HEVEA DISEASES OF THE AMAZON VALLEY

By

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Prior to the past decade, the greatest single obstacle to establishment of a sound rubber-growing industry in the Amazon Valley was destructive attacks by diseases of the Hevea rubber tree. The greatest damage was caused by attacks of South American leaf blight which has destroyed large areas of rubber in various parts of the Western Hemisphere. Other diseases have caused less damage but some of them have been serious enough to necessitate control measures.

Since its establishment in 1940, the Instituto Agronômico do Norte has conducted investigations on Hevea. One phase of this program has been to study the major Hevea diseases and to develop satisfactory control measures against them. Brief descriptions of these diseases and the measures that have been found effective against them are given in this paper.

SOUTH AMERICAN LEAF BLIGHT

Control of leaf blight, caused by *Dothidella ulei,* is one of the major factors that must be considered in plans for establishment of plantings of high-yielding rubber trees in the Amazon Valley. Although initial severity of the disease on susceptible clones will vary from place to place, the ultimate sucess of plantings can be insured only by utilization of blight-resistant material.

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Distribution and Damage — Leaf blight has long occurred on wild Hevea trees growing in their native habitat in the Amazon basin and adjacent areas of the South American continent. During the past few decades, it has become established in Trinidad, northern Colombia, Panama, Costa Rica, Nicaragua, Honduras, Guatemala, and Mexico. Wind-borne spores can be expected eventually to spread the disease over the entire Hemisphere.

Hevea trees growing in the jungle are generally too widely separated for leaf blight to develop in epiphytotic proportions. However, in nurseries and plantations, with the plants growing in close proximity one to another, the opportunities for disease spread and development are greatly increased. During the past few decades, thousands of acres of blight-susceptible Hevea trees have been destroyed by leaf blight. Among the ruined plantings was a portion of the area at Fordlandia, Pará, Brasil.

Symptoms — Leaf blight causes the most serious damage by attacks on young leaves. In severe cases, the leaves curl up and drop. Successive defoliations result in die-back and loss of the trees. Young stem tissue may also be attacked and distorted by the leaf blight fungus. On leaves of blight-tolerant clones, as well as highly susceptible clones that have passed the peak of susceptibility, lesions (fig. 1) may develop without causing defoliation. The time required for lesions to appear after infection occurs varies from 5 days to more than 3 weeks, depending on the clone.

The Fungus — The causative agent of leaf blight is the fungus *Dothidella ulei*. In 1917, G. Stahel (1), working in Dutch Guiana, described three spore forms that develop in the following order: conidia, pycnospores, and ascospores. The writer has demonstrated infections by conidia and ascospores, but no function of the pycnospores has yet been found. Conidia account for practically all secondary spread of the disease.

(1) Stahel, G. 1917. De Zuid-Amerikaansche Hevea-bladziekte veroorzaakt door Melanopsammopsis ulei. Nov. gen. (*Dothidella ulei* P. Hennings). Suriname Dept. Landl. Bul. 34, 111 pp., illus.

Exposure to moisture for at least 8 or 10 hours is required for the conidia to germinate and penetrate the leaf surface. The disease is favored, therefore, by wet weather and is greatly reduced by dry weather. It should be remembered, however, that dew or fog can be just as effective as rain in inducing a severe outbreak of leaf blight.

The period during which young leaves remain susceptible to leaf blight varies with susceptibility of the clone and conditions under which the plants are growing. The leaves of highly susceptible clones may be subject to infection until they are 3 or 4 weeks old, especially on plants growing under cool wet conditions. The leaves of blight-tolerant or semi-resistant clones may become immune within a week.

Control — Two control measures have been found effective against leaf blight. They are (1) application of protectant sprays, and (2) use of resistant clones (fig. 2).

Spraying is feasible only as a means of controlling leaf blight in nurseries and on high-yielding Oriental clones prior to top-budding with resistant clones. In cases where resistant seedlings are available, nursery spraying is eliminated. In some parts of the Amazon Valley, Oriental clones growing at field spacing will reach top-budding size without being protected by sprays.

Where spraying is required, zinc ethylene bis dithiocarbamate (sold under the trade names "Dithane" and "Parzate") should be used. Recommended usage is 1-1/2 pounds per 100 gallons of water.

Effectiveness of the mixture is improved by the addition of a spreader and sticker such as calcium caseinate. Leaf blight can be controlled with other fungicides, the "insoluble" coppers for example, but it is relatively difficult to obtain good control.

The frequency of spray applications required to protect Hevea plants from damage by leaf blight depends on (1) weather conditions, (2) susceptibility of the plants, and (3) location of the plants with reference to sources of inoculum. In most places in the Amazon Valley, weekly spraying is

adequate. In some localities, no spraying is required for a period of several months during the dry season.

Except on susceptible nursery seedlings and Oriental clones prior to top-budding, the established method of controlling leaf blight is by use of disease-resistant clones. In establishment of field plantings, present procedures entail the use of blight-resistant selections to top-bud high-yielding panel clones. Clones combining both high yield and blight resistance are now being developed (fig.3).

Top-Budding Clones — Only a very small percentage of the blight-resistant clones have all of the characteristics required to make them suitable for use in top-budding Oriental clones. A study of approximately 100 blight-resistant clones used in experimental top-budding at Belterra revealed that slow growth and susceptibility to Phytophthora were the major factors making a high percentage of them undesirable for use as tops. Wind breakage, poor branching, and overgrowth eliminated others. Among the blight-resistant *Hevea brasiliensis* clones of the first series of selections that have not shown oustanding defects as top clones at Belterra are: F 1619, FB 54, FB 3363, F 212, F 1620, and FB 3333. Many promising new selections are now being tested at Belem and Belterra by Institute agronomists. Some of these induce much more rapid panel growth than the earlier selections listed above.

Blight-Resistant Breeding Clones — Since 1942, the Instituto Agronômico, in cooperation with the U. S. Department of Agriculture, has carried on an intensive cross pollination program to develop high-yielding, blight-resistant Hevea clones. Large populations of progenies from crosses between high-yielding Oriental clones and blight-resistant selections of various species of Hevea have been tested for resistance at Belem and Belterra. More than 7,000 of these progenies have proved resistant to leaf blight and are now being tested for yield.

On the basis of disease resistance and vigor, the progeny of F 4542 (a *Hevea benthamiana* selection) have shown

more promise than those of any other blight-resistant breeding clone. Unlike most other *H. benthamiana* clones, F 4542 has not been appreciably damaged by *Phytophthora palmivora* and it has shown tolerance to *Pellicularia filamentosa*. More than 50 percent of the progenies from certain back-crosses to the susceptible high-yielding parent have proved resistant to leaf blight.

Among the blight-resistant *Hevea brasiliensis* clones used in breeding work, the progeny of F 351 have shown the most promise.

Few of the progenies of *Hevea guianensis* and *H. spruceana* clones have proved resistant to leaf blight. This might be accounted for by the mediocre degree of resistance in the limited lots of material from which the parent clones of these two species were selected.

Strains of Dothidella ulei — Test plots in various parts of the Amazon Valley have demonstrated striking differences in regional populations of *D. ulei*. Resistance tests at Belterra have, in many cases, given results that vary widely from those obtained at Belem. In general, more clones have been heavily attacked at the former location than at the latter. In cases where the factors of weather and fungus inoculum have been ruled out, the variant results can be attributed to differences in strains of the leaf blight fungus in the various localities. Clones used in commercial plantings should be resistant to all strains of the fungus occurring in the valley.

PHYTOPHTHORA POD ROT, LEAF FALL, DIE-BACK, AND PANEL DECAY

The fungus *Phytophthora palmivora* attacks many parts of the Hevea tree, causing pod rot, leaf fall, die-back, and panel decay. Each of these different expressions of attack is usually described in the literature as a separate disease. Since they are caused by the same fungus, they will be treated as a unit in this paper.

Distribution and Damage — In Hevea plantings in which *Dothidella ulei* is controlled by use of resistant clones, *Phytophthora palmivora* often becomes the major cause of disease damage. This fungus attacks many genera of plants and is distributed throughout the Amazon Valley. It becomes damaging in Hevea plantings in most localities only after heavy seed production begins. The entire seed crop is often destroyed by Phytophthora.

Although loss of the seed crop by pod rot usually results in no direct loss, the inoculum that builds up on the seed pods may cause greatly increased Phytophthora damage to other parts of the tree. In the absence of infected seeds, the disease usually does not build up enough to cause severe damage.

The most serious damage from Phytophthora generally occurs on the tapping panels which may be ruined by decay of the bark. Considerable damage may also be caused by leaf fall during the rainy season. However, since heavy leaf fall seldom occurs more than a few months before annual refoliation, reduced yields occasioned by sparse foliage usually do not extend over a prolonged period.

Certain *Hevea benthamiana* clones selected for blight-resistance and used as experimental top-budding clones at Belterra have proved exceedingly susceptible to Phytophthora. On these clones, die-back often extends down the branches and trunk until the top of the tree has been killed.

