"Plants Have Diseases Too"

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The work of the plant pathologist at the Los Angeles State and County Arboretum may be best described by discussing separately the various roles he assumes. Often, he is an extension specialist, at other times, a research investigator, and on occasion, teacher. Actually, to separate these responsibilities except for convenience in discussion is unnecnecessary and difficult since each is so closely related to the other.

Invariably, whether the inquiry is from the professional staff at the Arboretum or from the remaining citizenry of Los Angeles and surrounding counties, the pathologist is greeted with the following two questions: "What is it?" followed quickly by "What should I do about it?". Of course, the questions are based on the assumption that the plant or plants in question are atypical in some respect or in other words, there has

Such plants may be pale green or even yellow by comparison with the normal thus been interference, in some way, with their normal development.
we would say that they are chlorotic. Or perhaps, definite lesions are present on the vegetative or floral parts. Wilting of a portion or all of the plan may have occurred. Again, plant parts may have become dwarfed or enlarged or in some other way malformed. Rotting is apparent by the dark brown of dead cells which are often foul smelling.

The same symptoms which instigated the inquiry of the pathologist may aid him initially to categorize the problem.

Before the extension specialist initiates his inquiry into the nature of the problem, he would like as much information as possible from the grower concerning nomenclature, degree of severity, extent of garden area involved, cropping history, weather and soil conditions, fertilization, watering practices, and pest control measures utilized.

In addition, to furnishing as much of the above information as is possible regarding the suspect plants, one should bring or send to the pathologist examples which show typical symptoms preferably several samples showing different stages in disease development. When possible, the entire plant should be included. In general, avoid fleshy fruit in advanced stages of decay. Plant materials are best shipped in sealed plastic bags or other types of moisture proof containers. Do not add water. Large specimens may be cut into sections, and the roots wrapped separately in paper or bag to avoid getting soil on the other plant parts. Sealed plastic bags should be used always when soil samples containing nematodes are included. Specimens should be enclosed in a crush-proof carton or mailing tube with a return address.

In the United States, plant diseases brought about by insects belong in the field of economic entomology; therefore, when initial examination of a plant specimen indicates that the incitant may be an insect, the staff entomologist is consulted. Close cooperation between these two disciplines is essential because correct interpretation of the symptom expression often rests upon direct or indirect evidence of the presence of a given organism supplied only by a specialist.

The plant diseases which are the concern of the phytopathologist may be grouped for convenience into three classes. The first, is non-parasitic, that is diseases incited primarily by products of plant metabolism, soil conditions, meterologic conditions, agricultural practices, or industrial by-products. In determining which of these factors represent the casual agent for a given disease, the pathologist relies on the close cooperation of specialists in a number of fields: plant physiology; soil science; horticulture; taxonomy; biochemistry, and meterology. The second class, is parasitic, that is those diseases incited by algae, bacteria, fungi, phanerogams, and certain animal parasites, for example nematodes. The third class, is virus diseases. Certain authorities might place virus diseases in either of the previous two categories.

Fortunately for the plant pathologist many of the problems which fall into the above mentioned classifications have been described in regard to one or more plant species and catalogued by both his predecessors and his contemporaries. This information is available in the literature concerning disease problems, and should be close at hand as a ready reference. Certainly, a part of this literature would be meaningful to the public, and should be used whenever possible.

An example of one of these important tools, which is of particular interest to a pathologist, is the United States Department of Agriculture, Handbook #165, Index of Plant Diseases in the United States.

A careful examination of the plant or plants in question, and a comparison when possible with the description of a similarily appearing disease may suffice to determine the probable nature of the problem. However, unless concrete evidence is present for example a characteristic symptom combined with the presence of the organism known to cause the disease expression, positive identification awaits the replicated reproduction of the problem as a result of a given causal complex, or number of factors. Once the nature of the problem is determined, it remains to furnish whatever control measures are feasible whether curative or preventive.

