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AI and Remote Sensing for Monitoring Onion under Salinity Stress

CRRHAB Centre Régional des Recherches en HORTICULTURE et AGRICULTURE BIOLOGIQUE
المركز الجهوي للبحوث في البستنة و الفلاحة البيولوجية
2PHD

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INTRODUCTION

Salinity is a major environmental stressor that adversely affects agricultural productivity globally. In Tunisia, poor water quality is a critical issue, with over 30% of water resources exceeding 4 g/l salinity. Traditional soil sampling methods are often time-consuming and spatially limited, making it challenging to accurately capture soil variability across fields. Remote sensing (RS) offers a rapid, large scale tool to monitor various indices, while artificial intelligence (AI) models can predict soil properties and integrate them with satellite data. This study combines AI-predicted soil properties with satellite-derived indices to assess onion responses under salinity stress, advancing a data-driven approach for precision agriculture.

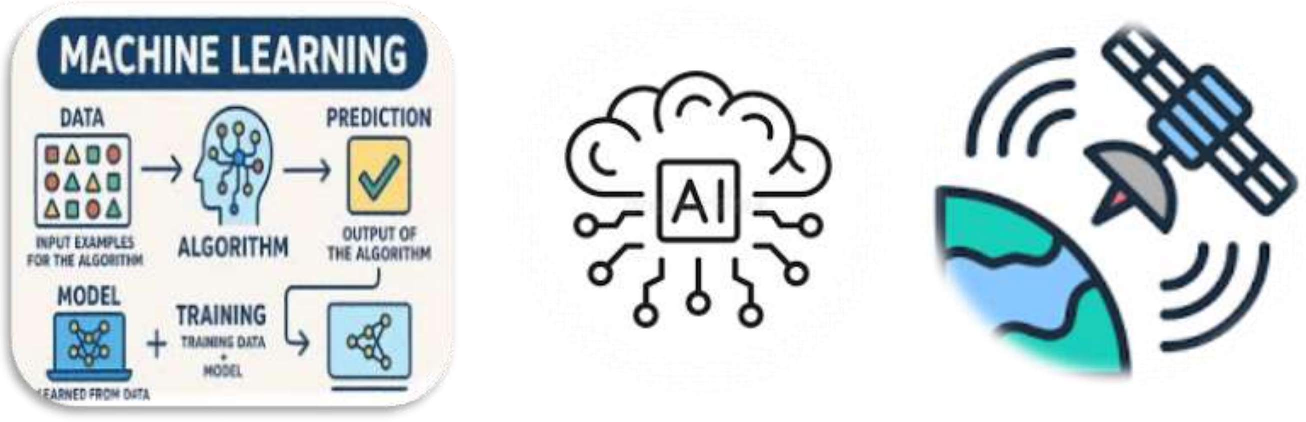
Objective: To monitor onion response to salinity stress using aSpace's AI-driven soil analysis and remote sensing platform

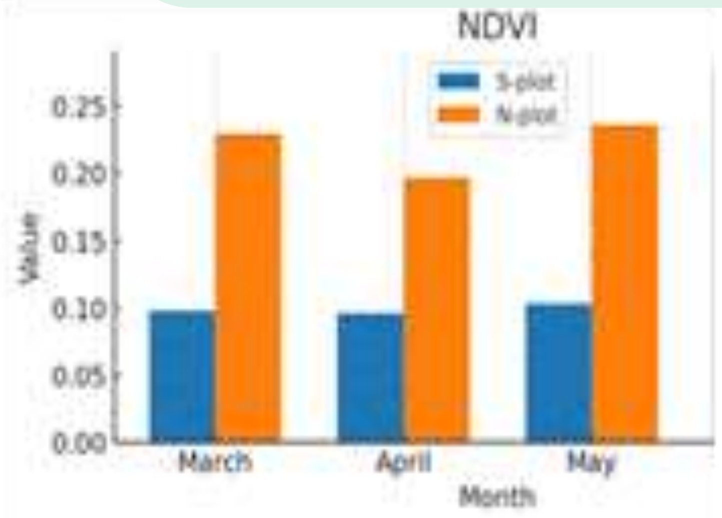
MATERIAL AND METHODS

Split-plot design within RCBD: Main plots: irrigation water type
saline water : 8.40 mS/cm (S-plot) , normal water: 1.83 mS/cm (N-plot)
Sub-plots: onion accessions (analysis focused on overall plot responses).

