On sensing non-visual symptoms of Northern Leaf Blight inoculated maize for early disease detection using IoT/AI

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1.Introduction

- **Background**: Plant diseases like Northern Leaf Blight (NLB) cause 10% stagnant growth in plant systems, with a 40% maize loss reported in East Africa.
- **Challenge**: Existing biomolecular approaches (PCR and ELISA) are accurate but not affordable for smallholder farmers, require destructive procedures, and can be expensive to implement.
- **New Approach**: Exploration of noninvasive disease detection using IoT sensors. Analysis of VOCs, ultrasound, and NPK consumption offers affordable detection.

2. Materials and Methods

2.1 Experimentation Approach for Data Collection

- **Target Disease**: NLB, causing large gray lesions on leaves; 30-50% yield loss if untreated.
- **Study Area**: Sokoine University of Agriculture, Tanzania; controlled environment.
- **Maize Varieties**: DK8033, DK9089, SeedCo 719 (Tembo), SeedCo 419 (Tumbili).
- **Experiment Setup**: Two sets, one healthy (T1) and one inoculated (T2), grown for 90 days with bi-weekly checks.
- **Fungal Isolation & Inoculation**: Spores of E. turcicum cultured and used to inoculate maize seedlings.

Fig. 1. Maize Plant Experiment set with inoculum, spore on the middle and last is the application of inoculum spores on maize plants

2.2 IoT Based Data Collection Approach

- **Sensors Used**: Bosch BME688 Development Kit for VOCs; OSEPP and DAOKI Sound Sensors for ultrasound; Taidacent and JXCT soil NPK sensors for NPK levels.
- **Data Transmission and Monitoring**: Data sent to ThingSpeak, with constant monitoring of temperature, humidity, and barometric pressure to validate conditions.

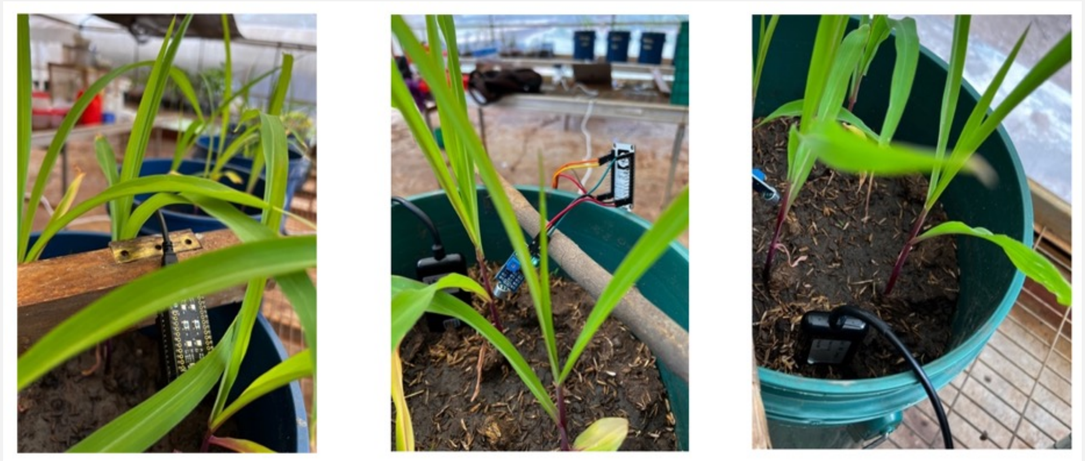

Fig. 2. Data collection using IoT sensors on Volatile Organic Compounds, microphone sensors and NPK fertilizer

3. Results and Discussion

- **Time-Series Data**: Collected from VOC, ultrasound, and NPK sensors.
- **Trends**: VOC emissions increased in NLB-inoculated maize; ultrasound showed stress from disease inoculation; NPK patterns less clear but suggested less efficient consumption in diseased plants.
- **Significance**: Strong trend and seasonality in VOC and ultrasound data, providing predictable patterns for early detection.

