International Journal of Research in Science and Technology
Volume 9, Issue 1: January - March, 2022
ISSN 2394 - 9554

AN INVESTIGATION INTO THE PLANT PATHOLOGY: THE CAUSE BEHIND MOST COMMON PLANT DISEASES

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ABSTRACT
Plant pathology is an essential branch of plant science for its significance in crop performance and crop stability. The terminology and concepts that precede are fundamental to the research of plant pathology. These are, though, just a brief explanation of the science's terminology. The ideas and language of plant tissues may be intimidating if you have little or no experience with the topic and are just getting started. This research was carried out to suit the requirements of students at different stages of education. It's crucial to grasp the fundamentals of plant pathology, such as pathogens, disease progression, plant defense systems against pathogens, and disease prevention. Someone who works with plants will frequently need to understand why plants look odd and what, if any, management methods are necessary. This study introduces the topic of plant pathology and the knowledge it contains, which will help you comprehend how plant diseases arise and how to manage them. It also helps to understand the classification of plant diseases and also various causes of plant diseases.

Keywords: *Plant Pathology, Plant Diseases, Classification and causes of plant diseases.*

1. INTRODUCTION

Plants are necessary for life to exist. Plants provide food for humans and animals and the billions of microorganisms that live in the environment. Although man has been capable of enslaving animals and plants for his benefit, competitive microorganisms continue to resist his attempts and acquire a significant portion of the resources that man would want to utilize. In this environment, the necessity to combat competing microorganisms and other agents that cause performance loss has become apparent (Nohales et al. 2012). The assault of these microorganisms on plants altered the look and production of the crop, and this shift was referred to as an ailment. Plant ailments have long been seen as stumbling blocks to the fast advancement of food production. A plant is only considered healthy if it maintains to execute all of its regular bodily functions and produces the anticipated harvest based on its genetic capability.

A flourishing plant's physiological functions:

1. Cell differentiation, division, as well as growth are all normal.
2. Water and nutrient absorption from the ground.
3. Photosynthesis is the process of making food from sunshine.
4. Phloem and xylem transport food and water to places where they are needed.
5. Synthetic material metabolism
6. Reproduction

A few of these activities are not performed by a sick plant. The impact of an illness on an organism's performance is determined by the pathogen's initially targeted cells or organs. For instance, decaying root tissues will impair water and mineral uptake from the soil, and if vascular tissues are damaged, water and photosynthate transfer will be halted or decreased. When pathogens attack leaf tissues, photosynthesis is disrupted, and the plant struggles from a lack of carbohydrates, which are needed to provide fuel for other processes (Owens et al. 2012). As a result, illness may be described as a malfunctioning process brought on by a pathogen's constant discomfort.

"American Phytopathological society & British Mycological society, Disease is a malfunctioning process caused by continuous irritation which results in some suffering producing symptoms". As a consequence of continual discomfort from the relative importance of any substance or variable, illness is a change in either one of the regulated consecutive wide ranges of physiological activities resulting in a damage of synchronization of vigor consumption in a plant.

The disease is defined as any dysfunction of host tissues and cells due to ongoing stimulation by a pathogenic agent or an ecological element, which results in the emergence of signs. Pathogens cause these annoying procedures in several ways, all of which are interconnected:

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1. by utilizing the components of the host cell,

2. by diminishing cells because of nutrient loss

3. by causing cell death or interfering with their metabolism through their enzymes, toxins, and development policymakers,

4. by interrupting with snacks, minerals, as well as water remobilization.

Objectives of Plant Pathology:
Plant pathology is a science with four primary goals:
1. to research the non-living, living, and ecological causes of plant ailments,

2. to research pathogen illness development processes,

3. to research plant-pathogen relationships, and

4. to create strategies for managing diseases and decreasing damages suffered by them.

2. Cataloging of Plant Diseases
(i) Diseases are categorized according to their frequency of incidence:
Epidemiology is the study of plant diseases in connection to their incidence. Bacterial and infectious diseases are possible. Contagious illness is a disease that develops gradually and is caused by a communicable pathogen, while infectious disease is defined as a disease that quickly spreads.

An endemic illness is a condition that repeats year after year in varying degrees of severity. Greeneria uvicola causes grape fruit rot, which is an endemic illness in India. However, an epidemic illness, an epiphytotic infection, occurs regularly in large regions and spreads quickly (Owens and Hammond 2009). The word epiphytotic is more often associated with plant disease.