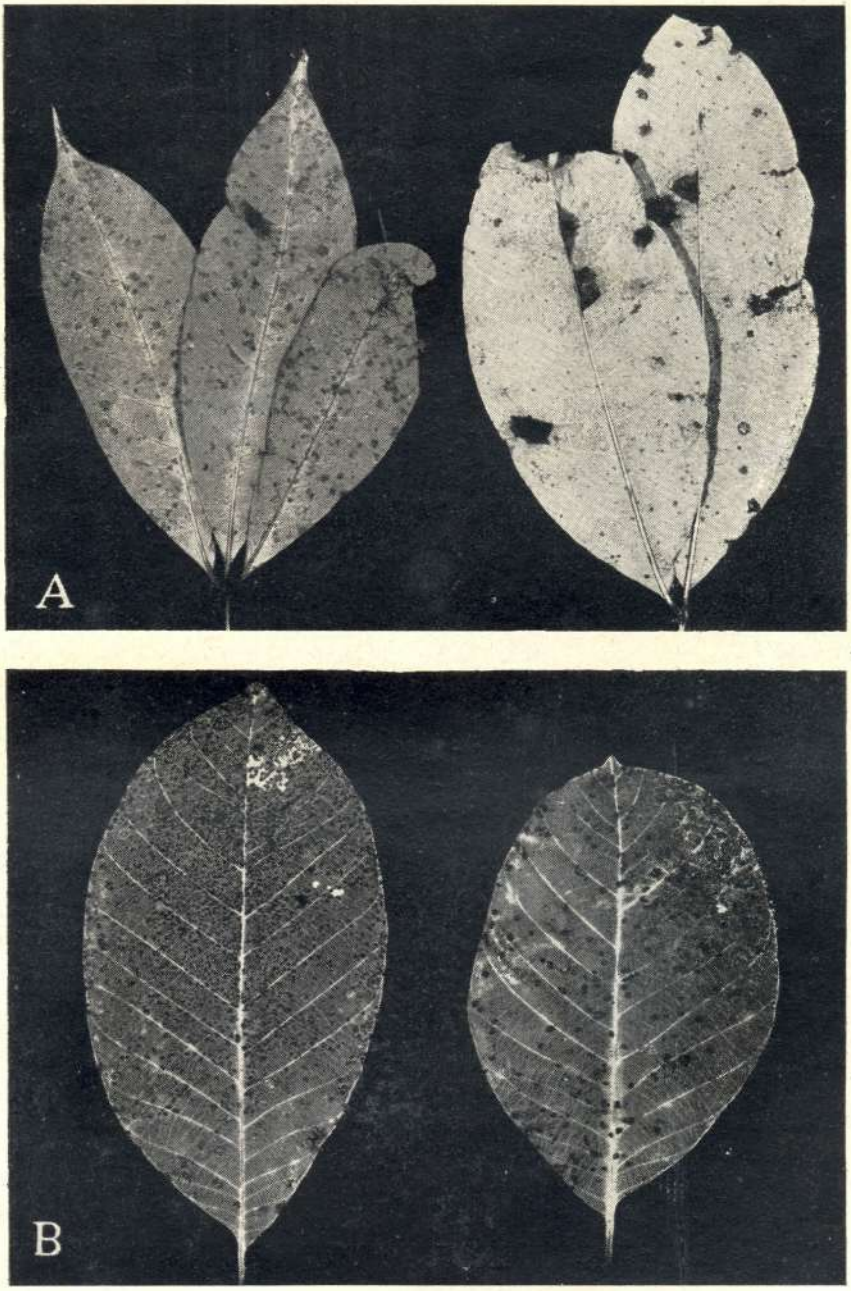


Figure 1. — Leaf blight lesions on Hevea leaves. *A*, young lesions producing conidia; *B*, old lesions producing pycnospores and ascospores.

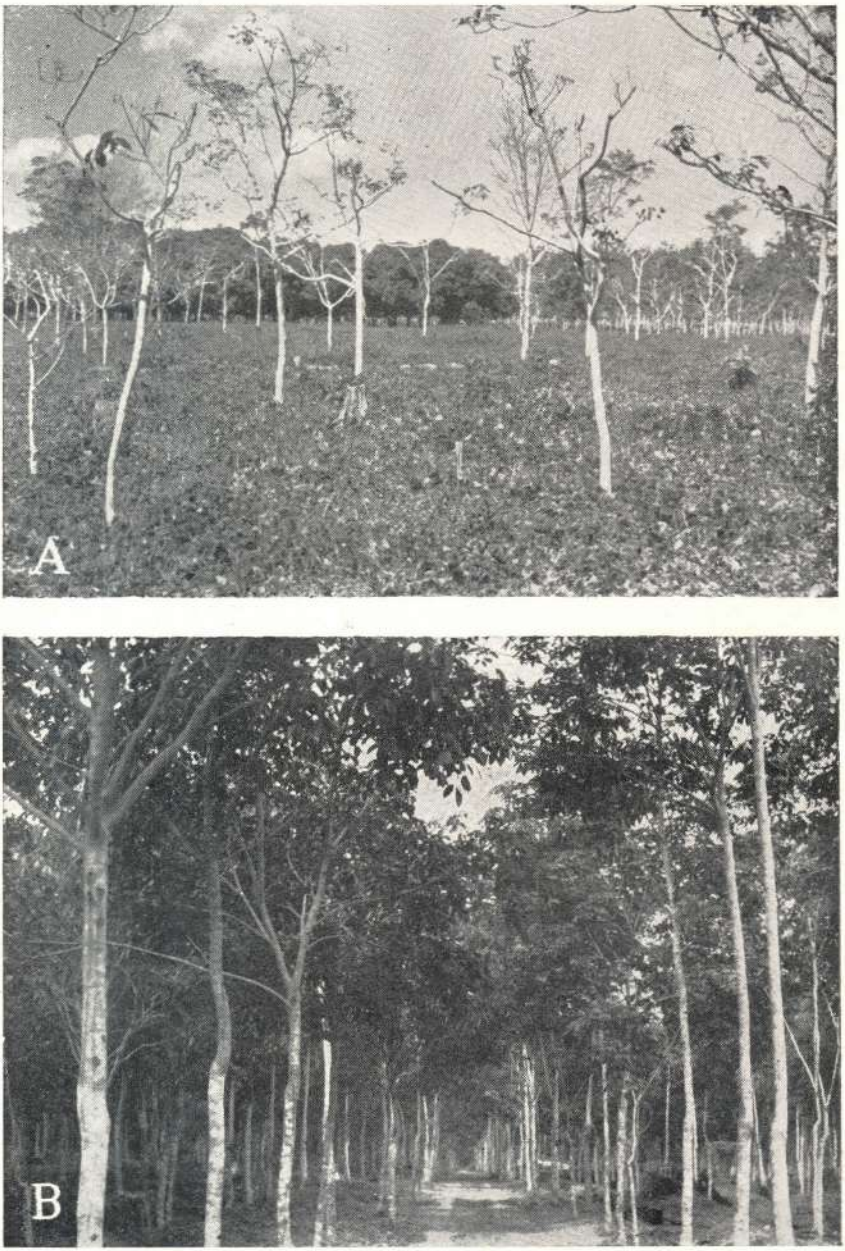


Figure 2. — Adjacent plots of 12-year-old rubber trees on Belterra Estate, Brasil. *A*, Eastern clones; *B*, Eastern clones top-budded with blight-resistant clones.

Figure 3. — Five-year-old Hevea trees produced by crossing a high-yielding clone with a blight-resistant clone.

The disease is rarely so destructive on trees of *H. brasiliensis* clones.

Symptoms — All above-ground parts of the Hevea tree are subject to attack by *Phytophthora palmivora* under certain conditions. The symptoms most commonly encountered are described below.

(1) Pod Rot. The first symptom of pod rot is a sodden greenish discoloration of a portion of the pod coat. This water-soaked area rapidly extends until the entire fleshy pod wall is involved. Glistening, black droplets of dried rubber form on the pod wall, and a downy white fungus growth may develop under very humid conditions (fig. 4, A). The entire fleshy wall of the pod may become soft and rotten. The seeds which are immature when infection occurs are hollow and decayed. Old diseased pods frequently hang on the tree from one season to the next.

(2) Leaf Fall. After a few days of very wet weather, a heavy leaf fall may occur, especially if the trees bear diseased pods or twigs (fig. 5). Examination of the fallen leaves usually shows irregular water-soaked blotches on the leaves or shrunken discolored spots on the petioles. Under very humid conditions, a whitish growth of the fungus, bearing typical Phytophthora fructifications, may be found on the discolored areas.

(3) Die-back. During the height of the rainy season, die-back of young shoots (fig. 4, B) may be widespread. On especially susceptible-clones, it may occur on a large percentage of the new shoots that emerge during the period of annual refoliation. Infected shoots rapidly die and blacken. On especially susceptible *Hevea benthamiana* clones, die-back often extends down major branches, killing a large portion of the top (fig. 6).

(4) Panel Decay. This phase of Phytophthora damage is commonly referred to as black stripe and patch canker. At Belterra, panel decay usually occurs as an irregular area extending either above or below the tapping cut (fig. 7). The wood below the decayed dark characteristically shows

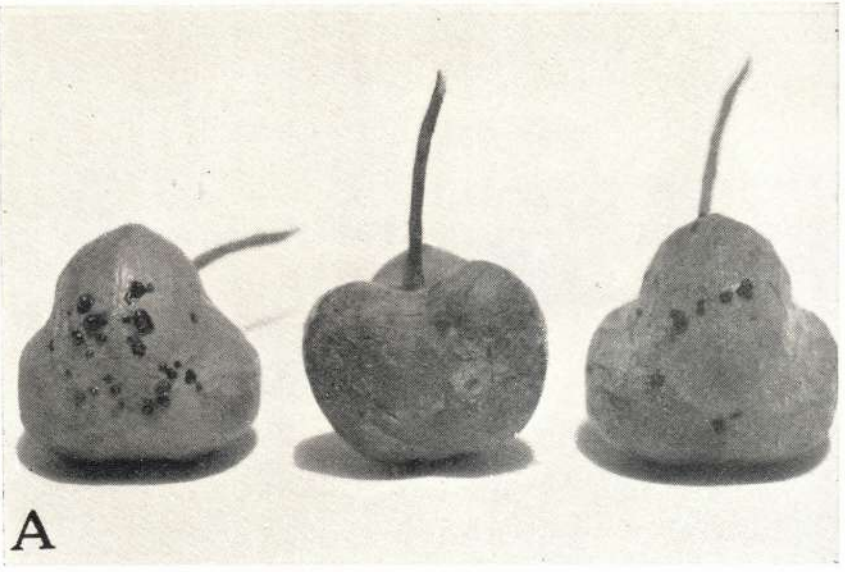
longitudinal black streaks which may extend to a depth of 1/4 inch or more.

