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Survey of Remote Sensing Technique in Plant Disease Management

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

Agriculture can be contemplated as the "vertebral column" of the human life and has substantial control on country's economy. In the aim of enhancing agricultural sustainability, effectiveness and plant health, cultivators are continuously innovating high technical and scientific estimation. Remote sensing is a quick, broad-spectrum, and sophisticated approach for analysing the spectral properties of earth surfaces from a variety of distances, ranging from satellites to ground-based platforms. In this process, the information can be obtained without coming into direct contact with the object. One of the main focus of remote sensing in agriculture production of crop including crop protection from various diseases and pests. Remote sensing technique is very helpful for incredibly spatial diagnostic results and its execution in agriculture, more sustain and safe by evading expensive and excessive use of different pesticides, fungicides etc. in production of crops.

Keywords: Agriculture; vertebral column; remote sensing; pesticides.

1. INTRODUCTION

The global demand for agricultural products outnumbers supply, necessitating more effective agricultural commodity production management. Working against this trend will be impossible without the use of modern technology [1]. So, use of such innovative technology like "Remote

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sensing" which gives an advance and authentic detection and diagnosis of plant diseases which are the major factors in crop production and reduction of both qualitative and quantitative losses in the earning of crop. Remote sensing process obtained the information about an object without coming into direct contact with the object. In remote sensing the carrier of information is electromagnetic radiation, which travels in the form of waves of different lengths. Near infrared, shortwave infrared to thermal infrared visible light, and microwave bands are the most useful wavelengths in remote sensing. Ground, airborne, or satellite-based remote sensing techniques are all possible. Variability in plant reflectance spectra arises as a result of disease, according to their methodology based on remote sensing data. Various spectroscopic and imaging approaches have been investigated for the detection of plant diseases, including visible, infrared, multiband and fluorescence spectroscopy, fluorescence imaging, multispectral and hyperspectral imaging, thermography, and so on. Phyto pathological elements of plant disease remote sensing at many scales and for varied objectives, such as spatial disease patterns, pathogen epidemic spread, and crop attributes. For the first time, remote sensing was utilized to research plant pathology in India. Coconut root wilt disease was first experimented through remote sensing by Prof.Pisharoth Rama Piscatory in Kerala.

2. DISEASE MANAGEMENT THROUGH REMOTE SENSING

- **Disease management through air borne remote sensing**

  At first aerial photography of cereal determination be used for management of diseases like wheat black stem rust, oat black stem rust, and oat yellow dwarf disease by use of panchromatic and infrared in this study.

  Identification of citrus greening disease by aerial imaging platforms or the detection of citrus greening disease using an unmanned aerial vehicle sensor and an aircraft-based sensor with a wide range of spatial resolutions [2]. Hyperspectral photos were captured using a single engine mounted on an aeroplane. Hyperspectral imaging sensor AISA (Advance Imaging Spectrometer for Applications). The classification accuracy of the UAV-based sensor was 67-85 percent, whereas the accuracy of the aircraft-based sensor was 61-74 percent UAVs at low altitudes could become a low-cost and reliable disease detection tool, according to the sensor [2]. Through this method citrus greening disease could be controlled and managed.

- **Disease management through hyperspectral remote sensing**

  Advanced wheat yellow rust disease identification can be achieved utilizing hyperspectral imaging. For increasing the quality and quantity of information the hyperspectral technology uses narrowband sensors. Using a field spectroradiometer, hyperspectral remote sensing data was obtained for winter wheat crops at various levels of disease infestation spanning the spectral range 350-2500nm. The diseased plants had a higher VIS reflectance due to decreased chlorophyll activity, and a higher absorption in the NIR due to interior leaf structural degradation [3].

  Mapping of disease infection in oil palm plantation through hyperspectral imagery Ganoderma basal stem rot disease in oil palm fields was detected using airborne hyperspectral imaging [4]. Ganoderma causes serious infection due to which there is a huge loss in the oil palm yield and reduction in the quantity of oil because of infection the damaged palms were unable to transfer water and nutrients from the roots to the stem, fronds, leaves and fruits. By root-to-root contact Ganoderma fungus can infect other oil palms. So before infecting the other oil palms, there is an immediate action to be taken and apply control measure to kill the fungus. If the disease symptoms could be detected at an early stage, before the onset of foliar symptoms, so that planters can treat the infected oil palm as soon as possible, extending the oil palm's economic life.

  Citrus canker is one of the most damaging diseases to citrus crops, posing a serious danger to their commercial viability. Citrus canker is detected using a hyperspectral imaging approach [5]. Reflectance images of citrus samples in the wavelength range of 400-900nm were captured using a hyperspectral imaging equipment. Overall

classification accuracy was 96.2% in citrus fruit with citrus canker and other problems were studied using hyperspectral imaging. Knowing before time about the concerned disease we can control the disease and bring a dynamic production and check the loss of crop through which quality and quantity of the crop could be enhanced.

