



COMMUNICATION IN DESERT

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PROJECT MEMBERS



OBJECTIVE

The primary objective of the project on communication in deserts, focusing on how plants communicate with each other, is to deepen our understanding of the intricate mechanisms and processes through which desert plant species interact and exchange information. By investigating the various forms of communication among desert plants, the project aims to uncover the ecological significance, evolutionary adaptations, and potential applications of plant communication in arid environments. Through structured research and experimentation, the project seeks to elucidate the specific signals, cues, and responses involved in plant communication within desert ecosystems, ultimately contributing to advancements in ecological science and conservation efforts.

MOTIVATION

The motivation for taking on this project stems from a desire to unravel the mysteries of nature and contribute to our understanding of the intricate relationships that shape ecosystems.

Additionally, the unique challenges posed by desert ecosystems, such as extreme temperatures and scarce resources, heightened our interest in understanding how plants have adapted and evolved to thrive in such harsh conditions. The key motivations that underscore the significance and purpose of this endeavour:

- Ecological Understanding
- Biodiversity Conservation
- Climate Adaptation
- Biotechnological Innovation

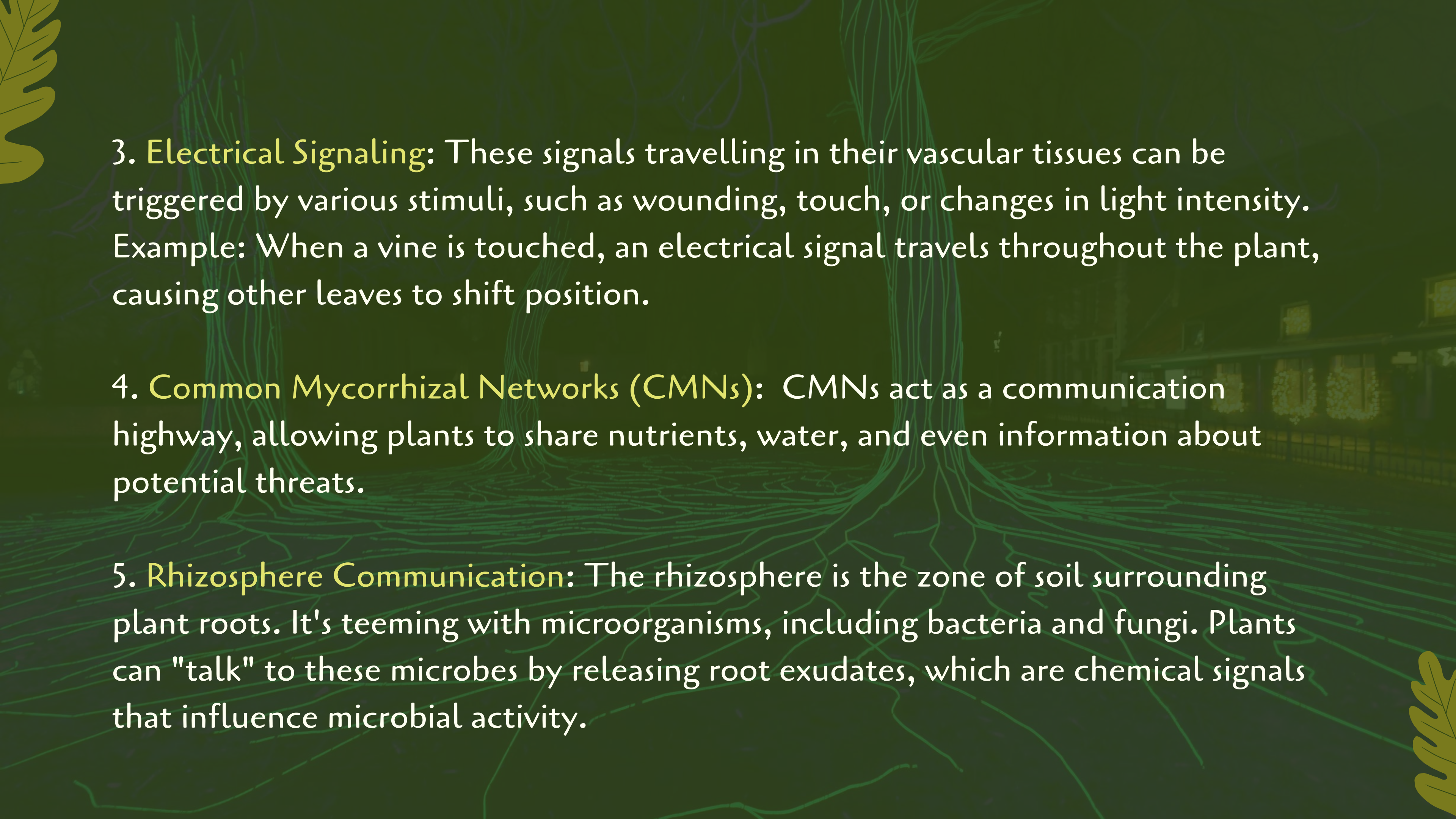
WAYS OF COMMUNICATON IN PLANTS

1. **Chemical Signalling:** Plants release a variety of volatile organic compounds (VOCs) through their roots and leaves. These airborne signals act like messages, carrying information about the plant's health, stress levels, and even the presence of predators. Neighbouring plants can detect these VOCs and respond accordingly.