The Fungus — Inoculation studies at Belterra have shown that pod rot, leaf fall, die-back, and panel decay are all caused by the same fungus, *Phytophthora palmivora.* During periods of very humid weather, a white downy growth bearing hyaline lemon-shaped sporangia may appear on the surface of infected tissues. These sporangia germinate either by producing zoospores or by putting out a germ tube as do ordinary conidia. Under adverse conditions, the more long-lived clamydospores (resting spores) and co-spores (sexual spores) may be formed.

Phytophthora palmivora is extremely sensitive to weather conditions. At Belterra, the fungus builds up to a high level during the rainy season and sinks to a low level during the dry season. Fluctuations in disease intensity are also caused by short wet or dry periods.

Control — The most effective control of Phytophthora lies in use of clones having tolerance or resistance to the disease. Incidence of the disease can be further reduced by avoidance of clones that bear heavy seed crops.

The panel phase of the disease is controlled to a large extent at Belterra by opening new panels only during the dry season. Experiments on tapping cut disinfectants are in progress.



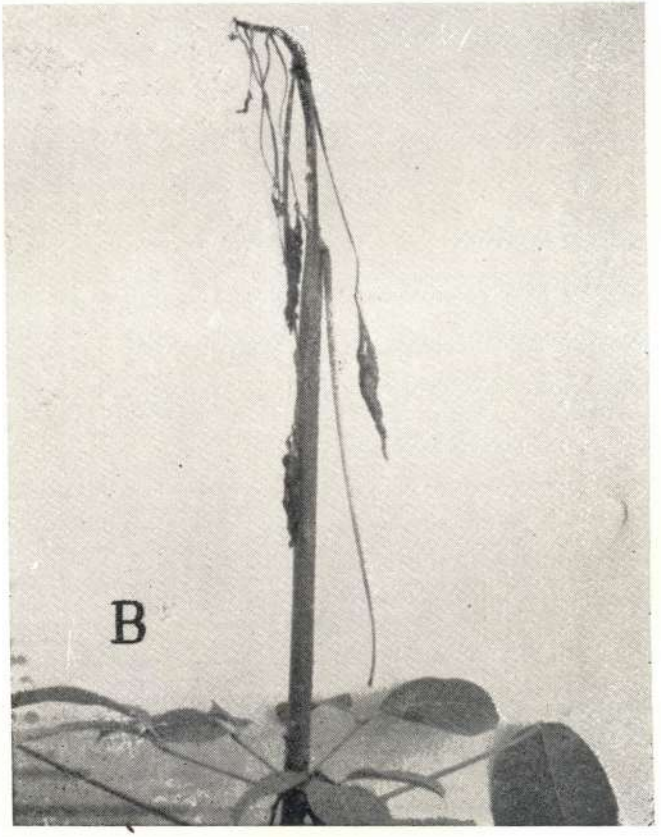


Figure 4. — *A*, Phytophthora pod rot; *B*, Phytophthora die--back.

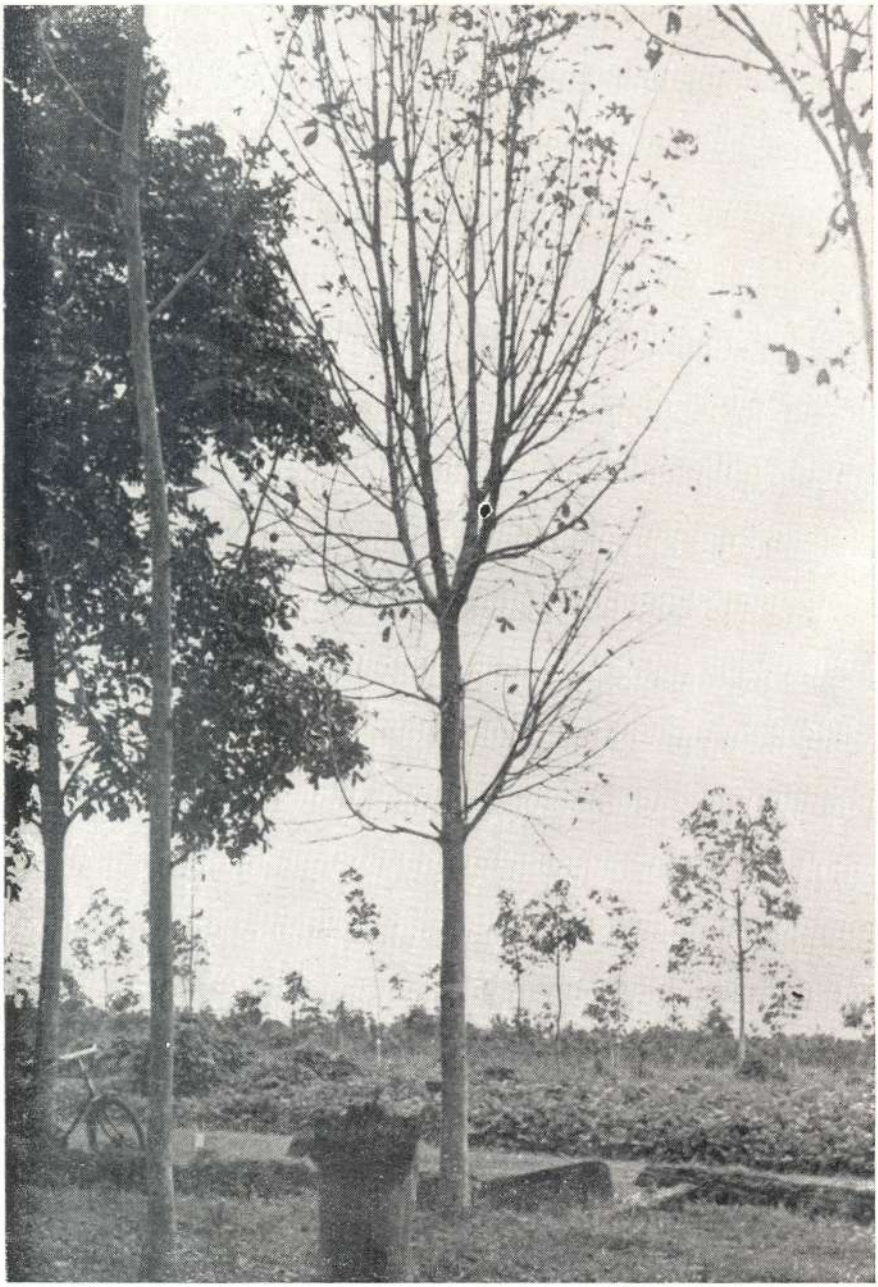


Figure 5. — Defoliation caused by Phytophthora leaf fall. Note the mummied seed pods.

Figure 6. — Phytophthora damage to an extremely susceptible *Hevea benthamiana* clone.

Figure 7. — Phytophthora damage to the tapping panel of a Hevea tree.

TARGET LEAF SPOT

Target leaf spot (caused by ***Pellicularia filamentosa***) was first reported as the cause of serious damage to Hevea trees less than a decade ago. Since that time, it has been recognized as one of the major diseases of Hevea in some parts of the Amazon Valley. A comprehensive study of this disease was made in Peru by J. B. Carpenter (2).

Distribution and Damage — Target leaf spot occurs throughout the Amazon Valley. It causes severe damage to both nursery and field plantings in the uppermost part of the valley. Control measures against the disease have proved necessary for the successful culture of Hevea in most parts of Peru.

In the lower part of the Amazon Valley, target spot has not seriously interfered with the satisfactory development of Hevea plantations. At both Belem and Belterra, in the State of Para, Brazil, the growth of nursery plants has been somewhat retarded by the loss of new foliage emerging during the wettest months of the year, but damage has been light or negligible during the remainder of the year. The loss of foliage from trees growing in field plantings has usually been only a small percentage of the leaves emerging during the year.

After Hevea trees reach the age at which a high percentage of the new foliage emerges during the relatively dry weather of the annual leaf change period, damage from target spot steadily decreases.

Symptoms — Target leaf spot attacks only the young leaves of Hevea trees. Usually, the first conspicuous symptom of a lesion is an exudate of latex which blackens and dries on the under surface of the leaf. During the first few

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(2) Carpenter, J. B. 1951. Target leaf spot of the Hevea rubbertree in relation to host development, infection, defoliation, and control. U. S. Dept. Agr. Tech. Bul. 1028, 34 pp., illus.

days after they appear, target spot lesions may be very similar in appearance to black crust lesions.

Mature target spot lesions range up to 2 inches in diameter and are usually zonate (fig. 8). They are covered on the under side by a network of silvery fungus threads. Under very humid conditions, the disease may assume the appearance of a web blight, especially on young seedlings. The growing points of either nursery or field plants may be completely defoliated during wet weather. Repeated defoliations retard growth and reduce the vigor of young trees.

The Fungus — Target leaf spot is caused by the fungus *Pellicularia filamentosa*. The disease is spread by large numbers of wind-borne basidiospores. Upon exposure to moisture, some spores may germinate and infect a young leaf in as little as 3 hours. The leaves generally remain susceptible to infection for only a week or 10 days after unfolding. A lesion first becomes visible approximately 1 week after infection occurs but may require an additional 2 weeks to attain its maximum size.

The target leaf spot fungus spreads and develops rapidly only under high moisture conditions. Dry weather limits new infections as well as sporulation and expansion of established lesions.

