Jones (1905)	Reported the role of cytolytic enzymes in soft rots caused by bacteria.
Brown (1915)	Recognized role of pectic enzymes, followed by discovery of the role of cellulases.
Tannka (1933)	Gave the first experimental proof of role of toxins in black spots of pear caused by *Alternaria*.
Orton (1900–1909) and Biffen (1905–1912)	Were pioneers in the field of resistance breeding.
Biffen (1905)	Described inheritance of resistance to yellow rust in two varieties of wheat and their progenies on the basis of Mendelian laws of inheritance.
Orton (1909)	Worked with wilt diseases of cotton, watermelon and cowpea. Developed varieties resistant to the disease and distinguished disease resistance from disease escape and disease endurance (tolerance).
Erickson (1894)	The phenomenon of variability among fungi was first discovered when he reported the existence of physiologic races in the rust fungi.
Ward (1903) and Salmon (1903–1904)	They discovered physiologic specialization in fungi causing rust and powdery mildew of cereals.
EC Stakman (in the second decade of the twentieth century)	After prolonged studies he came to the conclusion that due to continuous evolution of races and biotypes in botanical species of the rust fungi their pathogenic capability goes on changing in their favour and as a result the resistance capability of the host also shows changes. Resistance to disease in plants was considered to be due to presence of some toxic substances in the host.
Flor (1946)	He, working with linseed (flax) rust advanced the gene for gene concept of disease resistance and susceptibility. According to him susceptibility to a disease depends on compatibility of genes in the host and the pathogen. For every gene controlling resistance or susceptibility in the host there must be matching genes for avirulence or virulence in the pathogen. This gene for gene relationship is now proved in a large number of host-disease systems. Wherever genetic information is sufficient in both the host and the pathogen it is usual to find a gene-for-gene relationship between the avirulence gene in the pathogen and the resistance gene in the host.
Gallmann (1946)	The phenomenon of resistance through hypersensitivity was reported.
Miller (1961) and Cruickshank (1963)	They confirmed accumulation of antimicrobial plant metabolites called *Phytoalexins* during pathological processes and their role in resistance.
van der Plank (1963)	He suggested that there are two kinds of resistances: One, controlled by few 'major' genes is strong but race specific (vertical resistance) and the other determined by many 'minor' genes is weaker but effective against all races of a pathogen species (horizontal resistance). The plant cell structures and substances that impart resistance are controlled by genes.

Society, Ottawa, Canada. Website at http://www.cps-sep.ca/

"Mycological Research" published by the British Mycological Society, U.K. Website at http://www.uk.cambridge

"Molecular Plant Pathology" online-the British Society for Plant Pathology runs an e-journal Website at http://www.bspp.org.uk/mppol

"Physiological Plant Pathology" from U.K.

"Phytopathologia Mediterranea" Italy

"Phytopathologische Zeitchrift" Germany

"Zeitschrift für Pflanzenkrankheiten and Pflanzenscutz" Germany

"Journal of Bacteriology" Website at www.journal.asm.org

"Journal of Virology" Website at http://gvi.asm.org/

"Review of Plant Pathology"U.K. Website at http://uk.cambridge

"Tropical Pest Management"

CAB International had launched database of plant pathology literature CABI publication Website at http://www.calbi.org.

Several other journals publishing articles of plant pathological importance are:

American Journal of Botany, Annals of Botany, Annals of Phytopathology, Annals of Applied Biology, Canadian journal of Botany, Journal of Experimental Botany, New Phytologist and journals from Elsevier's and Academic Press.

Some important Plant Pathology journals from India are:

"Indian Journal of Mycology and Plant Pathology", Udaipur, Rajasthan

"Indian Journal of Plant Pathology", Lucknow

"Indian Phytopathology", New Delhi.

International Centers for Agricultural Research

Centers Funded by the cooperation of Rockefeller and Ford Foundations and local governments are:

International Rice Research Institute (IRRI) in Philippines (1960).

International Maize and Wheat Improvement Center (CIMMYT) in Mexico (1966).

International Institute of Tropical Agriculture (IITA) in Nigeria (1968).

International Center of Tropical Agriculture (CIAT) in Columbia (1969).

Further finances for additional centers were met by joint collaboration of World Bank and Rockefeller and Ford Foundations. They set up a consortium of potential donors from wealthy countries, development banks and other agencies. The consortium, known as the Consultive Group on International Agricultural Research (CGIAR) receives help in determining research priorities from technical advisory committee, which consists of 13 scientists and economists. Additional centers established by this group are:

International Potato Center (CIP) in Peru (1972).

International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in India (1972).

Asian Vegetable Research and Development Center (AVRDC) in Taiwan (1972) is not funded by consortium.

More recent centers include:

International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria.