Epiphytotic illness is typically susceptible to changes in ecological circumstances, which regulate its occurrence. The pathogen may be present more or less continuously, similar to endemic illness, although favorable environmental circumstances are required for disease development.

(ii) Diseases categorized according to the evacuation medium's nature:
Seed-borne disease, Soil-borne disease, wind-borne disease, and other classifications are common. The pathogen's dispersion channel is the only thing that counts in this case.

(iii) Diseases are categorized based on which components of the host are impacted:
Plant diseases may be classified depending on the components of the host that are afflicted, as follows:

(a) stem disease, (b) Foliage disease, (c) vascular disease, (d), and boot disease are the four types of illness.

This categorization has few specific implications since it does not properly identify the type of causative agent or its impact on the host tissues.

(iv) Diseases categorized according to the hosts they affect:
It's just a question of ease to classify plant diseases according to the hosts they impact. This categorization system is not based on any fundamental principles (Purushothama 2020).

The following are a few of these ailments:

Vegetable diseases, often known as vegetable diseases, include fruit, cereal, timber, decorative plant, and shade tree diseases.

(v) Diseases categorized according to their signs:
Plant diseases are divided into three groups based on their signs:

(a) Necrotic diseases—diseases that cause the afflicted tissues to die.

(b) Diseases that cause a plant's or plant components' development to be slowed or stunted-atrophic and Hypertrophic diseases are diseases that cause the afflicted plants or organs to overgrow or grow.

Mildew disease, Blight disease, rust disease, rots, smut disease, cankers, and other illnesses are frequently named for their signs. This categorization method provides insight into the kind of harm done to the crowd and hence has some practical use.

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(vi) Diseases categorized according to the type of their causative agents:
One or more of the underlying causative factors may be blamed for plant diseases:

The First Group consists of:
(a) Bacteria, (b) Fungi are a kind of fungus, (c) Slime molds, (d) Parasitic angiosperms, (e) Viruses, (f) Algae, (g) Insects, (h) Mites, (i) Nematodes are a kind of parasitic worm.

The second group is:
(a) Nutritional problems, (b) An imbalance in soil moisture, (c) Asymmetry in light intensity, (d) Optimal temperature disproportion, (e) Gases, smoke, and other contaminants in the air, (f) Chemicals sprayed carelessly.

The first category consists of parasite causative agents, with the parasitic illness being the disease generated (Malinovsky 2020). The second category comprises non-parasitic causative agents, with the non-parasitic illness as the resulting disease.

The first category comprises a diverse range of living creatures that reside inside or are connected to the host plants, posing a health risk and resulting in death.

The degree of their parasitism varies wildly, depending on the nature of the host and parasite and their relationship. Certain parasites kill their hosts in a matter of minutes, while others may survive on their hosts for months or even years before dying.

Some parasites don't kill the host plant, but they decrease its vigor, development, and fruit output. "Some parasites do not need a lot of food from the host plant, but they develop in such a way that they obstruct the host plant's normal activities".

Plant illnesses are categorized to:
(i) have a comprehensive understanding of the disease's source or reasons,

(ii) track the disease's progression, as well as

(iii) prevent the spread of disease.

(iii) Evaluate the degree of the owner's harm.

These details are necessary for diagnosing a condition and recommending disease-control strategies. The categorization based on the type of causative agents provides sufficient data on the origin of disease development and associated facts among the different methods of classifying plant diseases mentioned above (Strahl et al. 2010). As a result, a very categorization has the most useful and is often referred to as a contemporary method of plant disease categorization. Depending on the nature of signs is the following best, and it's also constructive for diagnosing a condition.

A. Non-Parasitic Illnesses:
"Non-parasitic diseases or physiological disorders", often referred to as lack illnesses, are ailments generated by multi-causative agents. They are illnesses with distinct signs and symptoms. Even if the signs and consequences of some illnesses are well-known, the cause or mix of causes is still unknown.

I. An Unbalanced Soil-Moisture:
The overall state of water instability in sick plants is linked to a disruption in water preoccupation, transportation, and a disruption in other fundamental activities, including glucose and nitrogen metabolism, breathing, and mineral intake. It's fair to assume that a disease's main impact is on the water position of the cells, which manifests itself in different imbalances in metabolic processes, eventually leading to a gradual worsening of essential functions and death. It is not an exaggeration to state that plant life's fire burns in water (Dimitriu 2019).

