International Information and Engineering Technology Association
Advancing the World of Information and Engineering

Revue d'Intelligence Artificielle
Vol. 38, No. 1, February, 2024, pp. 331-340
Journal homepage: http://iieta.org/journals/ria

A Critical Implementation Strategy Proposed for Continuous Monitoring of Minerals in the Soil and to Identify the Diseases of Banana Plant Using Support Vector Machine

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https://doi.org/10.18280/ria.380135

Received: 13 July 2023
Revised: 1 November 2023
Accepted: 9 November 2023
Available online: 29 February 2024

Keywords:
minerals, insects, pesticides, PH levels, banana plant diseases, Support Vector Machine (SVM), micro nutrients

ABSTRACT

Agriculture is a strong foundation of economy for many agriculture-based countries like India. In the economies of many nations, including India, where banana farming is quite important, agriculture is a key component. Musa Acuminata is the scientific name for the banana, and a banana tree normally lives for about 25 years. Banana cultivation typically lasts 9 to 12 months. The persistent threat of illnesses, which can drastically affect yield and quality, is just one of the many difficulties faced by the banana industry. This study focuses on overcoming these obstacles by observing the health of the soil and detecting infections in banana plants. The yield and crop quality of bananas can be negatively impacted by a number of variables, including illnesses. Developing an efficient method for spotting diseases in banana plants is our main goal, and we're also constantly keeping an eye on the condition of the soil. The main methodology we use for identifying diseases is SVM. In addition, we use procedures for soil monitoring to measure soil pH levels, minerals, and other essential elements that affect the health of the soil. The study shows good results in identifying diseases, ensuring prompt treatments to reduce risks associated with diseases. Furthermore, strong plant growth and increased yields are facilitated by real-time soil health monitoring. By tackling the ongoing threat of illnesses in banana cultivation through SVM-based disease identification and ongoing soil health monitoring, this research offers a vital contribution to the agricultural sector. The study shows promise in identifying diseases and guaranteeing prompt actions to reduce risks associated with diseases. Furthermore, strong plant growth and increased yields are facilitated by real-time soil health monitoring. This paper is focused on both types of diseases of banana plant and minerals in the soil.

1. INTRODUCTION

Bananas are one of the main crops in Asia and the African regions. Numerous factors affects banana farming. Normal catastrophes ex- hurricanes, famine, volcanic eruptions, pollution, acid rains etc. and other factors like pest, soil pollution & infertility & insects. In present day farming.

Figure 1. Pictorial representing a banana plant (Taken from sqft)

The above Figure 1 represents the picture of banana plant in the particular field.

This paper centers around Continuous monitoring of minerals in the soil and to identify the diseases of banana plant based on health of the soil. Monitoring soil health and providing proper minerals and fertilizers improve the banana plant productivity and significantly improves and quality & prevents the plants from malnutrition diseases.

India relies heavily on agriculture, which is a vital component of its economy. The cultivation of bananas serves as a significant source of income in various regions of the country. With approximately 830.5 thousand hectares of land dedicated to banana production, the total output amounts to around 29,779.91 thousand tons. The main states engaged in banana cultivation are Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, and Gujarat. However, climate change has increased banana plant diseases such as cucumber mosaic virus, sigatoka, banana wilt, Panama disease, and bunchy top disease [1].

Traditionally, farmers have relied on expert opinions to diagnose plant diseases, which can be costly and time-consuming. Obtaining expert assistance is particularly challenging in remote areas. Hence, there is a pressing need for an automated system capable of identifying plant diseases through visible indications and providing guidance to farmers to mitigate yield losses. Various techniques for disease identification have been proposed, and among them, the Support Vector Machine (SVM) is a popular classifier for analyzing image data. While SVM is effective for binary classification, real-world problems often require classification into multiple classes. Multi-class patterns have been successfully applied in diverse fields like speech recognition, agriculture, optical character recognition, and bioinformatics [2].

A major source of food and income for many communities, bananas are an important agricultural product throughout Asia and Africa. The production of bananas has significant challenges as a result of both natural and artificial factors. Pests, degraded soil, infertility, insects, natural disasters like hurricanes and volcanic eruptions, as well as climate-related issues like famine and acid rain, are a few of these challenges. In the current agricultural climate, banana plant productivity and quality must be preserved and enhanced in order to prevent diseases associated with malnutrition.

It is difficult to undervalue the significance of studies on detecting banana illnesses and keeping track of soil health. Agriculture is a major component of India's economy, and banana growing is a significant component of that industry. Given the approximately 830.5 thousand hectares of land dedicated to their production and their annual output of nearly 29,779.91 thousand tons, it is obvious how important banana agriculture is in India. However, diseases that damage banana plants, such as Panama disease, bunchy top disease, banana wilt, cucumber mosaic virus, and sigatoka, have become more common as a result of climate change.