International Food Policy Reasearch Institute (IFPRI)

International Plant Genetic Resources Institute (IPGRI)

International Livestock Research Institute (ILRI)

International Center for Research in Agro forestry (ICRAF)

International Service for National Agricultural Reasearch (ISNAR)

International Irrigation Management Institute (IIMI)

International Center for Living Aquatic Resources Management (ICLARM)

Center for International Forestry Research (CIFOR)

West Africa Rice Development Association (WARDA) in Gold Coast.

		to survive and maintain its ecological niche.
1989	Singh et al.	A sum total of the altered and induced biochemical reactions in a system of the plant or plant part brought about by any biotic or abiotic factor(s) or a virus leading to malfunctioning of its physiological processes and ultimately manifesting gradually at cellular and/or morphological level. All these alterations should be of such a magnitude that they become a threat to the normal growth and reproduction of the plant.

1. **Disease is a malfunctioning process:** This can be better understood if the chain of events is taken into consideration. The first step is mutual recognization of host and parasite as compatible partners. Positive recognition is essential for establishment of genetic and subsequent physiological synchrony. This leads to series of biochemical changes in the host. Several biochemical reactions are induced, intensified inhibited or altered in integrated manner to support growth of pathogen. On the other hand, pathogen not only draws nourishment from host to support its growth and reproduction but also interacts with host resulting in synthesis or release of various types of enzymes and toxic metabolites detrimental to the host. If these alterations are beyond the tolerance limit of host, the latter suffers at its physiological, cytological and/or morphological level resulting in different types of symptoms and syndrome depending upon host and pathogen involved. Biochemical alterations are also observed in the host plants due to abiotic causes like herbicides, nutritional deficiencies, toxins and pollutants, etc. These changes result in malfunctioning of its physiological processes which are manifested at morphological level. As biochemical alterations preceded by physiological changes resulting in cytological and morphological alterations hence, it can be concluded that disease is synonymous to altered and induced biochemical changes which result in malfunctioning of host brought about by an invading pathogen and resulting in disease. This seems to be a convincing statement.
2. **Disease is a continuous irritation/interaction between host and pathogen:** There are two terms disease and injury. Disease is a dynamic process as it involves action and interaction between host and pathogen, whereas injury represents a static state. Certain situations as injuries caused by extreme hot or cold temperatures, pollutants or damage caused by stem borer are of such a magnitude to lead to the malfunctioning of physiological processes of plants beyond their tolerance level, and then it will lead to development of some morphological and cellular deviation. Similiarly, instead of the primary incitant (pathogen) if the host-specific toxins, nutritional deficiencies, insect toxemias and toxicities caused by air pollutants result in alterations in host. Thus, the question arises that what should be considered as a threshold point to demarcate between transient and continuous interaction. This leads to the conclusion that there is not much justification in including the concept of continuous interaction or association in definition of plant diseases.

"Disease" can be defined as "a sum total of the altered and induced biochemical reactions in a system of a plant/plant part incited by abiotic/mesobiotic/biotic factor(s) leading to malfunctioning of its physiological processes and ultimately manifesting gradually at cytological and/or morphological levels. This alteration should be of such a magnitude that

Chapter 4

Importance of Plant Diseases

Plant diseases damage plants and their products on which humans depend for food, clothing, furniture, housing and the environment. Plant diseases can make a difference between a happy life and a life haunted by starvation and hunger. The death from starvation of a quarter million Irish people in 1845 and Rice Famine in 1943–44 in Bengal are examples of consequences of plant diseases. Plant diseases may cause annihilation, devastation, disfiguring and limitations. Some of the major effects of plant diseases are:

1. May limit the kinds of plants and industry in an area.
2. May reduce the quantity and quality of plant produce.
3. May make plants poisonous to humans and animals.
4. May cause financial losses, and
5. The cost of controlling is also a direct loss.

DAMAGE AND LOSS

Zakok (1970, 1973) has suggested a classification of losses (Flowchart 4.1) that describes the complexity and interdependence of loss at all levels of society. He also proposed three useful concepts for describing the dynamics of crop destruction. They are:

1. **Injury:** Any observable deviation from the normal crop; injury may lead to damage.
2. **Damage:** Any decrease in quantity and quality of a product, damage may lead to loss.
3. **Loss:** Any decrease in economic returns from reduced yields and cost of agricultural activities designed to reduce damage.

EPIDEMICS AND HUMAN AFFAIRS

Plant disease epidemics have influenced man's food, his health, his social customs, his economics, etc.

1. **Epidemics—human culture:** Following epidemic diseases have replaced the industries, cropping system and food habits of people.
   a. ***Butternut canker:*** Butternut trees native to North America have been used for furniture and for carving. In 1967, the trees in Iowa developed multiple cankers on stem and branches leading to death. The disease caused by *Sirococcus clavigignenti-jugalandacearum* nearly killed 80% of the butternut trees by the mid-1990s.
   b. ***Chestnut blight:*** The destruction of majestic American chestnut is perhaps the best known epidemic. The trees produced delicious nuts and decay resistant timber for the natives as well as tannin for leather preservation. The trees filled several hundred miles in width and extending from the states of Georgia and Mississippi to