From Soil to Bloom: Soil Health and Fertility in Lavender Farming from the Ground Up

Front Porch Events

Panelists: Dr. Patrick Freeze, PhD

Director of Research and Development, Soil/Soil Health Testing

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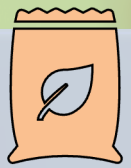
Soil Health: Quality and resilience hinge on the biology

Physical

- Erosion control
- Water holding capacity

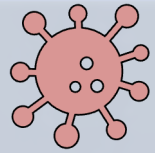
Chemical

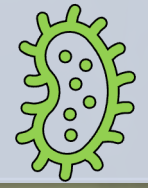
- Provide nutrients
- Buffer contaminants



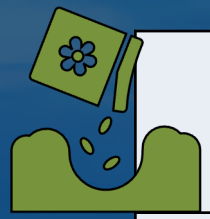
Biological

- Disease suppression
- Supports soil life





Soil Testing Objective:
Fertility vs Soil Health



Nutrients: Amounts	Health: Function
Nitrogen requirement	Carbon and nitrogen cycling
Organic matter amount	Available “food” for microbes
pH and salts	Aggregate Stability

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Preparing the Soil

- Good drainage is crucial to prevent root rot and fungal diseases.
- If soil is finer texture, sand, compost, mulches can be added.

- If soil is too alkaline, add elemental sulfur to lower the pH: ~ 800 - 1000 lbs/acre to drop soil 1 pH point.
- If soil is too acidic, add lime to raise the pH (determined from soil test and buffer pH).

Pulse Polls 1

How often do you have your farm's soil tested?

a) Annually
b) Every other year
c) At least every 5 years or so
d) I have never had my soil tested

Lavender and Soil Health

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Practical approaches to support soil health:

- Over-fertilization can reduce oil quality.
- Crop rotation and cover cropping to maintain soil health.
- Minimal tillage to preserve soil structure and microorganisms.
- Regular soil testing for targeted nutrient management.
- Use of **residues, mulches, and compost to enhance soil structure**.

Some Soil Health Indicators in Ag Systems:

- **Active carbon:** 24-hour CO_2 Respiration
- **Active carbon:** Permanganate Oxidizable-C (POX-C)
- **Active carbon:** Particulate Organic Matter (POM)
- **Active carbon:** Water-extractable Organic Carbon
- **Stable carbon:** Mineral-Associated Organic Matter (MAOM)
- **Wet Aggregate Stability**
- **Infiltration Rate**

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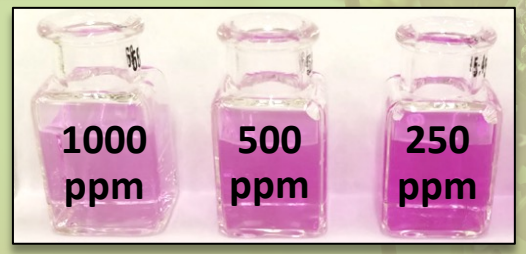
Soil Health and Active Carbon Pools

System	Percentage of Soil Organic Matter Pool		
	Particulate Organic Matter	Permanganate Oxidizable Carbon	Water-Extractable Organic Carbon
Grass pasture	11.7%	1.7%	0.5%
No-till	14.5%	2.2%	0.6%
Disked	14.7%	2.1%	0.6%
Spring plow	12.6%	2.2%	0.5%
Fall plow	13.5%	2.3%	0.6%



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From Awale et al. (2017). Percentages of each active pool compared to total soil organic matter (left table)

Yield and Profit

"Regenerative Agriculture: Merging Farming and Natural Resource Conservation Profitably", LaCanne and Lundgren, 2017.

Focus: profitability of **regenerative corn production** compared to conventional: 36 fields on 8 farms.

Key findings:

- Regenerative farming systems (no-till, cover crops, no insecticides) had **29% lower production but 78% higher profits** over traditional production systems.
- Regenerative farms had **significantly fewer pest problems** and reduced the need for costly inputs like insecticides.
- **Profit was positively correlated with the active carbon inputs, not yield**.