Example: When a caterpillar munches on a tomato plant, the plant releases VOCs that alert nearby tomato plants to the danger.

2. **Eavesdropping on Herbivore Communication:** Some plants are sensitive to the sounds of herbivores chewing on their leaves. By eavesdropping on these sounds, plants can activate their defense mechanisms before they suffer significant damage.


Example: Certain plants release sticky resins when they detect the characteristic sounds of chewing insects.



3. **Electrical Signaling:** These signals travelling in their vascular tissues can be triggered by various stimuli, such as wounding, touch, or changes in light intensity. Example: When a vine is touched, an electrical signal travels throughout the plant, causing other leaves to shift position.

4. **Common Mycorrhizal Networks (CMNs):** CMNs act as a communication highway, allowing plants to share nutrients, water, and even information about potential threats.



5. **Rhizosphere Communication:** The rhizosphere is the zone of soil surrounding plant roots. It's teeming with microorganisms, including bacteria and fungi. Plants can "talk" to these microbes by releasing root exudates, which are chemical signals that influence microbial activity.





APPROACH

Our investigation commenced with the premise that the microbial population within the rhizosphere plays a crucial role in plant communication. To explore this hypothesis, we employed a series of microbiological techniques.

1. We carried out the process of LB Agar preparation, pour plating and the process of serial dilution of soil sample collected of plants where they were near and far apart.
 2. After that we carried out the method of spread plating and incubated the agar medium at 37 degree celcius temperature and analysed the results.
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WHY NEEM?

- Known for its medicinal properties, Neem is also a powerful communicator.
- Neem trees release compounds into the soil through their roots.
- Neem trees are incredibly resilient, thriving in harsh conditions like drought and poor soil quality. We found neem trees readily on our college campus, so accessibility became easier.

Neem's Antibacterial Powerhouse:

- The neem tree produces a multitude of bioactive compounds, including azadirachtin, nimbin, nimbolide, and several others. These compounds disrupt bacterial cell membranes, essentially stopping their growth and function.
- Some neem compounds interfere with bacterial communication, hindering their ability to coordinate and form harmful biofilms.

Neem's Fungus Foe:

- Certain neem compounds can inhibit enzymes essential for fungal growth and reproduction. This disrupts the fungus's ability to thrive and spread.
- Similar to its antibacterial action, neem can disrupt fungal cell membranes, causing leakage of vital cellular components and ultimately leading to fungal death.

SAMPLE COLLECTION

- We collected samples of soil of Neem tree from outside the basic labs department and I2 hostel.
- The soil was collected in such a way that we could expermientally find out the communication between near and far both locations of the Neem tree.



COTTON PLUGGING IN CLOSED FLASK REACTIONS



Cotton acts as a barrier, preventing airborne contaminants like dust, bacteria, or spores from entering the flask during the reaction. This is crucial to prevent unwanted side reactions or product contamination.

PROCEDURE

Bacterial Isolation:

