

33rd Annual NATIONAL NO-TILLAGE CONFERENCE

January 7-10, 2025 • Louisville, Ky.

Raising Economic Bushels and Filling in the Nutrient Gaps

Bradford Forkner



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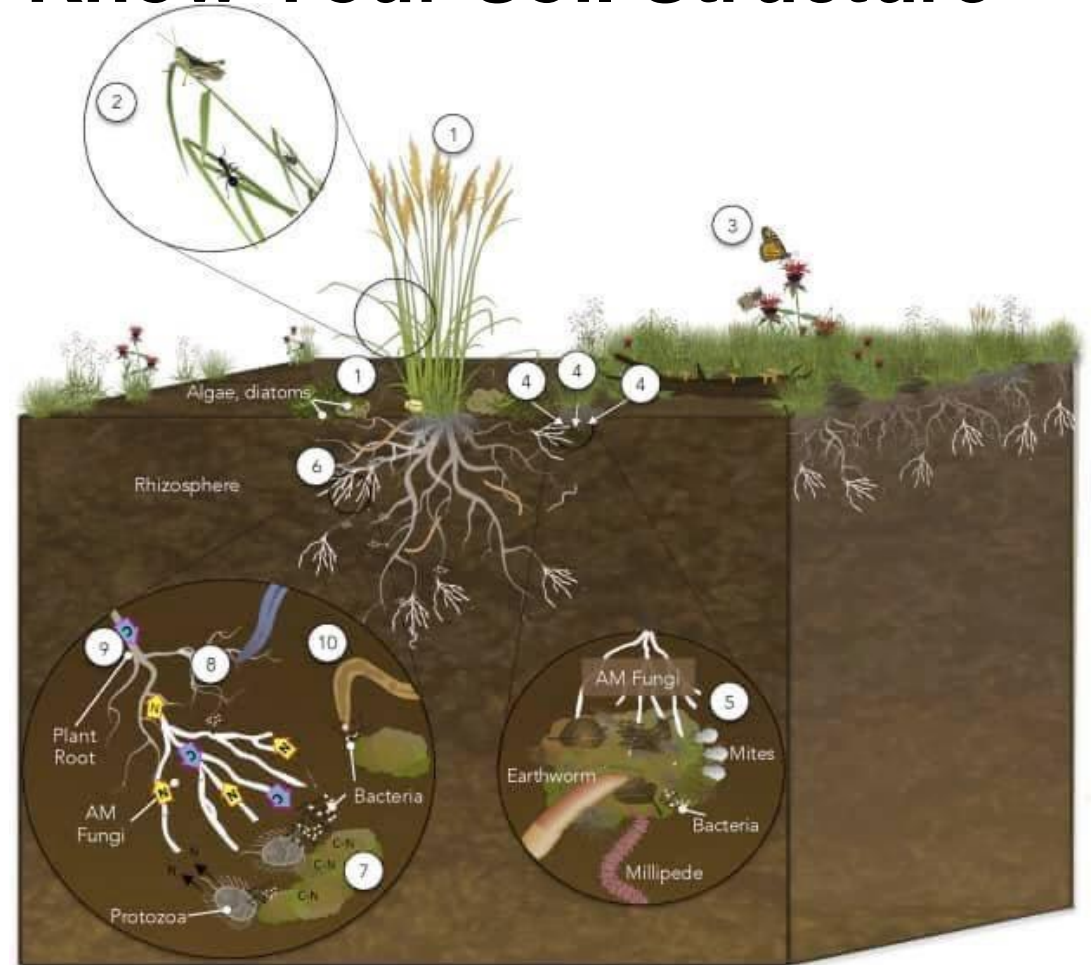
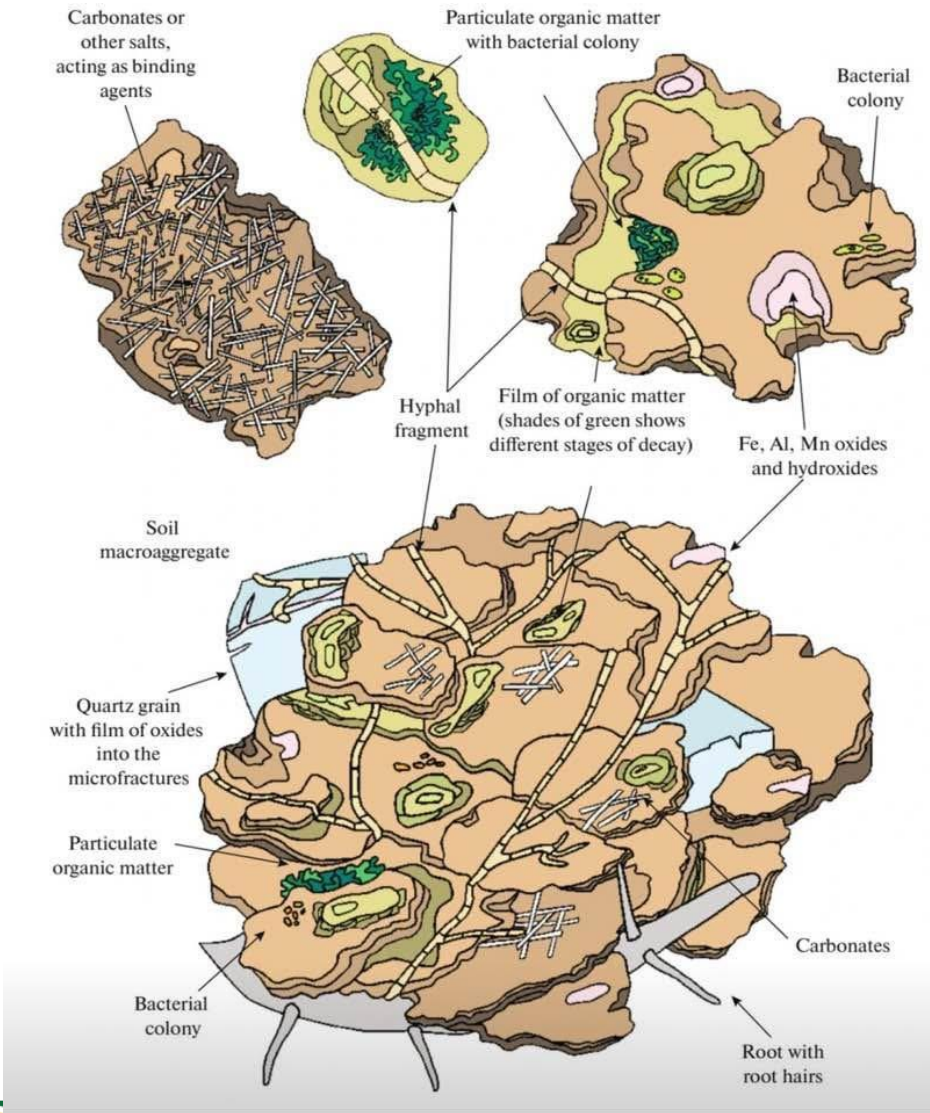
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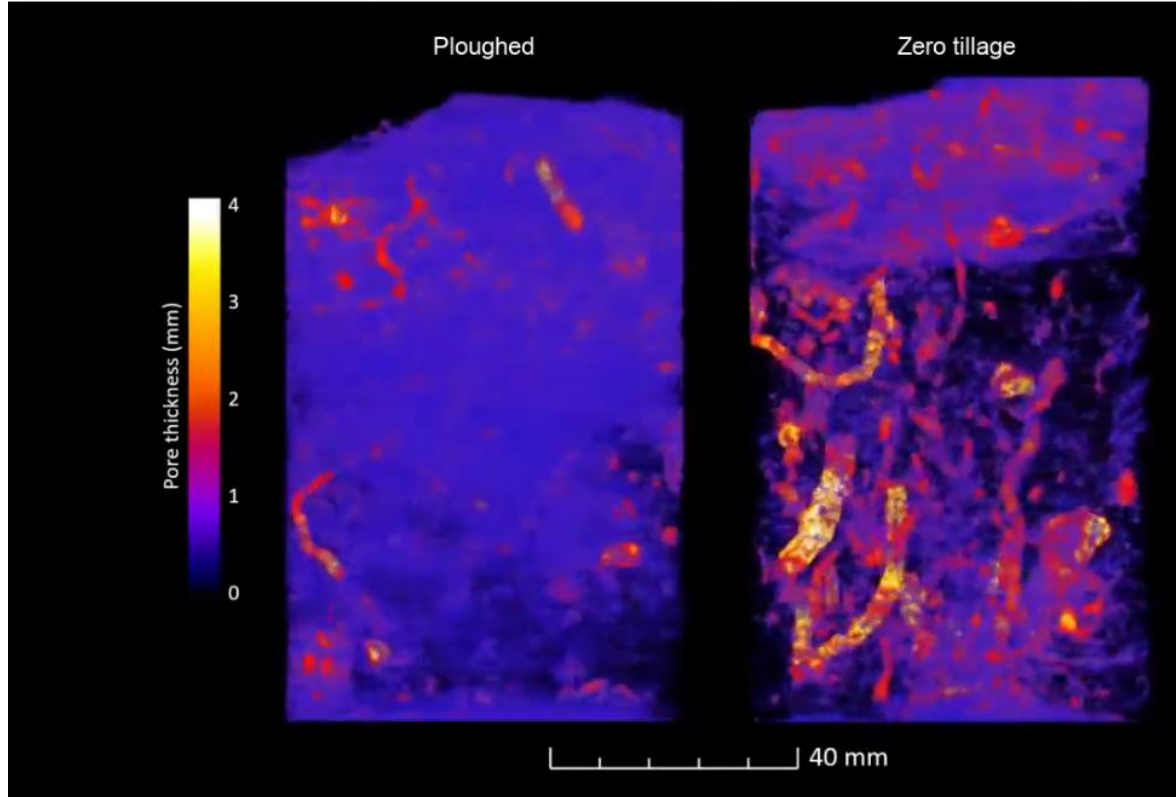
ENVIRONMENTAL
TILLAGE SYSTEMS



