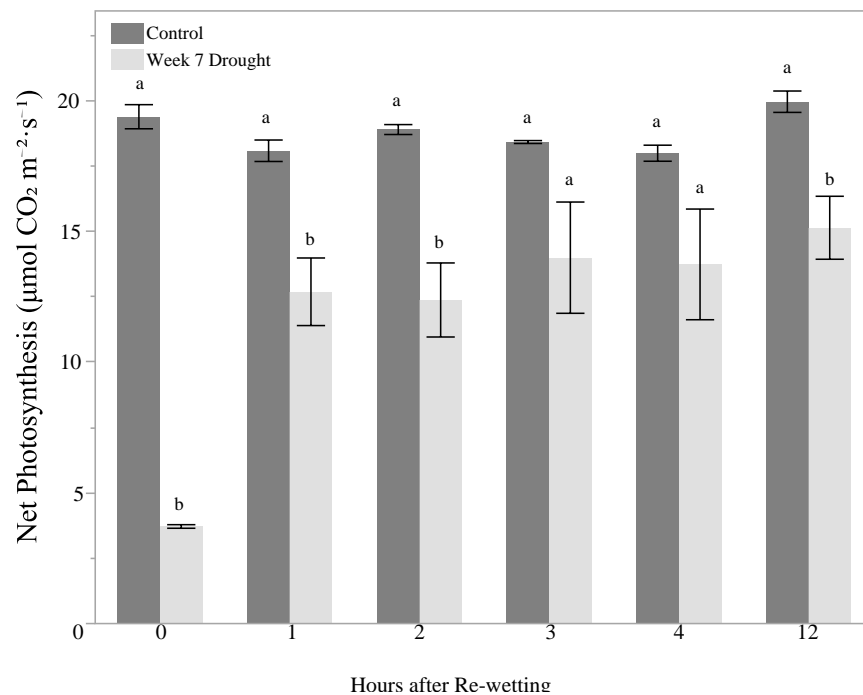


Stem Psychrometer



Photosynthesis measurement system

# Results: Drought Stress



Net leaf photosynthetic rate after drought stress and subsequent fertigation at seven weeks into the flowering stage.

# Results: Drought Stress

## Drought Stress Trial

- No difference in floral dry weight (yield) between drought and control
- Drought **Increased:**
  - THCA concentration by 12%
  - CBDA concentration by 13%
  - THCA yield by 43%
  - CBDA yield by 47%
  - THC yield by 50%
  - CBD yield by 67%

## Drought Stress Timing Trial

- No differences in yield or cannabinoid content among treatments
- Intermittent stress did not increase secondary metabolites or yield

### Early stress treatments:

- Linalool yield 49% higher than the control
- Cis-ocimene exclusively in these treatments

### Later stress treatments:

- Alpha-bisabolol yield 36% higher than the control
- Trans-ocimene detected only in these treatments and in the control





# Disagreement in Cannabinoid Results

- Drought increased cannabinoid content in the first drought trial but NOT in the second
- Same variety and similar environmental conditions
- Different pot size
- **Larger pot = slower onset of drought AND longer period of stress**



Pot size matters!

# Summary: Drought Stress

## Drought Stress

- Controlled drought stress can increase:
  - Concentration of THCA and CBDA
  - Yield of THCA, CBDA, THC, and CBD
- No reduction in floral dry weight irrespective of decreased photosynthetic rate

## Drought Stress Timing

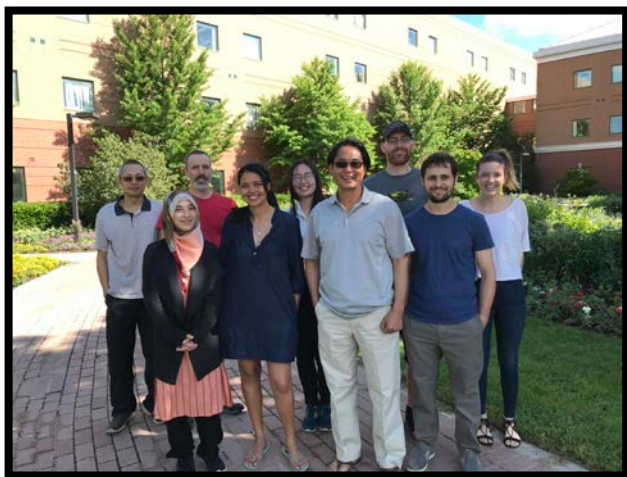
- Controlled drought timing can influence the concentration and/or yield of specific terpenoids in cannabis
- Pot size may influence rate of stress and cannabinoid content
- Importance of terpenoids?

# Looking Forward

- Horticultural research on cannabis in its infancy
- This research helps growers, consumers, and regulators
- Legalization in Canada



# Acknowledgements



ABCann

CESRF

**Advisor:** Dr. Youbin Zheng

**Committee:** Dr. Mike Dixon, Dr. Ian Tetlow

# References

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