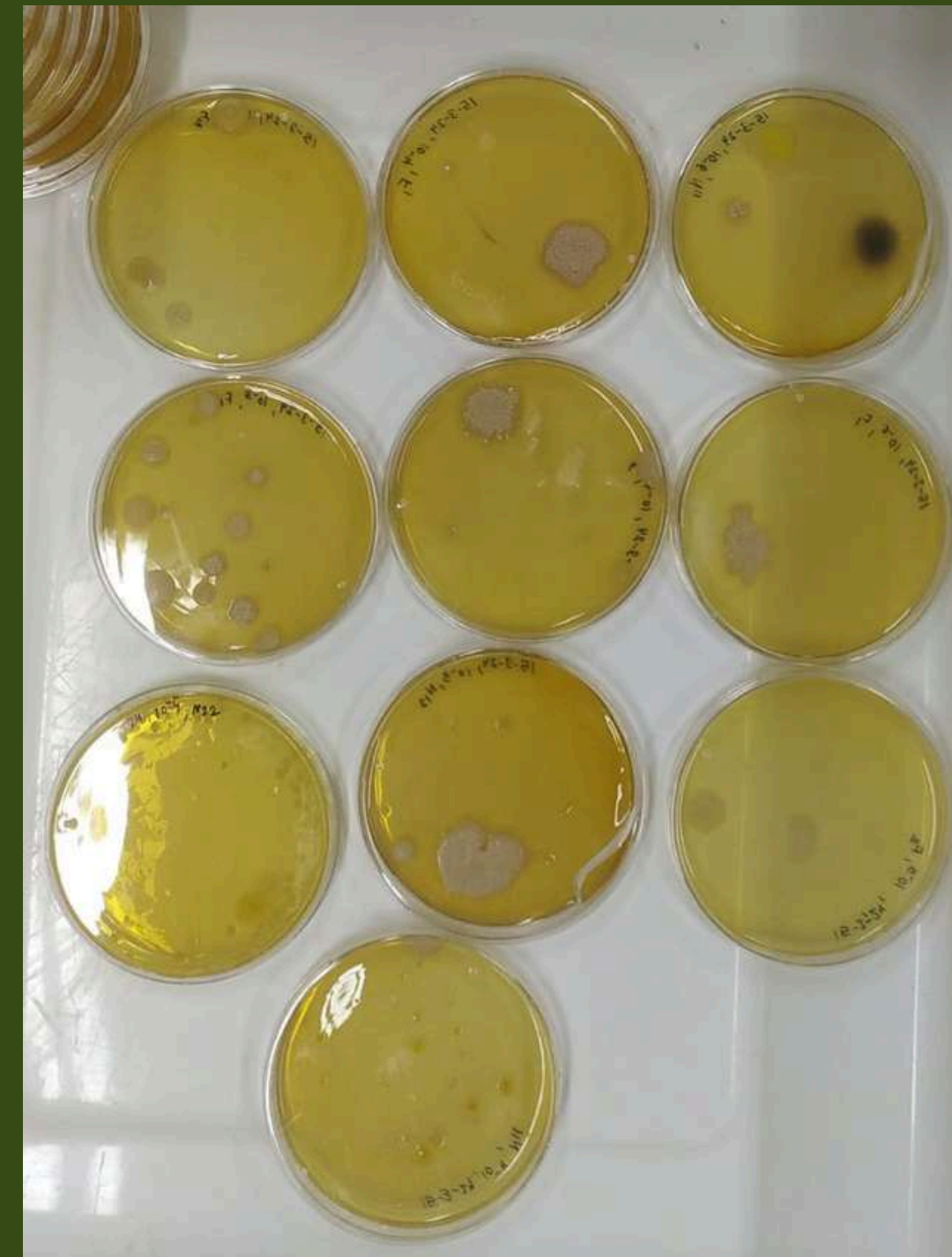
1. **Soil Dilution:** A small, measured amount of the collected soil was likely added to a sterile solution to create a suspension. This dilutes the concentrated soil microbes, allowing for easier spreading on the agar plate.
2. **Agar Plate Seeding:** A small volume of the diluted soil suspension was spread evenly onto the surface of a prepared agar plate using a sterile spreading tool. This distributes the bacteria from the soil sample across the plate's surface.
3. **Incubation:** The agar plates with the soil suspension were placed in an incubator set at a specific temperature at around 37°C , similar to human body temperature) for a designated period (typically 24-48 hours). This warm temperature provides optimal conditions for bacterial growth, allowing them to multiply and form visible colonies on the agar surface.

EXPERIMENT



CHALLENGES

- **Desiccation of agar plates:** Agar plates drying out due to exposure to air or improper storage conditions can hinder the growth of microorganisms, affecting experimental outcomes.
- **Intermittent interruptions in electrical supply to the incubator:** Sporadic power disruptions to the incubator can cause temperature fluctuations, compromising the growth conditions for microorganisms and experimental consistency.







Extreme Environmental Conditions: Desert environments can present extreme temperatures, water scarcity, and intense sunlight. These conditions can affect equipment performance, sample collection.

Sparse Vegetation: Desert landscapes often feature sparse vegetation, making it challenging to locate and study plant species of interest.

Data Analysis and Interpretation: Analysing and interpreting data collected from field studies of plant communication can be complex, requiring advanced statistical methods and expertise in ecological modelling.

Long-Term Monitoring: Understanding plant communication may require long-term monitoring of plant populations to capture seasonal variations and temporal dynamics accurately. Sustaining funding and logistical support for extended research periods can be challenging.