Since diagnosing these plant diseases can be expensive and time-consuming, farmers have long relied on qualified specialists in the field. In isolated and rural places, this reliance on specialized support raises serious issues. There is an urgent need for an automated system that can recognize plant illnesses from their visual indicators and give farmers advice in order to decrease crop losses.

This study is extremely relevant since it addresses important issues in banana cultivation, not just in India but also in places like Peru, where exports of bananas have increased significantly. Banana productivity is seriously threatened by diseases and pests like the banana weevil and Black Sigatoka, which could have an effect on overall national production levels. Therefore, to protect banana production, early diagnosis and detection of these illnesses are crucial.

A promising approach is to analyze and identify images of banana leaves using machine learning techniques, in particular Support Vector Machine (SVM) and. These innovations have effectively been used in a variety of industries, including agriculture, and they have the potential to transform disease detection and control in banana growing.

Generating a multiclass SVM model can be achieved through two approaches: one-versus-rest and one-versus-one. These models combine various multiple binary class optimized problems into a single-objective function, enabling the classification of the multiple disease categories. This study focuses on automating the identification of diseases in banana plants based on visible indications. The system takes an image of a banana leaf as input and classifies it into five possible diseases: sigatoka, cucumber mosaic virus (CMV), banana bacterial wilt, hairy rot, and Panama disease. This study includes four steps: image segmentation and preprocessing, image acquisition, classification and feature extraction [3].

Farmers have traditionally relied on professional judgments to identify crop illnesses, which can be costly and time-consuming. Obtaining expert assistance in rural areas can be particularly challenging. Therefore, a machine learning system is required to recognize plant illnesses based on their visible symptoms and provide farmers with guidance on minimizing crop losses. Support Vector Machine (SVM), One of most popular classifiers for analyzing image data, has been proposed as a disease diagnosis method in various research works. While SVM separates data into binary classes, real-world problems often necessitate classification into more than two classes. Multi-class patterns have been employed in different scenarios, including agriculture, optical character recognition, speech recognition and bioinformatics [4].

In recent years, the export of bananas from northern Peru has witnessed significant growth, with the Piura region being recognized as a primary banana export hub by the Ministry of Agriculture and Irrigation (Minagri). Peru's banana exports are predominantly organic, accounting for nearly 3% of global production, according to the FAO. Between 2010 and 2015, the production of organic bananas surged by 94%. This remarkable achievement is attributed to the national organic banana program initiated by Minagri in 1998, which aimed to facilitate the cultivation of "Valery Cavendish" organic bananas in conventional banana soils. Diseases and pests pose significant challenges to banana productivity, with Black Sigatoka being the most devastating disease and the banana weevil causing substantial damage to the banana tops. Banana marchitez has the potential to severely impact national banana production. Therefore, early identification and detection of these disorders are crucial [5].

The analysis or classification of photographs represents a deep learning application, particularly through Convolutional Neural Networks (CNNs), which are well-suited for processing 2D RGB images. Machine learning applications encompass various areas, including facial recognition, super-resolution imaging, and parameter measurement of goods. In the agricultural industry, RGB's images have been employed for the pest recognition using machine learning techniques for the several years. Hence, a potential solution would be an assistance tool that aids in the identification of banana diseases through automatic capture and analysis of plant leaf images [6].

2. ALGORITHM

The algorithm for obtaining data on temperature, relative humidity and precipitation is as follows:

1) Initial data includes real-time data for temperature, precipitation and relative humidity. Data's output to the gateway node.

2) Data received from each sensor is extracted and transmitted to the gateway node.

3) Activate a sleep thread every 20 minutes.

4) Repeat from step 3. Receive temperature, precipitation and relative humidity and sensor data for every 20 min. The time interval is determined by the requirements of banana growers and agronomists. After reading the data, the node goes into sleep mode for the next 20 minutes. Rain sensors are utilized to determine rainfall occurrence on the field, which is crucial during the rainy season. These readings provide

accurate warnings for Sigatoka disease. The soil moisture algorithm operates similarly, triggering an alert to start the water pump when the soil moisture falls outside a specific range [7].

The algorithm for Sigatoka disease alert is as follows:

1) Initial inputs include real-time readings from temperature, rainfall sensors and relative humidity. Generates Sigatoka disease attack alerts.

2) Compare real-time input values to thresholds stored in the database.

3) Continuously calculate the total number of weather data over a six-day period.

4) If the cumulative count exceeds 36 within two days, the disease severity is significant; if it exceeds 36 within four days, the severity is moderate; if it exceeds 36 within six days, the severity is normal.