Control — In localities where the growth of nursery plants is seriously retarded by target spot, the disease may be controlled effectively by spraying with zinc ethylene bis dithiocarbamate which is sold under the trade names "Dithane" and "Parzate". Other fungicides give less effective control. Ordinarily, the spray program required for leaf blight controls target spot also. Otherwise, applications once or twice weekly during the rainy season may be needed to reduce leaf infection and leaf fall.

Hevea clones vary greatly in their tolerance to target leaf spot but complete resistance in clones of the commercially-used species of Hevea has not yet been demonstrated. Disease tolerant top-budding clones have now been selected for use in areas where target spot damage is serious.

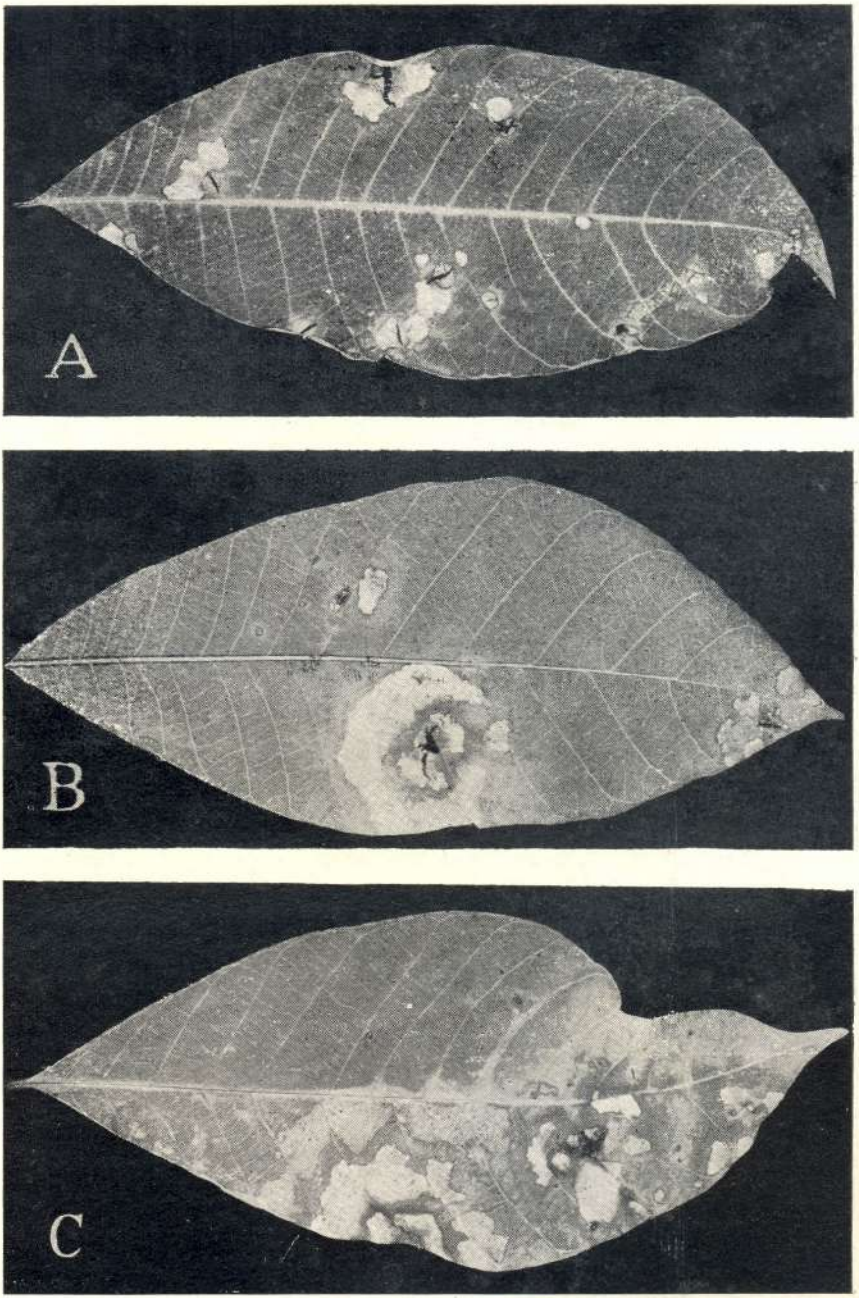

Figure 8. — Target leaf spot lesions on Hevea leaves.

GLOMERELLA DIE-BACK

Glomerella die-back (caused by *Glomerella cingulata)* is one of the most prevalent Hevea diseases of the lower Amazon Valley. All indications are that the high incidence of the disease in this area is attributable to poor or leached out soil. The disease occurs rarely or not at all on trees growing in fertile, well-drained soils.

Distribution and Damage — Glomerella die-back occurs throughout the Amazon Valley. In the lower part of the valley, it sometimes becomes more destructive than leaf blight or Phytophthora leaf fall and may cause the loss of a majority of the new leaf flushes emerging during the year.

Symptoms — The most characteristic symptom of Glomerella die-back is decay of young shoots at the nodes (fig. 9). These may break off while their leaves are still green. This distinguishes the disease from Phytophthora die-back which usually kills the tipmost part of the flush first.

The fungus causes rim blight of leaves as well as die-back. This phase of the disease can be distinguished from similar diseases caused by other organisms by the pinkish spore masses developing along the margins of the lesions during periods of wet weather.

The Fungus — The imperfect stage of *Glomerella cingulata* is *Colletotrichum gleosporioides.* This is the form of the fungus that is commonly found and it accounts for spread of the disease in a high percentage of the cases. Soon after a stem, leaf, or seed pod lesion becomes visible, it begins producing masses of pinkish spores which become whitish after a few days. These spore masses are visible to the naked eye.

The spores are spread by insects as well as by wind and water.

Control — Severe attacks of Glomerella die-back are largely confined to trees that are not in a vigorous state of

growth. The underlying cause of poor growth may be poor soil, inadequate drainage, an excessively dense stand of trees, or other factors. All indications are that the prevalence of Glomerella die-back in the lower Amazon Valley is largely attributable to poor soil. An application of fertilizer containing nitrogen, phosphorus, and potassium gave striking reductions in disease incidence in Hevea plantings at both Belem and Belterra.

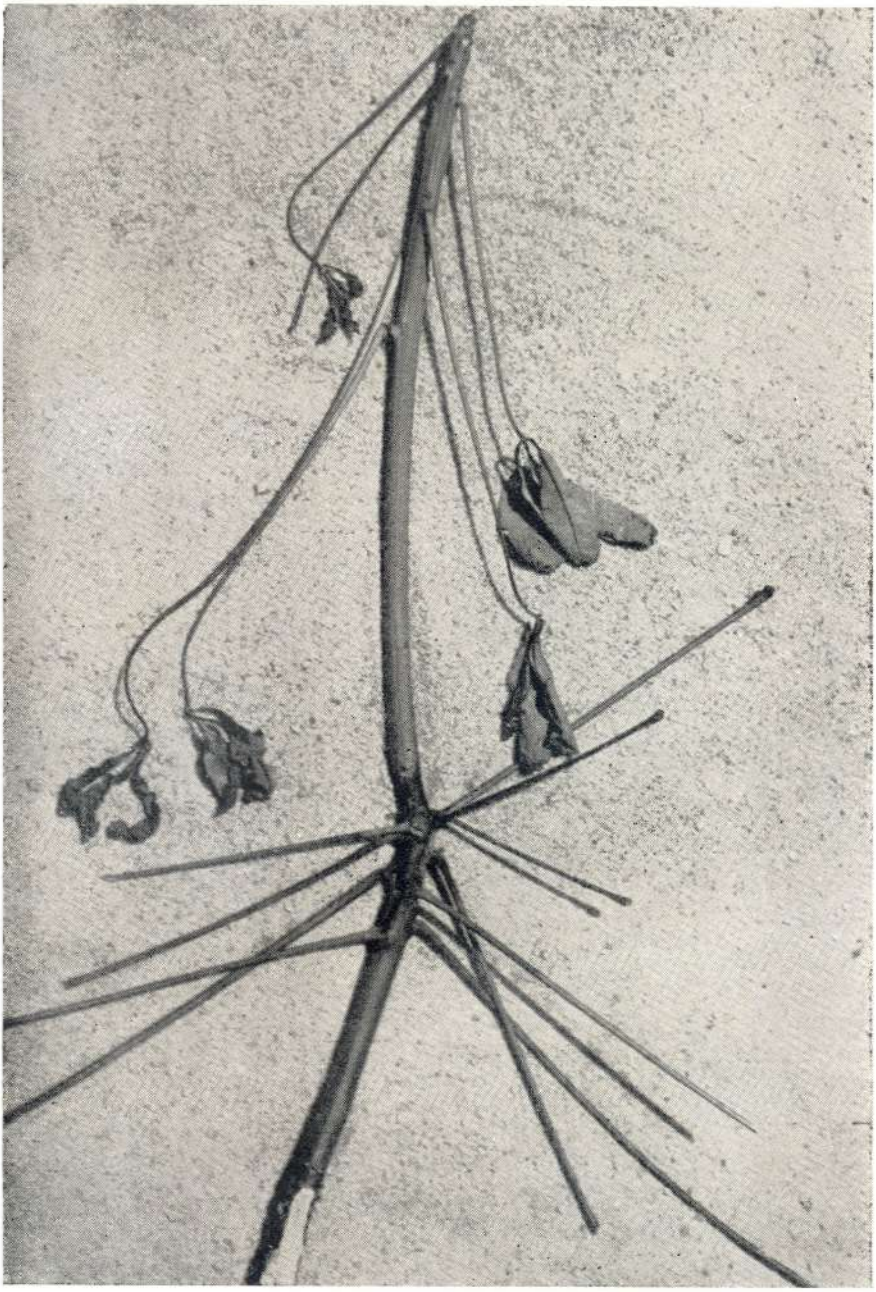

Figure 9. — Glomerella die-back. Decay and breaking at the node below the expanding flush are typical.