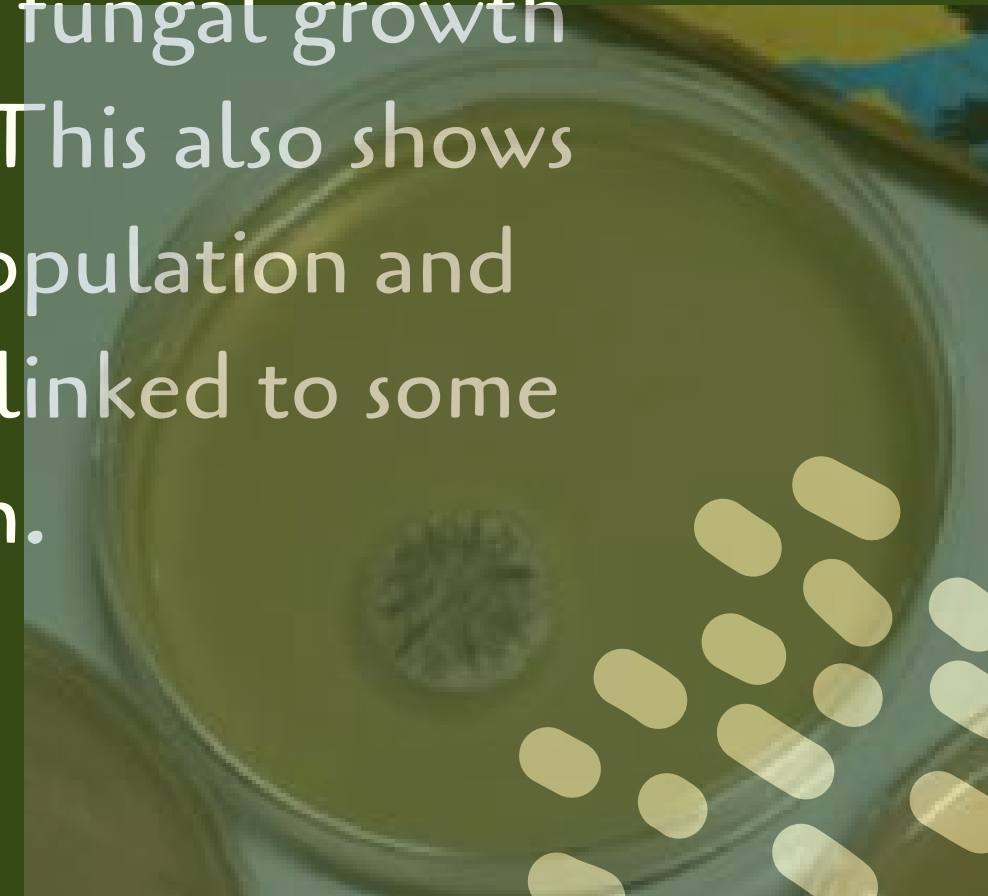
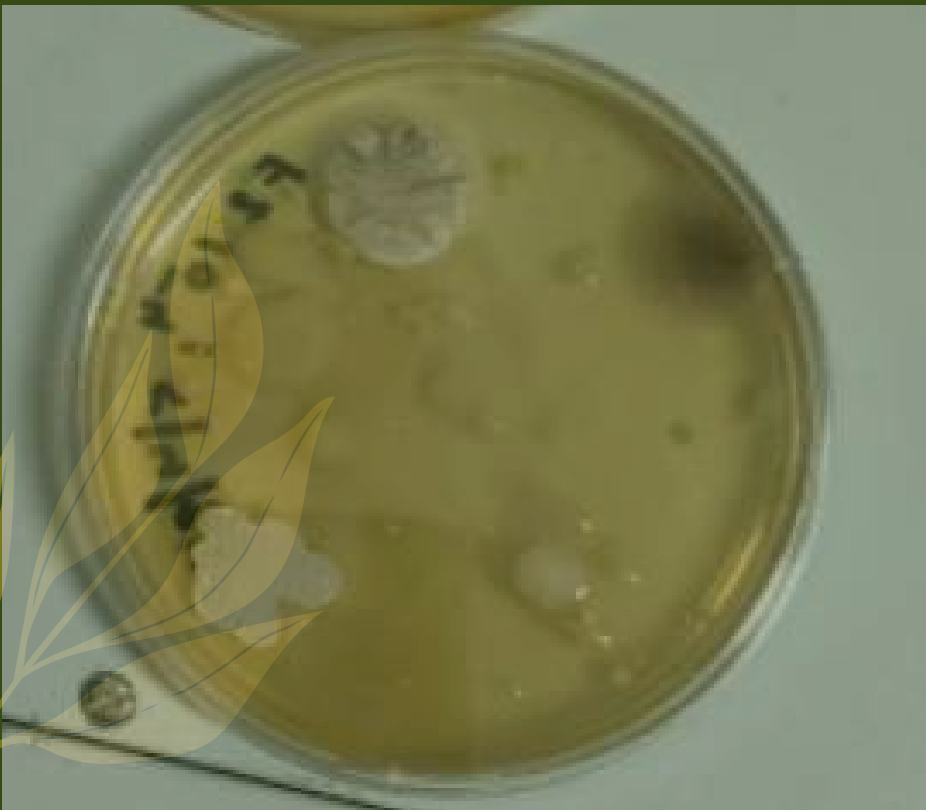


CONCLUSION



Our findings indicate that proximity of plants was associated with limited microbial growth, whereas greater distances between plants correlated with minimal microbial colonization.


In case of close proximity of plants, fungal growth was prominent but in distant case bacterial growth, fungal growth along with few algal growths were prominent. This also shows that distance between plants and microbial population and density are correlated, this correlation may be linked to some microbial mode of communication.





✦ UAV NAVIGATION

In the barren deserts where landmarks are scarce, UAV navigation faces unique challenges. Inspired by the resilient navigation tactics of desert ants, researchers are innovating UAV systems. By integrating path integration, visual landmarks, and celestial cues, UAVs can navigate with precision in featureless terrains.

- **Path Integration:** Just as desert ants rely on path integration to navigate featureless terrains, UAVs can utilize inertial navigation systems (INS) to continuously update their position relative to their starting point as they fly through the desert. By integrating data from accelerometers and gyroscopes, UAVs can maintain a precise estimate of their position and orientation
 - **Visual Landmarks:** Despite the seemingly barren nature of desert landscapes, UAVs can still leverage subtle visual cues as landmarks for navigation. High-resolution cameras onboard the UAVs can capture images of terrain features such as sand dunes, rock formations, or vegetation patches. Advanced computer vision algorithms can then analyze these images to identify and recognize visual landmarks, allowing the UAV to orient itself and navigate towards its destination.
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Polarized Light Detection: UAVs equipped with specialized sensors can detect polarized light patterns in the sky, similar to desert ants, to determine their heading. By analyzing the polarization of sunlight, even in dusty or cloudy conditions, UAVs can maintain a consistent direction of travel. This ability enhances navigation reliability, especially in environments where traditional GPS signals may be unreliable or unavailable.