5) Inform the farmer about the disease attack and its severity is based on the total number of cases. Using the above-described technique, we alert farmers to the occurrence of Sigatoka disease. This algorithm is continuously executed based on real-time field readings. The cumulative count increases by one when the temperature, relative humidity, and rainfall measurements surpass the threshold values. These counts are accumulated over a six-day period. If the count reaches 36 within two days, it indicates that the farm has experienced two days of favorable weather conditions for Sigatoka disease, such as high or extremely high relative humidity, rainfall, and suitable temperatures. Thanks to the algorithm's continuous and accurate monitoring of the WSN (Wireless Sensor Network), crop losses caused by disease attacks are prevented, and farmers receive timely warnings [8].

3. METHODOLOGY

3.1 Classification of soil

The loose material on upper layer of earth formed under specific natural conditions consisting very small particles of minerals/rocks and decayed organic matter which has ability of supporting plants to grow & thrive is known as "soil". Generally soil is composed of organic, inorganic or minerals, air and water. There are different types of soil. They are:

i. Alluvial Soil
ii. Black Cotton Soil
iii. Red & Yellow Soil
iv. Mountain Soil
v. Sandy Soil
vi. Alkaline Soil
vii. Peaty Soil
viii. Acidic Soil

3.2 Different types of soil

Soil is a valuable natural resource that's plays an important role in sustaining of life on Earth. It's a complex mixture of many minerals, water, air, organic matter, bacteria etc. providing the necessary support for plants to grow & thrive. Soil is not uniform throughout the world, they have remarkable diversity in their composition, texture, and fertility.

i) Alluvial Soil:

They are soils formed by the deposits of surface water. We can find them along banks of riverside, deltas. It is one of the best soil for crop cultivation with highest productivity w.r.t other soils & requires least water due to its high porosity and rich in potassium but poor in nitrogen. Colour of this soil changes from ash grey to light grey.

Figure 2. Sample of alluvial soil

The above Figure 2 represents the sample of Alluvial Soil which was collected in the village named as Nutakki, Vijayawada Rural, Andhra Pradesh, India.

ii) Black Cotton Soil:

Colour of black cotton soil differs from grey to deep black. It is generally clayey, deep & impermeable. This soil is extremely fertile. It is rich in elements like potassium, aluminium, iron, lime and magnesium but it is deficient in nitrogen, phosphorus and organic matter and it have great shrinkage & swelling capacity and well known for its moisture holding capacity.

Figure 3. Sample of black cotton soil

The above Figure 3 represents the sample of Black Cotton Soil which was collected in the village namely Nutakki.

iii) Red & Yellow Soil:

Red & Yellow soil is mostly found in areas having very less rainfall. It is in reddish yellow colour. The reddish colour is because of the presence of iron element in metamorphic and crystalline rocks. When this soil is in hydrated form it appears yellow. Generally such types of soils are deficient in humus and elements like phosphorous and nitrogen.

The below Figure 4 represents the sample of Red & Yellow Soil which was collected in the village Nutakki.

Figure 4. Picture of sample red & yellow soil

Figure 5. Field of red & yellow soil

The above Figure 5 represents the Field of Red and Yellow Soil which was captured in the village named as Nutakki.

iv) Mountain Soil:

It is found in the valley and sloppy regions of the mountains at higher altitudes and valleys. Generally formed by deposition of organic matter and heterogeneous in nature based on parent rocks, climate and ground configuration. The properties varies with mountainous climate and altitude. These are deficient in potash, phosphorus but high amount of humus.

v) Sandy Soil:

It is mostly found in desert areas or in dry areas with very less to no rainfall regions and at the banks of sea and oceans. The salt content is so high in this soil which makes the nature of sandy soil saline. As these soil has quick drainage of water most of the crops are not suitable to grown in this soil.

Figure 6. Field of sandy soil

The above Figure 6 represents the Field of Sandy Soil which was captured in the village namely Nutakki.

vi) Alkaline Soil:

Figure 7. Sample of alkaline soil

The above Figure 7 represents the sample of alkaline Soil which was collected in the village named as Nutakki.

Alkali or alkaline soils have poor infiltration capacity & poor structure of soil with high pH (>8). These contains high amount of calcium, sodium, magnesium. These are clay soils. The name of the soil is derived from the alkali metal group of elements where the sodium that belongs and which can induce basicity. These types of soils are referred as alkaline sodic soils.

vii) Peaty Soil:

This type of soil is formed by the accumulated decomposition of organic materials under waterlogged environment where there is lack of air supply or oxygen. It has large porosity character, low density and large water & organic matter and nutrient deficient.

viii) Acidic Soil:

It is mostly found in humid regions with heavy rainfall. Most of acidic soils are found in hilly terrains. These soils are sour & acidic in nature and have pH value less than 6.5. Such type of soils are generally have deficiency in nutrients.

