THE SOUTH AMERICAN LEAF BLIGHT AND DISEASE RESISTANT RUBBER.

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The history of many plant diseases that have become epidemic shows that those which have been most destructive or most difficult of eradication or control, are those which have been introduced from other countries. This may be due to several factors. The original host may occur in greater quantity in the new locality, a new and more susceptible host may be present, or it may occur in pure stands thus enabling the disease to spread more rapidly and become more thoroughly established, and finally the climate may be more favourable to the production and dissemination of reproductive bodies and infection.

With this introduction it is proposed to warn the rubber planting community of Malaya against the one leaf disease of Hevea which in all likelihood if introduced into Malaya and the East would cause as profound a change in agricultural economics as did the coffee leaf disease in Ceylon.

The disease referred to is the South American Leaf Blight and the casual fungus is *Dothidella Ulei*. The fungus is apparently coincident with the natural range of Hevea in South America. It occurs in Trinidad which is the only known extension of the parasite outside the mainland. The fungus is an obligate parasite and is highly specialized on Hevea. No other host is known. Although the life history of the fungus includes three distinct spore forms it is the first or the conidial stage which is largely responsible for the rapid spread of the disease. Young leaves as they unfold are rapidly parasitised and trees of all ages become entirely defoliated. The second crop of leaves is infected and the process goes on until the twigs and branches are depleted of food material and either die or fall a prey to various secondary fungi which hasten the death of the tree. In Dutch Guiana where the fungus caused a cessation of rubber planting three successive defoliations in a period of six months took place. The fungus also attacks the inflorescence, young twigs, and fruits. The immature pods are afterwards attacked by Diplodia, Gloeosporium and other fungi and their contents become black and shrunken. The writer found trees on the Amazon showing an infection of the pods of

more than 60 per cent. The worst feature of the infections on the young branches and pods is that the fungus is held in a condition making new infection on young leaves readily possible.

Conditions in Malaya Favourable to the Fungus.

The fungus causes little or no damage to wild rubber in the Amazon Valley. The density of the natural jungle is a factor in this connection. It is only when a species is established in pure stands that the conditions for the propagation of a parasitic fungus to which the species is susceptible are greatly intensified. Another factor which retards the development of the fungus in Brazil is the rather distinct dry season of some six months during which time rain may not fall for two or three months at a time. The 1926 report of the plant pathologist for British Guiana states that the activities of the fungus were very evenly checked by dry weather especially on inland estates which have long been abandoned on account of the injuries caused by its normal prevalence.

The existing conditions in Malaya are quite the reverse from those in Brazil. There is practically a continuous body of rubber throughout the entire length of the Peninsula and temperature and moisture conditions are fairly uniform. Experience teaches that the virulence of a plant parasite or rather the conditions of infection may be greatly intensified by a favourable climate. This means that when there is a uniform temperature and moisture relationship there is a more abundant production of spores and early stages of development by the parasite as regards establishing relations with its host. Under these conditions there is also a more uniform development of susceptible tissue.

Under the circumstances it is to the interest of the rubber planting industry in Malaya to guard against the introduction of the fungus. Any attempt to introduce promising races of rubber from Tropical America should be entrusted to thoroughly competent investigators. Propagating materials can be brought in disease free but it should be done under the direction and supervision of the authorities controlling such work.

Desirable Types of Rubber in South America.

One does not study *Hevea brasiliensis* in its native home very long before he is impressed with the great botanical variation of the species, especially with regard to those characters which if utilized in selection and breeding work would in all probability

be of great importance to the industry. Out of some thirteen species of Hevea described from S. America there are a few readily distinguishable, and one in particular that has certain leaf characters showing resistance to the South American Leaf Blight. In general, however, the great majority of trees encountered along the Amazon and southward are variations of the one common species. It is from this group that a careful study of forms and types would probably produce a tree of the highest possible value both from the standpoint of yield and of resistance to the Blight. The study of these forms particularly those in the upper Amazon has never been successfully carried out. It is a subject worthy of being on the roster of investigations by the industry.