Sun Compass: Incorporating information about the position of the sun into UAV navigation systems can provide additional guidance and orientation cues. By estimating the sun's azimuth and elevation relative to the UAV's position, navigation algorithms can adjust the UAV's heading to maintain a desired course. This complementary navigation strategy enhances overall navigation accuracy, particularly during long-duration flights in desert environments.

Landmark Navigation: Combining path integration with landmark-based navigation allows UAVs to navigate efficiently and adaptively in desert landscapes. Periodic visual inspections of recognizable landmarks, coupled with updates from inertial navigation systems, enable UAVs to correct any positional errors and maintain a precise trajectory towards their destination. This hybrid approach ensures robust navigation performance, even in challenging desert conditions.

CHALLENGES

1. Limited Range and Coverage:

- Relies on sunlight availability.
- Absence during certain times or heavy cloud cover.
- Impacts reliability and coverage, especially in darkness or bad weather.

2. Weather Dependency:

- Atmospheric conditions affect effectiveness.
- Haze, fog, or rain can distort polarized light patterns.
- Adverse weather degrades accuracy and robustness, posing challenges.

3. Sensitivity to Environmental Factors:

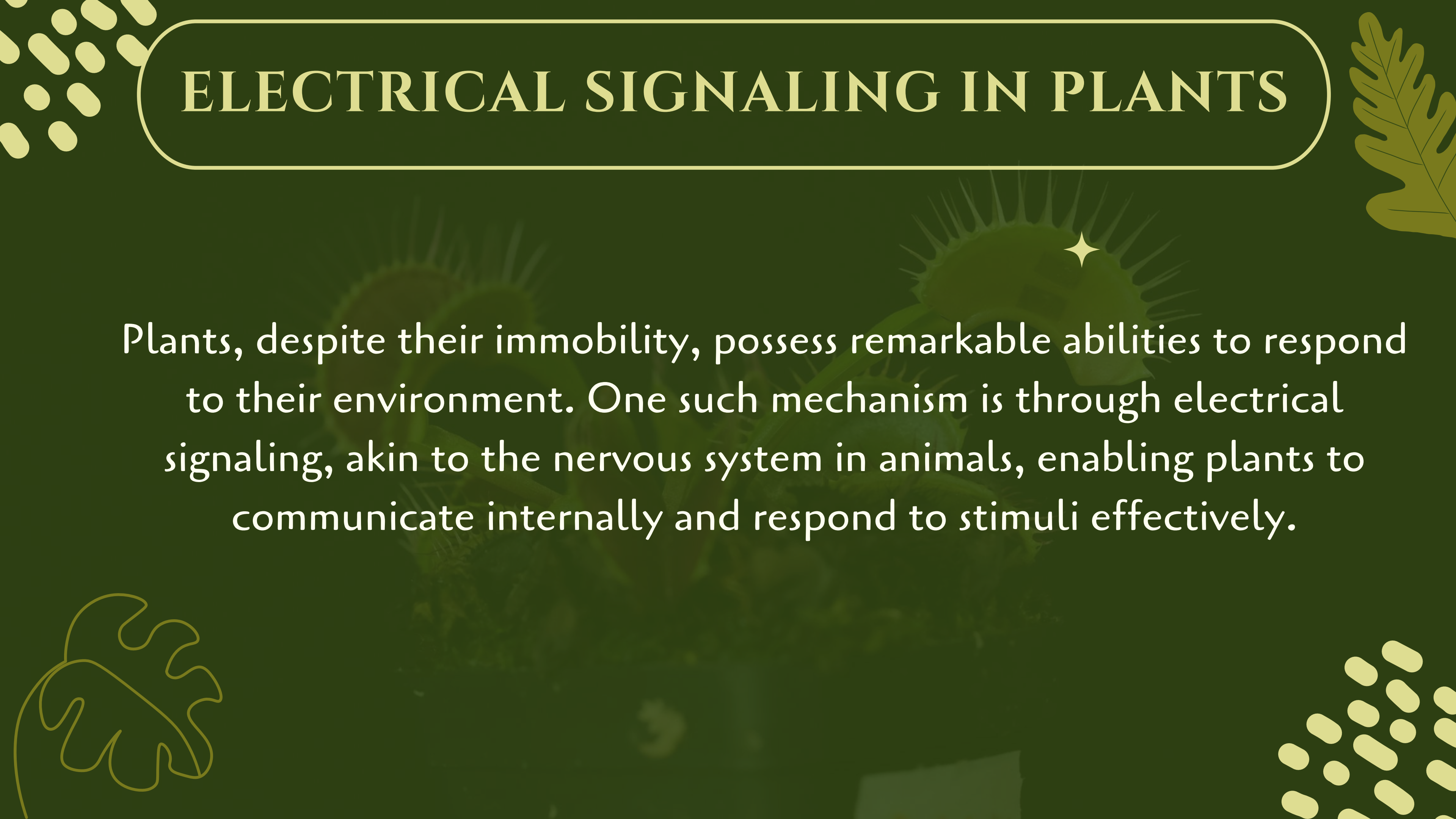
- Based on desert ants' navigation in specific conditions.
- UAV adaptation needs to consider terrain, vegetation, and atmospheric variations.