Know Your Soil Structure

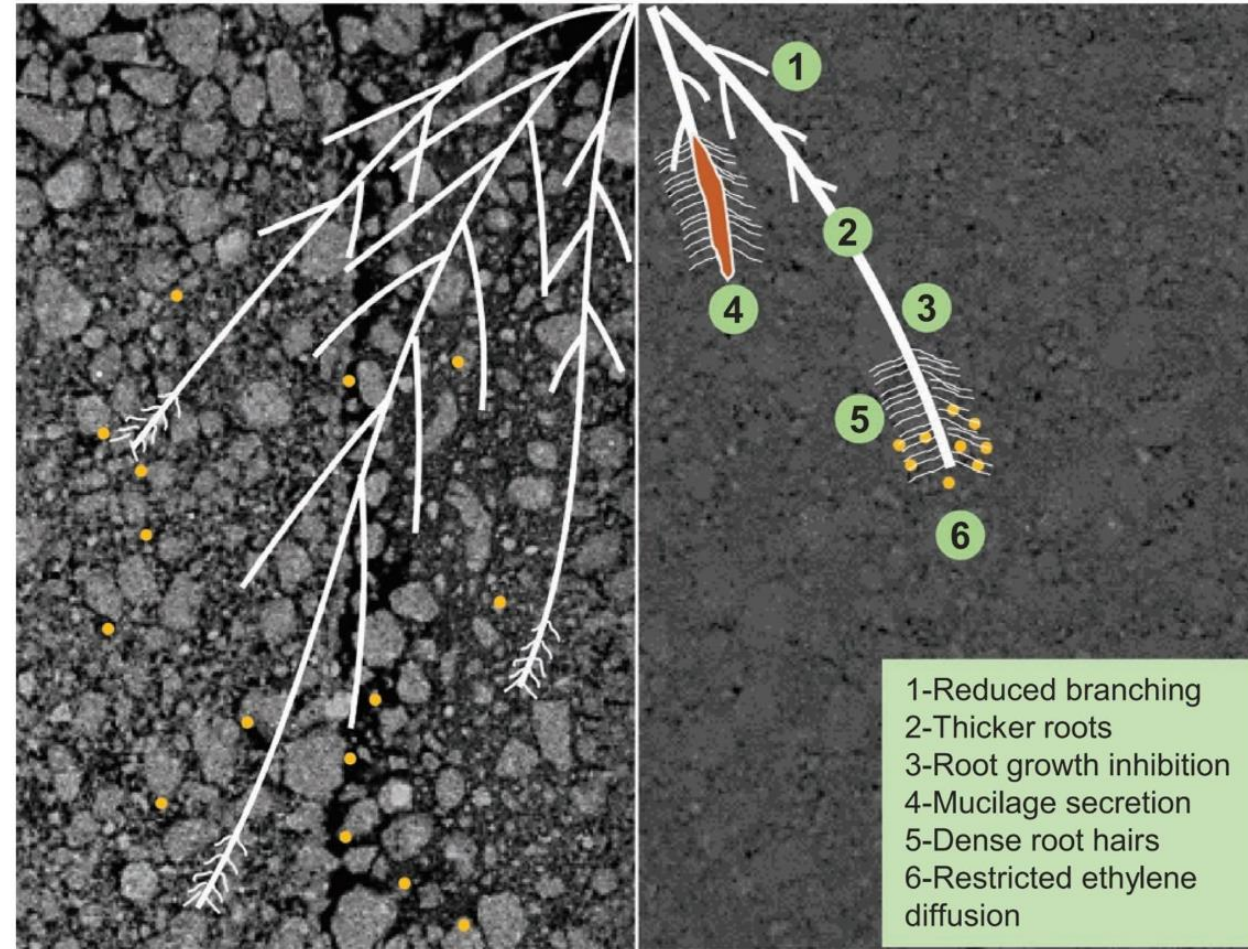


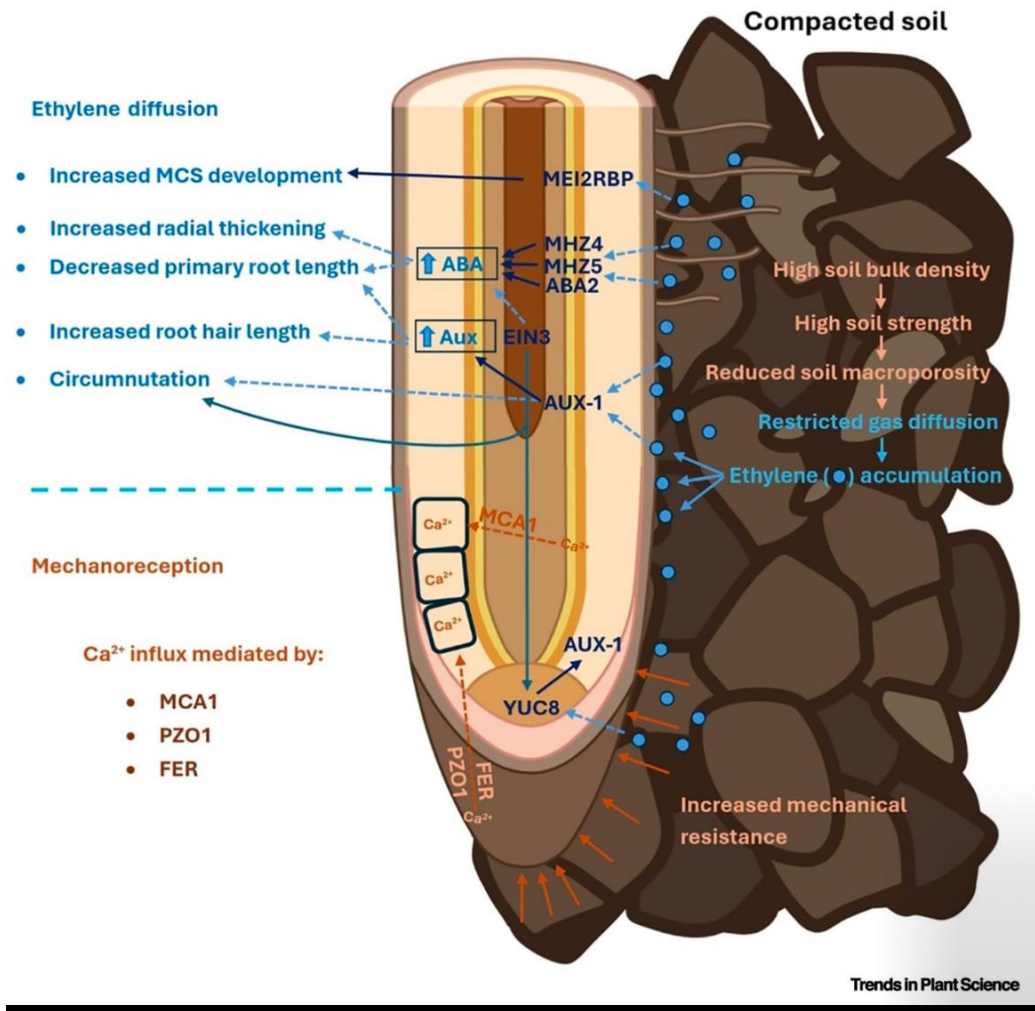
Tillage effect on soil pore architecture



Noncompacted soil

Compacted soil





Saturated Soils
Heavy Clays
Lack of OM
Oxygen Levels Low
Crop Rotations
Aluminum, Iron, Magnesium
Salt Load High

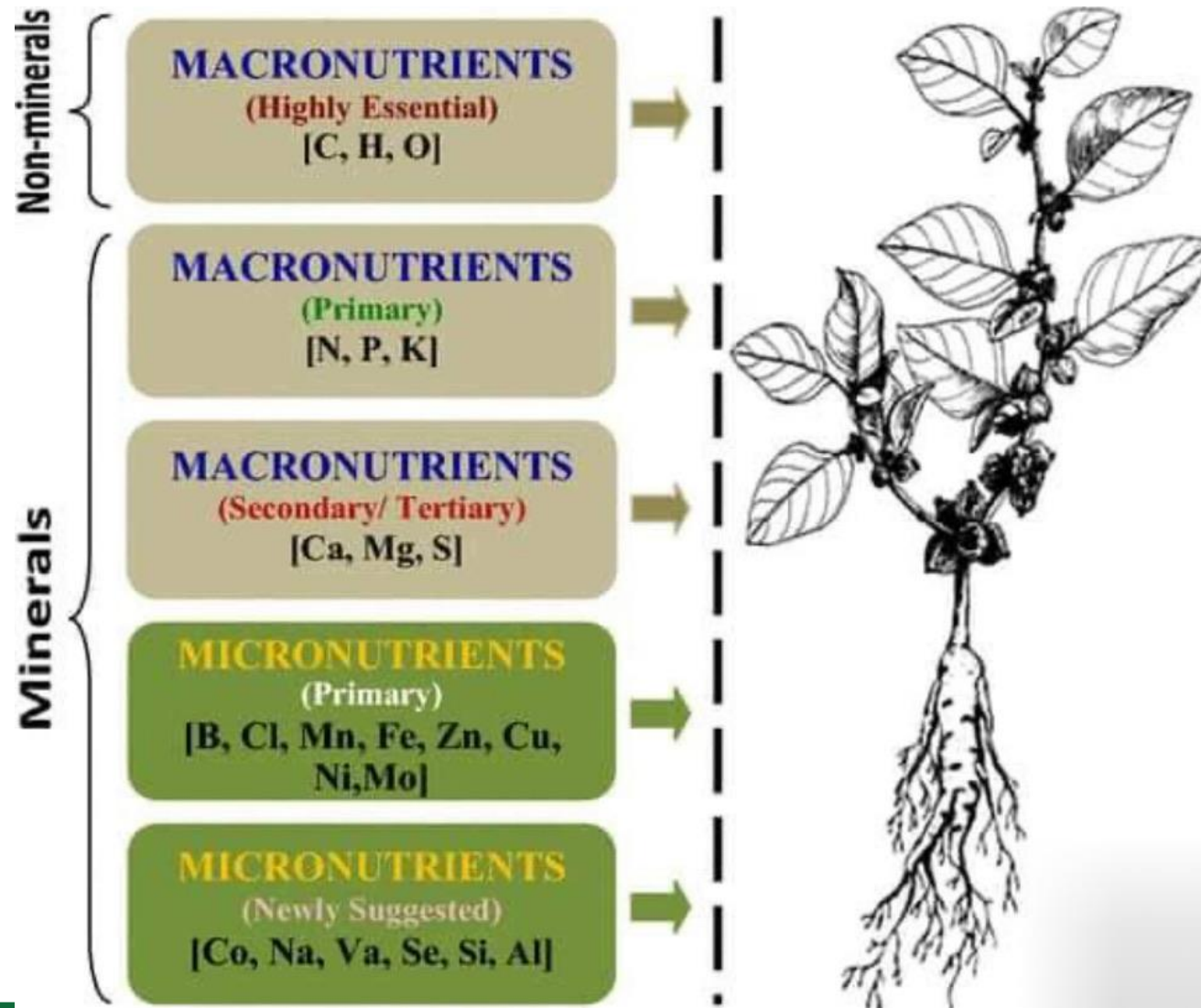




**Combine 40' and Spread 25'
Ever Change the A-B Lines
Do you Change Dry Spread
Directions or Starting Points**








































**Your Ideal K:P Ratio?
Zn:Cu Ratio?
Base Saturation of H**







Soil sensing methods

Soil sensor	Agronomic soil properties									
	Soil texture 	Soil organic matter 	Soil moisture 	Soil salinity 	Soil density 	Depth variability 	Soil pH 	Total N content 	Other nutrients 	Cation exchange capacity 
Electrical & electromagnetic										
Optical & radiometric										
Mechanical										
Acoustic & pneumatic										
Electrochemical										
Aerial sensing										

[based on: Adamchuk et al. 2004]

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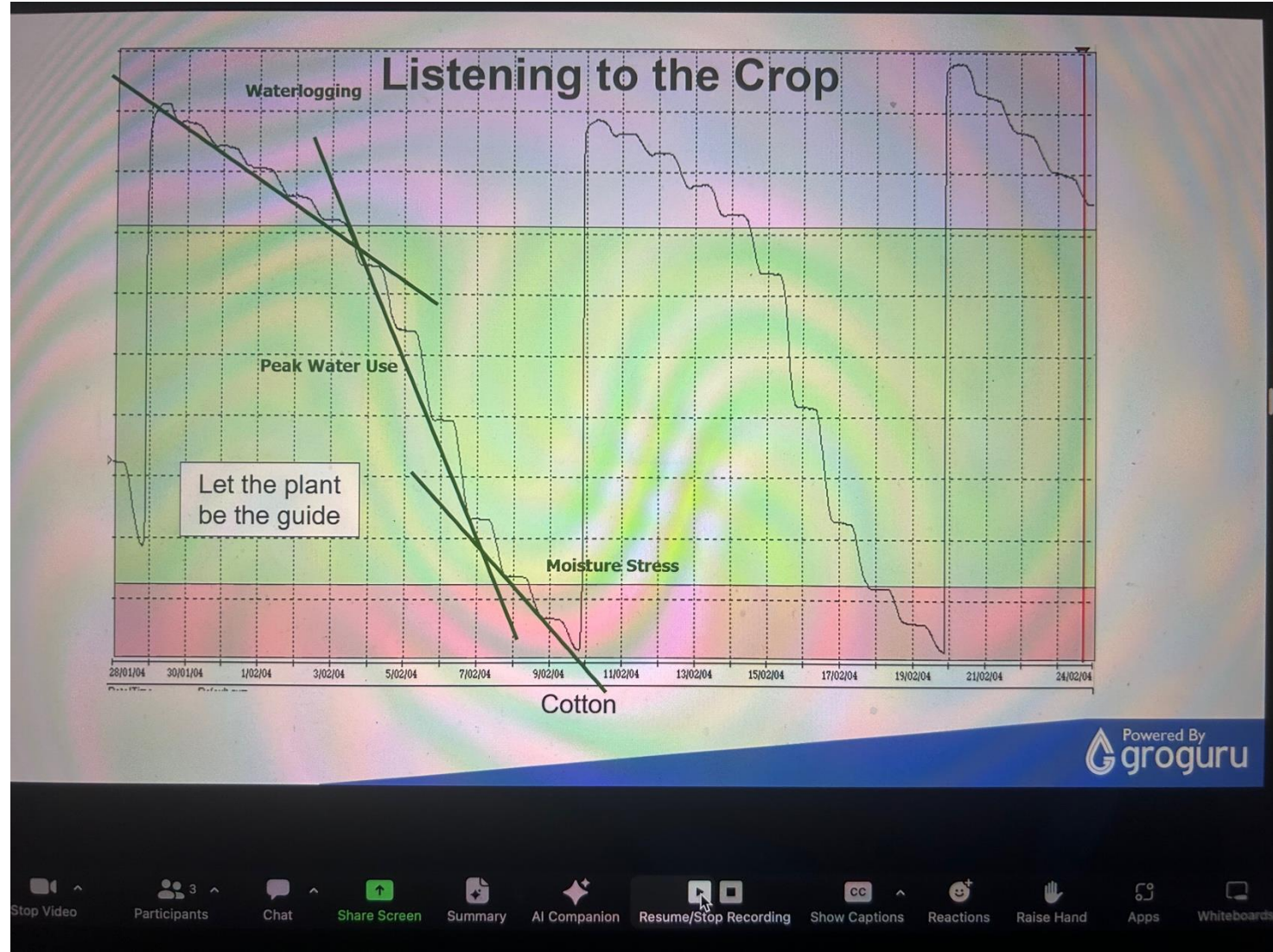
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Watching the Plant Drink





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BIOCHEMICAL SEQUENCE OF NUTRITION IN PLANTS

P E R I O D I C T A B L E	3 Li Lithium 6.941	4 Be Beryllium 9.012182	5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674
	11 Na Sodium 22.989770	12 Mg Magnesium 24.3050	13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761
	19 K Potassium 39.0983	20 Ca Calcium 40.078	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92160