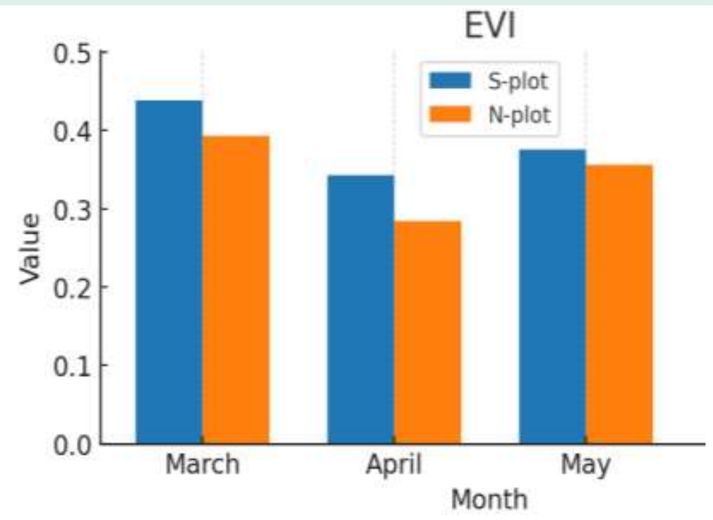
- **AI-predicted soil parameters** (organic matter, cation exchange capacity (CEC), electrical conductivity, pH, and N-P-K contents) to characterize soil variability and identify factors influencing onion response
- **Multi-spectral, multi-temporal satellite imagery** (Sentinel-2, PROBA-V, Landsat 8, and MODIS)
- **Key vegetation and salinity indices** (NDVI, EVI, SAVI, BSI, and NDSI) computed and cluster analysis performed to map healthy vegetation patches within the trial.

