**Unit 3: Plant disease epidemiology**

**Disease Triangle and Pyramid**

A plant becomes diseased in most cases when it is attacked by a pathogen or when it is affected by an abiotic agent.

There is three components in development of disease in plants.

First two component- For a plant disease to occur, at least two components (plant and pathogen) must come in contact and must interact.

Third components- a set of environmental condition within a favorable range, must also occur for a disease to develop.

Each of the three components can display considerable variability; however, as one component changes it affects the degree of disease severity within an individual plant and within a plant population.

For example, the plant may be of a species or variety that may be more or less resistant to the pathogen or it may be too young or too old for what the pathogen prefers, or plants over a large area may show genetic uniformity, all of which can either reduce or increase the rate of disease development by a particular pathogen.

Similarly, the pathogen may be of a more or less virulent race, it may be present in small or extremely large numbers, it may be in a dormant state, or it may require a film of water or a specific vector.

Finally, the environment may affect both the growth and the resistance of the host plant and also the rate of growth or multiplication and degree of virulence of the pathogen, as well as its dispersal by wind, water, vector, and so on.

**The interactions of the three components of disease have often been visualized as a triangle (Fig. 2-1), generally referred to as the “disease triangle.”**

**Each side of the triangle represents one of the three components. The length of each side is proportional to the sum total of the characteristics of each component that favor disease**

**For example, if the plants are resistant, the wrong age, or widely spaced, the host side — and the amount of disease — would be small or zero, whereas if the plants are susceptible, at a susceptible stage of growth, or planted densely, the host side would be long and the potential amount of disease could be great. Similarly, the more virulent, abundant, and active the pathogen, the longer the pathogen side would be and the greater the potential amount of disease. Also, the more favorable the environmental conditions that help the pathogen (e.g., temperature, moisture, and wind) or that reduce host resistance, the longer the environment side would be and the greater the potential amount of disease.**

**If the three components of the disease triangle could be quantified, the area of the triangle would represent the amount of disease in a plant or in a plant population. If any of the three components is zero, there can be no disease. The disease triangle is also represented as a triangle with the words of the three components (host plant, pathogen, environment) placed at the peaks of the triangle rather than along its sides.**

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When a pathogen spreads it affects many individuals within a population over a relatively large area and within a relatively short time, the phenomenon is called an epidemic. An epidemic has been defined as any increase of disease in a population. A similar definition of an epidemic is the dynamics of change in plant disease in time and space. The study of epidemics and of the factors that influence them is called epidemiology.

 Epidemiology is concerned simultaneously with populations of pathogens and host plants as they occur in an evolving environment, i.e., the classic disease triangle. As a result, epidemiology is also concerned with population genetics of host resistance and with the evolutionary potential of pathogen populations to produce pathogen races that may be more virulent to host varieties or more resistant to pesticides. Epidemiology, however, must also take into account other biotic and abiotic factors, such as an environment strongly influenced by human activity, particularly as it relates to disease management.

To describe the interaction of the components of plant disease epidemics, the disease triangle, describes the interaction of the components of plant disease, can be expanded to include time and humans. Indeed, the amount of each of the three components of plant disease and their interactions in the development of disease are affected by a fourth component: time. Both the specific point in time at which a particular event in disease development occurs and the length of time during which the event takes place affect the amount of disease.

**The interaction of the four components can be visualized as a tetrahedron, or pyramid, in which each plane represents one of the components. This figure is referred to as the disease tetrahedron or disease pyramid (Fig. 8-2).**

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If the four components of the disease tetrahedron could be quantified, the volume of the tetrahedron would be proportional to the amount of disease on a plant or in a plant population.

Disease development in cultivated plants is also influenced greatly by a fifth component: humans. Humans affect the kind of plants grown in a given area, the degree of plant resistance, the numbers planted, time of planting, and density of the plants. By the resistance of the particular plants they cultivate, humans also determine which pathogens and pathogen races will predominate. By their cultural practices, and by the chemical and biological controls they may use, humans affect the amount of primary and secondary inoculum available to attack plants. They also modify the effect of environment on disease development by delaying or speeding up planting or harvesting, by planting in raised beds or in more widely spaced beds, by protecting plant surfaces with chemicals before rains, by regulating the humidity in produce storage areas, and so on. The timing of human activities in growing and protecting plants may affect various combinations of these components to a considerable degree, thereby affecting the amount of disease in individual plants and in plant populations greatly. The human component has sometimes been used in place of the component “time” in the disease tetrahedron, but it should be considered a distinct fifth component that influences the development of plant disease directly and indirectly.

In Fig. 8-3, host, pathogen, and environment are each represented by one of the sides of the triangle, time is represented as the perpendicular line arising from the center of the triangle and humans as the peak of the tetrahedron whose base is the triangle and height is the length of time. In this way, humans interact with and influence each of the other four components of an epidemic, thereby increasing or decreasing the magnitude of the epidemic. Sometimes, of course, humans themselves can be affected to a greater or lesser extent by plant disease epidemics