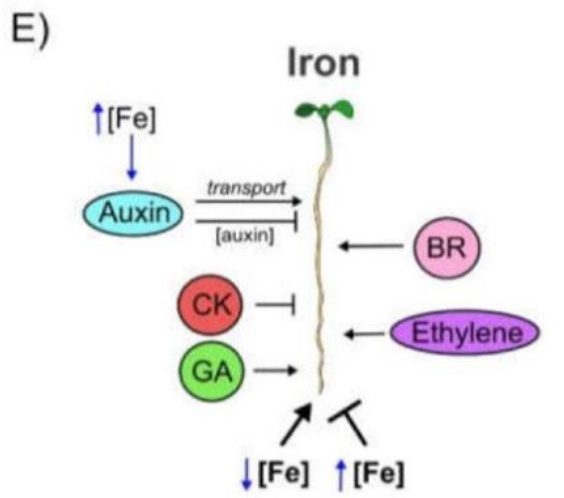
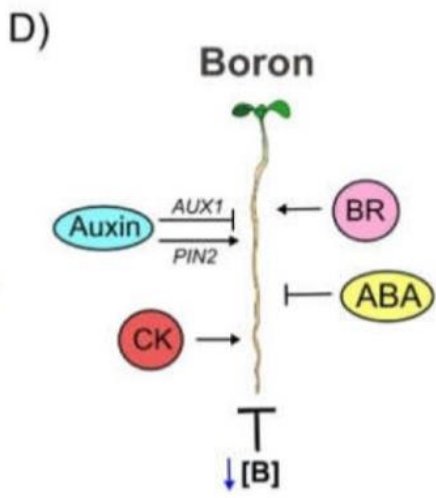
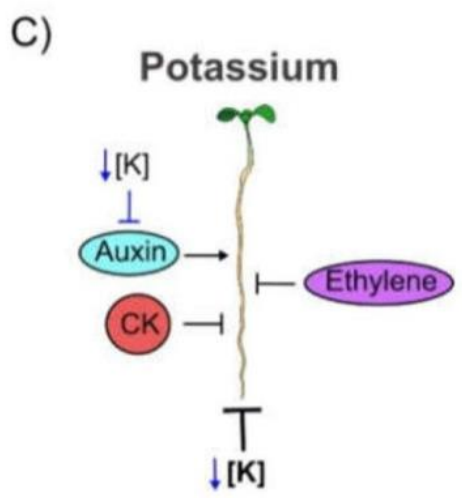
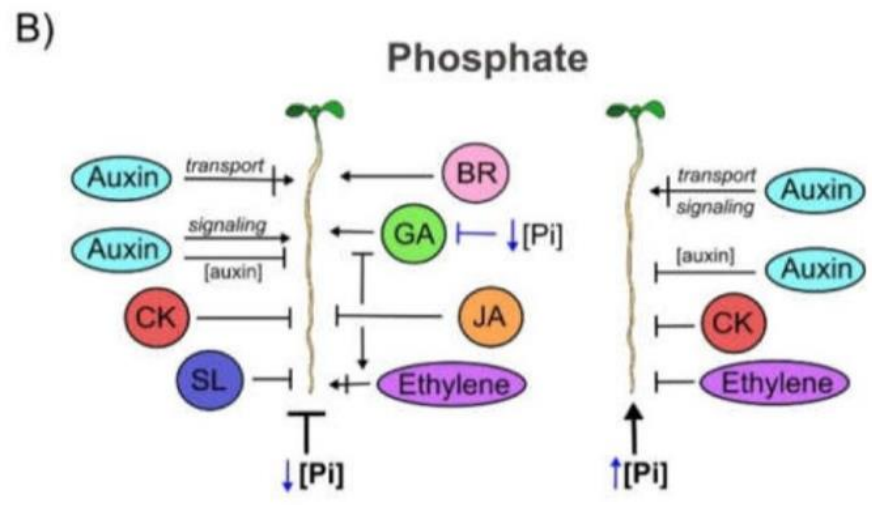
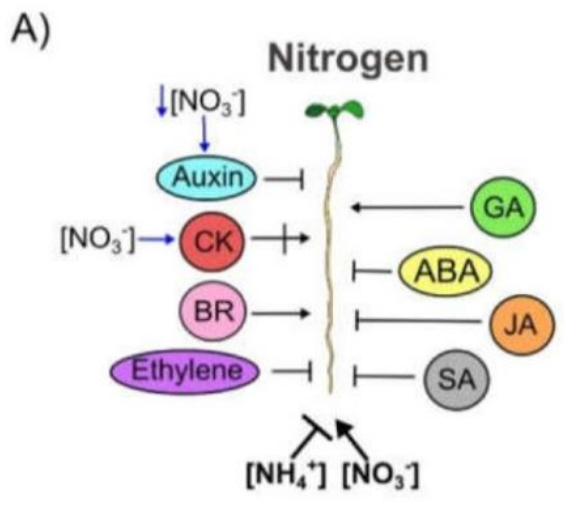
Plant biochemical sequences begin with:

1. **Boron**, which activates →
2. **Silicon** which carries all other nutrients starting with →
3. **Calcium** which binds →
4. **Nitrogen** to form amino acids, DNA and cell division.

Amino acids form proteins such as chlorophyll and tag trace elements, especially →

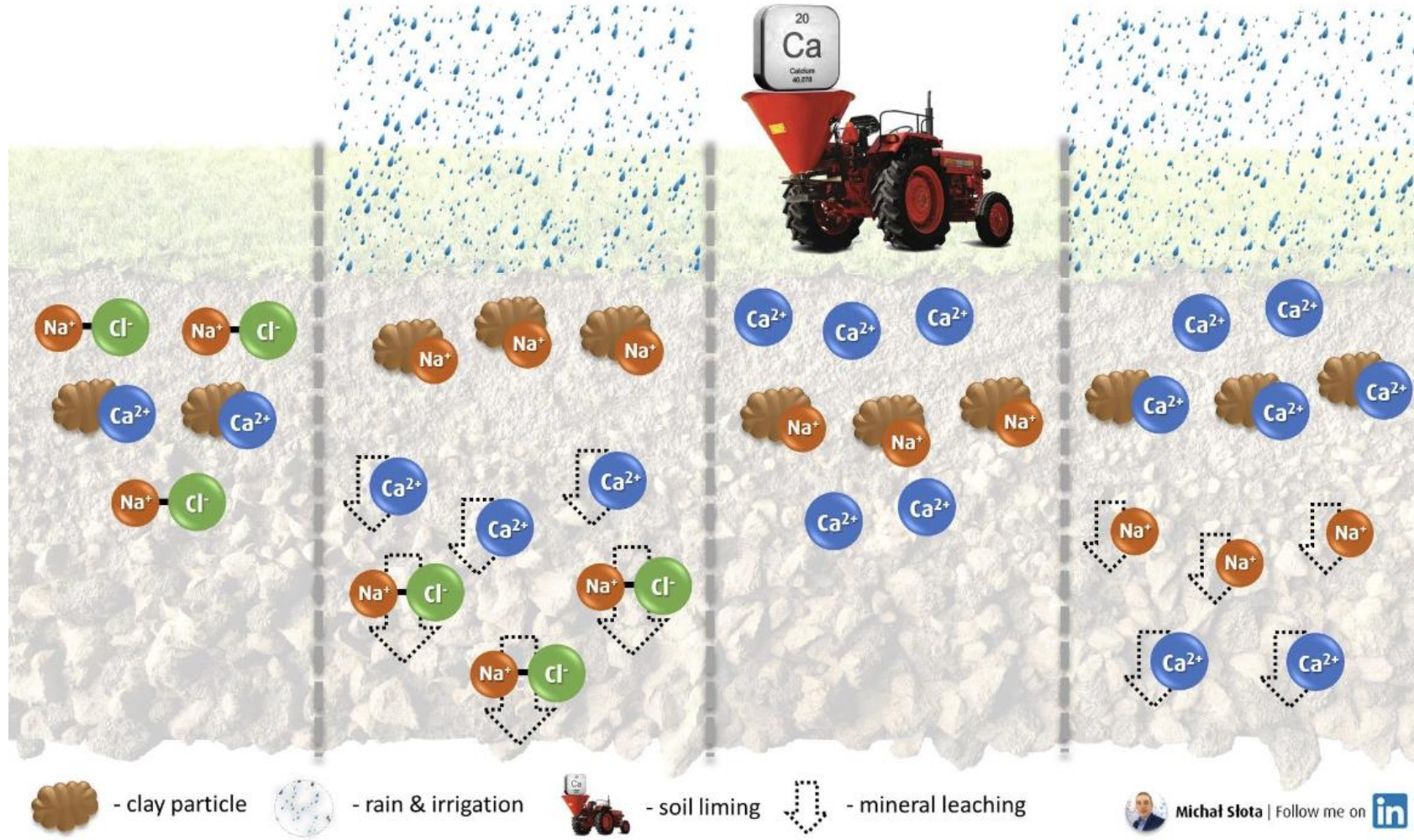
5. **Magnesium** which transfers energy via →
6. **Phosphorus** to →
7. **Carbon** to form sugars which go where →
8. **Potassium** carries them. This is the basis of plant growth.







Correction of sodic soils by Calcium (Ca) application



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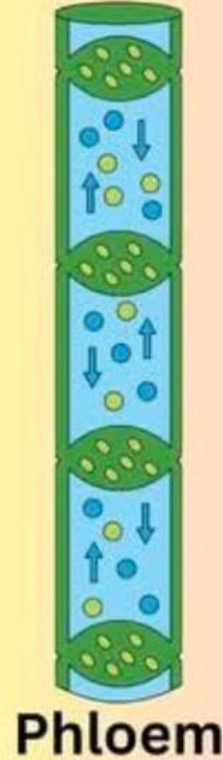
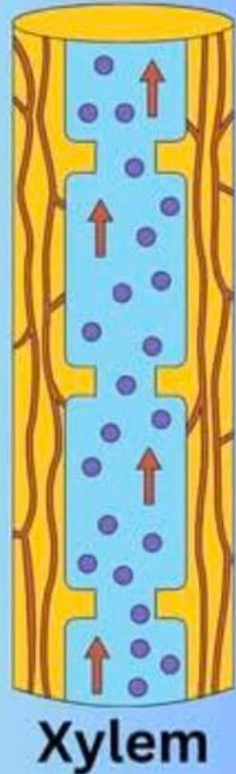


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Xylem and Phloem Plant Vascular System

- Transports water and minerals
- One-way (upward) flow
- Transport is bulk flow due to negative pressure
- Hollow dead cells
- No end walls
- Form center of the vascular bundle
- Rich in lignin, which supports the plant



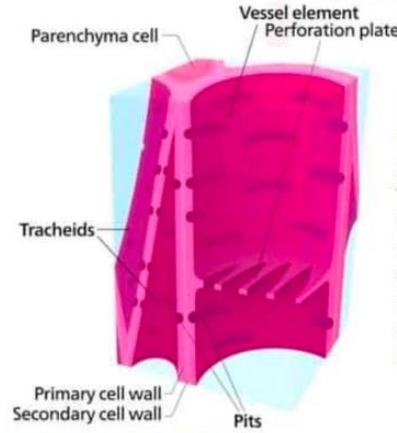
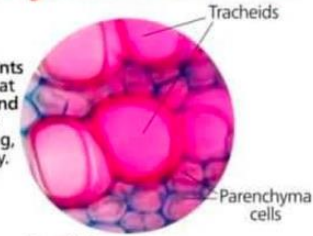
- Transports food in the form of sugars
- Two-way flow
- Transport is by osmosis/turgor pressure
- Live cells with no nucleus
- Perforated end walls
- Outside edge of vascular bundle
- Also transports amino acids, mRNA, and hormones



Xylem Phloem

Xylem

Xylem transports water and minerals through vessel elements and tracheids, which are dead at maturity and have a primary and secondary cell wall. In pits, the secondary wall is thin or missing, allowing water to flow laterally.



Xylem Role

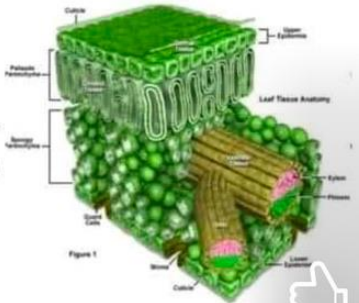
Now in Plants Xylem is a principal component of vascular tissue, together with phloem and cambium. Its main roles are transporting water and solutes originating from the plant-soil interface to the stems and leaves, and providing mechanical support and storage.

97 Sudhanshu

Phloem Role

And now the role of Phloem. moves food substances that the plant has produced by photosynthesis to where they are needed for processes such as: growing parts of the plant for immediate use. storage organs such as bulbs.