BLACK CRUST

Black crust (caused by *Catacauma huberi*) is one of the most conspicuous and least destructive diseases of Hevea. Because of its prevalence in the Amazon Valley and its conspicuousness, the damage attributed to it is often more than it actually causes.

Distribution and Damage — Black crust occurs throughout the Amazon Valley. The disease can usually be found on jungle trees, as well as on cultivated trees, in most parts of the Amazon basin. It is often more prevalent than the more destructive diseases such as leaf blight and target spot. This can be accounted for to a large extent by the fact that, whereas black crust seldom causes defoliation, leaves heavily attacked by leaf blight and target spot usually drop.

In many cases, the principal damage done by black crust consists of opening the way for invasion of the leaf by secondary invaders. Such weak parasites as *Glomerella cingulata* often attack the leaf through black crust lesions, which they greatly enlarge. This usually does not occur until the latter part of the rainy season, therefore the main effect is to advance the time of annual leaf fall.

Symptoms — Black crust can be identified by the shining black incrustations that appear on the under side of infected leaves (fig. 10). These incrustations occur only on the under surface of the leaves, the upper surface above each one being only slightly discolored. Old lesions have the crusts arranged in circles which may be separated by greenish zones.

Black crust attacks only the leaves of Hevea trees and, in the absence of secondary invaders, seldom causes defoliation.

The Fungus — Black crust is caused by the fungus *Catacauma huberi*. It attacks young leaves and develops very slowly in the host tissue, seldom appearing as a visible lesion

until the leaf is approximately one month old. The lesions slowly increase in size until the leaves drop during the annual leaf change period. By this time, the lesions may have attained a diameter of an inch or more.

Control — Black crust is not serious enough to warrant control measures other than avoidance of extremely susceptible clones. In selection work at Belterra, only a fraction of 1 percent of the clones tested in nursery and field plantings has fallen into this category.

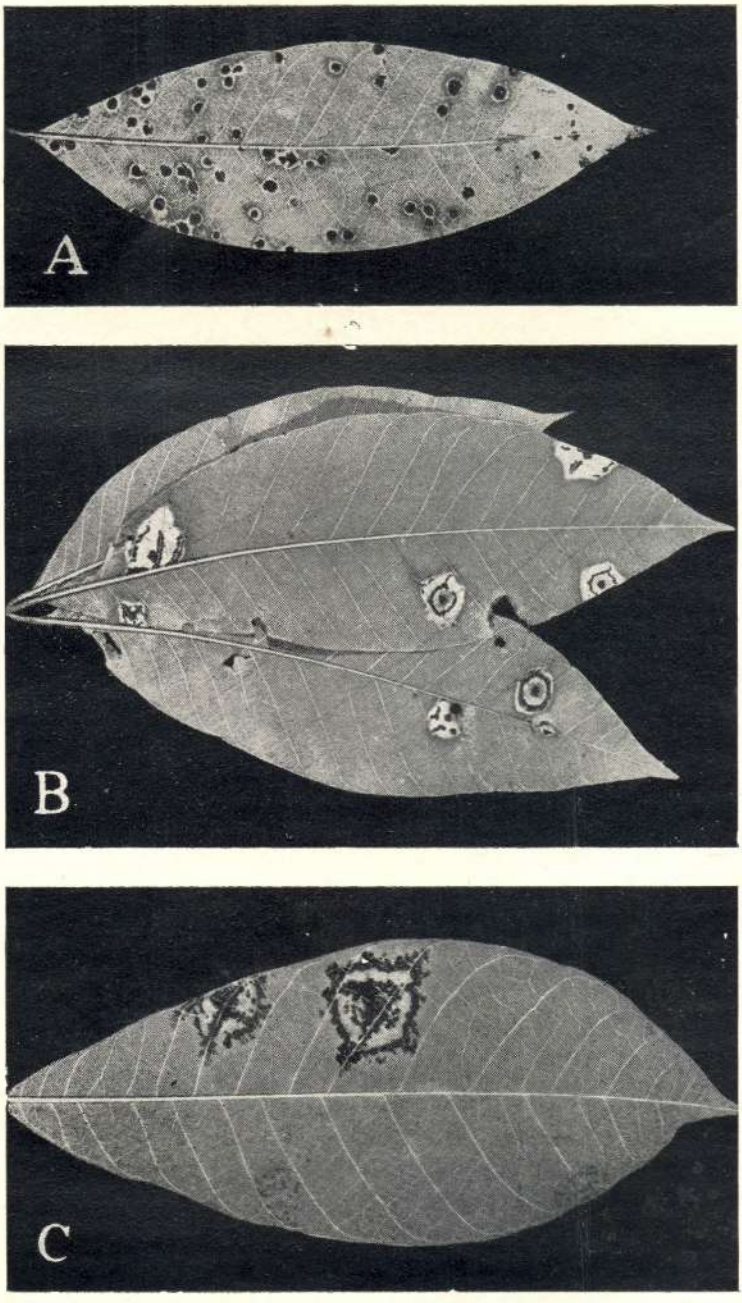

Figure 10. — Black crust on Hevea leaves. *A*, lesions 2 months old; *B*, lesions 4 months old; and *C*, lesions 6 months old.

PINK DISEASE

Pink disease (caused by *Corticium salmonicolor*) produces a conspicuous pink incrustation over the attacked portion of a tree; therefore, it is readily seen and identified. For this reason, the importance attached to it is often greater than is justified by the damage it causes.

Distribution and Damage — Pink disease occurs in the upper portion of the Amazon Valley. Its appearance in Hevea plantings in Peru has caused some concern among rubber planters, but the percentage of trees attacked has remained small — less than 1 percent in most cases.

At Belem and Belterra, in the lower part of the Amazon Valley, pink disease occurs rarely or not at all. At no place in the Western Hemisphere has it caused damage comparable to that reported from some Eastern estates.

Symptoms — The characteristic symptom of pink disease is the appearance in or near the fork of a tree of a salmon-pink incrustation (fig. 11). This brilliant fungus growth gradually loses its color until it becomes a dingy white. Production of green lateral shoots from the stem immediately below the attacked area is a very common secondary symptom. Bleeding of the attacked portion of the tree and wilting or death of leaves beyond the attacked area are also common symptoms.

Pink disease attacks only the stem and branches of Hevea trees. The infection usually starts in a fork or at the point where several branches arise. It may spread around the central stem or out on one or more branches. The disease does not often progress more than 2 feet from the point of attack. The main damage is caused by the death of branches or the central stem beyond the point at which the bark is attacked.

Attacks of pink disease are usually confined to trees between the ages of 2 and 10 years.

The Fungus — Pink disease is caused by the fungus *Corticium salmonicolor*. The disease is spread from one tree to another by airborne spores or fragments of bark. Wet weather favors both spore production and spore germination. Dry weather inhibits infection and spread of the disease.

Control — The old method of treatment of pink disease is by excision and burning of infected parts of the tree. A large portion of the crown is often lost as a result of this treatment. Recent work shows that most attacked stems and branches recover without treatment. Treatment of affected areas with a coal tar or asphalt preparation to reduce spore dissemination may be worth while.

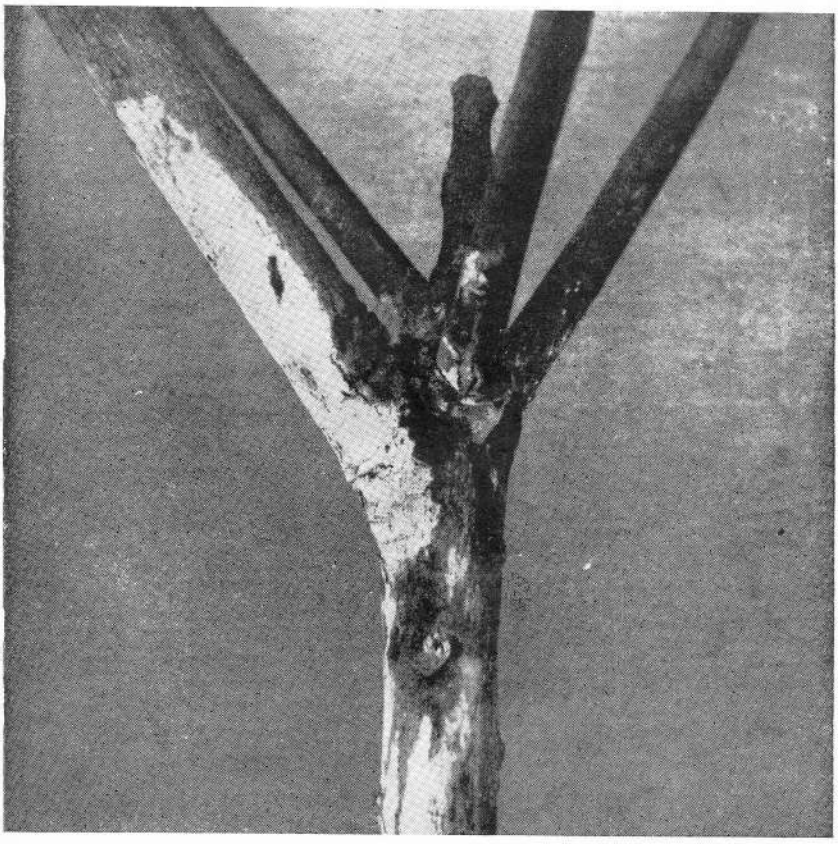

Figure 11. — Pink disease attacking a 2-year-old Hevea tree.