4. Complexity of Implementation:



- Technical and resource-intensive development.
- Requires specialized sensors, algorithms, and software engineering.
- Increases complexity and cost of UAV development and maintenance.



ELECTRICAL SIGNALING IN PLANTS



Plants, despite their immobility, possess remarkable abilities to respond to their environment. One such mechanism is through electrical signaling, akin to the nervous system in animals, enabling plants to communicate internally and respond to stimuli effectively.

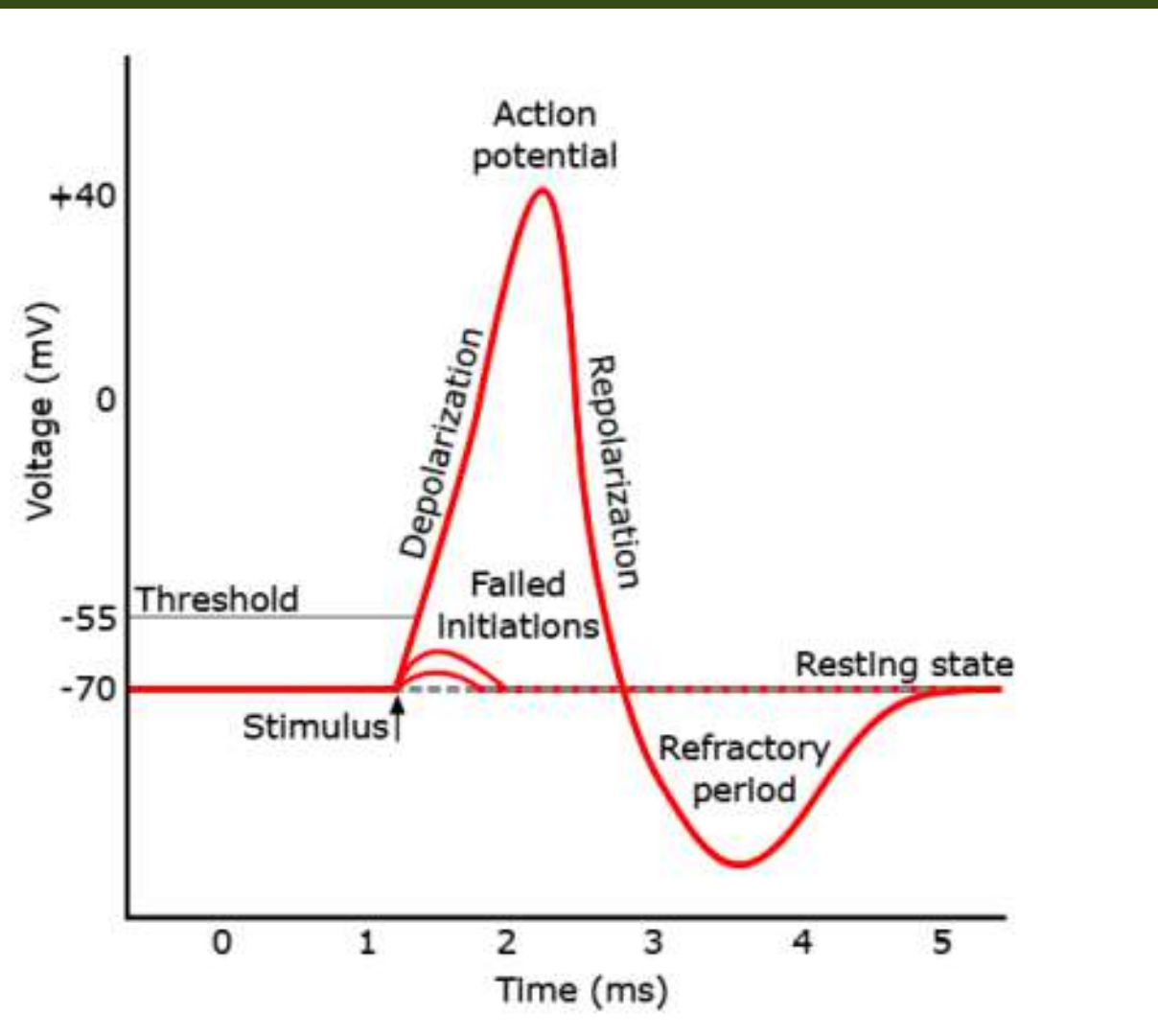


TYPES OF ELECTRICAL SIGNALS

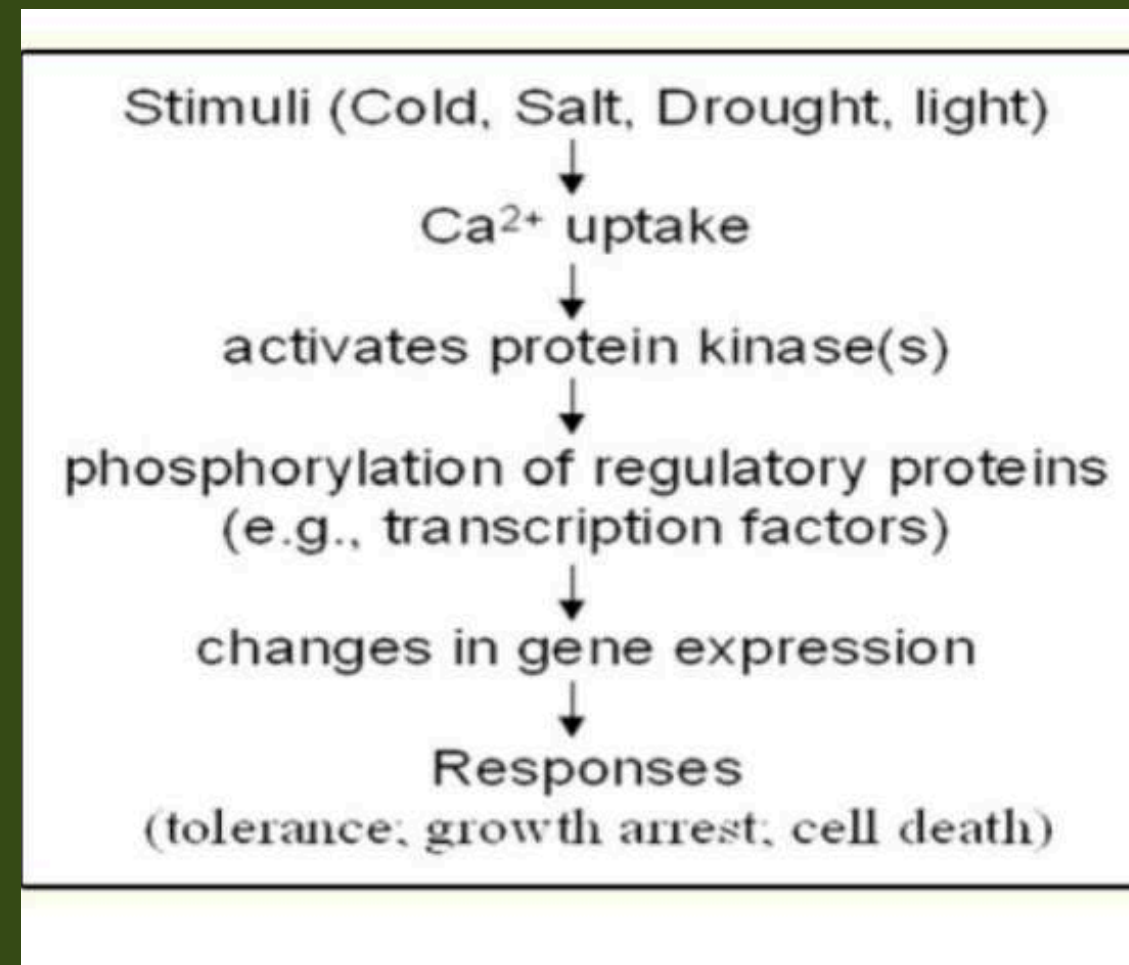
1. **Action Potentials:** Rapid changes in membrane potential allowing for quick information transmission.
 - Propagation: They can propagate along cells and tissues, enabling communication between distant parts of the plant.
 - Function: Action potentials allow plants to transmit information quickly in response to stimuli, coordinating responses across the plant.
 - Keywords: Action potentials, Plants, Ion fluxes, Longitudinal solitons.
2. **Calcium Waves:** Triggered by changes in calcium ion concentrations, crucial for stress signalling and growth coordination.
 - Role in Signalling: Calcium waves play a crucial role in signalling stress responses and coordinating growth and development in plants.
 - Function: They allow plants to respond rapidly to environmental cues by initiating various cellular responses.
 - Key Words: Calcium binding proteins, Ca^{2+} channel, Ca^{2+} -dependent protein kinases, $\text{Ca}^{2+}/\text{H}^{+}$ antiport, calcium memory, calcium sensors, calcium signatures, Ca^{2+} -transporters, EF hand motifs, plant signal transduction.