Various plants have various responses to changes in soil wetness. The most visible consequence of water deprivation is a loss of form in "herbaceous plant tissues" owing to turgor loss, which manifests as wilting, die-back, and other symptoms. A lack of water leads to a halt in growth and a reduction in auxin production. The actual body of the soil influences not only its water retention ability and aeration, but it may also inhibit root development, resulting in short and weak plants if it is suitably hard and packed.

A few of the signs owing to soil-moisture imbalance are:

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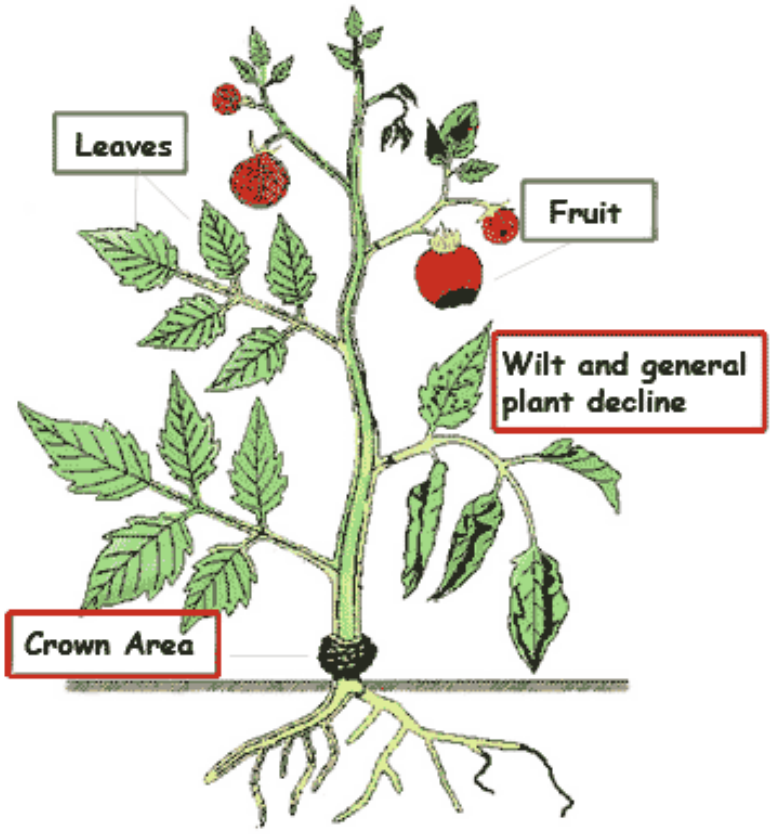

Figure 1: Verticillium wilt of tomato

(i) Die-back

(ii) Wilting

(iii) Scorch

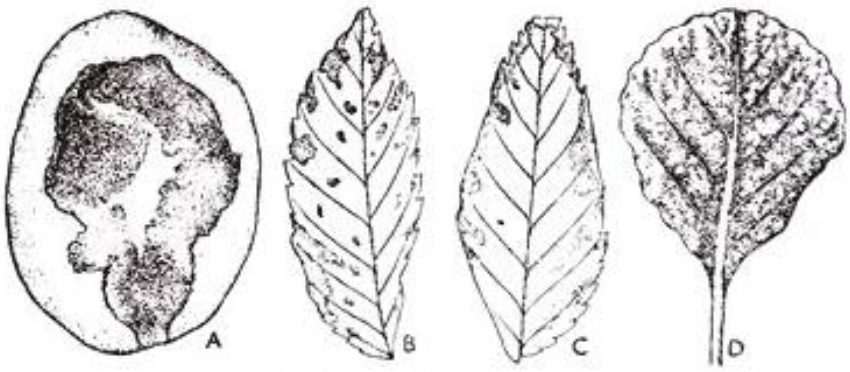

Figure 2: symptoms of the non-parasitic disease. A. Blackheart of potato. B-C. Scorch of leaves. D. Iron-deficiency disease of cabbage.