ROOT DISEASES

Root diseases caused by a number of different fungi have been reported from the Amazon Valley (3). Damage, however, has been much lighter than that occurring in many rubber-growing areas of the East. This is especially true in the case of white root disease caused by *Fomes lignosus*. Another root disease which, in the absence of fructifications of the fungus, has been tentatively identified as brown root disease (caused by *Fomes noxius)* has occurred more commonly.

Distribution and Damage — Brown root disease appeared on the Ford Plantation at Belterra a few years after planting operations began and has caused limited losses to plantings less than 10 or 12 years old during each subsequent year. Percentagewise, total losses have been small, and the disease is not considered a serious problem.

During the past few years, minor losses from root diseases have occurred in Hevea plantings growing in widely separated parts of the Amazon Valley.

Symptoms — The initial attack of brown or white root disease may occur on either the tap root or lateral roots. Brown root disease spreads slowly from this point, often requiring two or more years to destroy the major roots. White root disease advances more rapidly.

Wilting of the foliage and branch die-back are usually the first above ground symptoms of root disease. When the disease has progressed this far, the tree eventually dies or is blown over by the wind.

The rhizomorphs of brown root disease form a blackish crust over infected roots. This distinguishes it from white root disease, in which a whitish covering of fungal hyphae

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(3) Weir, J. R. 1926. A pathological survey of the Para rubber tree (Hevea brasiliensis) in the Amazon Valley. U. S. Dept. Agr. Dept. Bul. 1380, 129 pp., illus.

forms (fig. 12). The hyphae of brown root disease usually bind a covering of soil to infected roots.

The Fungus — The fungus causing brown root disease (*Fomes noxius*) and that causing white root disease (*F. lignosus*) are of similar behavior. They have a wide host range and attack many species of trees which grow in the jungle. When jungle land is cleared, these fungi continue to live on the roots that remain in the soil. They may infect the roots of young rubber trees that come in contact with diseased jungle tree roots.

Both *Fomes noxius* and *F. lignosus* spread along infected roots by means of rhizomorphs. After the trees in a plantation reach the stage at which their roots interlace, the disease may pass from one tree to another through root contact. Outward spread of the disease from infection centers after the trees reach tapping size indicates that this may be the major means of disease spread in 5-to 10-year-old plantings.

Control — In plantings where only scattered cases of root disease occur, no control measures are required.

In plantings where root disease shows a tendency to develop in patches by spreading out from one or more infected trees, trenches around those patches may prevent further spread of the disease by eliminating contact with the roots of adjacent trees. When this procedure is followed, a careful examination should be made to see that diseased roots have not already passed beyond the encircled area when the trench is dug.

Treatment of diseased roots with coal tar preparations or fungicides is ineffective and cannot be recommended.

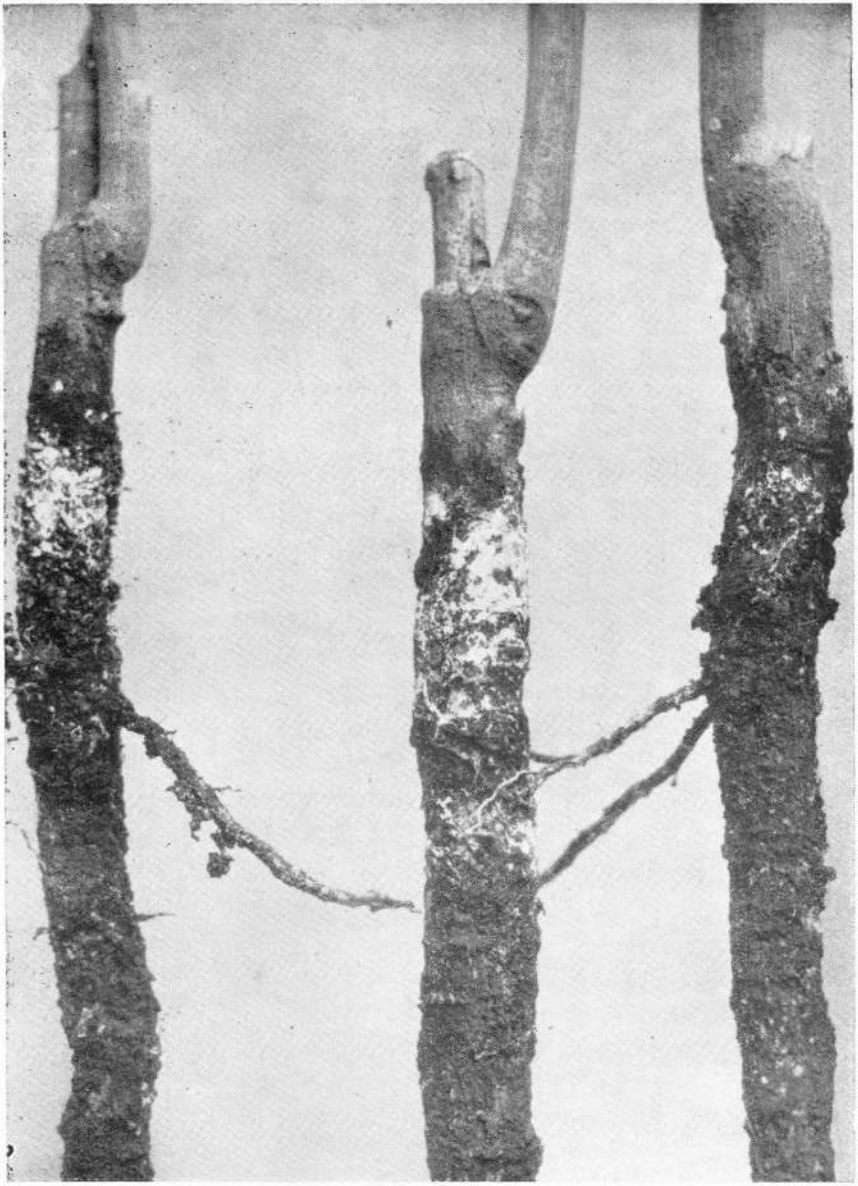

Figure 12. — White root disease attacking young Hevea buddings.

COLLAR ROT OF SEEDLINGS

Collar rot sometimes causes the loss of a high percentage of the young seedlings growing in nurseries or at stake in the field. The primary cause of this disease is sunscald which injures the plant stem just above the soil line, thus making it subject to attack by semi-parasitic fungi. Attacked plants are often girdled at the soil line.

The same factors that induce collar rot of young seedlings often cause wounds on older trees.

Distribution and Damage — Collar rot occurs throughout the Amazon Valley. It is especially prevalent in areas having a poor sandy soil which reflects sunlight to a high degree.

Damage is confined largely to seedlings that are less than 4 months old. The losses among seedlings planted a month, or less, before the beginning of a period of hot dry weather have exceeded 50 percent in some cases. Losses among seedlings planted on good soil in the early part of the rainy season are usually small.

Symptoms — Attention is usually first called to an attack of collar rot by wilting and dying plants. Affected plants show a blackened section of the stem beginning at the soil line and extending upward for an inch or two (fig. 13, A). A careful examination of the affected area shows that the bark is checked and cracked and has been invaded by one or more semi-parasitic fungi. After this short section of the stem has been killed, the above ground part of the plant becomes desiccated and dies. A new plant sometimes arises from the stem below the soil.

On trees that are a few years old, sun-scorch followed by fungus invasion of the damaged bark often causes wounds extending from near the ground line to a height of a foot or more up the trunk (fig. 13, B). These wounds invariably occur on the side of the tree that is exposed to

the hottest rays of the sun (usually the west) and often have the shape of a spear head. They are especially common where vertical rays strike at the junction of the stock and scion. Attacked trees are seldom killed and the wounds are eventually covered by callus tissue.

The Fungus — Fungi of a number of different genera (Fusarium, Glomerella, Diplodia, etc.) may be involved in attacks of collar rot. Although sunscald is the predisposing or primary factor, these fungi may complete the girdling process and cause the plants to die.

Control — Collar rot may be controlled by shading the soil at the base of the plants with a thin cover of straw or dead grass, or, if availability of seed permits, by planting several months in advance of periods of dry hot weather. The latter procedure allows the young plants partially to shade the soil before conditions favoring very high soil temperatures occur. Since damage is always heavier among weak plants, an application of fertilizer lessens damage from collar rot to plants growing on poor soil.