- **Disease management through thermography remote sensing**

  In temperate region downy mildew of cucurbits caused by *Pseudoperonospora cubensis* is a devastating disease, where the humid condition favors for spreading of disease. Thermography's efficacy in detecting cucumber downy mildew illness before it becomes symptomatic [6]. Pathogenesis of *P. cubensis* result in changes in the metabolic process within the cucumber leaves including the rate of transpiration. A negative correlation between the rate of transpiration and leaf temperature, digital infrared thermography permitted a non-invasive monitoring and an indirect visualization of downy mildew development. The maximum temperature difference within the leaf could be quantified by spatial heterogeneity of leaf temperature. During pathogenesis MTD increases, when the necrotic tissue formed but changes in temperature of diseased leaves allowed differentiation between healthy and infected areas in thermograms even before obvious symptoms of downy mildew appeared, only under controlled conditions. So, by this pre-symptomatic thermographic detection, it is helpful to apply control measures to kill the fungus which can help the cultivators to control the disease severity.

  Management of scab disease of apple by thermographic detection. The fungus may affect both the cuticular and the stomatal conductance of the plant tissue resulting in significant modifications of leaf temperature. The fungus *Venturia inaequalis* colonises below the cuticle of apple leaves, causing apple scab disease. The effect of *V.inaequalis* on apple water balance in relation to disease stage and severity of scab is assessed using digital infrared thermography for sensing and quantifying apple scab. The maximum temperature difference of leaves increased significantly when there is a decrease in temperature of leaves due to the growth pathogen in subcuticular region where the pathogen is localized. The severity of disease and the size of infection sites with respect to scab development is strongly correlated with increase in the maximum temperature difference. With the help of thermographic detection, the severity of apple scab can be controlled by using fungicides. Through this management a high amount of apple production could be possible as it controls the severity of disease and helps the farmers to grow up their economic standards in the field of apple production in quantity and quality.

- **Disease management through satellite remote sensing**

  Narrow band indices from Hyperion satellite, EO-1 Hyperion hyperspectral imagery used to detect orange rust disease in sugarcane [7]. The pathogen *(Puccinia kuehnii*) causes severe damage to the sugarcane crop there by reducing the yield and quality of crop. Orange rust is a fungal disease which produces orange leaf lesions (pustules) and that are grouped in patches in sugarcane leaves. When the pustules ruptured, the leaves allow the water to escape from the plant, leading to moisture stress condition. Orange rust occurs when the environment is favored by warm humid conditions. The symptoms were diagonized from image datasets by observing the changes in leaf pigments, internal leaf structure and moisture content. The disease -affected areas have relatively lower reflectance values than unaffected sites in the green and NIR regions. The areas with orange rust have higher reflectance value than the areas which are not affected by orange rust in red and SWIR regions. So, it is helpful for the farmers to apply control measures before the severity of disease and they can save themselves from huge economic loss and productivity.

- **Disease management through multi-temporal remote sensing**

  Now a days monitoring of plant diseases has been conducted by remote sensing. Remote sensing has played an important role in monitoring plant disease and

making discussion for the management of plant diseases. Powdery mildew is one of the most dangerous diseases affecting winter wheat production, with potential yield losses and grain quality reductions. Remote sensing can be effective for illness detection in this case. Powdery mildew and leaf rust in wheat can be detected using high-resolution Quick bird satellite multispectral multitemporal imagery [8]. Powdery mildew has a characteristic symptom: pustules form on leaves that are light white or light yellow in colour. Such physiological and leaf colour changes can result in spectral fluctuation, with increased reflectance in visible regions and decreased reflectance in near infrared wavelengths. Powdery mildew in winter wheat could be mapped with 78 percent accuracy using multi-temporal intermediate resolution pictures. The performance of MTMF and PLSR in mapping disease severity and the area afflicted by disease is superior. This can help the farmers to identify the area and severity of disease, so that they could control the disease by applying different fungicides.

3. CONCLUSION

For effective disease management, it reduces production cost and yield returns. Any way the traditional methods of disease detection based on visual symptoms are time consuming and laborious, on the other hand the accuracy is mainly depend on the knowledge and experience of the inspector. The characteristics of disease symptoms can be processed through unmanned aerial vehicle remote sensing and that provides unprecedented spectral, spatial and temporal resolution which can distinguish disease tissue and planned, cropped areas for healthy tissue, plant and cropped areas based on the symptoms of disease. Along with UAV can be used as an innovative fungicide applicator for disease control. At low altitude, UAV sprayer can operate, flying with various speeds and low fungicides volumes which is suitable for situations where precision of fungicide applications needed for more economically and environmentally effective control of disease. For disease management, Large-scale agricultural crop growing necessitates disease identification and management that is time-based. For epidemic monitoring and forecasting, remote sensing offers a quick, precise, broad spectrum, dependable, and accurate technology that aids illness detection. Hyperspectral data taken from low altitude can be used for remote sensing have a high spectral and spatial resolution, which can be quite beneficial in detecting illnesses in green vegetation. Remote sensing technology can be used to spatialize diagnostic data, making agriculture more sustainable, safe, and cost-effective by reducing the usage of fungicides and pesticides in crop protection. With these advanced, cutting-edge technologies, a multidisciplinary approach involving plant pathology, informatics, and engineering is necessary. To conclude the above methods which are described above is very essential and effective in disease management in the field of agriculture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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