(iv) Blast

(v) Firming

(vi) Dropsy

(vii) Blossom-end rot

II. Nutritional Disorders:

Plants develop irregularities of one type due to either a severe lack of supply or an abundance of necessary components, disrupting the normal nutritive processes. Mineral deficiency or mineral-excess disorders are the terms used to describe these anomalies. Chlorosis, yellowing, defoliation, resetting, black patches, and

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other symptoms are signs of these illnesses (Gupta 2000). Only the most popular, extensively used, and readily recognized ones are covered in this article.

Plants may be harmed by the unsuitable chemical composition or pH of the soil. Some plants can tolerate a certain amount of alkalinity or acidity, but most thrive in a neutral or slightly acidic environment. Unfavorable pH causes poor development and, in rare cases, demise. It has a secondary impact on the accessibility of mineral components in the soil to plant origins, such as reducing the accessibility of iron and manganese in calcareous soils. Excessive acidity may occasionally be corrected by adding lime, while high alkalinity can be rectified more difficultly by adding sulfur, but this might have phytotoxic consequences. Irrigation may occasionally wash away the salts that cause the unfavorable ph.

Plants with poor mineral nutrition are more likely to be attacked by pathogens. Phytophthora infestans-caused potato blight is reported to be more unadorned on plants developing in "magnesium-deficient soil". At the same time, too much nitrogen causes 'soft' plants that are more vulnerable to diseases and pests.

(i) Iron-deficiency diseases

(ii) Boron-deficiency diseases

(iii) Potassium-deficiency diseases

(iv) Phosphorus-deficiency disease

III. TEMPERATURE EFFECTS:

Every developing plant has its own natural development temperature assortment. Because temperature impacts virtually every aspect of life, any change above or below this causes abnormalities (Green, 2015). The different symptoms of illnesses caused by high temperature and low reflect these growth abnormalities.

The severity of the signs is also determined by the kind of plant, the sections of the plant that are afflicted, and the degree of temperature fluctuations.

(i) High-temperature effects

(ii) Low-temperature effects

IV. Effects of Alteration in Concentration and Quality of Light:

Concentrated or amplified intensities and any significant shift in light quality cause the illness to manifest itself in a variety of ways. Reduced light intensity encourages succulent growth, producing internodes that are longer than usual and becoming feeble in physical construction, and inhibiting chlorophyll synthesis, leading to etiolation, which is a fairly common symptom (Bergmiller et al. 2017). Whenever the environment is clean, for instance, short waves touch the bottom with higher strength, causing sunscald to the leaves and seeds of crops.

V. Impact of Atmospheric Filths:

Plant components are severely damaged by gas, smoke, and other air contaminants in the environment. Unfavorable air and soil circumstances resulting from commercial operations are often detrimental to farms, including cover plants. Most of these dangers are avoided by forest plants (Ignatov et al. 2015). In young succulent plants that are sensitive to certain of the components of illuminating gas, death or damage is often caused by the leakage of artificial lighting gas into the soil or by the release of vapor overheating the soil.

Smoke has a significant impact on forest trees. Sulfur dioxide regularly causes considerable damage, and the signs, ranging from yellowing and reddening of leaf tissues to defoliation and adversely affecting. Smoke harm is triggered by gases emerging from imperfect coal combustion, from the smelting of ores that usually contain sulfur, and the smelting of ores usually contains sulfur.

Three stages of smoke injury are recognized:

(i) The acute stage, caused by a high density of thick smoke, creates rapid discoloration of the foliage, accompanied by defoliation and, in serious situations, plant death;

(ii) The chronic stage, caused by small amounts of gas present in the environment, allows plants to be harmful, manifested by developmental problems; and

(iii) The unknown stage, caused by the action of gas in a minimal concentration, allows plants to be unnoticeable.

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VI. Impacts of Fungicides and Insecticides:
Some chemicals, such as fungicides and insecticides, whenever sprinkled on plants as a component of an improved planting strategy, may cause damage, especially to the leaves, if proper precautions are not followed (Kakizawa et al. 2006).

The damages are characterized by discoloration of the afflicted areas, aberrant growth, and unusually fast growth of specific leaf sections, all of which are caused by the negligent application of pesticide 2, 4-D. "Resetting in apples may be induced by parathion"; incorrect use of Bordeaux mixture mists can produce burning and noticeable discoloration.

B. Parasitic Diseases:
Parasitic illnesses are diseases caused by parasitic causative agents. The progression of a parasite illness caused by parasitic causative agents like fungus, bacteria, slime molds, and viruses follows a cyclic pattern called the disease wheel. The disease cycle's series of events is highly conditioned able. The illness cycle, on the other hand, is divided into two phases: dormant and active.