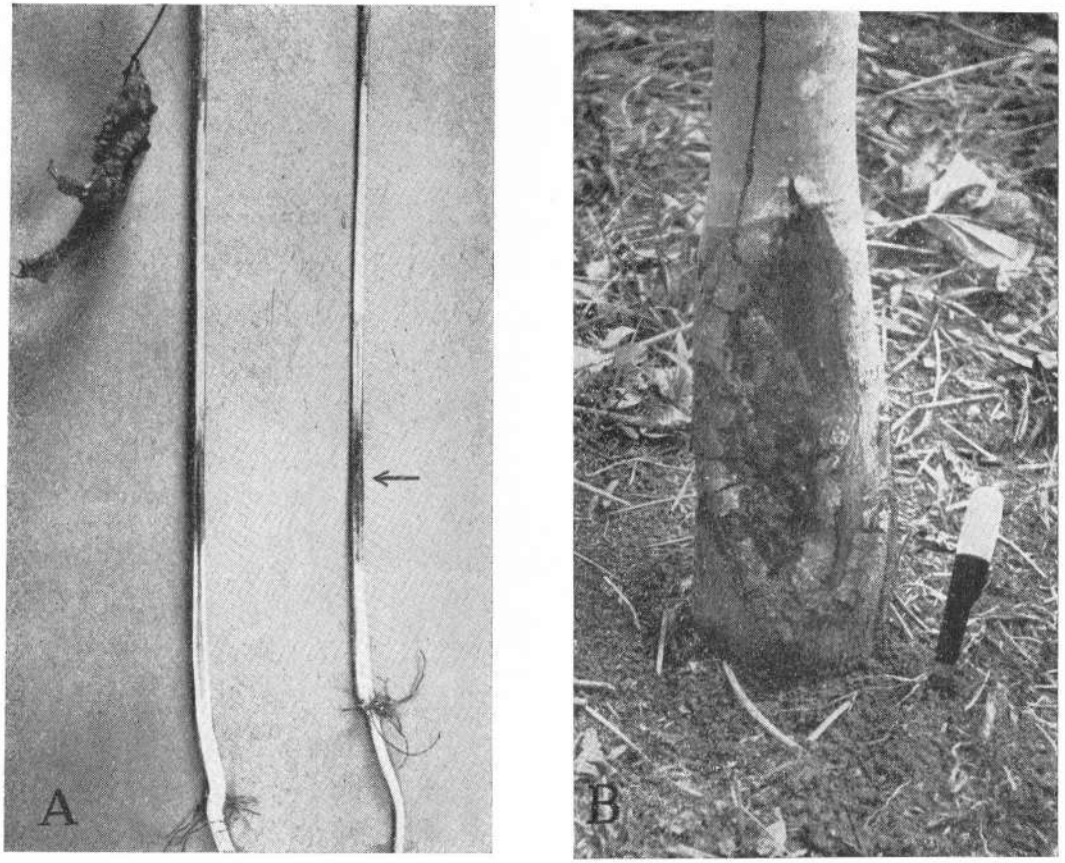

Figure 13. — *A*, collar rot of young Hevea seedlings (Arrow points to infected portion of stem); *B*, wound caused by sun-scorch and bark decay on 4-year-old Hevea tree.

SUMMARY

Since its establishment in 1940 the Instituto Agronômico do Norte has conducted investigations on Hevea, including studies on the major diseases and their control. This paper describes each of these diseases and gives the control measures now recommended for use against them.

South American leaf blight is the most destructive Hevea disease occurring in the Amazon Valley. It attacks the young leaves and may kill susceptible trees by causing repeated defoliations. Control measures that have proved effective against it are: (1) application of protectant sprays and (2) use of resistant clones. Spraying is recommended only as a temporary expedient to bring high-yielding blight-susceptible clones to top-budding size. Control thereafter is accomplished through use of blight-resistant crowns. A breeding program designed to combine the high-yield of Oriental clones with the blight-resistance of indigenous selections has yielded more than 7.000 blight-resistant progenies. These are now undergoing field tests at Belterra.

Phytophthora pod rot, leaf fall, die-back, and panel decay are expressions of attack on different parts of the Hevea tree by the fungus, *Phytophthora palmivora*. It is extremely sensitive to weather conditions and usually causes severe damage only during the height of the rainy season. It can be controlled, at least in part, by use of Phytophthora-tolerant top-budding clones and by opening new panels only during the dry season. Incidence of the disease can be further reduced by avoidance of clones that bear heavy seed crops.

Target leaf spot attacks only young leaves but it has caused severe damage to both nursery and field plantings in some localities of the upper Amazon Valley. At Belem and Belterra heavy leaf fall has usually been confined to the three wettest months of the year. This disease may be controlled in nurseries by spraying with Dithane (Z-78) or Parzate. Use of Pellicularia-tolerant top-budding clones is recommended for field plantings in areas where damage is serious.

Glomerella die-back is one of the most prevalent Hevea diseases of the lower Amazon Valley. Severe attacks of this disease are largely confined to trees that are growing on poor soils, in excessively dense stands, or under other conditions that reduce vigor. Striking reductions in incidence of Glomerella die-back were obtained at both Belem and Belterra by applying a complete (N-P-K) fertilizer to weak trees.

Black crust is one of the most conspicuous and least destructive diseases of Hevea. Avoidance of extremely susceptible clones is the only control measure warranted at the present time.

Pink disease, a common pest in many rubber-growing areas of the Far East, has not yet been noted in some Hevea plantings in the Amazon Valley. In localities where it has occurred, less than one percent of the trees have usually been attacked. In most places control measures are not required against this disease.

Losses caused by root diseases have been much smaller in the Amazon Valley than in many areas of the Far East. Usually, control measures against root diseases are not required.

Collar rot causes high losses among young seedlings in some areas. It may be controlled by shading the soil at the base of the plants with a thin cover of straw or dead grass: or, if availability of seed permits, by planting several months in advance of periods of hot dry weather.

SUMARIO

Desde sua instalação em 1940, o Instituto Agronômico do Norte tem realizado estudos sôbre a seringueira, sôbre as principais moléstias que a atacam e respectivos meios de combate. O presente trabalho descreve cada uma dessas moléstias ao mesmo tempo que indica os meios de contrôle atualmente recomendados contra as mesmas.

A "moléstia da folhas" *(South American leaf blight)* é a mais destruidora das moléstias que atacam a seringueira no vale Amazônico. Ela ataca as folhas novas e pode matar as árvores suscetíveis provocando desfolhamentos sucessivos.

Os meios de combate que se têm mostrado eficazes contra ela são: (1) aplicação de pulverizações protetoras e (2) emprêgo de clones resistentes. A pulverização é indicada apenas como expediente temporário, até que os clones de alta produção e suscetíveis à moléstia alcancem a idade em que poderão sofrer a enxertia da copa. O contrôle da moléstia se fará em seguida mediante o emprêgo de copas resistentes.

Por meio de um programa de cruzamentos que consistia em combinar a alta produtividade dos clones orientais com a resistência à moléstia, que possuem as seleções nativas, obtiveram-se mais de 7.000 progênies resistentes, que estão sendo submetidas agora a experiências de campo, em Belterra.

A "podridão das sementes" (*Phytophthora pod rot*), a "queda das folhas" *(leaf fall)* a "morte lenta" *(die-back)* e o "apodrecimento do painel" (*panel decay*) representam formas de ataque do fungo *Phytophthora palmivora* sôbre diferentes partes da seringueira. O fungo é extremamente sensível às condições do tempo e geralmente só causa grande dano no auge da estação das chuvas. Pode ser controlado, pelo menos em parte, mediante o emprêgo de clones de copa enxertada e tolerantes à Phytophthora, e abrindo-se novos paineis sòmente durante a estação sêca. A incidência da moléstia pode ser ainda reduzida evitando-se o emprêgo de clones que produzam grande quantidade de sementes.

A "mancha das folhas" (*target leaf spot*) só ataca as folhas novas, mas tem provocado grave dano tanto em plantações de viveiro como de campo, em algumas regiões do alto Amazonas. Em Belém e Belterra, a queda das folhas, em caráter sério, tem-se geralmente confinado aos três meses mais úmidos do ano. Esta moléstia pode ser controlada em viveiros mediante pulverização com Dithane (Z-78) ou Parzate.

O emprêgo do clones copa enxertada e tolerantes à Pellicularia é indicado para plantações de campo em regiões onde o dano se apresenta em caráter grave.

A "morte lenta" (*Glomerella die-back*) é uma das doenças mais frequentes que atacam a seringueira no Baixo Amazonas. Os mais pesados ataques da moléstia estão confinados, em grande parte, àquelas árvores que se encontram em solos pobres, em formações excessivamente densas, ou sob outras condições que concorram para lhes reduzir a vitalidade. Sensiveis reduções do ataque da "morte lenta" causada por Glomerella, têm-se obtido tanto em Belém, como em Belterra, mediante aplicações de um adubo completo (N-P-K) para as árvores fracas.

A "crosta preta" das folhas *(black crust)* é uma das moléstias mais evidentes e menos destruidoras da seringueira. Sòmente evitando-se o emprêgo de clones extremamente suscetiveis se poderá, presentemente, controlar a moléstia.

A "moléstia rosada" (*pink disease*), praga muito comum em muitas regiões de cultura de seringueira no Extremo Oriente, ainda não foi observada em algumas plantações de seringueira existentes no Vale Amazônico. Em localidades onde ela tem sido registada, menos de um porcento das árvores tem sido em geral atacado. Na maior parte das localidades onde ocorre, não se fazem necessárias medidas de contrôle contra essa moléstia.

As perdas causadas pelas moléstias radiculares têm sido em número muito menor no Vale Amazônico do que em muitas regiões do Extremo Oriente. Em geral, não se tornam necessárias medidas de contrôle contra tais moléstias.

A moléstia chamada "collar rot" ocasiona, em algumas áreas, grandes perdas entre os seedlings novos. Pode ser controlada sombreando-se o solo na base das plantas com uma fina cobertura de palha ou de capins mortos; ou, havendo sementes em quantidade, fazendo-se o plantio vários meses antes da estação quente e sêca.

RÉSUMÉ

Depuis sa fondation en 1940, l'Instituto Agronômico do Norte a poursuivi des recherches sur l'Hevea, notamment sur les principales maladies et les méthodes de lutte. L'auteur du présent travail décrit chacune de ces maladies et indique les méthodes de lutte preconisées actuellement.

La "maladie sud-américaine de la feuille" ("South American leaf blight") est la maladie de l'Hevea qui cause les plus grands ravages dans la vallée de l'Amazone. Cette maladie des jeunes feuilles peut même entraîner la mort d'arbres réceptifs en provoquant à plusieurs reprises des défoliations. Les méthodes de lutte qui se sont avérées efficaces dans ce cas sont (1) les pulvérisations de protection, et (2) l'utilisation de clones résistants. On recommande la pulvérisation uniquement en tant qu'expédient temporaire visant à permettre aux clones de haute production et réceptifs en ce qui concerne cette maladie d'atteindre les dimensions requises pour la greffe de couronne. Ensuite la lutte consiste dans l'utilisation de couronnes résistantes (immunes) en ce qui concerne cette maladie de la feuille.