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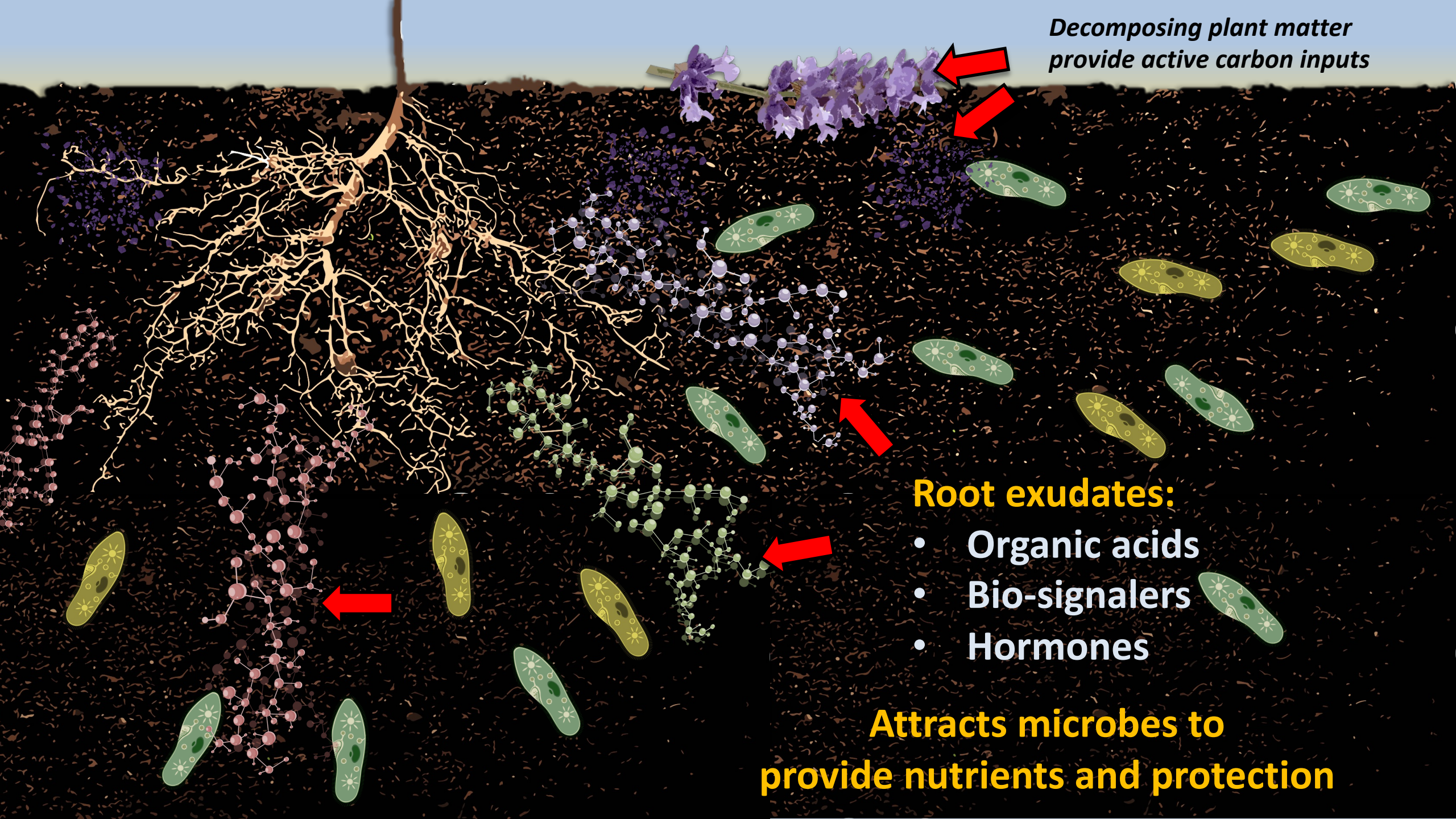
Pulse Polls 2

Our farm currently utilizes regenerative farming practices.

a) yes - in everything we do!
b) yes - but we can do more...
c) no - these practices aren't possible for us to execute
d) no - these practices don't align with our operational mission
e) I'm not sure or not applicable