Experimental Station of Sahline

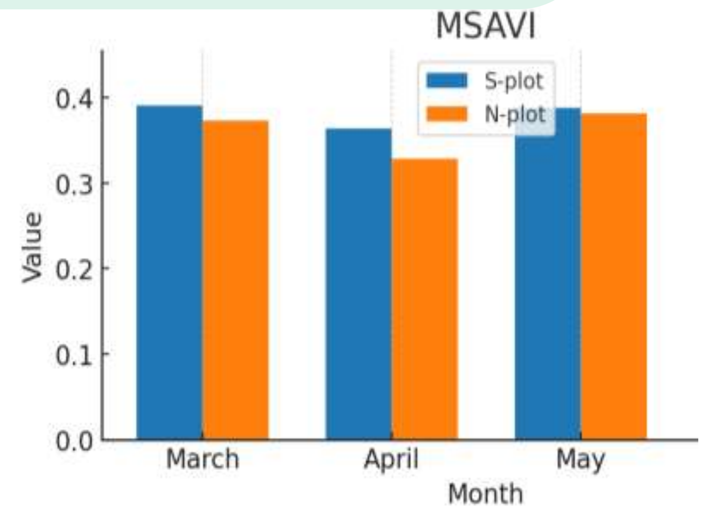




Normalized Difference Vegetation Index

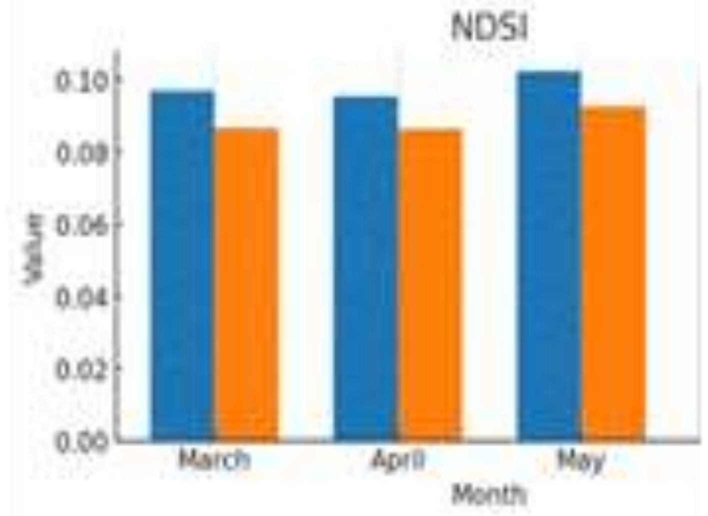


Enhanced Vegetation Index



Soil-Adjusted Vegetation Index

Bare Soil Index

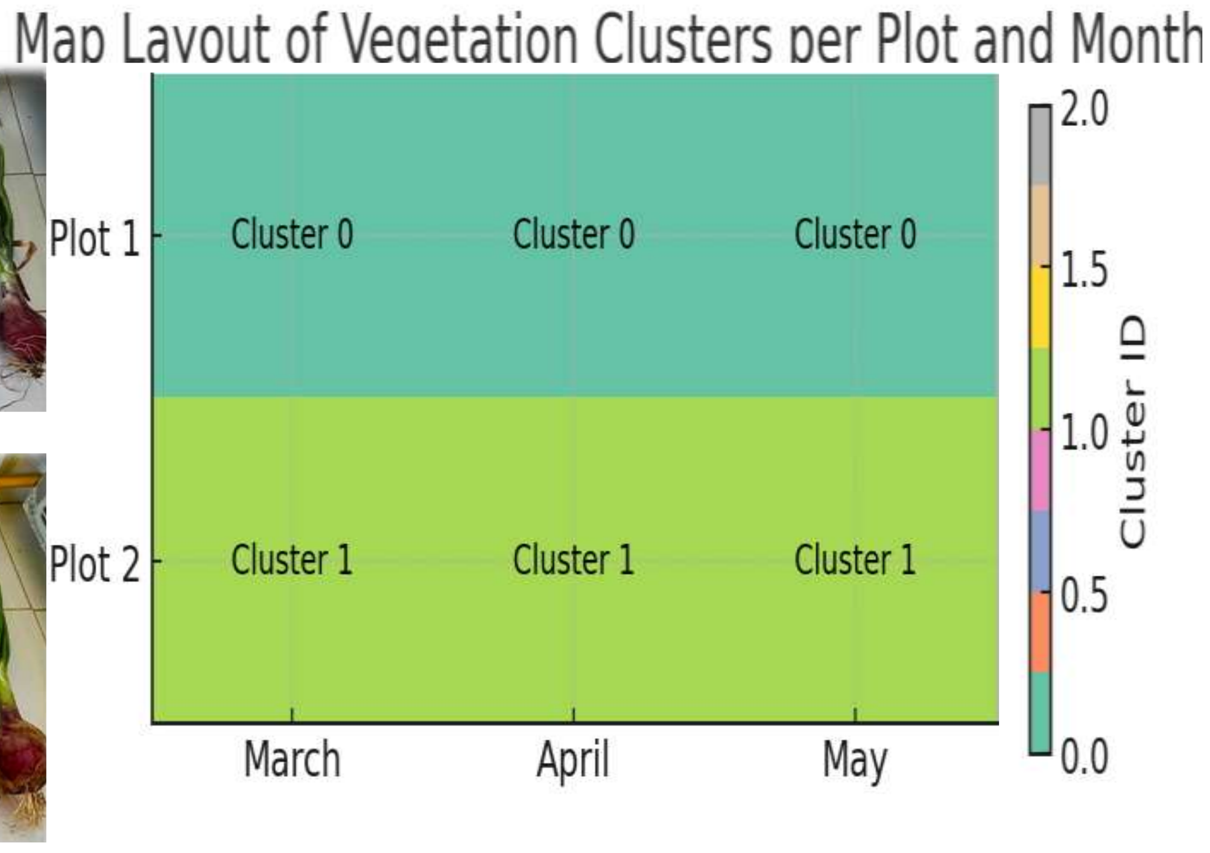


Normalized Difference Salinity Index

RESULTS

- NDSI remained consistently higher in the saline plot throughout the monitoring period, confirming persistent salinity stress in the affected plot and aligning with the lower NDVI values observed under saline conditions.
- BSI was slightly higher in the non-saline plot, which was unexpected and could be attributed to soil background, moisture effects, or early canopy development differences.
- MSAVI and EVI were slightly higher in the saline plot across months, possibly due to surface reflectance effects or early-stage physiological responses to stress.

AI-Predicted Soil Properties of the Experimental Site	S-plot and N-plot
Soil properties (pH, Carbon content, texture)	pH: 6.7 and carbon content 9 g/kg Sandy clay loam soil : Sand (55%, Clay 26%, Silt 20%)
Macronutrients (N, P, K, S)	>100 ppm , 6.4 ppm , 80.5 ppm and 12.6 ppm
Micronutrients (Mg, Ca, Zn)	163 ppm , 991.3 ppm and 1 ppm
Organic matter	11 g /kg
CEC (cmol/kg)	8



Plot 1 (S-plot) shows lower vegetation vigor (Cluster 0) from March to May
Plot 2 (N-plot) dispalys better vegetation condition (Cluster 1).

CONCLUSION

- aSpace's AI platform enabled rapid, field-plot-scale estimation of soil properties, overcoming the limitations of traditional sampling methods.
- NDSI and NDVI were the most effective indices for detecting salinity effects in onion plots, suggesting their suitability as key indicators in future monitoring and varietal screening efforts.
- This first-year study, demonstrated the potential of AI and remote sensing for rapid, non-destructive assessment of salinity effects. Future trials will refine this approach, enabling more detailed varietal-level evaluation and providing a scalable framework for precise crop selection and assessment of abiotic stress resilience.

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