On a obtenu plus de 7000 descendants résistants issus de croisements effectués suivant un programme méthodique en combinant la haute productivité des clones de l'Extrême-Orient avec la résistance à la maladie, resistance que présentent les formes obtenues par sélection de formes d'Hevea natives en Amazonie. On soumet actuellement ces descendants résistants à des cultures expérimentales à Belterra.

La "pourriture des fruits et graines" ("Phytophthora pod rot"), la "chute des feuilles" ("leaf fall"), la "mort lente" (ou "point sèche", "die-back") ainsi que la "pourriture du bourrelet cicatriciel" ("panel decay") représentent des formes d'attaque fongique dues à *Phytophthora palmivora* atteignant différentes parties de l'Hevea. Le champignon est extrêmement sensible aux facteurs climatiques et généralement ne cause de grands ravages qu'au point culminant de la saison des pluies.

La lutte contre ce champignon est, tout au moins en partie, possible par l'emploi de clones à couronne greffée et immuns vis-à-vis de *Phytophthora*, ainsi que par le fait de limiter à la saison sèche l'ouverture de nouvelles surfaces cicatricielles. On peut encore reduire l'incidence de la maladie en évitant l'utilisation de clones produisant de grandes quantités de graines.

La maladie de la "tache des feuilles" ("target leaf spot") n'attaque que les jeunes feuilles; elle a cependant, causé de graves

dégâts tant dans les pépinières que dans des plantations, dans quelques régions du Haut-Amazone.

A Belém ainsi qu'à Belterra, la maladie dite "chute des feuilles" atteignant un certain degré de gravité s'est généralement limitée à la période des trois mois les plus humides de l'année. On peut lutter contre cette maladie, quand elle s'étend aux pépinières, au moyen de pulvérisations à base de Dithane (Z-78) ou Parzate.

L'utilisation de clones à couronne greffée et immuns vis-à-vis de Pellicularia est tout indiquée quand il s'agit d'établir des plantations dans des régions où cette maladie cause des dégâts assez sérieux.

La maladie dite "mort lente" ("Glomerella die-back") est une des maladies les plus fréquentes de l'Hevea dans le Bas-Amazone. Les attaques les plus graves de cette maladie n'ont été observées, en grande partie, que chez ces arbres que l'on rencontre dans les sols pauvres, en formations excessivement denses, ou dans d'autres conditions de millieu qui entraînent une réduction de la vitalité. On a obtenu a Belém ainsi qu'à Belterra de sensibles réductions des attaques de la maladie "mort lente" due à *Glomerella* par l'emploi d'un engrais complet (N-P-K) appliqué aux arbres de faible constitution.

La maladie dite "croûte noire" des feuilles ("black crust") est une des maladies les plus apparentes et les moins destructrices de l'Hevea. Ce n'est uniquement qu'en évitant l'utilisation de clones extrêmement réceptifs que l'on pourra actuellement lutter contre cette maladie.

La maladie dite "maladie rosée ou rubelose" ("pink disease") maladie très commune dans de nombreuses régions de culture de l'Hevea en Extrême-Orient, n'a pas encore été observée dans l'une ou l'autre plantation de l'Hevea de la vallée de l'Amazone. Dans les localités où cette maladie a été signalée, on compte en général un pourcentage d'arbres atteints inférieur à 1%. Dans le plus grand nombre des localités où cette maladie est signalée, on ne doit nullement recourir à des moyens de lutte contre cette maladie.

Les pertes dues aux maladies des racines de l'Hevea ont été beaucoup moins fréquentes dans la vallée de l'Amazone que dans de nombreuses régions de l'Extrême-Orient. En général, des mesures de lutte contre ce genre de maladies ne s'imposent pas.

La maladie dite "collar rot" (porriture du collet) causa, dans certaines régions de grandes pertes de jeunes plantules dans les pépinières. On peut lutter contre cette maladie par l'aménagement de l'ombrage du sol à la base des plantes en étendant une fine couverture de paille ou d'herbes mortes; ou bien encore, au cas où on disposerait de grandes quantités de graines, on peut les planter plusieurs mois avant la saison chaude et sèche.

ZUSAMMENFASSUNG

Seit seiner Gründung im Jahre 1940 führt das Instituto Agronômico do Norte Untersuchungen durch über den Gummibaum, über die hauptsächlichen Krankheiten, die ihn befallen, und über deren entsprechende Bekämpfungsmittel. Die vorliegende Arbeit beschreibt alle diese Krankheiten und gibt gleichzeitig die gegenwärtig empfohlenen Massnahmen an, durch welche diese Krankheiten unter Kontrolle gehalten werden können.

Die "Blattkrankheit" ("South American leaf blight") ist die zerstörerischste aller Krankheiten, die den Gummibaum im Amazonastal angreifen. Sie befällt die jungen Blätter und kann die Bäume durch sukzessive Entlaubungen töten.

Die Bekämpfungsmittel, die sich als wirkungsvoll gegen diese Krankheit erwiesen haben, sind: 1.) Anwendung von Schutzbestäubungen, und 2.) Verwendung widerstandsfähiger Klone. Die Bestäubung ist nur als zeitweilige vorübergehende Massnahme angezeigt bis zu dem Zeitpunkte, in dem die für die Krankheit empfänglichen Klone hoher Produktion das Alter erreichen, in welchem eine Kronenpfropfung ausgeführt werden kann. Die Kontrolle der Krankheit wird dann durch die Aufpfropfung resistenter Kronen erreicht.

Durch ein Kreuzungsprogramm, welches darin bestand, die hohe Produktivität südostasiatischer Klone mit der Resistenz, gegen die Krankheit, die hiesige, amazonische Selektionen besitzen, zu vereinigen, wurden mehr als 7000 neue Ausgangsformen erhalten, die augenblicklich Feldversuchen in Belterra unterworfen werden.

Die "Samenfäule" ("Phytophthora pod rot"), der "Blattfall" ("leaf fall"), das "langsame Absterben" ("die-back") und die "Schnittwundenfäule" ("panel decay") sind Befallsformen durch den Pilz *Phytophthora palmivora* auf verschiedenen Teilen des Gummibaumes. Der Pilz ist für die Witterungsverhältnisse äusserst empfindlich und verursacht im allgemeinen nur während des Höhepunktes der Regenzeit grossen Schaden. Er kann, wenigstens teilweise, kontrolliert werden durch die Anwendung Phytophthora-toleranter Klone mit aufgepfropfter Krone und dadurch, dass neue Schnittflächen nur während der Trockenzeit begonnen werden. Die Häufigkeit der Krankheit kann fernerhin reduziert werden, indem die Verwendung von Klonen vermieden wird, die grosse Mengen von Samen produzieren.

Die "Blattfleckenkrankheit" ("target leaf spot") greift nur junge Blätter an, hat jedoch in einigen Gegenden des oberen Amazonas sowohl in Baumschulen wie in Feldpflanzungen schweren Schaden angerichtet. In Belém und in Belterra blieb der Blattfall ernsten Charakters im allgemeinen auf die frei feuchtesten Monate des Jahres beschränkt. Diese Krankheit kann in Baumschulen durch Bestäubung mit Dithane (Z-78) oder Parzate kontrolliert werden.

Die Verwendung von Pellicularia-toleranten Klonen mit aufgepfropfter Krone ist für Feldpflanzungen in Gegenden angezeigt, in denen der Schaden in schwerer Form auftritt.

Das "langsame Absterben" ("Glomerella die-back") ist eine der häufigsten Krankheiten, die den Gummibaum im unteren Amazonasgebiet befallen. Die schwersten Angriffe der Krankheit sind zum grossen Teile auf diejenigen Bäume beschränkt, die auf armen Böden, in übermässig dichten Beständen oder unter anderen Bedingungen wachsen, die dazu beitragen, ihre Lebenskraft zu vermindern. Merkliche Abnahme des Befalls mit "langsamen Absterben", der durch Glomerella verursacht wird, wurde sowohl in Belém als auch in Belterra durch Gaben vollständiger Düngung (N-P-K) an die schwachen Bäume erzielt.

Die "schwarze Kruste" der Blätter ("black crust") ist eine der auffälligsten und am wenigstens zerstörerischen Krankheiten des Gummibaumes. Wenn nur die Verwendung übermässig empfindlicher Klone vermieden wird, kann die Krankheit gegenwärtig unter Kontrolle gehalten werden.

Die "Rosa-Krankheit" ("Pink disease"), sehr verbreitet in vielen Gegenden der Gummibaum-Kulturen im Fernen Osten, wurde bisher in einigen Gummipflanzungen im Amazonastale noch nicht beobachtet. An den Orten, wo sie jedoch auftritt, ist im allgemeinen weniger als ein Prozent der Bäume von ihr befallen. Im grössten Teile der Plätze ihres Auftretens sind Kontrollmassnahmen gegen die Krankheit nicht notwendig.

Die durch Wurzelkrankheiten hervorgerufenen Verluste sind im Amazonastale zahlenmässig viel geringer als in vielen Gegenden des fernen Ostens. Im allgemeinen sind Kontrollmassnahmen gegen solche Krankheiten unnötig.

Die sogenannte "collar rot"-Krankheit verursacht in einigen Gebieten grosse Verluste unter den jungen Sämlingen. Sie kann dadurch kontrolliert werden, dass der Boden an der Basis der Pflanzen durch eine dünne Bedeckung mit Stroh oder Heu beschattet wird, oder, wenn genügende Mengen von Samen zur Verfügung stehen, indem die Samen mehrere Monate vor der heissen und trockenen Jahreszeit gelegt werden.

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