The Leaf: Vascular Tissue
The VEINS - made up of xylem and phloem which are bundled together in thin strands. They allow the movement of water and nutrients



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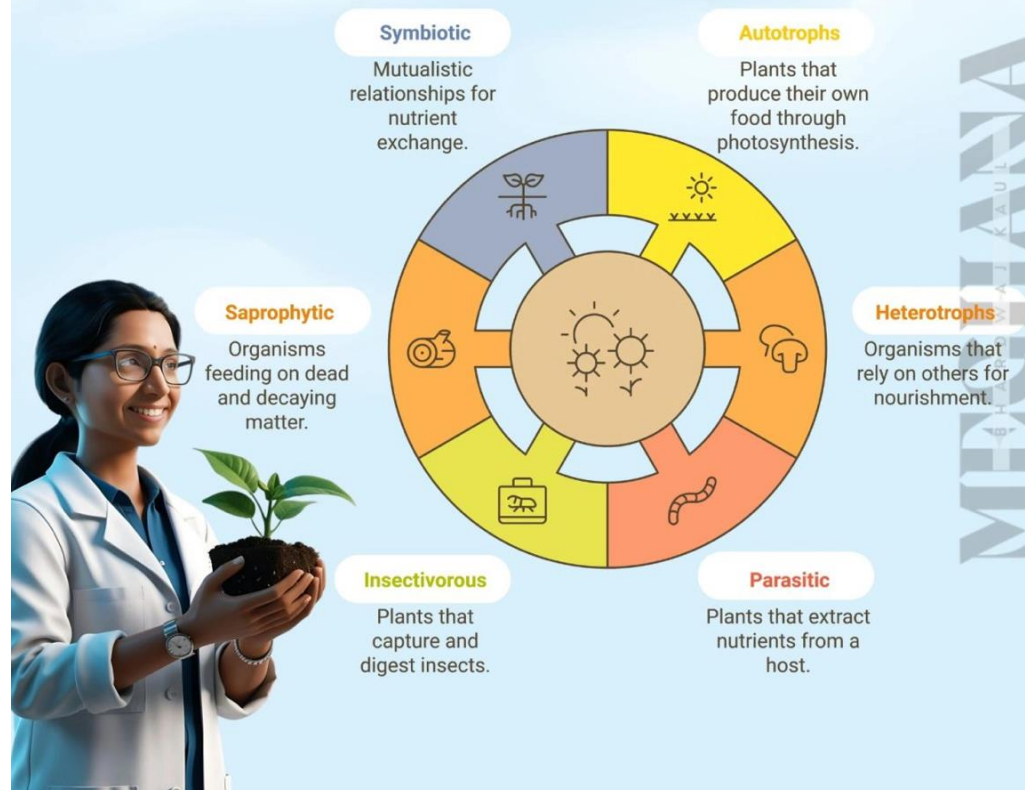
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Modes of Nutrition in Plants

Did you know that plants have several unique "modes of nutrition" that allow them to thrive in diverse environments? From self-made meals (autotrophs) to dining with a partner (symbiosis), plants teach us how nutrition drives growth!

Here's a quick breakdown:



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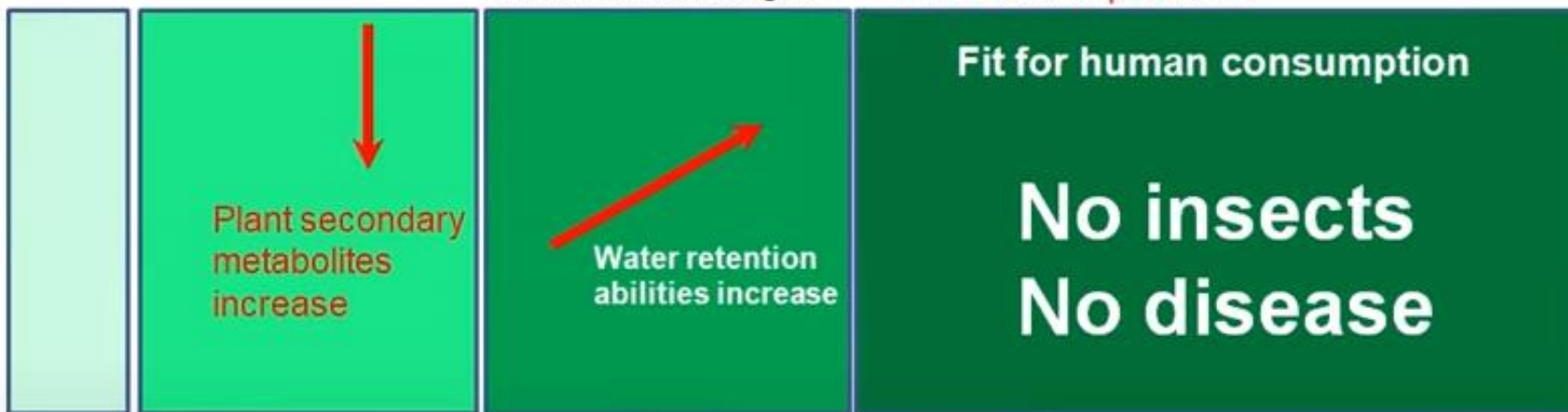
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Leaf Brix chart- generalized markers

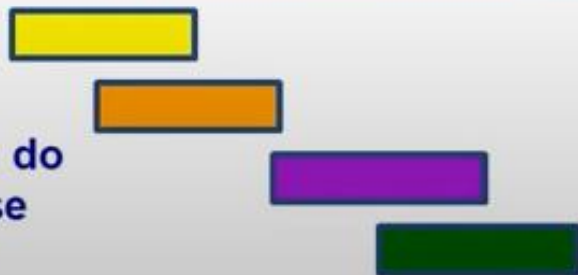
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Insect resistance begins

Food is now produced



At what Brix levels do various insects lose interest in plants?



Aphid group	6-8 Brix
Sucking insects	7-9 Brix
Chewing Insects	9-11 Brix
Grasshopper group	10-12+ Brix

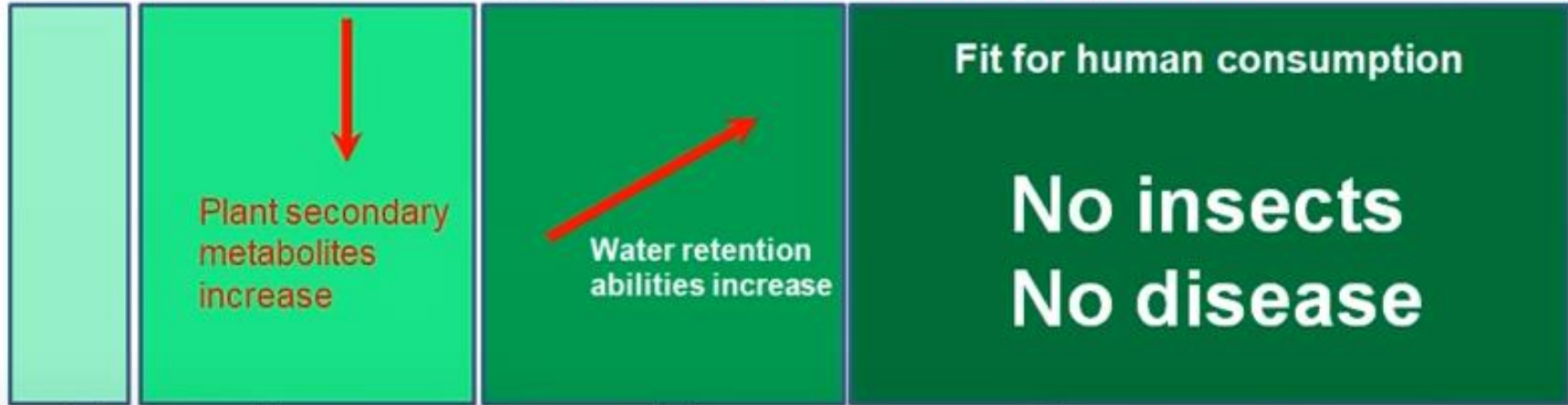


Leaf Brix chart: generalized markers

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

Insect resistance begins*

Food is now produced



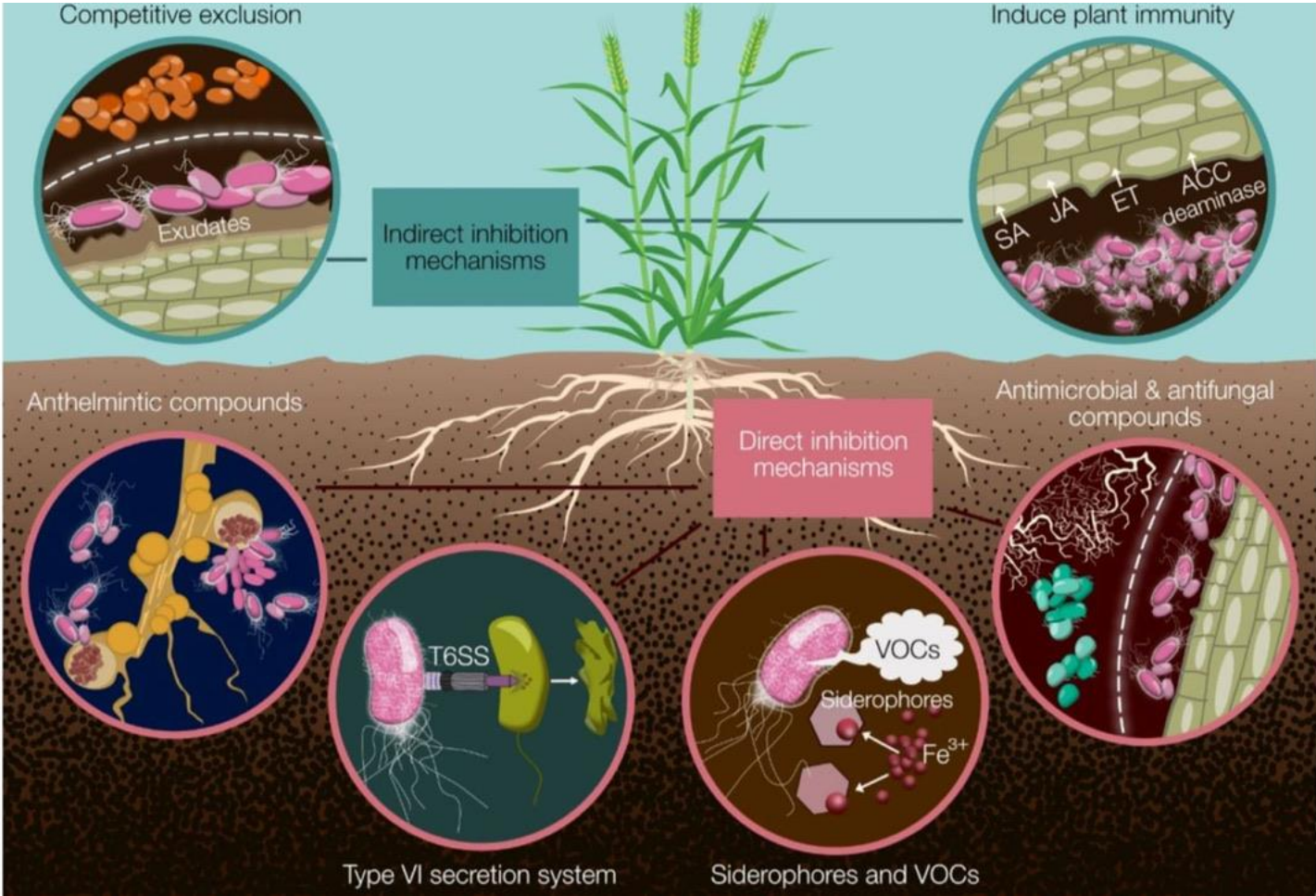
Force feeding necessary

Fighting chance

Sword and shield

Objectively healthy





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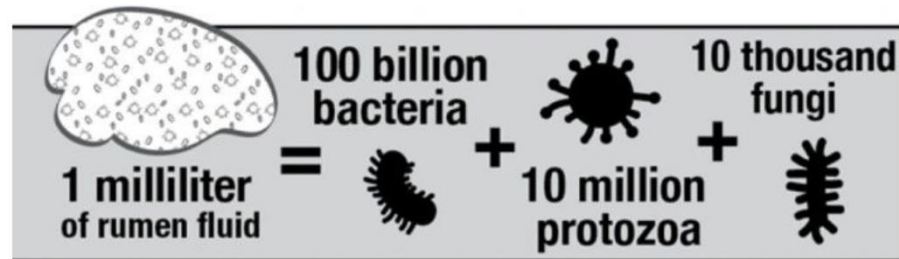
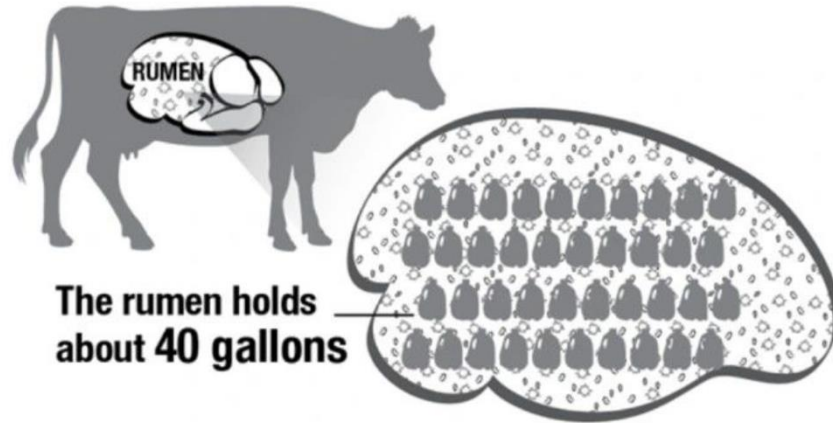
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just 1 milliliter of rumen fluid you can find 100 billion bacteria, 10 million protozoa and 10,000 fungi. ...more



≥ 1,000,000,000,000,000 rumen bugs per cow

How many of you have livestock for Biological Diversity from animals?