The causative agent (pathogen) stays latent throughout the dormant phase and resists the adverse circumstances in the perennating organs. "Such perennating organs may be spores in various forms, vegetative cells in rest, mycelium in rest, virus particles, and so forth". The perennating organs may stay in or on the host's spreading organs, sick plant residues, soil, collateral hosts, insect bodies, and so forth (Uenoyama et al.2005). When favorable environmental circumstances are present, the pathogen becomes active. The active phase begins, as well as the perennating organs generate the main inoculum.

When illness strikes, the quality, intensity, and epidemic potential are determined by the interplay between the host, pathogen, and surrounding environment.

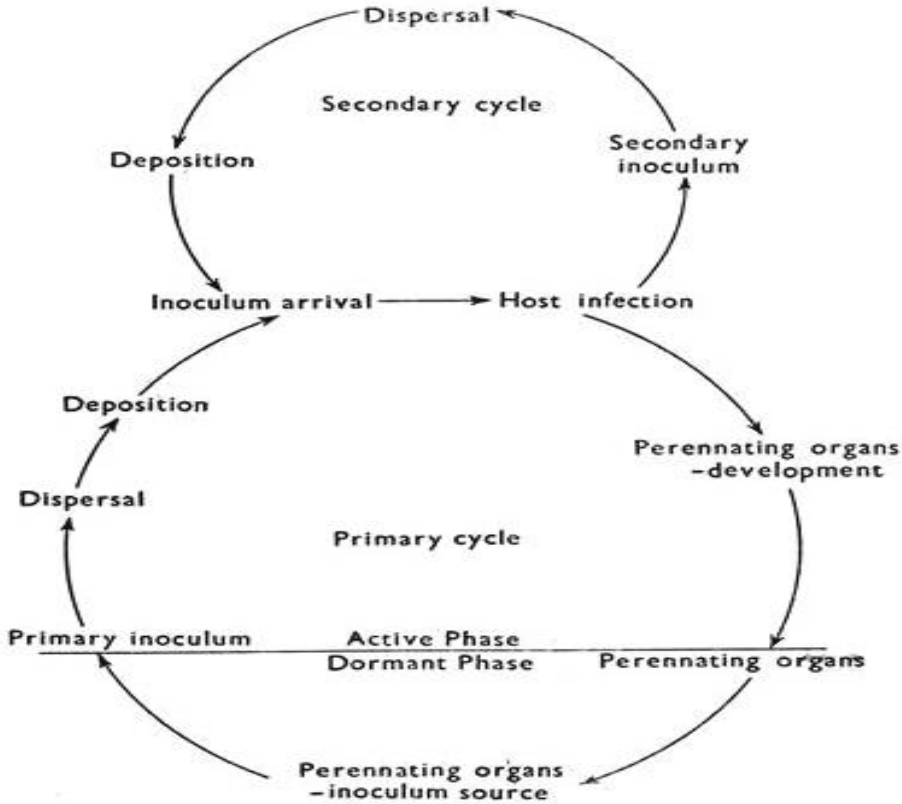

Figure 3: General pattern of the disease cycle

3. Causes of Plant Diseases
Pathogenesis and sporogenesis
The phase of disease pathogenesis occurs when the pathogen is in close contact with live host tissue. There are three main phases associated:

1. Inoculation: pathogen transmission to the infectious disease court, or area where the plant is invaded.

2. Incubation: the period between the pathogen's entrance in the infected chamber and the onset of signs.

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3. Infection: the onset of illness signs, followed by the development and propagation of the pathogen.

Regarding their capacity to infect, virulence is one of the most significant properties of pathogenic organisms (Shaevitz 2005). A variety of factors influences a pathogen's capacity to propagate through and damage tissue. "Toxins that kill cells, enzymes that break cell walls, extracellular polysaccharides that impede the flow of fluid through the plant network", and chemicals that disrupt healthy cell development are all examples of virulence determinants.

EPIPHYTOTIC

An illness is considered to have become epidemic when the number of persons it affects significantly rises. Epiphytotic ("on plants") is a more specific word for plants, whereas epizootic ("on animals") is the equivalent term for animals. Enphytotic (endemic) illnesses, on the other hand, happen at fairly consistent levels in the very same region every year and pose minimal worry.

