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Popular Article

Detection of Basal Stem Rot of Oil palm: Conventional to Modern Approaches

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Abstract

Basal Stem Rot (BSR) disease is a significant economic constraint looming over plantation crops and forest trees. *Ganoderma*, the causal agent critically affects the sustainability of the palm oil industry, globally. Employing a spectrum of detection methods is essential, encompassing conventional, molecular, and remote-based approaches. Conventional techniques involve visual inspections for visible symptoms such as crown abnormalities or basidiocarp presence. Molecular methods, like polymerase chain reaction (PCR), enable the genomic identification of *Ganoderma*, offering high sensitivity and accuracy even in asymptomatic cases. Remote-based approaches, such as satellite imagery or drones equipped with sensors, provide a large-scale surveillance. Early detection through these methods is paramount, allowing for prompt interventions against the infection and safeguarding the oil palm trees. The integration of diverse detection techniques enhances the industry's ability to identify *Ganoderma* infections coherently, facilitating effective management practices for mitigating the economic decline in oil palm production.

Keywords: Basal Stem Rot, Oil palm disease, *Ganoderma spp*, Detection

Introduction:

The future global demand for vegetable oil is expected to be primarily fulfilled by palm oil due to its unparalleled yield advantage, producing an average of 4 to 6 tonnes of vegetable oil per hectare per year. This yield is 5 to 10 times higher than that of other oil crops. Thus, oil palm is the crop for the future. The fascinating fact about this crop is that to produce one ton of oil only 0.26 hectares of land are required (Idris, 2003). Globally, around 0.36% of agricultural land is occupied by oil palm. Due to the increasing gap between the demand and supply of edible oil, India has heavily relied on its import to meet the ever-increasing demand.

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The latest report indicates that we have imported nearly 133.5 lakh tonnes of edible oil, valued at Rs. 80,000 crores. Palm oil alone constitutes 57%, followed by soybean (27%) and sunflower oil (16%). Basal stem rot caused by *Ganoderma* species is a major adversary in oil palm incurring global annual yield loss of 68.73%. It is expanding at an alarming rate, posing a significant obstacle to India's goal of self-sufficiency in edible oil. The disease is considered a silent killer due to its long gestational period and asymptomatic nature. This hampers the early detection and proper management measures. By the time, visual symptoms are seen, more than 50 % of tree will have fungal invasion and become recalcitrant to any management measures. If the pathogen is not detected early, and control measures are not implemented, the infected palm may die within six to 24 months in immature palms and one to two years in the case of mature palms after the appearance of visual symptoms.

Basal Stem Rot:

Ganoderma is formidably posing serious threat to oil palm cultivation. The disease, basal stem rot (BSR), primarily caused by the fungal pathogen-*Ganoderma* sp, has escalated to become a significant economic concern. Detection and management of BSR is arduous task from crop as well as pathogen perspective. The perennial monocropping of oil palm results accumulation of large reservoirs of inoculum and evolution of virulent and fungicide resistant strains. The perennial monocropping of oil palm leads to the accumulation of large inoculum reservoirs and the evolution of virulent and fungicide-resistant strains. However, Ganoderma exhibit the dual nature of saprophytic as well as parasitic mode.

The capacity to generate recalcitrant resting structures and release numerous basidiospores increases the pathogen's survival and dispersal rates. Ganoderma species complexity and morphological plasticity upended taxonomic investigations. Monitoring plant health and early detection of the pathogen are essential to reduce disease spread and facilitate effective management practices. Hence, a feasible rapid diagnosis of the disease is required and crucial to prolong palm’s life span via available curative methods.