Constant effort by all members of the professional staff is needed to maintain satisfactory plantings at the Arboretum. The pathologist contributes by supplying information designed to prevent plant disease, by diagnosing when possible the nature of exist-

Honey colored mushrooms, the fruiting body of the oak root fungus, *Armillaria mellea.* The host tree is the California pepper, *Schinus molle.* Photo: Denis Kucera

ing disease, and furnishing appropriate disease control recommendations. In addition to offering suggestions concerning preventative measures, such as soil sterilization, the pathologist may plan a seed treatment program or suggest a preventative spray schedule to avoid fungus disease in such varied items as turf grasses, roses, or perhaps sycamores. Again, a suggestion may be made for a fungicide drench to inhibit the spread of a disease in an existing plant bed, or information may be given concerning a fumigant such as "Vapam" which may be used to sterilize the soil in a garden area prior to planting or to prevent further problems in an area where disease has occurred.

Prerequisite to satisfactory control recommendations is the correct diagnosis of the diseases occurring on the grounds. Requests for identification of the casual agent involved in a given disease may come from the plant propagator who may be having a problem with damping off of seedlings in the greenhouse, the Arboretum gardener who may be losing plants in a particular location in the field, or the orchid specialist who may need help to determine the nature of leaf lesions on his plants.

Periodic inspections of the shrubs and trees on the Arboretum grounds by the staff pathologist enables early recognition of diseased conditions thus often avoiding further loss. For example, the close examination of a single diseased palm may show that it is being destroyed by the fungus, *Penicillium vermoeseni Biourge.* Prompt removal of this source of inoculum may avoid further loss among surrounding palms. Again, determining the extent of root rot in an oak may be helpful in making the decision either to remove portions of the tree to prolong its life or to destroy it.

The Arboretum gardeners keep a record of the reasons why plants are removed from their respective sections. When disease is involved, the pathologist is asked to determine the probable cause of death.

In addition to the plant diseases which have been described in the literature and for which control measures have been worked out, there are those which exist without satisfactory remedy. For some of these no control is known and for others existing controls need improvement. Periodically new problems arise which require research to establish their nature and possible control. It is for these reasons, primarily, the pathologist becomes investigator.

For example, currently at the Arboretum, the emphasis in plant disease research involves the problem of the oak root fungus, *Armillaria mellea* (Vohl.) Quel., particularly from the standpoint of effecting a more satisfactory control in ornamental plantings. This very destructive disease is not limited to oaks. Most ornamental trees, shrubs, and herbaceous plants are affected. Even weeds may become a host.

Early symptoms of this disease are similar to those caused by any root disturbance whether brought about by living organisms or not. A general dying back of the branches occurs, particularly from the tips. In some plants, oaks for example, the bark becomes cracked. In some other plants such as pines, acacias, etc., gumming near the base of the tree may be seen. Usually during the months of December through February, depending upon the season, the fruiting body of the fungus, a honey colored mushroom appears around the base of diseased trees, or growing on the roots of dead plants. These fleshy mushrooms are found in clusters and their size and shape varies somewhat depending upon their environment. Often, a ring shaped structure, annulus, is seen on the stem; and the white colored gills from which basidiospores are discharged are attached to the stem. The spores are air-borne and may initiate saprophytic development on dead plant parts. Between the bark and the wood, in diseased trees, a characteristic white to cream-colored mycelial mat develops. It is the vegetative stage of the fungus, and is rather

tough in consistency. Often, the mycelium appears to grow in a fan shaped pattern. The fungus and the associated plant tissue usually has a rather pronounced mushroom odor. Certain plants, particularly Engleman oak, have white tissues present in the bark which may be confused with the mycelium. In addition the fungus has a mycelial structure, the rhizomorph, which is resistant to adverse environmental conditions and may be seen on diseased roots or under the bark of trees which have been diseased for some time. Rhizomorphs appear as black strings with a white interior, and have a diameter approximately equal to that of a pencil lead. These structures are the means by which the fungus grows through the soil from one plant to another. The rhizomorphs become attached to the host, at least in part, by the hardening of a resin-like substance. The mycelium penetrates the outer cells of the root and growth continues, unless the host is resistant, until the lower portion of the tree trunk is completely girdled. Once this has occurred, movement of food downward from the leaves to the roots ceases and the tree ultimately die. Evidently, in some trees, not all of the tissue is affected, because the plant remains alive even though the fungus has completely girdled the trunk.