Disease-Resistant Rubber.

The improvement of rubber from a yield standpoint has been so industriously followed during the past few years that the problem of disease resistance and immunity in the tree has been almost entirely neglected. The existence of natural types or forms of wild rubber has been indicated. It has also been observed that certain of these forms and species exhibited a natural resistance to disease to a certain degree. In the Guianas, observers have called attention to the existence of apparently immune trees in all plantations affected by the leaf blight. Such a condition in the latter case could scarcely be attributed to accident in spore dissemination, or failure of the trees to produce leaves at the same time. Individual seedlings in our nurseries are occasionally observed to exhibit a high degree of resistance to the Helminthosporium leaf blight. In India rubber trees resistant to leaf fall have been noted. Some observations in Ceylon indicate natural immunity of rubber trees to bark rot. These observations point the way. The relative liability of varieties and species to disease has been known since early times. Remarkable results have been obtained in several horticultural, field and garden crops. These results however are of comparatively recent development. The results obtained are of such a hopeful character that the possibility of placing the study of disease resistance on a scientific and practical basis may be expected. This is abundantly illustrated by the work that has been done in developing resistance in plants against various soil organisms. The old idea of soil being "sick" to certain crops has been largely exploded. In many cases of this kind they have been found to resolve themselves into disease situations, with definite causal factors separate and apart from any toxic action which any crops may have on succeeding crops of the same kind. These so called "sick soils" have been found to be infested with various

wilt and rootknot organisms. With the development of resistant varieties it has been found that these troubles can be controlled to a large extent at will. The breeding and selection of plants for local adaptation and disease resistance is the most important future line of work in the control of many plant diseases. The problem of what constitutes disease resistance and the difficulty of defining the factors involved should not prevent the expenditure of energy in promoting the development of disease-resistance in rubber.

The search for trees exhibiting resistance to disease is being made. It is also proposed to establish a special test garden for the accumulation and intensification of local pathogens in soil and trees for the purpose of emphasizing "the survival of the fittest" through elimination of non-resistant individuals. It will be desirable to bring to this garden Hevea Guyanensis, H. Spruceana, H. Collina, H. Benthamiana and other species for the purpose of studying the quality of their root systems and vigor of growth in relation to infection and resistance. Other methods of work are planned.

The factors involved in beginning work on a previously uninvestigated plant such as the rubber tree are extremely varied and range through all the methods of selection by seeds and vegetative propagation and of studies in parasitism. A few fundamental considerations may be briefly mentioned.

From the standpoint of the organisms against which we direct our efforts there are two main classes. There are those which feed upon dead parts of the tree only becoming pathogenic under certain conditions and those which directly attack or affect the living cell.

These being the natural enemies of plants and responding to the same factors of growth it is reasonable to assume that there has been a struggle going on between plants and their enemies both animal and vegetable. The weaker individuals in the forest yielded to their attacks while the strong and vigorous did not and in conformity with a general law of nature gradually developed characteristics or qualities that enabled them to withstand attack. This naturally did not take place in a short time for such changes in the nature of a wild plant may require ages to develop. It is the work of the plant pathologist to seize upon the most desirable characters which bear upon his problems and attempt to hasten or fix the most desirable feature already initiated in nature. He will begin by observing some simple natural phenomena.

Temporary Immunity.

It is not uncommon to observe that leaf age or leaf growth is a factor in susceptibility to any particular disease. This gradual development of resistance or immunity is very striking and important when considered from the standpoint of amount of inoculum (i.e. quantity of infection), elevation and climate. It often happens that a dry season as previously indicated prevents the development of the particular spore responsible for infection of young leaves. In the meantime the leaves of the susceptible plants continue to develop and reach that stage which owing either to a change in the materials available as food for the early nutrition of the fungus or to certain changes in the thickness and composition of cell walls, leaf covering etc. and which may be classed as physical are no longer susceptible to infection.