Figure 8. Sample of acidic soil

The above Figure 8 represents the sample of Acidic Soil which was collected in the village named as Nutakki.

These soil samples are collected from the various farms of Village called Nuthakki, Near Vijayawada, India. A survey has been conducted by our team to analyze the soil samples and able to know the types of soils present in various regions. Each type of soil which are used for planting the banana plant has been analysed by soil testing, visual inspection. And those are been analysed because to get the detailed information of

Nutrition levels, PH values and other all important properties of soils. Visual Inspection comes under analysing the soil color, soil texture to find out the fertility and health of the soil.

Properties of soils were measured by testing the soil at initial stage and after the fertilization stage. PH value of the soils were determined on the basis of initial stage and the fertilization stage.

4. TYPES OF DISEASES FOR BANANA PLANT

Bananas are highly susceptible to a range of diseases caused by fungi, bacteria, and viruses. These diseases can have significant effect on the yield and quality of the banana crops, leading to reduced incomes for farmers and higher prices for consumers. Therefore, it is essential to monitor and manage the health of banana plants to ensure a healthy harvest.

It is caused by a type of fungus called Fusarium oxysporum f.sp.cubense and it is one of the most destructive diseases of the banana crops. The fungus infects the roots of the plant, causing them to rot and preventing the uptake of water and nutrients. This leads to wilting, yellowing, and ultimately death of plant. Panama disease can be spread through contaminated soil, water, and plant material, making it challenging to control. However, by using good sanitation practices, such as removing and destroying infected plant material, farmers can reduce spread of diseases. Additionally, monitoring the nitrogen and phosphorus levels in the soil can help prevent Panama disease, as these minerals have been shown to reduce the severity of the disease.

Now the culture is endangered by different diseases. At the moment, the use of pesticides is more efficient, but increasing the use of pesticides can treat the environment. To overcome this we can there is another way by using biological control by using natural enemies of these particular pests and it is observed that Bacillus species are more effective role of biogents [9].

Microbial inoculants and organic fertilizers have been identified for productivity and Growing plants; it is recognized worldwide as an alternative source of fertiliser. Rhizobacteria suitable for plant growth (PGPR) are used to improve nutrients and other sources of fertiliser. PGPR can improve bacterial colonization at the root surface and places where there are more microbial cells were present [10].

The diseases of banana plant are as follows as – Black Sigatoka, Panama Wilt / Banana Wilt Disease (BXW), Banana Bunchy Top (BBTV), Rhizome rot, Anthracnose, Moko disease, Tip Over, BBMV - Banana bract mosaic virus, BSV - Banana streak disease, CMV - Infectious chlorosis.

i. Black Sigatoka, Mycosphaerella leaf spot:

Black Sigatoka is another significant threat to banana crops worldwide. It is caused by the fungus Mycosphaerella fijiensis, which infects the leaves of the plant, leading to premature death of the leaf. This reduces the photosynthetic capacity of the plant, which in turn reduces yield. Black Sigatoka can be managed through the use of fungicides, planting disease-resistant cultivars, and maintaining proper nutrition levels in the soil. By monitoring soil minerals such as nitrogen, phosphorus, and potassium, farmers can ensure that their banana plants have the necessary nutrients to resist the disease.

ii. Bunchy Top (or) Curly Top:

Banana Bunchy Top Virus (BBTV) is a viral disease that affects the entire banana plant. The virus causes stunted growth, yellowing of the leaves, and a bunchy appearance at the top of the plant. BBTV is primarily spread by the banana aphid, which feeds on infected plants and then spreads the virus to healthy plants. There is no cure for BBTV, and infected plants must be removed and destroyed to stop the spread of diseases. However, farmers can reduce the danger of BBTV by using virus-free planting material, planting disease-resistant cultivars, and controlling the banana aphid population through the use of insecticides.

iii. Panama Wilt(or) Banana Wilt Disease (BXW):

Banana Wilt Disease (BXW) is caused by the bacterium Xanthomonas campestris and is characterized by wilting and death of the entire banana plant. The bacteria can be transmitted through contaminated soil, water, and plant material, and can persist in soil for several years. There is no known cure for BXW, and infected plants must be removed and destroyed to stop the wide spread of the disease. Monitoring levels of the potassium in the soil can help prevent BXW, as potassium has been shown to reduce the severity of the disease.

iv. Rhizome Rot:

The Symptoms of **Rhizome Rot: Erwinia chrysanthemum** disease are as follows - This type of disease is more noticeable in the young shoots, causing rot and rotting spells to be released, the breaking of pseudostem is familiar in later stages of infection in cultivars robusta grand nine, Early in the infection, the dark brown (or) yellow watery areas become larger in the cortex.