Decomposing plant matter provide active carbon inputs
Root exudates:
- Organic acids
- Bio-signalers
- Hormones
Attracts microbes to provide nutrients and protection

Soil Organic Matter

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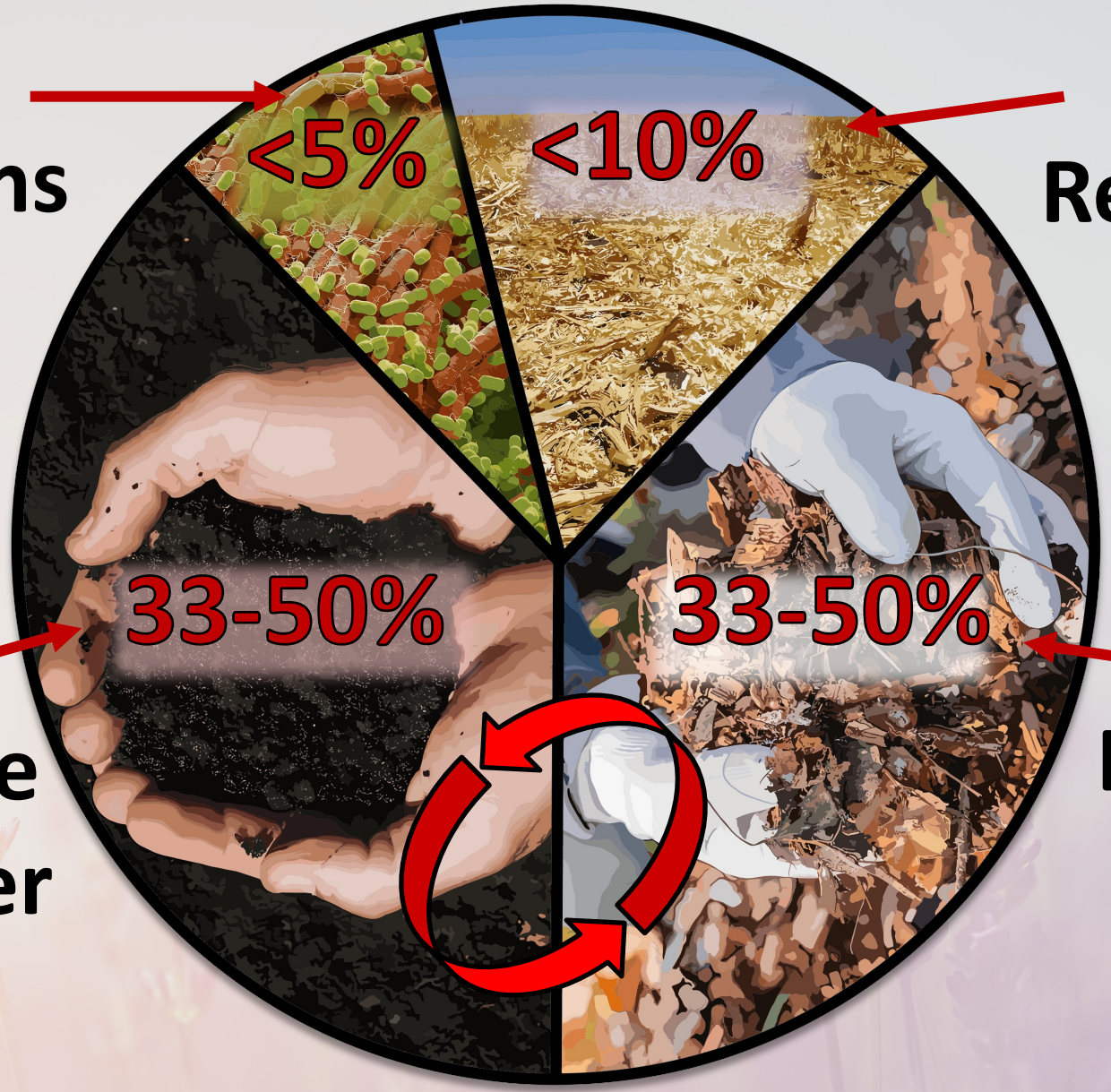