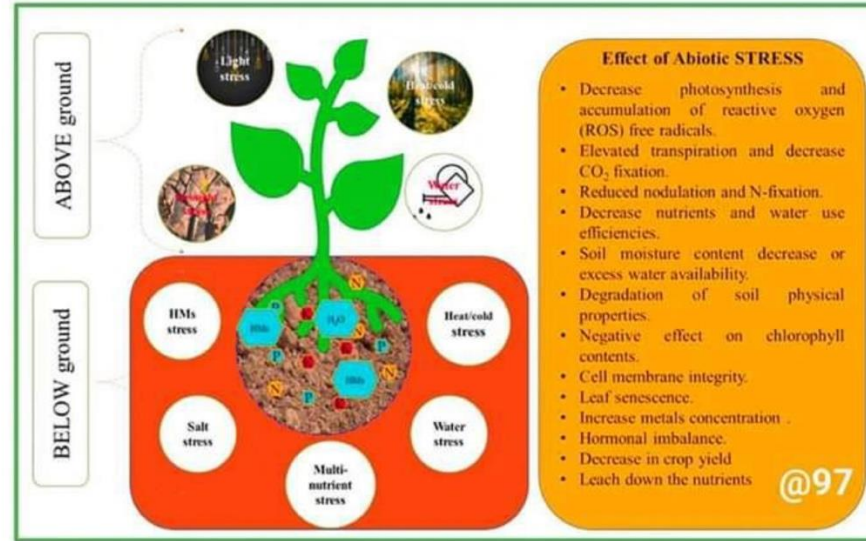
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Plant Growth Regulation



****Plant growth regulation**** refers to the process of controlling or influencing the growth and development of plants through natural or synthetic substances. These regulators, such as plant hormones or growth-promoting chemicals, affect various physiological processes like cell division, elongation, flowering, fruit ripening, and stress responses. The goal of plant growth regulation is to optimize growth, enhance yield, or control unwanted growth in agricultural or horticultural settings.



The Role of Plant Hormones in Growth and Life Cycle



	Germination	Growth and Maturity	Flowering	Fruit Development	Abscission	Seed Dormancy
GIBBERELLIN	✓	✓	✓	✓	✗	✗
AUXIN	✗	✓	✓	✓	✗	✗
CYTOKININS	✗	✓	✓	✓	✗	✗
ETHYLENE	✗	✗	✓	✓	✓	✗
ABSCISIC ACID	✗	✗	✗	✗	✓	✓

This simple yet powerful chart sheds light on the key players – plant hormones – and their roles in each stage of the plant lifecycle!

SEED TO FRUIT

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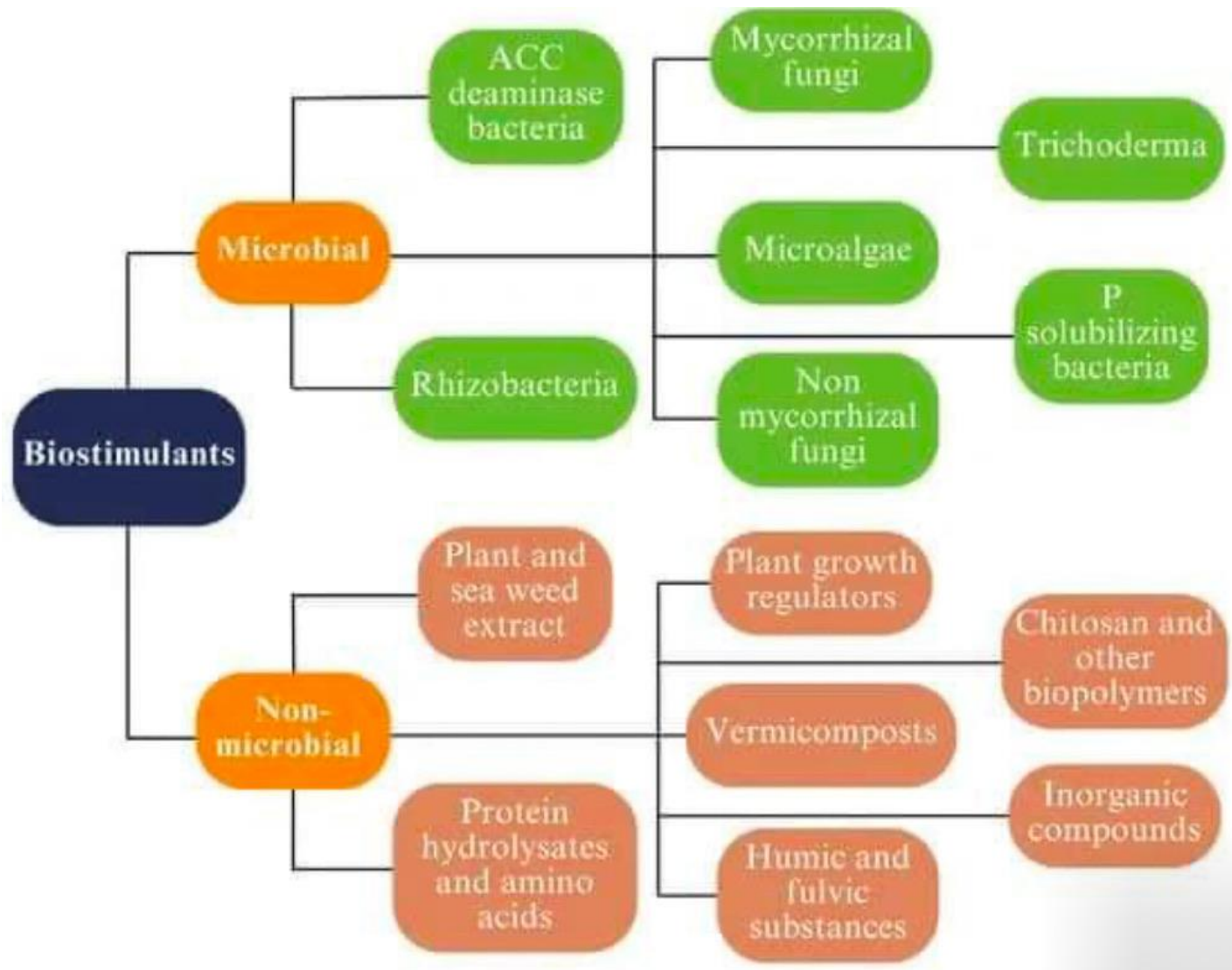


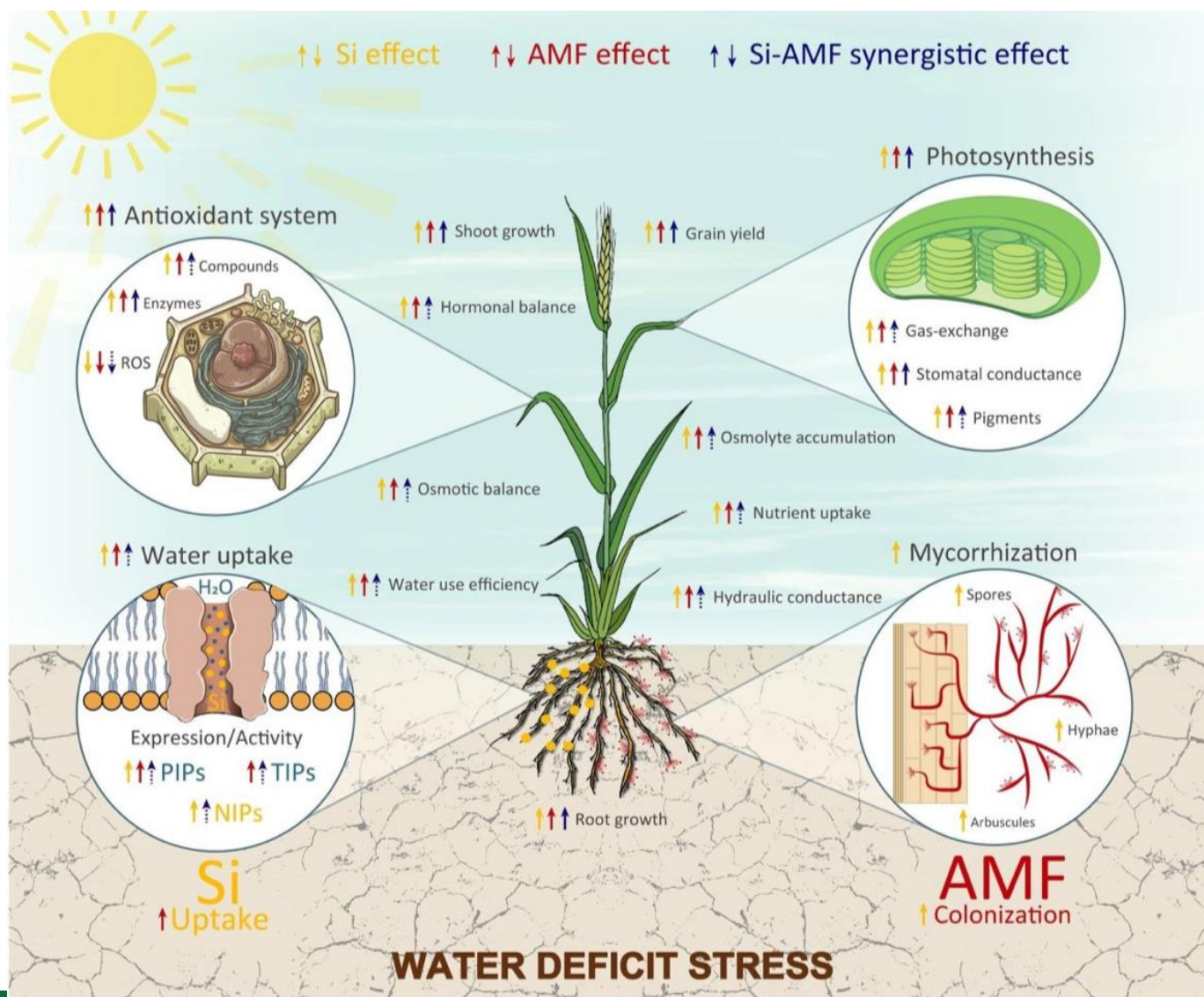
Nitrogen-Fixing Phosphate-Solubilizing Potassium-Solubilizing Organic Matter Decomposing