The management of Rhizome Rot will be as follows – Rotation of crop with sugarcane or rice should be for 3 to 4 years, you must ensure that only planted dip suckers or healthy suckers in copper oxychloride, (0.5g/lr) + monocrotophos 2.5ml/lr solution.

v. Anthracnose:

In the early stages small, round, black spots appears on the affected fruit. At this point, these spots will increases the size and turns to brown color.

The skin of the natural product darkens, turns pale and is covered with a characteristic pink acerbilin coating. Ultimately, the entire finger is affected. In the future, the disease will spread and affect the entire group.

This disease causes premature ripening as well as wrinkling of fruits which have been covered in pink spore masses. If black spots appear on the stem, then the stem will wither and your fingers will fall off your hand. Sometimes the main stem of a bunch may get sick then the infected fruits turns to black color and rot.

The spread of that disease is carried out by airborne conidia, as well as numerous insects that stay at banana flowers at frequent times.

The disease is promoted by the susceptibility to high temperatures and humidity, cuts and bruises of fruit varieties.

This disease gets appeared whenever the deficiency of the minerals get reduced.

vi. Moko disease:

The Moko Disease is also known as Bacterial Wilt.

This Disease Symptoms are as follows - The leaves gets turned into yellow and move up. The petiole is broken and the leaves droop. At the time of incision, there is a discoloration ranging from light yellow to dark brown in the blood vessel area. The discolouration will be appeared in the central part of the corm. The inside of the fruit rots and turns dark brown.

Whenever the pseudostem has been cut transversely then the bacterial ooze can be seen clearly.

These organisms can live in the plant material, in the vegetative reproductive organs, in wild hosts, and in the soil.

The best atmosphere for this disease are high temperatures and high humidity.

vii. Tip Over:

Tip Over is also known as bacterial soft rot. This disease is reportedly killing young people, resulting in rot and an unpleasant odour.

If the affected plant is stripped, it will leave the throat and then leave the light in the soil.

In the initial stage of the disease, the dark brown (or) the yellow water often appears on the skin. When the affected plant is cut, yellow or red mud appears on the neck. Plant pathogens can survive on plant debris and spread by irrigating damaged tissue. It is worse in hot, humid conditions, where the disease can spread in polluted water. Temperature and humidity are ideal for bacteria.

viii. Banana bract mosaic virus (BBMV):

Symptoms of this disease are as follows: - The disease appears from red to the red spindle group in pseudostem, in the midrib and in the pedicel.

Typical mosaic and spindle-like light mosaic stripes on the bracts, stems and on the fingers were also detected. Suckers display an unusual reddish-brown stripe as they emerge and detach the leaf sheath from the central axis. Characteristic symptoms are travel palms, elongated flower stalks, and crown leaf accumulation with the appearance of a half-double hand. The Survival and the spread of this disease are as follows - This illness is caused by a infection that has a place to the potyvirus bunch. Virions are flexible and fibrous. This disease is transmitted by aphid vectors such as Pentolonia nigronervosa, Pentolonia nigronervosa, Aphis gosypii and Rhopalosiphum Maidis. This illness is transmitted by people running outside.

ix. Banana streak disease (BSV):

Disease The symptoms of the disease are as follows - One of the main symptoms of BSV is yellow streaks that gradually die off on leaves and black streaks on older leaves.

The Survival and the spead of this disease are as follows - The virus is primarily transmitted through infected plant material, but is also believed to be transmitted by the mealybug (Planococcus citri) and, more likely, Saccharicoccus sacchari.

In shoot tip culture, shoot tips cannot be removed from the vegetatively propagated material.

x. Infectious chlorosis (CMV):

The Symptoms of this disease are as follows - In all the stages of the growth of crop, this disease shows itself.

Revaccination of infected plants spreads the virus, resulting in reduced yield and quality.

This type of diseases may occur in all the states of banana growth. There are pale yellow stripes parallel to the veins, and the stripes are visible on the leaves.

The streaks will usually runs between mid rib and edge of that blade. The type of disease was distributed by suckers and Aphis gossypi.