Living organisms

Fresh Residues

Humus: Stable Organic Matter

Decomposing Organic Matter

Soil Organic Matter

- Improves physical condition
  - Tilth, water holding, aeration
- Improves nutrient supply
  - Mineralized N and P
  - CEC
- Range 1 to 5+ %
- **1% OM contains:**
  - **1000 lbs of N**
  - **220 lbs of P_2O_5**
  - **140 lbs of S**
  - **20,000 gallons water holding capacity**

Soil Sampling for Best Results

- ✓ Accuracy and precision in sampling and analysis
  - Number of cores
  - Depth of sample
- ✓ Seasonal and annual variations
- ✓ Monitor your long-term progress
  - Observe trends related to external variables
  - Evaluate management over several seasons

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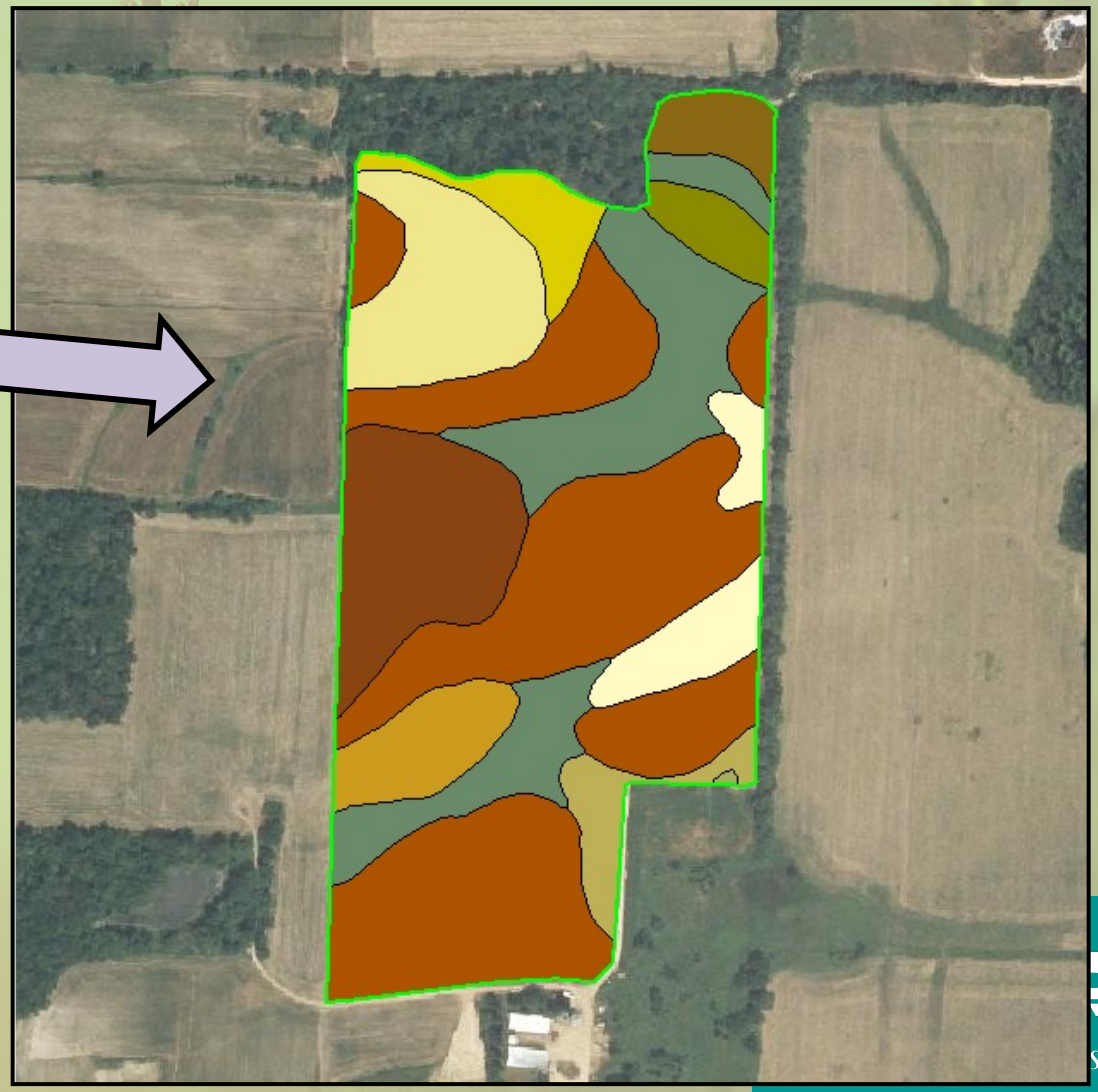
Soil Sampling for Best Results