1. **Conventional Methods:** Conventional methods are the major bedrock for BSR identification. BSR is distinguished by aberrant foliar symptoms such as multiple unopened spears, petiole cracking, skirting, and necrosis, as well as advanced indications of bracket formation and rotting. However, early foliar symptoms resemble moisture stress, certain leguminous indicator plants, such as red gram, green gram, subabul, and glyricidia, also aid in the identification of BSR in the field. The isolation of Ganoderma from infected plant tissues and basidiocarps is facilitated by Ganoderma selective medium, supplemented with specific fungicides and antibiotics. However,

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these techniques are laborious, time-consuming, and primarily diagnose the infection at the advanced stage.

2. **Biochemical and Physiological Methods:** The phenolics accumulation upon BSR can be estimated using KOH test, Iodine staining, EDTA method, Ortho phenanthroline reagent methods, alkaline $CuSO_4$ test and TTC tests. ABTS [2,2 (prm1)-azinobis(3 ethylbenzathiazoline 060sulfonic acid)] medium can be used to validate Laccase assay. The physiological changes caused by BSR infection in electrical conductivity, relative water content, photosynthesis, and transpiration rate can differentiate between infected and healthy palms. However, these techniques can provide only indication as other wood rotting fungi fungal infection may provide similar observations. also provide similar results.

3. Molecular Techniques: Both polyclonal and monoclonal antibodies were deployed, but immunoassay-based detection can create false positive and cross-reactivity among other fungi that are commonly found in oil palm plantation. The advent of RPLP, RAPD-PCR, PCR using genus and species-specific primers and Multiplex PCR enhanced sensitivity and specificity in detection techniques. Real time PCR is yet another technique that can quantitatively estimate the pathogen inoculum load in infected tissues as well as soil.Recent advanced techniques, including Loop-Isothermal Amplification Assay, DNA biosensors, and Recombinase Polymerase Assay, have ushered in a new era of methods enabling rapid, on-field detection of BSR.Nuclear ribosomal DNA (rDNA) sequences, mitochondrial small subunit rDNA (mt SSU rDNA), translation elongation factor 1-α gene (EF1-α), and second subunit of RNA polymerase II (RPB2) are widely employed universal genetic markers in Ganoderma taxonomy. Functional gene markers encoding manganese superoxide, fungal immunomodulatory protein and laccase possess high resolution specificity than other genetic markers (Keerthana et al., 2023)

4. Omics: The advances in genomics technologies and the development of sequence analytical tools have opened avenues for identifying strain-specific genomic regions. This is achieved by comparing the whole genome of closely related strains of Ganoderma. This enabled identification of Ganoderma with high resolution at strain level. The transcriptional reprogramming of oil palm upon BSR infection has revealed genes encoding Leuco, Ethylene, Chalcone, Anthocyanidin, Mannose, and Senescence. Chalcone can be used as a potential biochemical marker in the detection process. The proteins such as cysteine synthase and malate dehydrogenase are considered to be susceptibility determinants in oil palm (Al-Obaidi 2016). The comparative metabolic profiling of *G. boninense*-infected oil palm leaves revealed differential patterns of metabolites in partially tolerant and susceptible phenotypes. Steroidal compounds, fatty

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acid derivatives and plant defense metabolites like asparagine and chelidonic acid, plant sugars and phenolics could serve as biochemical markers for detecting *Ganoderma boninense* infection.

5. Remote based techniques: Various remote based techniques such as VOC profiling, Tomography, Microfocus X-Ray Fluorescence (μXRF), Electrical Resistance (ER): Hyperspectral imaging (HRS), Multispectral imaging, Terrestrial Laser Scanning (TLS) are the advanced cutting-edge technologies. These advanced tools provide comprehensive insights into infection dynamics, enabling timely and targeted management interventions (Lakshmi, et al., 2023)

Conclusion

The availability of efficient cost-effective diagnostic techniques that are readily accessible for large-scale screening of infected oil palms would facilitate effective control measures. Therefore, there is a necessity to integrate cultural, biochemical, molecular, and remote-based approaches for the rapid early detection of the disease with heightened specificity and sensitivity. This approach will enable timely management interventions, preventing the spread of the disease.

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