3. Hydraulic Signals: Generated by changes in water pressure, responding to mechanical stress and injury.

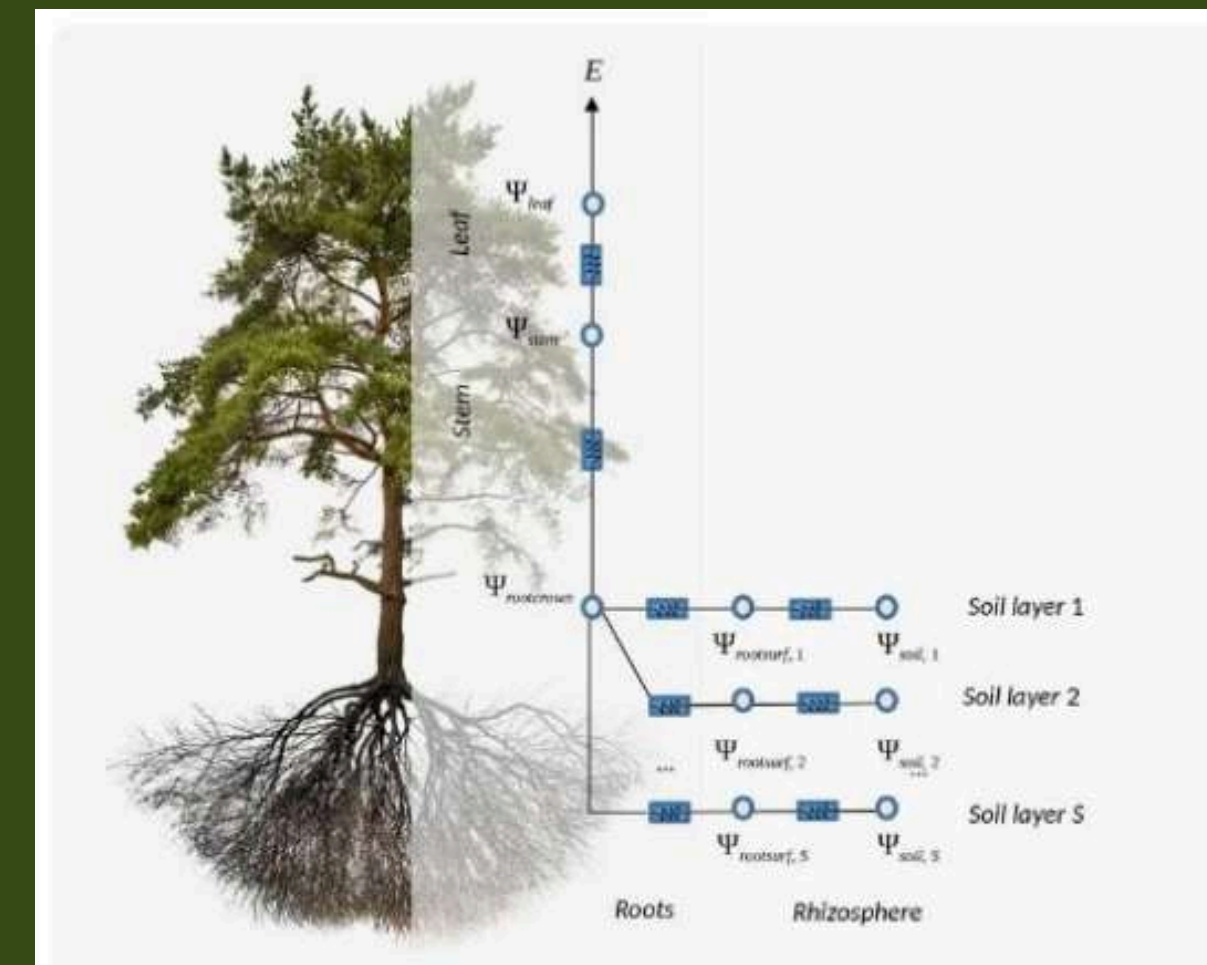
- Generation: These signals are generated in response to environmental cues such as mechanical stress or injury.
- Function: Hydraulic signals play a crucial role in plant responses to stress, triggering responses such as the closure of stomata and the activation of defense mechanisms.



1.




2.



3.




SIGNALING PATHWAYS AND RESPONSES

- **Generation:** Signals arise from environmental cues like stress or injury.
 - **Transmission:** They travel through the plant's vascular system, the xylem.
 - **Role in Plant Response:** They trigger responses like stomatal closure and defense chemical production.
 - **Integration with Other Pathways:** Hydraulic signals coordinate with phytohormones for comprehensive plant responses.
 - **Importance:** Understanding these signals enhances crop resilience and water use efficiency in agriculture.
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INTER-PLANT COMMUNICATION

- **Mechanism:** Plants emit signals when under stress, detectable by neighboring plants.
 - **Response:** Neighboring plants activate their own defense mechanisms.
 - **Significance:** Enhances collective plant survival and underscores plant signaling complexity.
 - **Implications:** Offers strategies for enhancing crop resilience and reducing pesticide use.
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CONCLUSION

- Electrical signals in plants can regulate growth and development processes, such as seed germination, root growth, and flowering, influencing overall plant health and productivity.
 - Studying electrical signaling pathways can help identify stress responses in plants, such as drought, salinity, or pathogen attacks, leading to the development of strategies for stress tolerance and crop protection.
 - By deciphering the complex network of electrical signals in plants, researchers can uncover novel insights into plant behavior and adaptation strategies, contributing to the broader understanding of biological systems.
 - Implementing this knowledge in agriculture can lead to the development of innovative technologies, such as smart farming systems, that optimize plant growth and resource utilization, promoting sustainable agriculture practices.
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CONTRIBUTION

NAMAN JAIN : Enhanced research on microbial based communication , design and analysis of experimentation of hypothesis .

MOHIT JINGAR : Setting up experiments, collected data, research, result analysis .

TANISHA : Hypothesis development, sample collection, Cell culture experiment, drafted the presentation.

ROHAN REGAR : Helped in pour plating and experiments, brainstorming ideas for UAV navigation.

VISWASRI : Neem tree research, cotton plugging and data analysis

SHARDUL DATE : UAV-Nav and research-based work.

VISHAL MEENA : Assisted in soil sampling activities , presentation .



THANK YOU