

Principles of Plant Pathology

PLP 315, Cr. hrs. 3+1.5

Summer Term 2020

Principle: A basic idea or rule that explains or controls how something happens or works.

Plant Pathology:

Plant pathology or phytopathology is the science, which deals with the plant diseases. It is concerned with health and productivity of growing plants. Phytopathology (Greek: *Phyton* = Plant + *Pathos* = Disease, Ailments + *Logos* = Discourse, Knowledge) is the branch of agricultural, botanical or biological science which deals with the causes, etiology (etiology; the cause of a disease or abnormal condition), epidemiology, resulting in losses and management methods of plant diseases.

Plant disease:

Plant diseases are recognized by the symptoms (external or internal) produced by them or by sick appearance of the plant. The term plant disease signifies the condition of the plant due to disease or cause of the disease. Plant disease is mainly defined in terms of the damage caused to the plant or to its organ. The other definitions for the term disease are:

- Disease is a malfunctioning process that is caused by continuous irritation, which results in some suffering producing symptoms. This definition is accepted by both American Phytopathological Society and British Mycological Society.
- Any malfunctioning of host cells or tissues that results from continuous irritation by a pathogenic agent or environmental factor and leads to development of symptoms.
- Any physiological abnormality caused by biotic or abiotic stress which expressed as symptoms.

Objectives of Plant Pathology:

1. To acquire knowledge about biotic plant pathogens and abiotic environmental factors, which are responsible for causing diseases.
2. To study the mechanisms of disease development by pathogens.
3. To study the plant (host)-pathogen interaction in relation to environmental factors.
4. To adopt suitable methods of preventing or controlling the diseases, thereby reducing the damage caused by the pathogens.

History of Plant Pathology

Since organized agriculture developed 4000 years ago, special attention was given to plant diseases and pests. Symptoms such as blight, wilt and root rot etc. were known to the people at that time.

The occurrence of plant diseases and their control were written in the holy book *Rigveda*, *Atharvaveda* (1500-500 B.C.)

The Greek philosopher Theophrastus (370-286 B.C.) was the first who studied and wrote about diseases of trees, cereals and legumes. In his book '*Enquiry into plants*' Theophrastus has recorded his observations, imaginations and experiences but they were not based on any experiments.

Micheli (1729), Tillet (1755) and Prevost (1807) worked on bunt disease of wheat and proved that it is caused by a fungus and the fungus is seed borne.

The foundation of modern experimental plant pathology was laid by the German scientist Heinrich Anton de Bary (1831-1888). He made a great contribution to the understanding of science of Plant Pathology and is suitably regarded as **Father of Modern Plant Pathology**. Anton de Bary (1861) worked out the life cycle of potato late blight and first to prove experimentally *Phytophthora infestans* is the cause of potato late blight. The disease caused devastating epidemics for which millions of people died in Ireland in 1845-46. It caused famine in Ireland and millions of peoples migrated to USA.

de Bary (1853) also established that smut and rust diseases are caused by fungi.

Brefeld (1884 -1912) contributed to plant pathology by introducing and developing modern techniques for growing microorganisms.

Millardet (1885) discovered the Bordeaux mixture (mixture of copper sulphate and hydrated lime) as an effective fungicide to control downy mildew of grape caused by *Plasmopara viticola* which damaged grape in Europe specially in French during 1878.

Ward (1882) investigated coffee rust caused by *Albugo candida* in Ceylon which completely damaged coffee cultivation in Ceylon.

In 1929 Sir Alexander Fleming isolated the antibiotic, Penicillin from the fungus, *Penicillium notatum*. He got the Nobel Prize in 1945.

Tisdale (1934) discovered dithiocarbamate fungicide (Thiram) to control fungal diseases.

In 1675 the Dutch worker Anton van Leeuwenhoek developed the first microscope and in 1683 he described bacteria seen under with this microscope.

Louis Pasteur and Koch (1876) proved that the animal (cattle) anthrax disease is incited by a bacterium.

Burill (1878) showed that fire blight of pear and apple is caused by a bacterium.

Biffen (1905) worked on rust disease resistance in two wheat varieties.

In 1972 Windsor and Black observed rickettsia in the phloem of cover plants.

The first report of plant parasite nematodes was in 1743 by Needham who observed nematodes within wheat galls. Root knot nematodes were discovered in 1850.

In 1886 Mayer reproduced tobacco mosaic disease by infecting juice from infected tobacco plant into healthy plant. Beijerinck (1898) finally concluded that tobacco mosaic caused not by a microorganism but by a *Contagium vivum fluidum* which he called a virus.

W. M. Stanley (1935) proved that viruses can be made as crystals. He got the Nobel Prize in 1946.

Diener (1971) discovered viroid while he was working potato spindle tuber disease.

In 1967 Doi and his colleagues in Japan discovered mycoplasma as a cause of plant disease.

Scope of Plant Pathology:

Plant pathology is related to many other sciences such as Botany, Plant Anatomy, Plant Physiology, Mycology, Bacteriology, Virology, Nematology, Genetics, Molecular Biology, Genetic Engineering, Biochemistry, Horticulture, Tissue Culture, Soil Science, Forestry, Physics, Chemistry, Meteorology, Statistics etc., all of which provide the knowledge required for the correct diagnosis and management of plant diseases.

Importance of Plant Diseases:

Globally, enormous losses of the crops are caused by the plant diseases. The loss can occur from the time of seed sowing in the field to harvesting and storage. About 34% of the crop yield is lost annually due to diseases, insect-pests and weeds on the global basis (Cramer, 1967); out of which, 12% is lost due to diseases (caused by fungi, bacteria or viruses), 11% due to nematodes, 7% due to insect-pests and 3% due to weeds. When plant protection measures are not implemented, annual loss of 30-50% are common in major crops including horticulture (Encyclopedia Britannica, 2002)

Epidemics

Late blight of potato caused by *Phytophthora infestans* was responsible for causing Irish famine in 1845 by destroying the potato crop, the staple food of the people. Hundreds of thousand people died of hunger and disease, and there was a large scale migration of the population to other countries including North American continent. The population of Ireland was 8 million in 1840, which was reduced to 4 million after the famine. This single disease forced man to realize the importance of plant diseases, and brought the science of Plant Pathology to lime light.

Other Famines:

- Wheat rust epidemics occurred from time to time in many countries. Wheat rusts forced farmers to change their cropping pattern and wheat was replaced by corn or maize or rye.
- Brown spot of rice caused by *Bipolaris oryzae* was responsible for Bengal famine in 1943, which many people think one of the reasons for the division of Bengal.
- Coffee rust caused by *Hemileia vastatrix* forced to cut down the coffee plants in Sri Lanka in 1867.
- Powdery mildew of grapevines caused by (*Erysiphe necator*), by 1854, reduced the French wine production by 80 per cent.

Impact on Society:

- Infected grains or the fruits may contain toxins (such as aflatoxin, fumonosin etc.) which cause insanity, paralysis, stomach disorder and liver cancer.
- The money spent on the management of plant diseases is also a loss because in the absence of diseases this money could be saved.
- There are many other implications on the transport and agro-based industry in the event of plant disease inflicted yield loss.
- There is restriction on the movements of food grains and other agricultural products due to the threat of quarantine pathogens and pesticide residues in the products causing further loss.