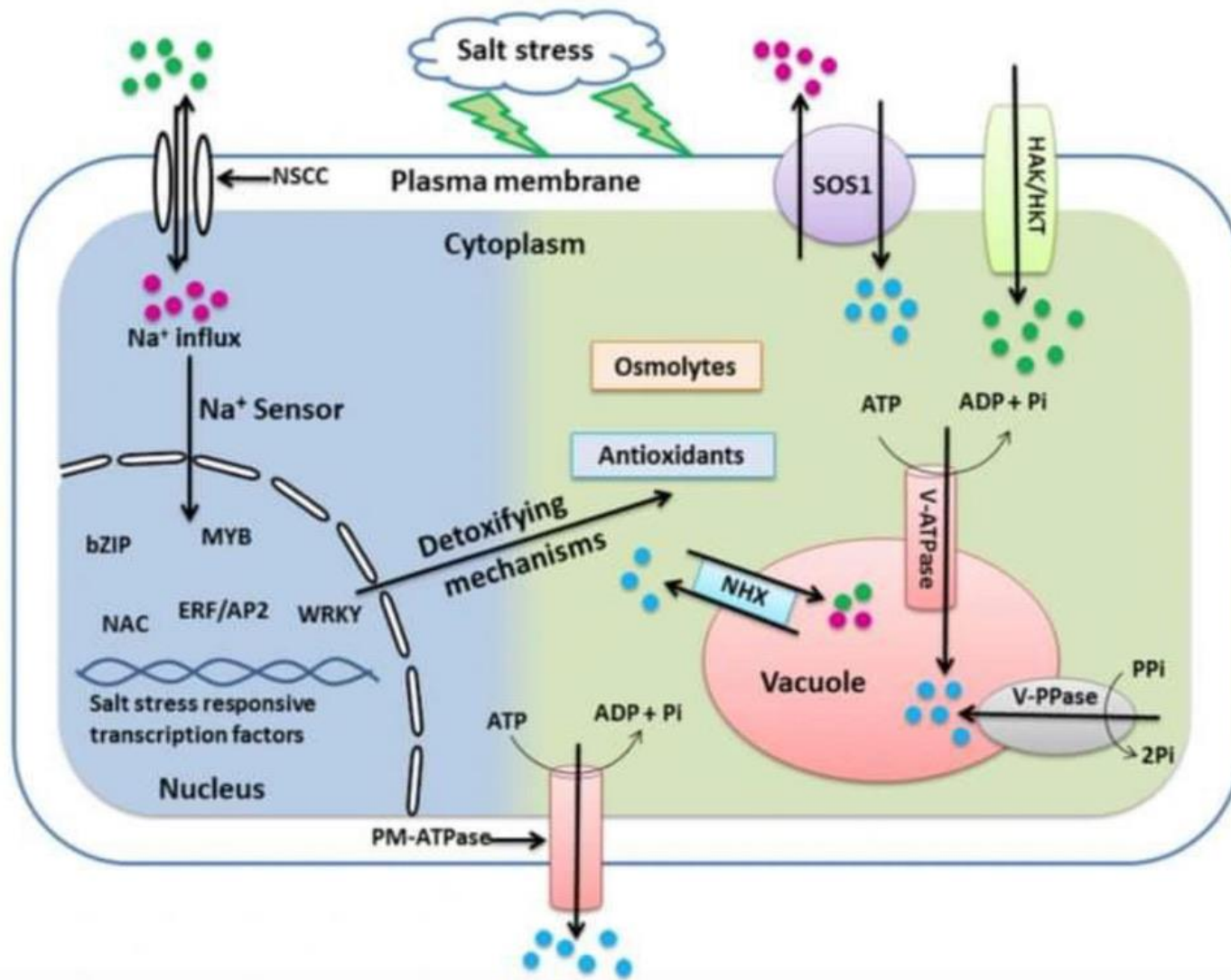


- Rhizobium
- Azotobacter
- Azospirillum
- Blue-Green Algae (Cyanobacteria)
- Pseudomonas
- Bacillus
- Aspergillus
- Penicillium
- Frateuria aurantia
- Bacillus mucilaginosus
- Bacillus edaphicus
- Bacillus circulans
- Trichoderma
- Penicillium
- Aspergillus
- Cellulomonas









Antibiotic Sensitivity Overview
(taken from the wellingtonicu.com drug manual)

Gram Positive Cocci			Gram Negative Bacilli			Anaerobes
MRSA	MSSA	Streptococci	E.coli, Klebsiella	Pseudomonas	ESCAPPM*	
		Penicillin				
		Amoxicillin				
		Flucloxacillin				
		Cephazolin				
		Clindamycin				Clindamycin
		Rifampicin/Fusidic Acid				
		Vancomycin/Teicoplanin, Linezolid, Daptomycin				Metronidazole
		Trimethoprim				
		Ciprofloxacin				
		Gentamicin/Tobramycin, Aztreonam				
		Moxifloxacin				Moxifloxacin
		Cefuroxime				
		Ceftriaxone				
		Ceftazidime				
		Cefepime				
		Amoxicillin-clavulanate				Amoxicillin-clavulanate
		Ticarcillin-clavulanate, Piperacillin-tazobactam				Ticarcillin-clavulanate, Piperacillin-tazobactam
		Meropenem†, Imipenem†				
		Ertapenem†				Ertapenem†

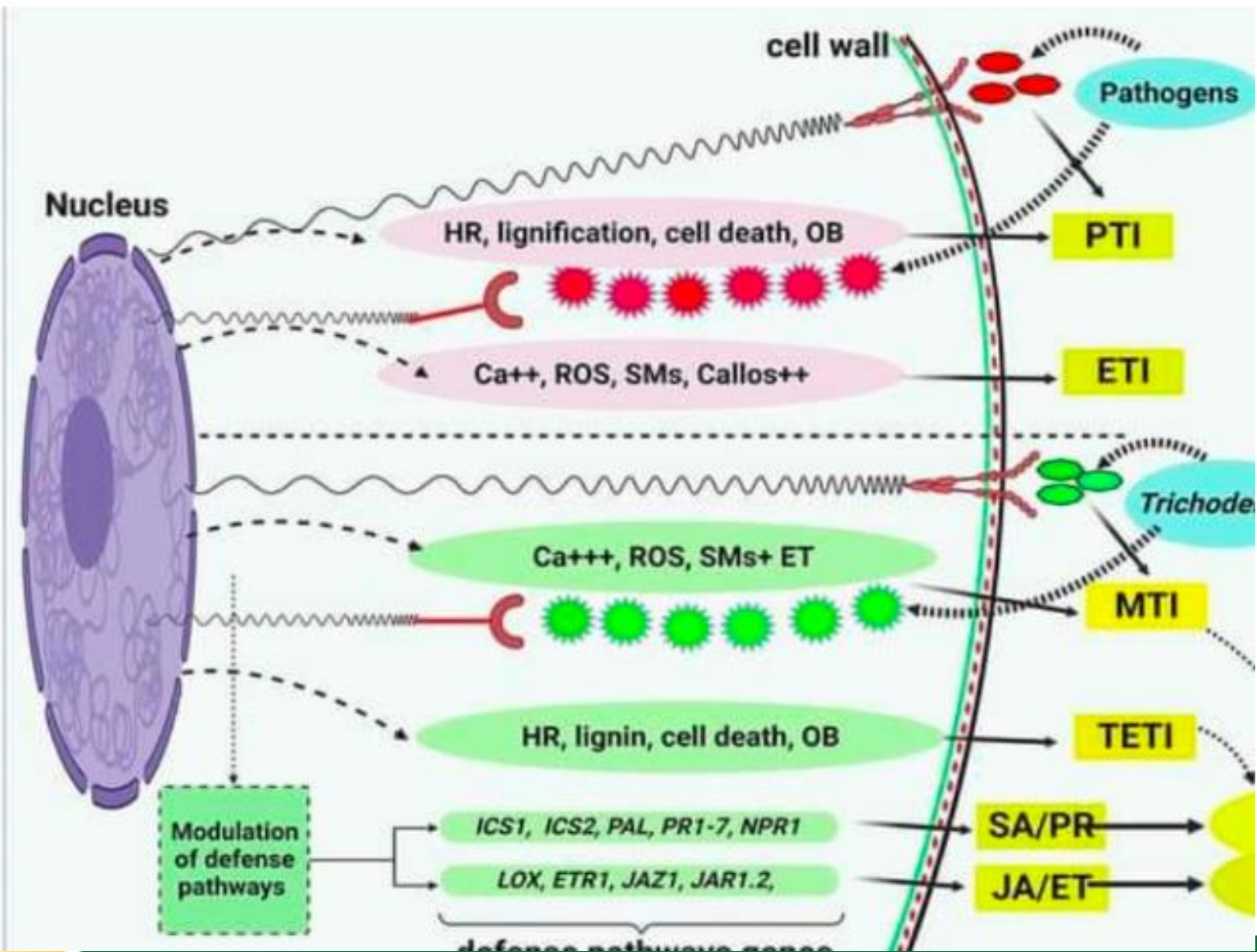
Antibiotics in **bold** also cover Enterococcus Faecalis. For simplicity, atypical organisms are not shown.

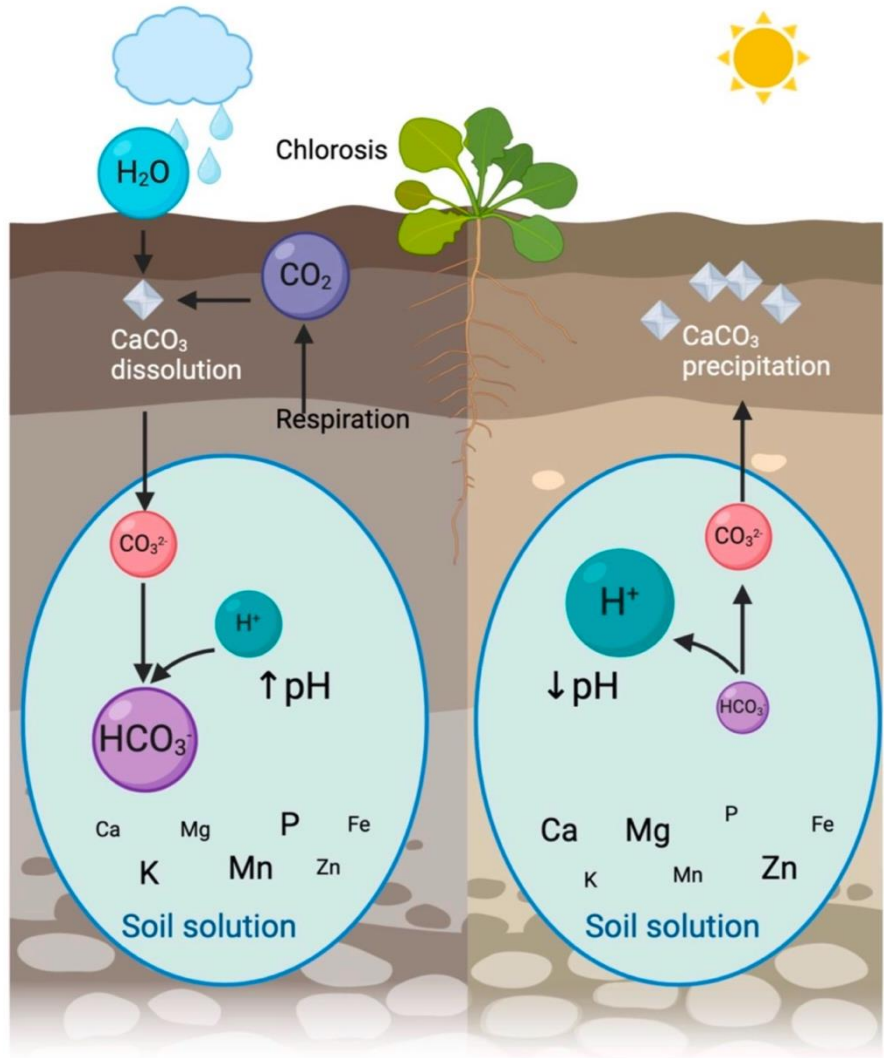
ESBL-producing organisms are **not** susceptible to most antibiotics containing a beta-lactam ring; carbapenems† are the usual agent of choice.

*ESCAPPM organisms are Enterobacter spp., Serratia spp., Citrobacter freundii, Aeromonas spp., Proteus spp., Providencia spp. & Morganella morganii.

This antibiotic sensitivity chart is intended as a rough guide pending specific identification & sensitivities - it does not replace expert ID advice.