Many different soil types and properties can exist within a single field.

Zone or grid

Higher number of cores and composites



Lavender and Climate Change

Increased Droughts: Reducing water availability, stressing plants, and potentially decreasing oil quality and yield.

Temperature Fluctuations: Affecting flowering times, growth cycles, and essential oil profiles.

Pest and Disease Pressure: Changing climates may introduce new pests or diseases to lavender fields.

Soil Degradation: Extreme weather events can lead to soil erosion, affecting lavender's growth environment.

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Lavender and SALT STRESS

- Lavender can tolerate soil **electrical conductivity levels up to 4 dS/m with minimal impact** on growth and oil composition.
- Studies indicate that above this level, **oil yield decreases by approximately 25%**
- Breeding/genotype selection focused on adaptation to saline soils.

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Lavender and 

- Lavender plants exposed to high temperatures (above 95°F) for short periods may show a **temporary reduction in growth but can recover without significant loss in oil yield**.
- Certain genotypes have demonstrated a **10-12% increase in essential oil production** when exposed to temperatures slightly above their optimal growing conditions.
- Heat stress may increase oil production but impair total yields

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Lavender and DROUGHT

- Climate change affects water supply, nutrient cycling, and erosion
- **Varieties ‘Rapido’ (L. angustifolia) and ‘Sumian’ (L. x intermedia) identified as best candidates for cultivation under intense drought conditions.**
- Studies showed that water deficit altered the amounts of stored terpenes in both species but minimally.
- Modification in terpene amounts under water stress **could economically impact the essential oil sector.**

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Pulse Polls 3

My farm seems to be exhibiting more frequently...

a. Drought stress
b. Heat stress
c. Salt stress
d. more than 1 of the above
e. none of the above/other

Changing Climate, Changing Altitude

- Significant variations in oil composition were observed at different altitudes.
- At higher altitudes (800-1400 m ASL), lavender oil had a **higher percentage of camphor; greater aroma.**
  - cooler temperatures and greater solar radiation
  - increase in specific terpenes
- Lower altitudes resulted in oils with a **greater concentration of 1,8-cineole.**
- **Still will have variability in yield, based on cultivar**