Source: https://vikaspedia.in/agriculture/crop-production/integrated-pest-managment/ipm-for-fruit-crops/ipm-strategies-for-banana/diseases-and-symptoms

Ripening of banana:

Ripening is one of the most important phase in agriculture. Ripening of fruits are categorized into two types either climacteric or non-climacteric. Non-climacteric fruits do not ripen off the tree after harvesting whereas climacteric fruits ripen even after harvesting. Banana belongs to climacteric fruit. Generally, bananas are green in colour and slowly turns into yellow after ripening. Bananas are ripened in chambers with controlled temperature of around 15-18 degrees, humidity, and ethylene gas at 100-150 ppm concentration with exposure time of 24 to 48 hours. The peel colour of banana transforms from green to yellow colour. When the banana peels is converted from green to yellow then the starch is converted into sugars and pulp gets soft. Bananas are well cleaned, pre-cooled and well processed at full yellow colour and exported into the market [11].

Improper temperature and insufficient amount of ethylene gas leads into problems like chilling injury & unripen bananas. It can be well noticed by observing its peel colour. Colour of banana peel is an important key to maintain the level of temperature and ethylene in ripening process. An expert operator's attention is required in this entire banana ripening process to get successful results [12].

There are also some automated process for this ripening which sorts, controls and adjusts the temperature, humidity & concentration of ethylene gas by observing the colour changes of the banana peel. Electrical methods, Spectral methods & Image processing Methods are some of the processes used to detect the level of ripeness of the fruits in this ripening process. These methods prevent and warns us if any abnormal activity occur in the process [13].

Figure 9. Stages of ripening of banana fruit

The above Figure 9 represents the stages of ripening of banana fruit of a banana tree.

Reference: Irzal Ahmad Sabilla, Cahyaningtyas Sekar Wahyuni, Chastine Fatichah and Darlis Herumurti, "Determining Banana Types and Ripeness from Image using Machine Learning Methods", 2019.

Type of earthworm in the banana tree:

Earthworms dwells in the soil and undergrounds of the earth. Generally, people use them as bait for fishing, making medicine and in agriculture. Earthworms are found in the soil around banana trees or crops, because the soil around the banana trees have plenty of moisture and with low temperature which is preferred by earthworms. Presence of earthworms benefits a lot for the banana tree habitat. Earthworms have both environmental chemical and physical requirements with optimum humidity, high organic matter etc..., [14].

The physical and chemical factors of life of earthworms are pH, moisture, temperature, soil type & structure, humidity, organic matter, porosity of the soil and limiting factors are elements of carbon and nitrogen. Existence of earthworms makes the soil more fertile and increases its porosity which helps in flowing of air into the soil and also helps water to penetrate deep into the soil and helps the tree roots to get required amount of water. Earthworms plays an important role in soil ecology as they provide plenty of organic matter through their stool and also increase the porosity of the soil [15].

5. SOIL PH

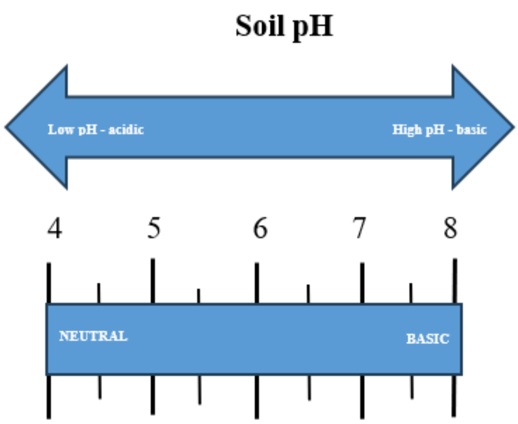

Figure 10. pH value ranges

The above Figure 10 represents the soil PH scale with a range of 4 to 10 units which was named as range from Low PH – acidic to High PH – basic.

pH Ranges:
< 4.6 Extreme acidic
4.6 – 5.5 Strong acidic
5.6 - 6.5 – moderately acidic
6.6 – 6.9 slightly acidic
7.0 – neutral
7.1 – 8.5 Moderately alkaline
> 8.5 – strongly alkaline

Soil pH is a measurement value of the acidity or alkalinity of soil and important factor in growth of the plant as it influences various soil processes, plant growth, availability of nutrients, toxicity & nature of the soil. Soil pH is expressed on a numerical scale ranging from 0 to 14 where 7 is considered as neutral, values below 7 indicates acidic soil while above 7 indicates alkaline or basic soil. pH is a fundamental property. soil pH plays a crucial role in determining the suitability of soils for plant growth, nutrient availability, and overall ecosystem health. Proper management and maintenance of soil pH are essential for maximizing agricultural productivity, preserving natural ecosystems, and ensuring sustainable land use practices.

6. MICRO NUTRIENTS AND IT'S DEFFICIENCY SYMPTOMS

Micro nutrients are essential nutrients that plants requires in small quantities for various biochemical & physiological processes necessary for healthy crop growth [16]. Soil is an important source of micro nutrients for plants. Deficiencies of micro nutrients may leads to poor growth or diseases of plants. Proper micronutrient management is essential for optimizing crop yeilds and overall agricultural productivity. Nitrogen (N), phosphorus (P) and potassium (K) are the three main nutrients, together the trio is known as NPK.