Environmental factors affecting disease development

Learn how diseases infect plants by watching rainfall droplets splash from leaf to leaf.

"Temperature, relative humidity, soil moisture, soil pH, soil type, and soil fertility are all significant ecological variables that may influence the development of plant diseases and decide whether they become epiphytic".

TEMPERATURE

Every pathogen has a growing temperature that it prefers. Furthermore, various phases of fungal development, like the generation of spores, their germination, and the development of the mycelium, may have somewhat varied optimal temperatures (Kube et al. 2008). Certain fruits, vegetables, and nursery stock are stored at different temperatures to prevent fungus and bacteria that induce storing rot, as long as the temperature does not affect the integrity of the goods. There is little that can be done to regulate air temperature in areas, apart from minimal frost cover. However, greenhouse temperatures can be controlled to prevent disease growth.

RELATIVE HUMIDITY

In the sprouting of fungal microorganisms, besides the growth of storage rots, relative humidity is crucial. Even though the storage temperature is optimal for pathogen development, "Rhizopus soft rot of sweet potato is an instance of a storing illness that does not grow if the relative humidity is kept at 85% to 90%". The sweet potato root develops suberized tissues that block off the Rhizopus fungus under such circumstances.

SOIL MOISTURE

In the growth of some root rot infections, lower or higher soil moisture may be a major bottleneck. High soil moisture encourages the growth of harmful water mold fungus-like Aphanomyces, Pythium, and Phytophthora species shown in fig 4. "Overwatering houseplants is a frequent issue". Drenching renders roots more vulnerable to root-rotting organisms by reducing oxygen and increasing carbon dioxide concentrations in the soil (Kumari et al. 2019).

Figure: Potato's (*Solanum tuberosum*) harmful water mold fungus

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SOIL PH

Soil pH measures acidity or alkalinity and has a significant impact on a few illnesses, including typical potato scab and crucifer clubroot. A pH of 5.2 or slightly below inhibits the development of the potato scab organism (Zeilinger et al. 2016). Whenever the normal soil pH is about 5.2, the scab is usually not an issue. To maintain the pH of their potato soil at 5.0, some growers apply sulfur. On the other side, Crucifer clubroot is often managed by carefully adding "lime into the soil until the pH reaches 7.2" or above.

SOIL TYPE

Loam soils favor convinced diseases, whereas clay soils favor others. In the southern US, "Phymatotrichum root rot affects cotton and over 2,000 other plants". Especially black alkaline soils with a pH of 7.3 or above and little organic content are dangerous to this fungus. In lighter and higher soils (Karandashov et al. 2004), the Fusarium wilt infection, which affects many cultivated plants, produces greater harm. In lighter soils that warm up rapidly, nematodes are also the most destructive.

SOIL FERTILITY

Increasing or decreasing the thresholds of some of these nutrient aspects needed by plants has been displayed to affect the future of some infectious diseases, such as "fire blight of apple as well as pear, stalk rots of corn or even sorghum, Septoria diseases, Botrytis blights, powdery mildew of wheat, and northern leaf blight" of corn, in greenhouse and field studies (Wang et al. 2014, Lamichhaneet al. 2015). Such diseases and a slew of others become more damaging when an overabundance of nitrogen fertilizer is applied. Potash, a potassium-based fertilizer, may frequently be used to alleviate this problem.

4. CONCLUSION

When it comes to diagnosing a plant disease, comprehending the differences between a symptom and a sign is crucial. Plant disease cannot emerge if a vulnerable host, pathogen, and favorable environment are not present simultaneously. Fungi, bacteria, viruses, and nematodes are the most common plant pathogens that cause illness (Scherbakova 2019, Freeman et al. 2014). The disease cycle explains the pathogen's relationship with the host. In the field of plant science, there are a staggering number of words and meanings, most of which you may never encounter. Terms and titles will be brought to fruition and become known to you due to your curiosity, research, and practice. Don't stress more about infections and illnesses' scientific names; yet, don't be frightened of them either (Martinelli et al. 2015). The more you know about the topic, the more at ease you'll be interacting with your peers and the general public. With time, you'll begin to see trends in pathogen and illness names as well as biology. Such principles will provide you with a broad understanding of the science and a basis on which to develop your expertise. We've all experienced the sensation of being swamped by fresh knowledge.

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