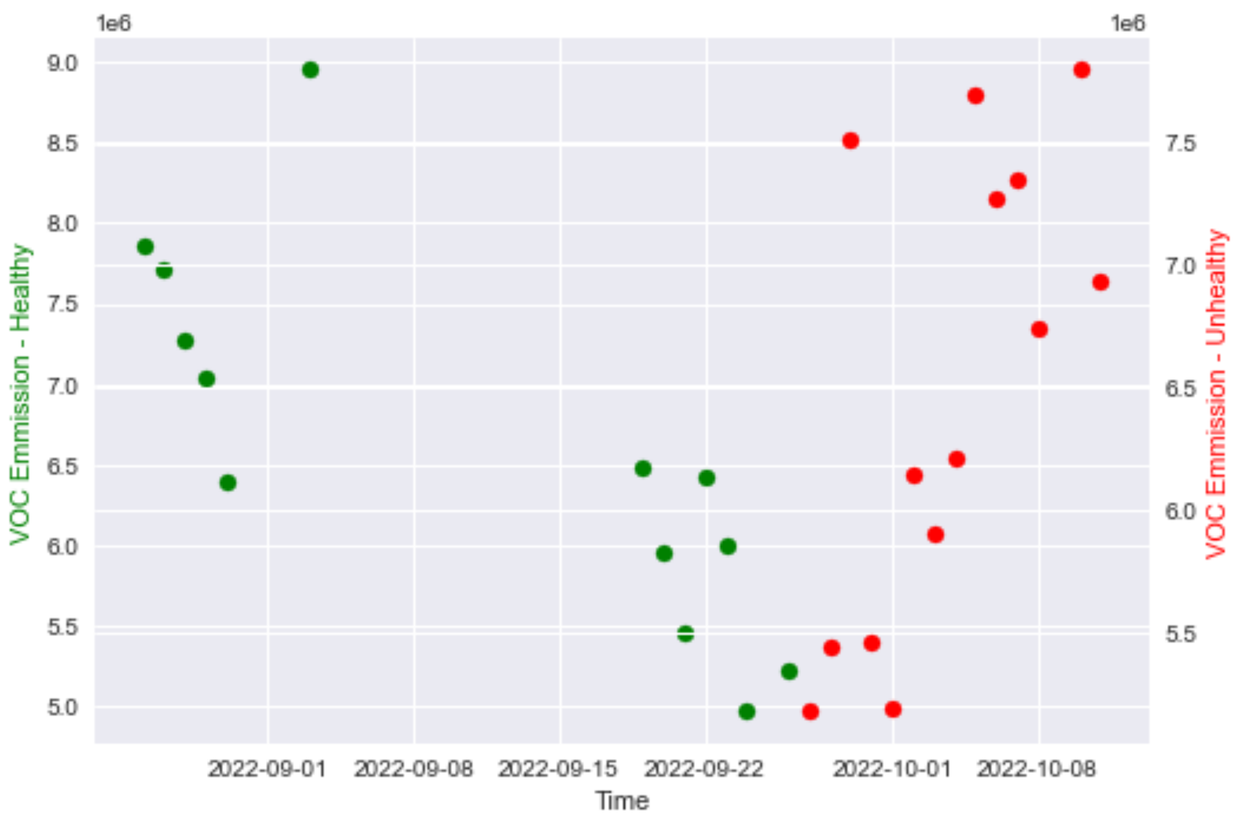

Fig. 3. Calculated mean sample of VOCs emission for healthy vs inoculated maize

4. Conclusion

- **Success in Early Detection**: IoT sensing technologies enabled detection of non-visual symptoms of NLB, a critical maize disease, within less than seven days before visual symptoms.
- **Impact and Future Scope**: Potential reduction in yield loss and a move towards affordable disease detection for smallholder farmers; sets the stage for broader implementation and more studies.

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