Nitrogen

It is an essential nutrient for plant growth. It is found in all plant cells, proteins, hormones, chlorophyll, etc. The source of soil nitrogen is atmospheric nitrogen. Soil with a lot of organic matter usually has more nitrogen. When there is enough nitrogen, photosynthesis occurs at a high rate.

Deficiency symptoms:-

i. Stunted growth
ii. Lower protein content
iii. Flowering is greatly reduced
iv. Leaves turning into light green to pale-yellow colour from tips followed by shedding/death based on degree of deficiency
v. Leaching
vi. Consumption by plants and other organisms

Phosphorus

It helps in transferring the sunlight energy to all parts of the plants and helps in plant growth & stimulating early root growth. All manure contains phosphorus, and its rich in source in manure from grain-fed animals. Generally concentration of phosphorus in plants ranges from 0.1% to 0.5%.

Deficiency Symptoms:

i. Overall stunned appearance
ii. Root development restriction
iii. Poor fruit & seed development
iv. Delaying of maturity
v. Matured leaves have dark to blue-green colour characteristics.

Potassium

Potassium helps by improving disease resistance of plans, helps in moving and formation of sugars, starches and oils and also improves the quality of fruits. It involves in many enzymatic reactions, involves in helping during transpiration.

Deficiency Symptoms:-

i. Slow and stunted growth
ii. Shrivelled seeds of fruits
iii. Stalks weaken and plant lodge easily

Some common deficiency symptoms are:-

Fall of pre-matured buds & leaves – deficiency of K&P.

Retarded plant growth – deficiency of N, P, K. For banana plant, pH value should be around 5.5-6.5, N:k ratio should be 1:1 or 1:1.6 depending on method and yields.

Table 1. Guide to preffered levels for bananas from a typical soil test

Phosphorous (P)	80 ppm
Potassium	0.5 meq /100g
Calcium (Ca)	4 to 10 meq / 100g
Magnesium (Mg)	1 to 3 meq / 100g
Electrical conductivity (EC)	<0.15 ds/m

Source: https://www.haifa-group.com/banana-fertilizer/crop-guide-banana-fertilizer-recommendations

The above Table 1 identifies the preferred levels for bananas from a typical soil test that describes about with respect to microlevels.

The order of nutrient uptake and removal uptake of macronutrients is (K) Potassium> (N) Nitrogen (Ca) Calcium > (Mg) Magnesium>(P) Phosphorus.

Young banana plants needs around 0.25 to 0.5 pounds of fertilizers per month. We recommend using a balanced 8-10-8 (NPK) fertilizer. In general, bananas need an average of 4 to 6 inches of water per month, or about 1 to 1.5 inches per week, depending on the season. Make sure the soil drains well and does not have standing water, as overwatering causes root rot.

Soil sample collection process:

Selecting sampling spot

-> remove surface litter

-> make a 'V' shaped cut to a depth of 15 cm

-> remove thick slices of soil from top to bottom of exposed face and place in a clean container

-> mix samples thoroughly

-> label the information (i.e location of farm, date of collection etc..,) on the container

-> send soil samples for testing.

7. COMPARATIVE ANALYSIS

At initial stage of planting the banana plant of acidic soil, the values will be as follows:

Table 2. Values at initial stage of banana plant of acidic soil

Type	Value
PH	4.90
Organic Carbon	0.76%
Available Nitrogen	389.01 kg/hector
Available Phosphorous	21.30 kg/hector
Available Potassium	452.79 kg/hector
Available Sulphur	27.32 kg/hector
Zinc	0.63 bpm
Boron	3.45 bpm
Iron	26.47 bpm
Manganese	10.34 bpm
Copper	0.58 bpm

From the above Table 2, the Above values are calculated based on the temperature and these are calculated at initial stage of planting.

After a 15 days of testing, the values may be increased or decreased. If the values are decreased then fertilizers will be added in the soil to maintain the soil fertility. Then the values will be increased.

At fertilization stage the values will be as follows:

Table 3. Values at fertilization stage of acidic soil

Type	Value
PH	4.96
Organic Carbon	0.81%
Available Nitrogen	391.01 kg/hector
Available Phosphorous	21.34 kg/hector
Available Potassium	453.7 1kg/hector
Available Sulphur	27.38 kg/hector
Zinc	0.69 bpm
Boron	3.50 bpm
Iron	26.51 bpm
Manganese	10.38 bpm
Copper	0.59 bpm

From the above Table 3, the above values are the values at fertilization stage. Compared to initial stage and fertilization stage. In initial stage, the values are getting decreased. In fertilization stage, the values are increased by adding fertilizers in the soil.