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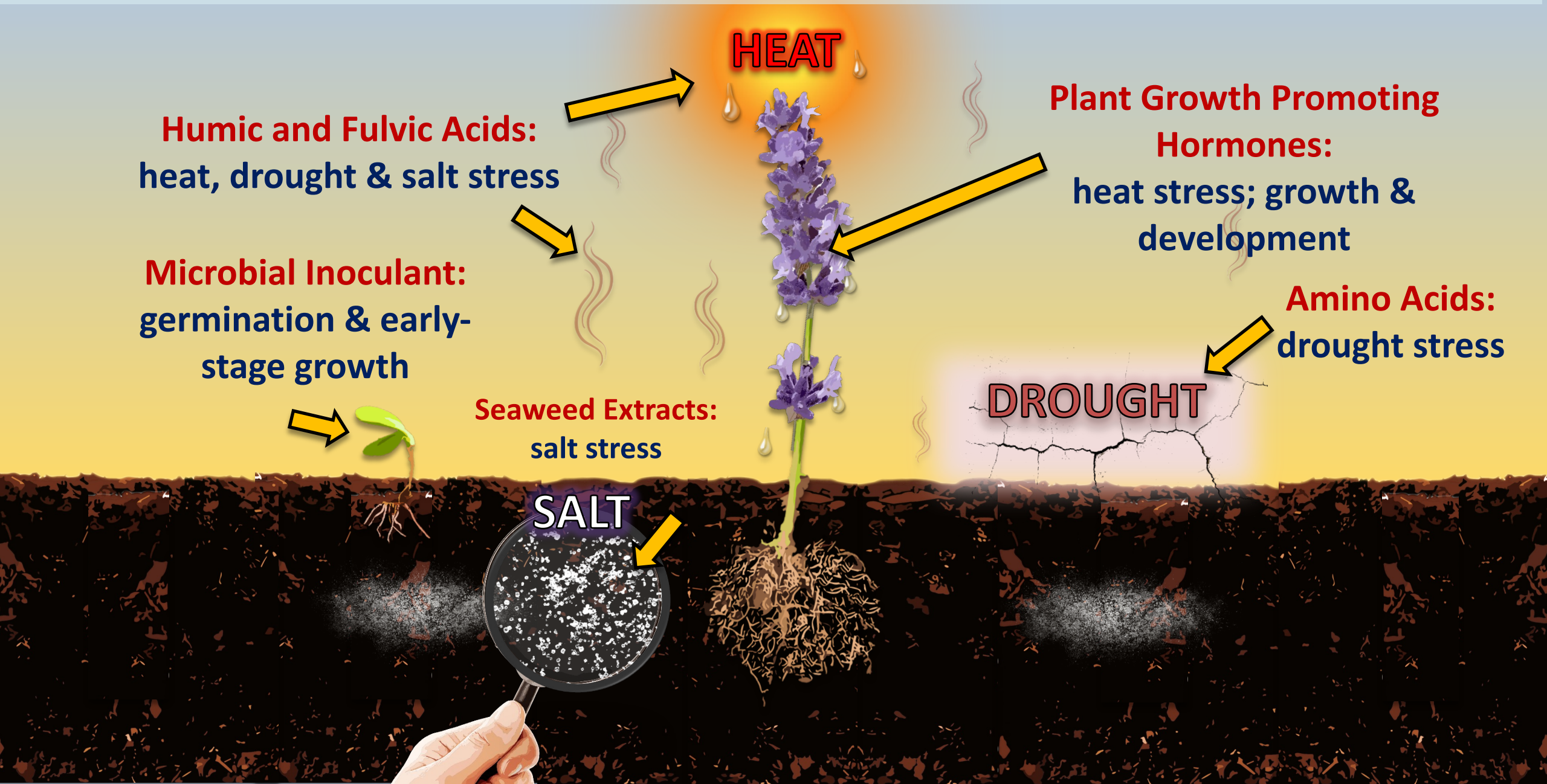
Lavender and Biostimulant Use



Biostimulant & Source	Roots	Shoots	Whole Plant
Microbial Inoculant/ PGPH  *Bioreactor*	• Water absorption efficiency • Enhanced growth signaling	• Stomatal control • Hydration regulation	• Antioxidant defense • Cell stability • Water management
Humic and Fulvic Acids  *Leonardite*	• Enhanced nutrient uptake • Metals protection (chelation)		• Antioxidant Defense • Cell Stability • Water Management • Stress protection
Amino acids (Protein Hydrolysates)  *Animal/Plant meal*	• Improved nutrient uptake • Metals protection (chelation)	• Antioxidant Defense • Cell Stability • Water Management	• Environmental stress support
Seaweed Extracts  *Seaweed/Kelp/Algae*	• Enhanced water availability • Improved water uptake	• Water regulation • Internal water flow support	• Oxidative stress reduction • Cell stability • Water stress support

Lavender and Biostimulant Use

Subject of interest due to its potential to enhance the antioxidant properties and secondary metabolite synthesis.