Because the oak root fungus lives both as a parasite in living tissue, and as a saprophyte in dead plant material, it is necessary not only to destroy diseased plants, but also to remove non-living host tissue or destroy the fungus within the dead plants. By 1894, partial sterilization of the soil with the soil fumigant, carbon disulfide, was tried in Europe, in an effort to destroy the saprophytic stage of the fungus. As early as 1914, in California, efforts were made to eradicate this fungus using fumigants. Since that time, much effort has been expended to find better fungicidal materials and means of application. Recent work at the University of California at Riverside, California has shown that methyl bromide at the rate of two pounds per one-hundred square feet of soil will kill the fungus in blocks of citrus roots, 2 to 3 inches in diameter, at a depth of five feet under optimum conditions for the diffusion of the gas. Unfortunately this fumigant, as well as others, has the disadvantage that it will kill the roots of all living plants. Thus, as is often the case for the homeowner, in areas where diseased roots are intermingled with the root systems of living plants, treatment with a fumigant is not feasible. When the disease has not progressed too far, it is often possible with trees and shrubs having a single basal stem, to prolong life by removal of the diseased tissue followed by an application of wound dressing. Another measure, the exposure of the roots adjacent to the trunk, seems to slow the movement of the fungus into the crown. Proper fertilization and supplemental watering as needed will help maintain the tree in good condition and increase disease resistance. When watering, one should avoid wetting the base of the trunk, and always apply the water in the root zone.

Seemingly, the most satisfactory control would be the introduction of oak root fungus resistant plants, those which have some structural or physiological characteristics which prevent successful invasion by the parasite.

The University of California has published a revised list of plants tested at San Jose, California, which were found to be resistant or susceptible to *Armillaria* root rot. Unfortunately some of the plants listed as immune or highly resistant at that location have been found to be quite susceptible in southern California. Consequently, a program has been initiated by the Arboretum to screen, under local conditions, selected ornamental trees ,shrubs, and herbs, which would be of particular interest in southern California.

In 1961, two field plots were established, the first at Descanso Gardens in La Canada, California, and the other at the Lux Arboretum in Monrovia, California. Over three-hundred plants are under test at these locations. Sixty ornamental species are represented.

Thus far, twenty-two plants have become diseased. These represent five genera; *Brassia, Cassia, Euphorbia, Geranium,* and *Pinus.* Efforts are being made to screen additional species in the greenhouse.

Another approach to the control of oak root rot in living plants may be the use of systemic fungicides, that is, those which spread through a plant internally. At present, these materials are available in very limited numbers. Some of the antibiotic materials, such as Agrimycin, Griseofolvin, etc., have been used successfully in the control of certain bacterial and fungal diseases in plants. It is hoped that these or similar materials may be useful in the control of *Armillaria mellea* (Vohl.) Quel. Investigations to determine suitable plants for screening these materials are in progress.

The third and a very rewarding contribution which the pathologist makes is to offer, through education, some understanding of the nature of plant disease, its numerous causes, and the methods employed to control plant diseases.

Information is being offered to various groups at different times. Currently, the professional gardening staff is receiving a series of monthly lectures to better acquaint them with the various aspects of the disease problems which they are constantly observing in the field.

The annual curriculum of the Professional Gardener's School which is held at the Arboretum, includes thirty hours of class work in plant pathology.

An adult education program, sponsored by the Arcadia Unified School District, is being offered to the citizens of the surrounding area. As a part of this program, a series of fourteen lectures is being given in the study of plant diseases. In addition to the above series of lectures, a limited number of lectures are presented for special interest groups who require such information as a background for the performance of their professional duties.

In all of these lectures, within the limits of the time allowed, specific examples are used to point out the various problems due to animate and inanimate causes. Illustrations, as well as diseased plant material augment discussion to assist the student in recognition and study of various plant diseases. Crown gall of roses, fire blight of pyracantha, and other dieases illustrate clearly how much damage is done by bacteria. Various fungi responsible for plant injury are examined both from the standpoint of individual characteristics as well as their role in disease development. A number of important fungus diseases such as root and stem rots, wilts, and blights found in California and elsewhere are described. Information concerning the many plant diseases caused by viruses and nematodes is an important part of the course. Attention is given to many of the non-parasitic problems, including heat damage, inadequate soil mixture, air pollution, wind damage, and nutrient deficiencies. The importance of resistant varieties in plant disease control is explained along with a discussion of cultural and chemical control measures being used today. Throughout the lectures, additional sources of information are furnished.

The pathologist's duties at the Arboretum are varied and extremely interesting. All are direct responses to the challenge inherent in gaining a better understanding of the nature and control of plant disease, and making this knowledge useful to all.

Plant Pathologist