Striking examples of this condition are found in the secondary leaf falls with which fungi are associated and more especially in the South American Leaf Blight.

In conditions like the above the opportunity is afforded to observe the effects of rapid growth, physical peculiarities of leaves, site requirements of individual trees looking toward selection and propagation.

Varying Individual Susceptibility Within a Species.

Careful observation will show that all individuals of a species are not equally subject to disease. This observation can be made in many directions among plants as well as among animals and the human species. The conditions of susceptibility to infection varies not only with the individual but also with the infection itself. For example a certain few diseases of rubber secure an almost universal dissemination while others, the effects of which after they become established may be equally or even more severe, affect far fewer individuals. The latter condition dealing with the problem of different types of parasitism greatly extends the scope of the search for resistant forms. The cytologic and physiologic forces which govern a parasitic reaction are but poorly understood, nevertheless constant observations will result in many practical applications. The isolation of individuals of a species exhibiting apparent immunity is a preliminary step. Several theories have been advanced to account for this phenomenon. Observation has led to the belief that in some cases the condition is a direct result of previous heavy infection without destruction. Naturally when a plant has been severely diseased for several

successive seasons its growth is greatly inhibited and the opportunity for infection would be proportionally reduced. This eventually results in a certain degree of resistance being set up in the plant. The process by which individual rubber trees have built up a certain degree of resistance against the South American Leaf Blight may have resulted from a constant struggle with the disease. There is a probability that naturally resistant strains of chestnut may result from the devastation of the North American chestnut forests by the bark canker fungus.

Varying Racial Susceptibility.

It is of the greatest significance that in both plants and animals there is often a marked racial distinction as regards disease. Certain races or strains of oaks are resistant to diseases which attack all other species. Most of all races of wheat are subject to the ravages of the rust fungi of one kind or another, while certain other races are highly resistant. Examples of this racial distinction could be multiplied. Complete immunity is known in but few cases. There are certain races of potatoes which exhibit complete resistance to Wart Disease.

As to the nature of disease resistance it has been shown that genetically considered, in certain plants at least, it is closely associated with the plant metabolism and growth. In such a case the phenomenon becomes a matter of chemical constitution which may determine the difference in disease behaviour. In some instances it is the presence of a toxic substance in the coloured tissues of the host which prevents infection. In races of the same plant devoid of this coloring matter no such substance is present and infection is possible. The nature of resistance will probably be found to vary considerably with each particular race or group.

The actual conditions of inheritance of resistance characters are very little known. In one particular class of parasitism it has been shown that resistance may be regarded as a unit character behaving in crosses of resistant and non-resistant races as a Mendelian unit character.

The foregoing is intended to show the benefits which may be derived from this field of activity. In economic saving and ease of application in those cases where mechanical or cultural methods have failed to produce the desired effect the production of resistance or immunity is most attractive. The knowledge that a certain strain or race of plants is resistant against any particular disease of importance would do away with many of the present

day practices in disease control. It should not be forgotten however that resistance is only one of the many important characters sought in Hevea. The necessity of combining resistance with a high quantity and quality production character is obvious, especially since some lines of budded rubber show a decided weakness in the former respect.

In conclusion it is safe to assume that the only way to successfully combat such a disease as the South American Leaf Blight is through the development of resistant types and this holds true for Brown Bast as well. The selection of high-yielding strain of Hevea resistant to Brown Bast has already been shown to be a promising line of investigation.

Note.—In the interests of experimental work on disease resistance in rubber the co-operation of the planting community is solicited in the discovery of individual seedlings and trees showing an apparent resistance to disease.

Individual seedlings in the nursery may exhibit comparative immunity from Helminthosporium leaf disease.

Individual mature trees may be found showing an apparent resistance to secondary leaf-fall, due to mites or fungi and root and collar rots.

This apparent resistance may be observed in connection with particular soil types, high yielding trees, etc. and the relation should be noted.

Communications on the above subject are greatly desired.