- **Seaweed extract, nettle extract, and inoculums** were found to effectively increase the total phenolics, flavonoids, and antioxidant capacity in the leaves
- **Effective even under standard growth conditions**, not just adverse conditions
- Modes of action is not yet fully understood
- **Increases in phenolics and flavonoids**, indicating their potential as enhancers of medicinal plant quality and antioxidant properties

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Lavender and Biostimulant Use

"Effects of Biostimulants on the Chemical Composition of Essential Oil and Hydrosol of Lavandin"

- The study used two commercial biostimulants: **an amino acid-based and a seaweed extract.**
- These biostimulants are commonly employed in organic food crop production.
- They were applied to Lavandula x intermedia cultivar "Grosso" during the 2020 growing season.

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Lavender and Biostimulant Use

- Application of these biostimulants **increased essential oil yield per plant by 11% to 49%.**
- This increase varied depending on the specific combination of treatment and farm location.
- Despite the increase in yield**, there was no significant change in the chemical composition of the essential oils and hydrosols**.

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Lavender and Biostimulant Use

"***The effect of plant growth regulators on productivity of lavender (Lavandula angustifolia Mill.) in the conditions of the Southern Steppe of Ukraine***", Manushkina et al 2023

- The study investigates the effects of **plant growth regulators Stimpo and Radostim on lavender productivity** in Ukraine's Southern Steppe.
- Stimpo significantly enhances growth and yield, producing 5400 to 6400 lbs/acre, a **14.8–21.1% increase over control**.
- Stimpo treatment yields the **most essential oil (137.30 to 147.36 kg/ha), up to 16.7% more than control**.
- Varieties Sinieva and Vdala are recommended for cultivation with Stimpo for optimal productivity.

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Fertility and Lavender Oil

- **Soil fertility influences oil composition.**
- Soils with higher fertility produced oils with more camphor.
- Conversely, less fertile soils resulted in oils with higher levels of 1,8-cineole.
- This underscores the need to **consider soil fertility when cultivating lavender for specific oil profiles**.

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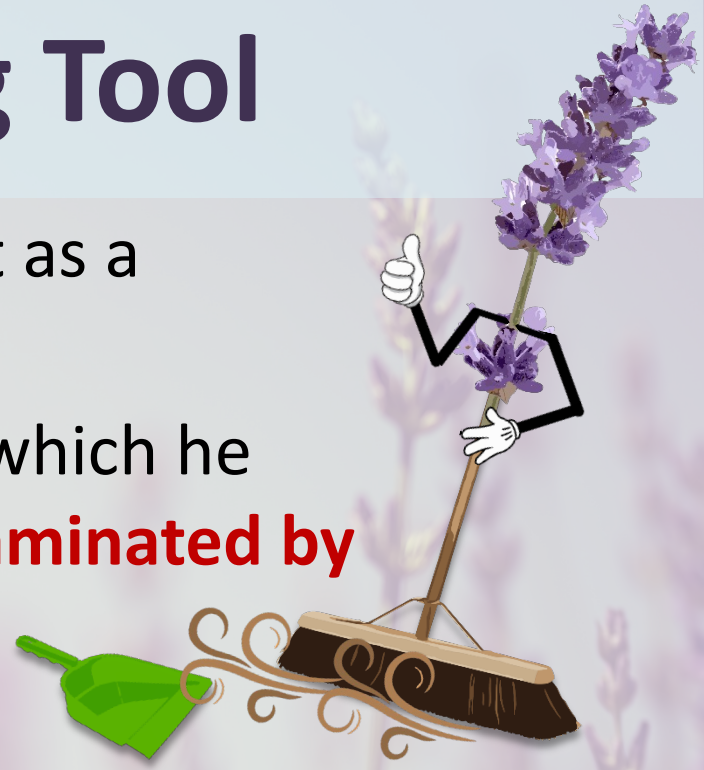
Lavender as a Soil Cleaning Tool



- Angelova et al. (2015) reported that Lavender can act as a **potential hyperaccumulator of Pb, Cd, and Zn**.
- Zheljazkov and Astatkie (2011) conducted a study in which he reported that **essential oil of lavender was not contaminated by heavy metals**.

- Heavy metal accumulation in lavender was reported in the following order –
- **Cadmium:** leaves>roots=inflorescences=stems
- **Lead:** stems>leaves=inflorescences>roots.

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Questions?

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