Trends in Plant Science

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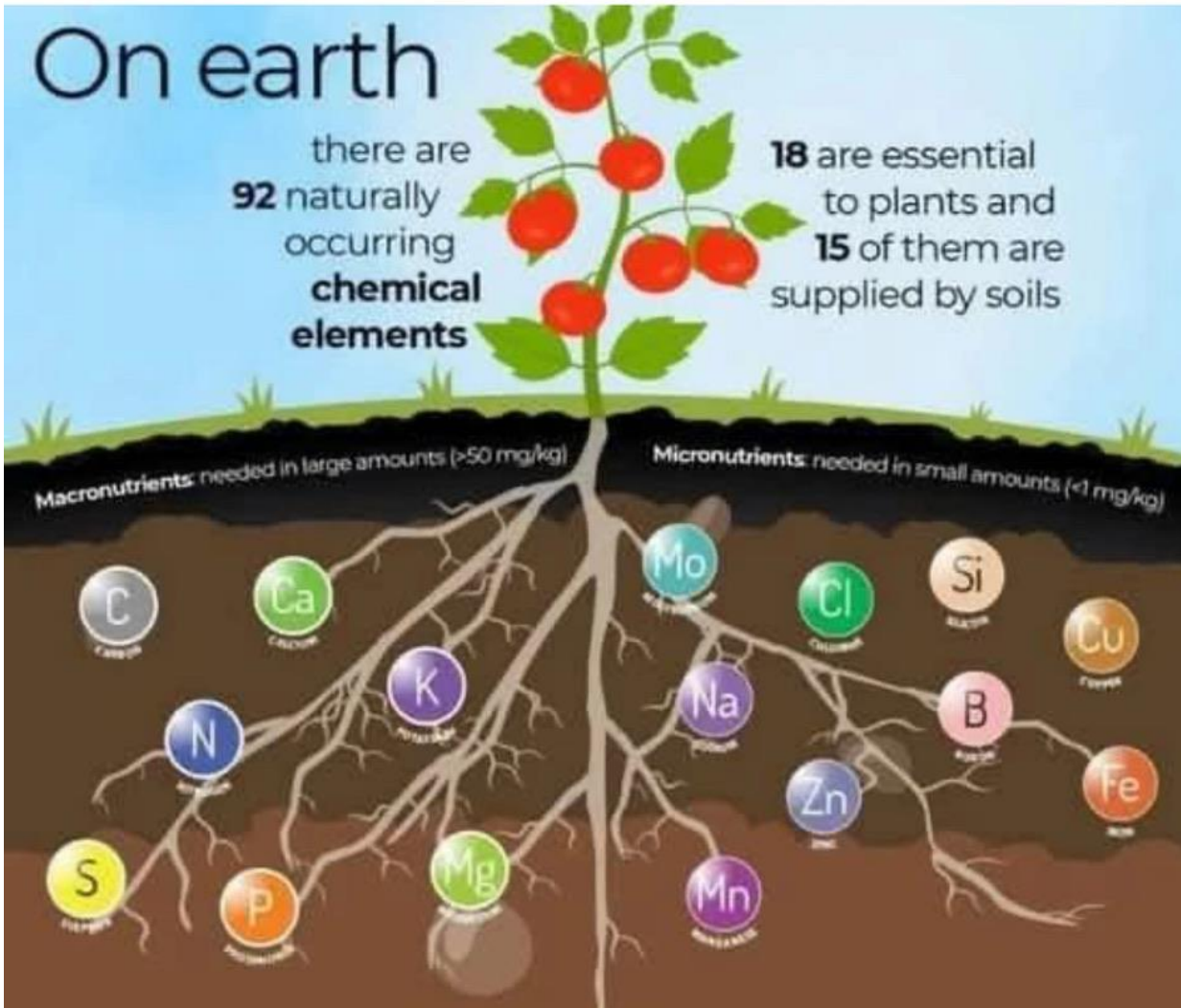
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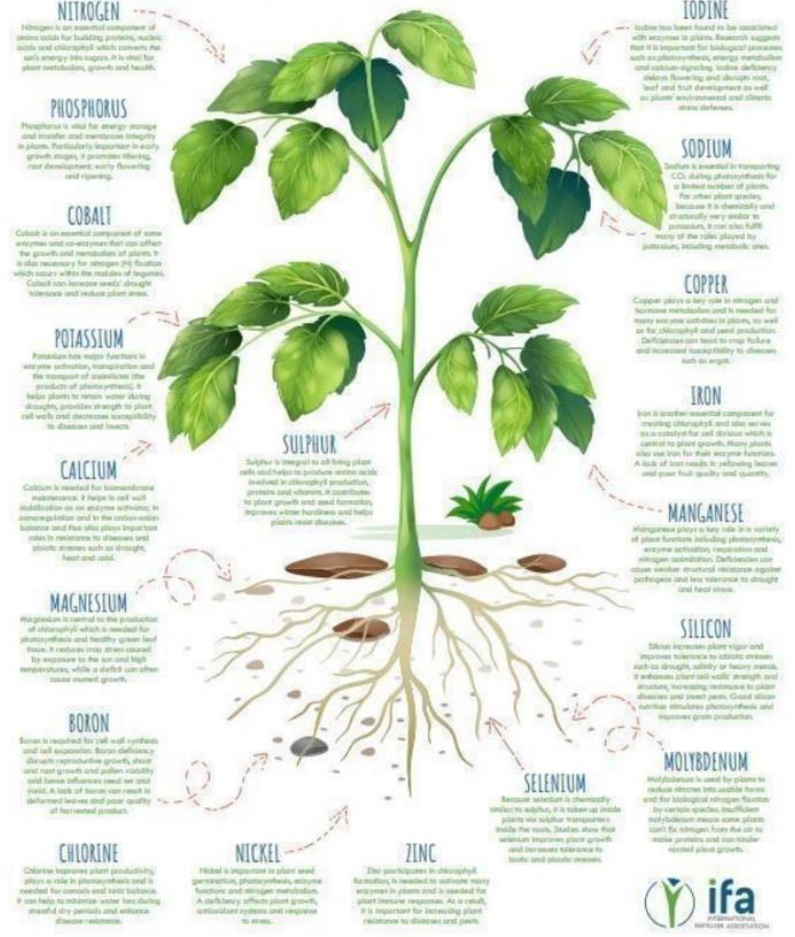
there are **92** naturally occurring chemical elements

18 are essential to plants and **15** of them are supplied by soils



19 PLANT NUTRIENTS FOR IMPROVING AND PROTECTING PLANT HEALTH

Plants use minerals present in the soil and water in order to grow and flourish. Just like with humans, if they don't get enough of these nutrients it can seriously affect their health. Ensuring proper plant nutrition by using fertilizers (organic and mineral) to supplement the nutrients already available in the soil is essential for plant health. Here's a look at 19 nutrients that can benefit plant health (in addition to improving yields).



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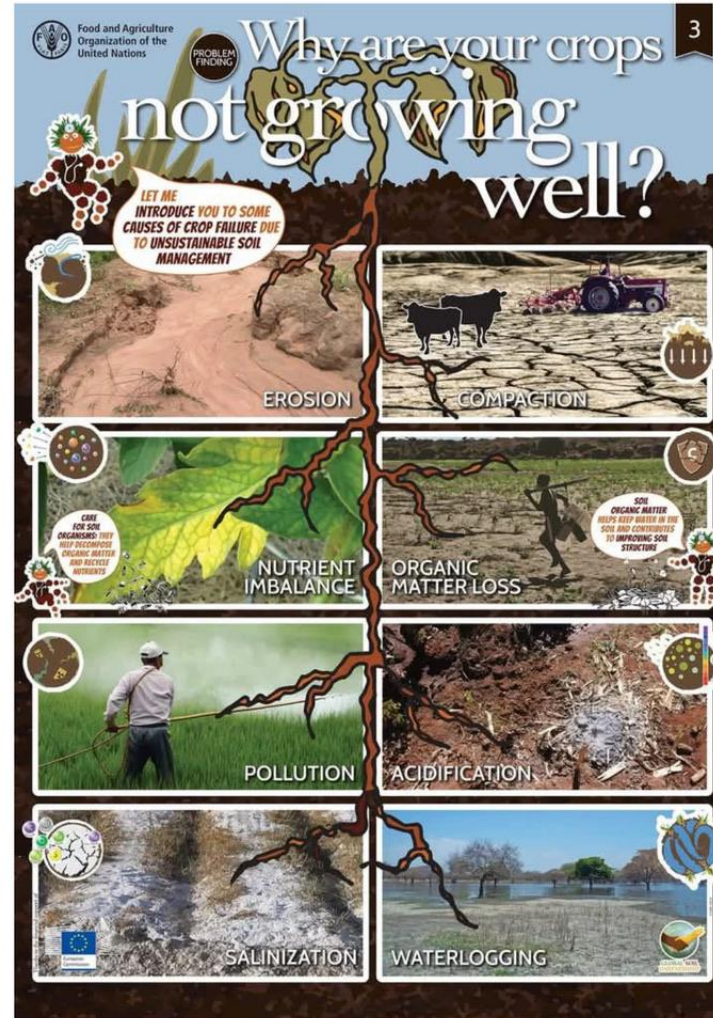
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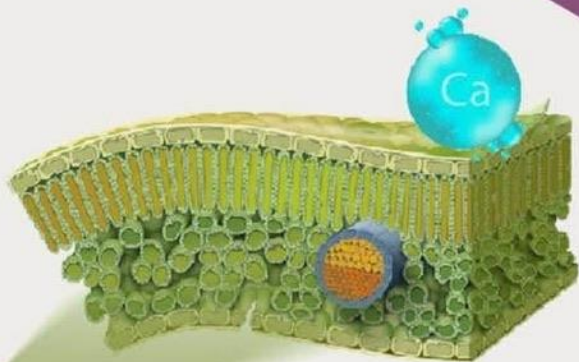
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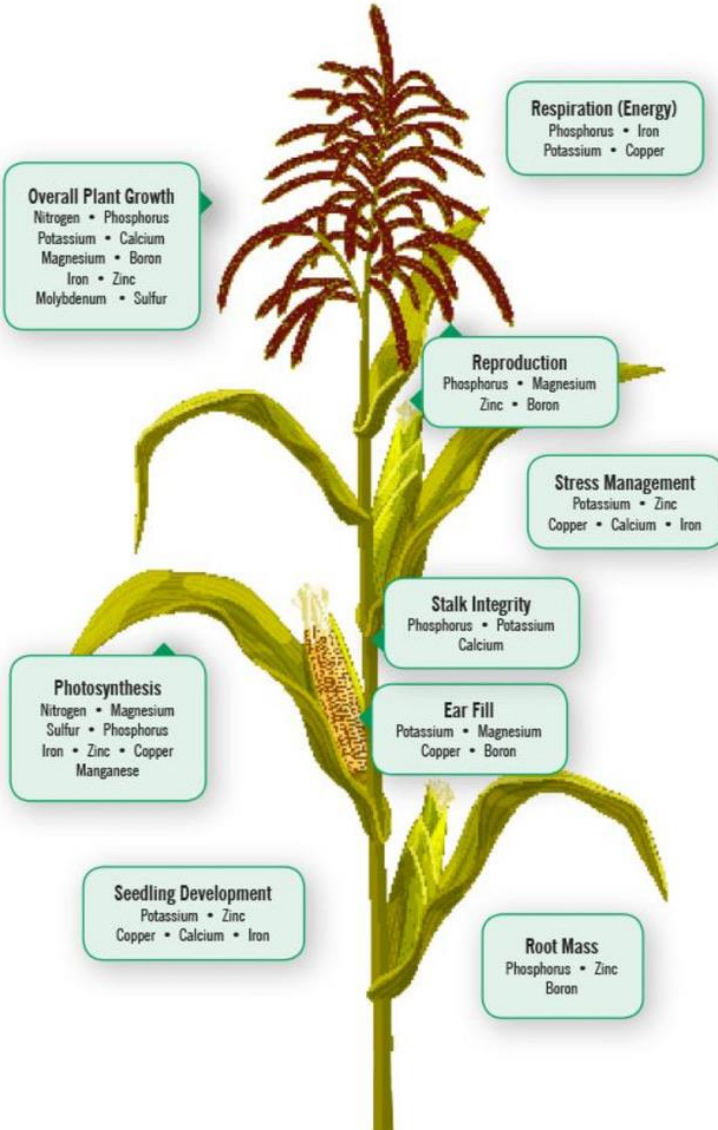
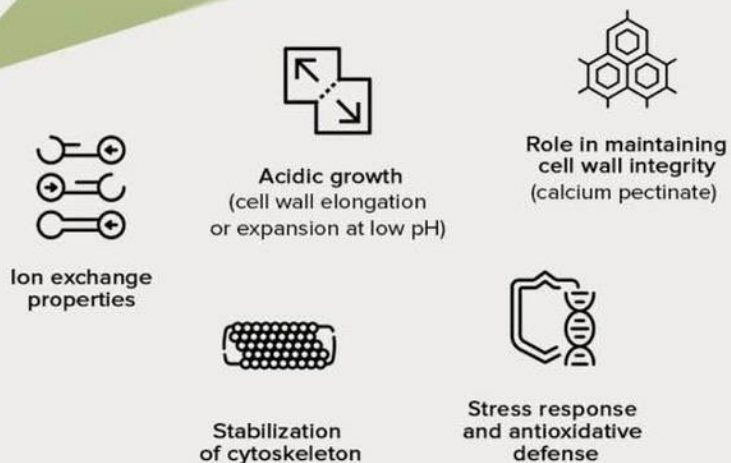
Why are your crops not growing well?



Effects of CALCIUM on stabilization of cell wall structures and expansion control



- VITICULTURE
- HORTICULTURE
- SMALL CROP



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EIS ENVIRONMENTAL TILLAGE SYSTEMS

HORSCH

Martin Till

TTAN

LSW Low Speed Technology

The Carbonic Acid – Bicarbonate Buffer System



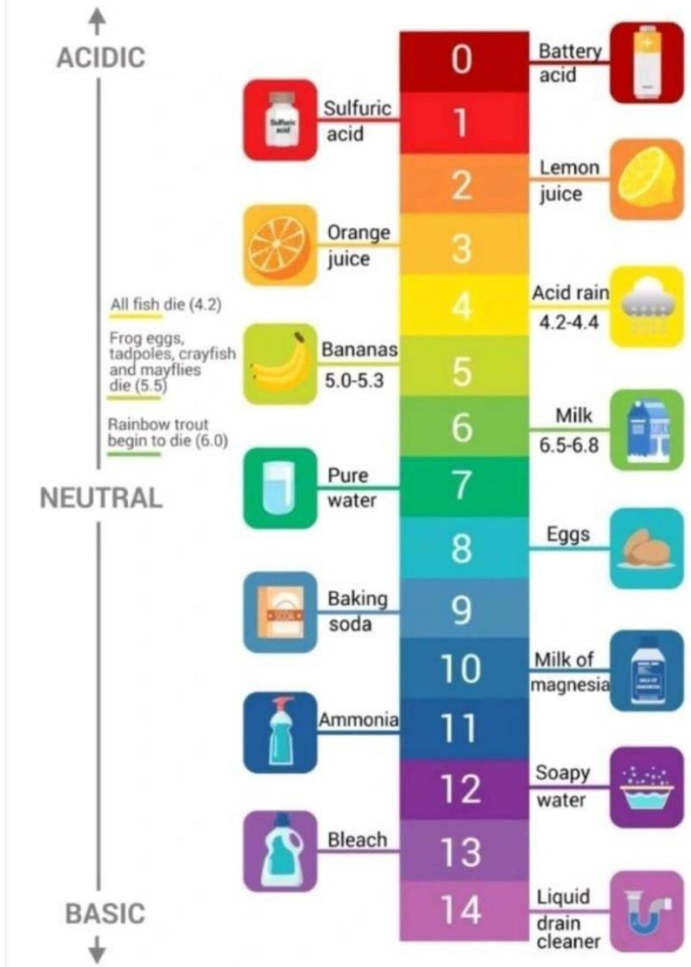
- The carbonic acid-bicarbonate system is a buffered system so while it produces acidity to allow for soil reactions, the pH is moderated and (depending upon other ions in solution) commonly buffers out in the 5.3 - 5.6 pH range in the near-root rhizosphere.
- By comparison, plant roots produce/exude acidity to facilitate nutrient uptake in a 4.2 - 5.8 pH range

Tydronium as an Acidic Salt

- Acting as an acidic salt, Tydronium is able to foster the formation of acid (carbonic acid) through hydrolysis without itself being consumed in the process
- As acid reacts with matter in soil solution and protons (H⁺ ions) are consumed, these protons are donated from carbonic acid rather than from the Tydronium itself
- In this way, Tydronium is long lasting and **small amounts** can significantly impact the soil solution chemistry



The Ph Scale



33rd Annual NATIONAL NO-TILLAGE CONFERENCE
January 7-10, 2025 • Louisville, Ky.