In the Table 2 and Table 3, PH value has been increased with 0.06% because at fertilization stage the fertilizers are added to increase the value. Similarly, the values of available nitrogen, Organic carbon, available potassium, available phosphorous, available boron, zinc, sulphur, Iron, Manganese, Copper values have been increased due to the addition of fertilizers in the crop to get best and accurate values [17].

As per our knowledge, here's the comparative analysis of the minerals in the soil. At the initial stage of planting the banana plant of acidic soil the values which we have got are not efficient and does not support the crop to grow. So to resolve this problem, the fertilizers will be added at later stage. Whenever the fertilizers is been added, then the values will be increased and the values we get are efficient when compared to initial stage [18]; And then the diseases will be identified based on the values which we have got while testing the soil and the diseases can also be identified based on the health of the soil.

8. IMPLEMENTATION

Figure 11. Image-1

The above Figure 11 represents the image uploader of a Banana disease predictor tool which is used to predict the banana plant disease and to predict the accuracy of banana plant.

Figure 12. Image-2

The above Figure 12 shows the type of disease and it's accuracy of a Banana plant which was uploaded in the Figure 11.

Figure 13. Image-3

The above Figure 13 shows the other type of disease and it's accuracy of banana plant.

Figure 14. Image-4

The above Figure 14 shows the other type of disease and it's accuracy of a banana plant.

This prototype has been designed using Flask web framework, SVM model, Image Preprocessing, Prediction and Static file serving. Flask web framework is used to create a web application. A pre-trained SVM model is loaded from the 'svm_model.pkl' file. This model is used for image classification. Images uploaded by users are preprocessed before making predictions. The uploaded image is resized to match the training data size (224x224 pixels). The preprocessed image is fed into the SVM model for prediction. Decision values are obtained from the model. The class with the highest decision value is selected as the predicted disease. A prediction percentage is calculated based on the decision value. The application serves static files like 'index.html' file and uploaded images.

Code:

```
from flask import Flask, request, render_template, send_from_directory, url_for
import cv2
import numpy as np
import joblib
import os

app = Flask(__name__)

model = joblib.load('svm_model.pkl')

def preprocess_image(image_path):
    img = cv2.imread(image_path)
    if img is None:
        raise Exception("Invalid image file")
    img = cv2.resize(img, (224, 224))  #
    img = img / 255.0
    return img

@app.route('/', methods=['GET', 'POST'])
def index():
    disease_name = None
    prediction_percentage = None
    uploaded_image = None
    error = None
    image_uploaded = False

    if request.method == 'POST':
        if 'file' not in request.files:
            error = 'No file part'
        else:
            file = request.files['file']
            if file.filename == '':
                error = 'No selected file'
            else:
                try:
                    uploaded_file_path = 'uploads/temp.jpg'
                    file.save(uploaded_file_path)
                    image_uploaded = True

                    img = preprocess_image(uploaded_file_path)

                    img = img.reshape(1, -1)
                    decision_values = model.decision_function(img)

                    disease_name = model.classes_[decision_values.argmax()]

                    prediction_percentage = (1 / (1 + np.exp(-decision_values.max()))) * 100

                    uploaded_image = url_for('uploaded_file', filename='temp.jpg')
                except Exception as e:
                    error = str(e)

    return render_template('index.html', disease_name=disease_name, prediction_percentage=prediction_percentage, uploaded_image=uploaded_image, error=error, image_uploaded=image_uploaded)
#BackEnd Serving
@app.route('/index.html')
def serve_index():
    return send_from_directory(os.getcwd(), 'index.html')

@app.route('/uploads/<filename>')
def uploaded_file(filename):
    return send_from_directory('uploads', filename)

if __name__ == '__main__':
    app.run(debug=True, port=8080)
```

9. CONCLUSION

The monitoring soil minerals is crucial for preventing and identifying diseases that affect banana crops. Many factors of soil such as its type, health, pH, humidity, porosity, nutrients and minerals etc.., effects the growth & production of banana crops. As per results of comparitive analysis by adding fertilizers to the soil after monitoring soil's health and minerals leads to healthier and good quality crop yeild. Essential amount of nutrients are required for crops by ensuring that the soil has the necessary nutrients, farmers can promote healthy growth and yield of their banana plants. Additionally, good sanitation practices, regular inspection of banana plants for signs of disease, and the use of disease-resistant cultivars can further reduce the risk of disease. By taking these steps, farmers can protect their crops, reduce losses, and provide consumers with high-quality bananas. These findings can be applied in real-world contexts by taking the insights from the web application which has been created using Support Vector Machine (SVM).

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