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Crop Protection Chemicals



Herbicides

- Selective Herbicides
- Non-Selective Herbicides
- Contact Herbicides
- Systemic Herbicides
- Pre-emergence Herbicides
- Post-emergence Herbicides
- Others



Pristine®

Insecticides

- Chemical Insecticides
- Biological Insecticides
- Systemic Insecticides
- Contact Insecticides
- Organophosphates
- Pyrethroids
- Ingestion Insecticides
- Others



Fungicides

- Contact Fungicides
- Systemic Fungicides
- Protective Fungicides
- Eradicant Fungicides
- Triazoles
- Strobilurins
- Carboxamides
- Others



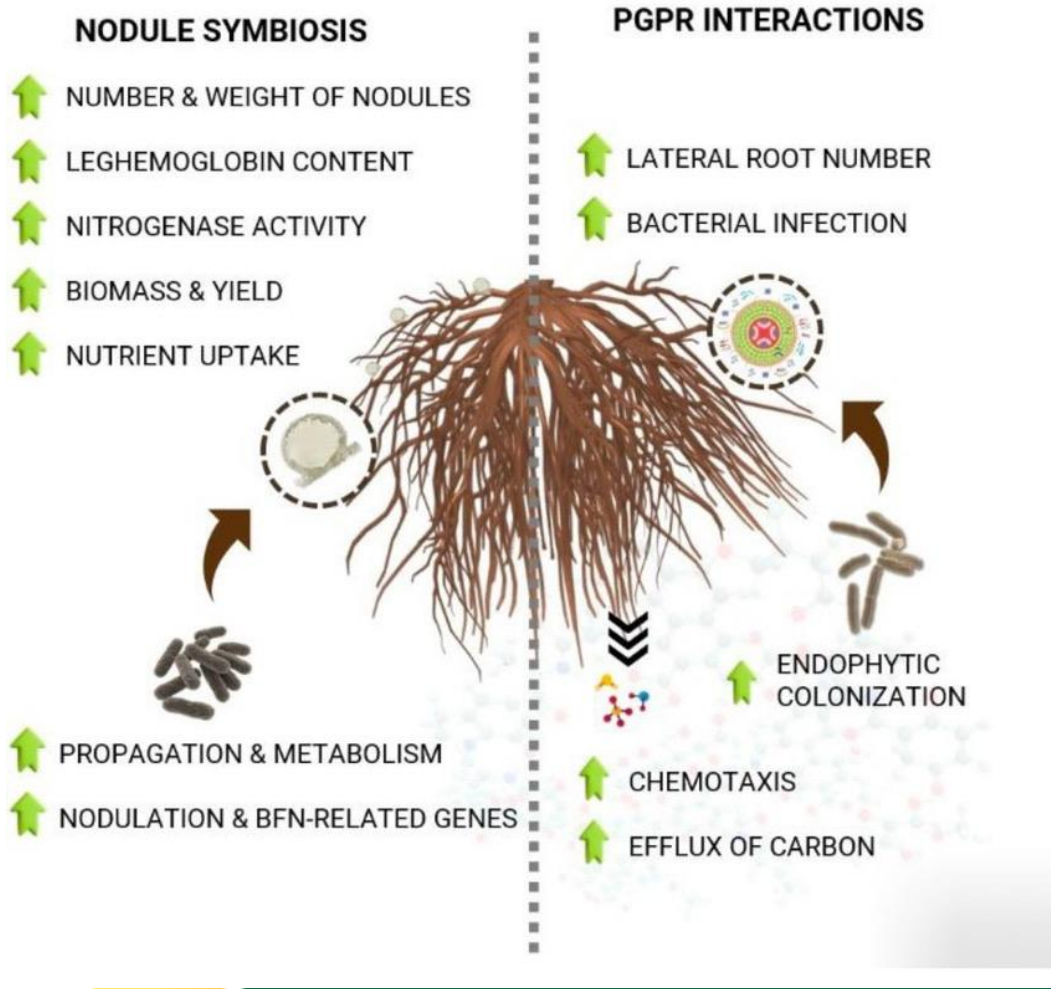
Other Types

- Nematicides
- Molluscicides
- Acaricides (Miticide)
- Plant Growth Regulators (PGRs)
- Biopesticides
- Others

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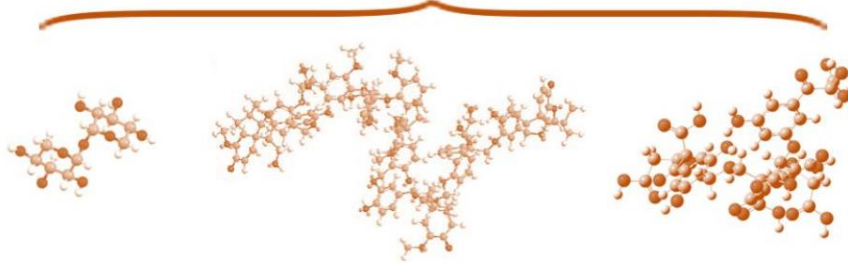
HUMIC ACIDS | BENEFICIAL EFFECTS ON MICROBIOME





HUMIC ACIDS | CARBON ABSORPTION CAPACITY

HUMIC SUBSTANCES



HUMINS

INSOLUBLE IN
BASE AND ACID

HUMIC ACIDS

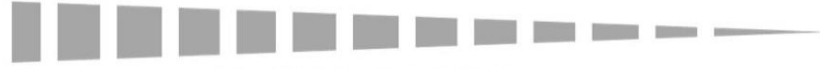
SOLUBLE IN BASE
INSOLUBLE IN ACID

FULVIC ACIDS

SOLUBLE IN WATER



CARBON CONTENT



MOLECULAR WEIGHT AND DEGREE OF POLYMERIZATION



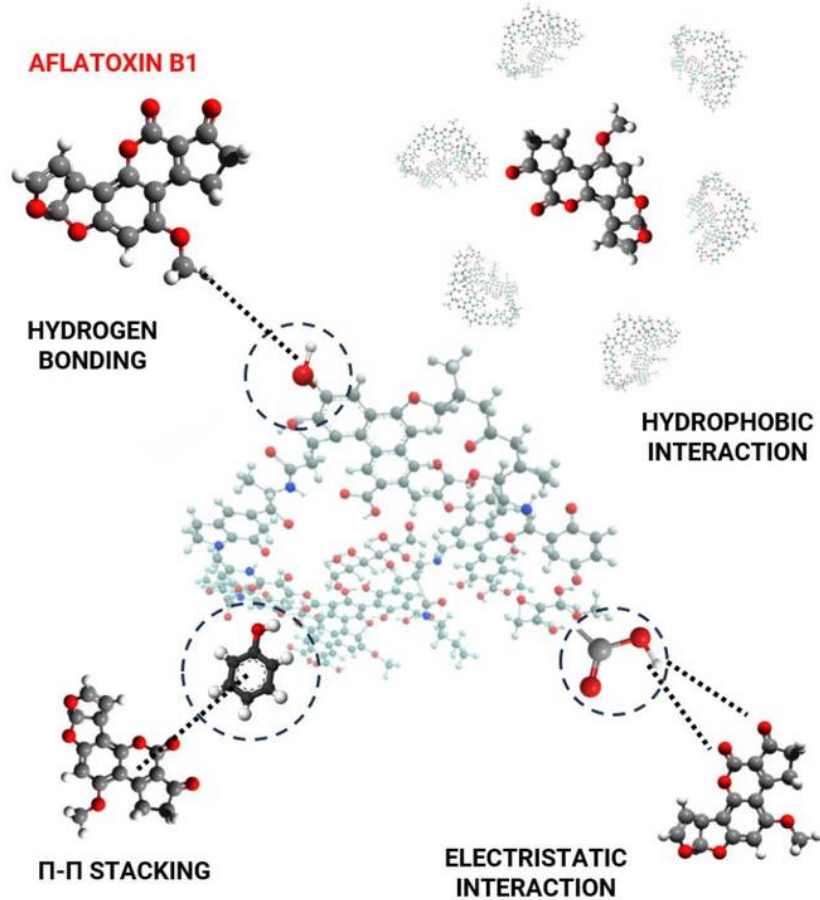
ABUNDANCE OF CARBOXYL AND HYDROXYL GROUPS

[SOURCE: Spietz et al. 2024]

www.terra-optima.ch



HUMIC ACIDS | ADSORPTION CAPACITY FOR AFLATOXIN B1



[SOURCE: Maguey-González et al. 2023]

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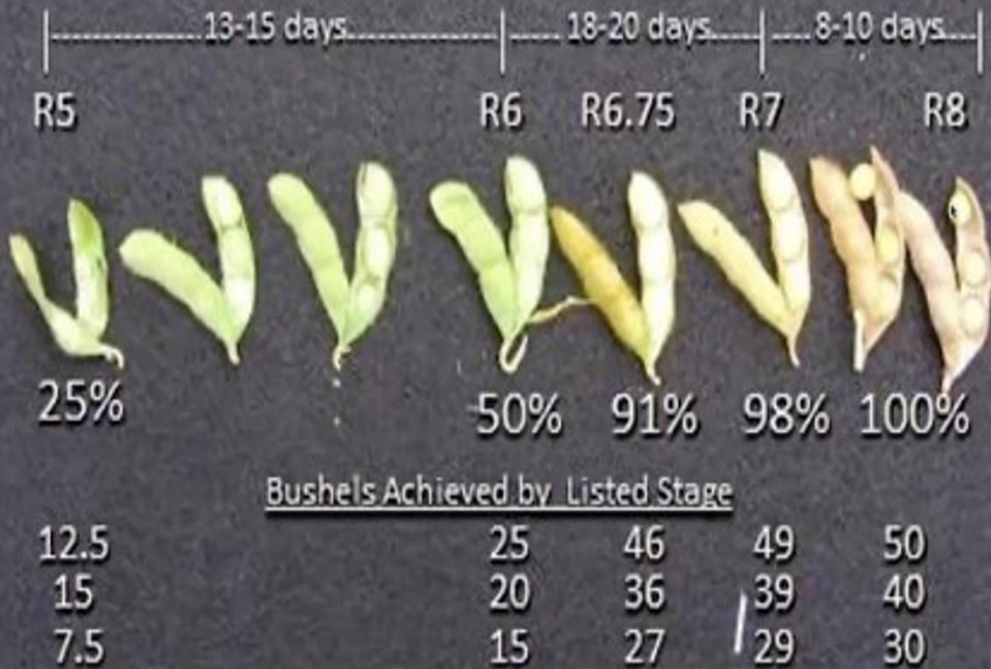
LSW
Low Stress Technology



<https://crops.extension.iastate.edu/cropnews/2013/08/scout-crops-aphids>



Seed Formation through Maturity Estimated Yield Achieved at Stated Development Stage



<https://blogs.ext.vt.edu/soybean-update/2012/09/04/soybean-crop-is-still-at-risk-to-drought-pests/>

Lots of Opportunity Late

At R5 – killed beans yield 25%

At R6 – killed beans yield 50%

Maximize seed fill and test weight late



There is more to driving a Car than turning the Key

On Farm Testing

I invest 5-10% of my profit in R&D Each year;
I have found it hard to get 3 year data without 1 year data.



Cover Crops
Our Roots Run Deep



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ENVIRONMENTAL TILLAGE SYSTEMS



What do we still need to learn?

Who is ready to study on their own?

Final Questions



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ENVIRONMENTAL TILLAGE SYSTEMS

