Reprinted from FAO PLANT PROTECTION BULLETIN, Vol. VIII No. 8, May 1960,
published by the Food and Agriculture Organization of the United Nations, Rome, Italy

Quarantine Arrangements for Intercepting Cocoa Material Infected with West African Viruses

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At the first FAO Technical Cocoa Meeting held in Accra in February 1959, many delegates stressed the importance of distributing improved planting material and disease-resistant clones throughout the major cocoa-growing areas of the world. It was also emphasized that every precaution should be taken to ensure that pests and diseases are not spread in this way. Indeed, a special session was held to discuss quarantine arrangements, particularly those designed to reduce the risks of spreading viruses. These are widespread and important in West Africa, where they have been found in Sierra Leone, the Ivory Coast, Ghana and Nigeria. Viruses also occur in Trinidad and Ceylon and suspicious symptoms have been reported from Java, Sumatra and certain South American countries (4). The apparent absence of virus from some of the most important cocoa areas and the limited distribution of the most virulent strains emphasize the necessity for the strictest possible quarantine control.

It was suggested in Accra that quarantine stations should be established at main centers of communication in the Americas, Africa and the Pacific, to handle the exchange of material within and between continents. Puerto Rico, Kano in Northern Nigeria and an accessible island in the Pacific or Indian Oceans were suggested as possible sites in tropical areas where cocoa is not already established. The methods which could be used for detecting the known cocoa viruses of West Africa and some of the problems likely to be encountered in quarantine work with cocoa are discussed in the present paper. A double grafting technique is described for testing vegetative material for virus.

Methods of detecting cocoa viruses

Various methods have been developed for detecting viruses but with cocoa the available techniques are limited. For example, the chemical tests suggested by Hancock (1) and Tinsley and Usher (6) have limited application. Furthermore, mealybug transmit only some of the known cocoa viruses and are not always readily available or easy to handle (3). Thus, grafting is the only reliable method and the presence of virus can be assumed if a diseased condition is transmitted by grafting infected tissues into healthy plants. At the same time, comparable uninoculated controls should remain healthy.

Symptoms are not always easy to see on infected plants and the swollen shoot and cocoa mottle leaf viruses cause a transient red banding along the veins of young leaves, which is not always followed by a permanent pattern of vein-clearing or chlorotic banding. Thus, test plants should be examined weekly to ensure that the leaves are seen before and after they mature. The plants should also be vigorous, growing in the best possible conditions and treated with foliar sprays or soil dressings of fertilizer to correct any nutrient deficiencies. Particular difficulty is encountered in Ibadan because of the alkalinity of the topsoil and the

water supply. Under these conditions, symptoms of manganese or iron deficiency frequently mask those caused by virus, unless the plants are sprayed or the soils treated with chelate compounds.

It is also essential to keep the plants in adequately screened houses and to eliminate any insects by routine sprays. These should include a systemic insecticide particularly effective against mealybugs. Additional sprays with acaricides may also be necessary, as spider mites tend to multiply and damage the leaves of potted plants kept for a long time in screened houses.

The efficiency of quarantine arrangements depends largely upon an ability to recognize the symptoms of virus infection whenever they occur on cuttings, budlings or test plants. This is easy when symptoms are obvious and can be recognized by reference to published photographs and even descriptions (4). However, viruses causing such conspicuous symptoms are likely to be detected in the country of origin and before vegetative material is dispatched. This means that quarantine officers are likely to encounter only the mildest viruses or those which occur in tolerant varieties. Under these circumstances, symptoms tend to be very inconspicuous and restricted to a few leaves, perhaps those appearing only at certain stages of development. An ability to detect such symptoms depends upon considerable experience and even then it may be necessary to carry out additional graft tests on the suspected material. For this reason it is suggested that the officers responsible for quarantine control should receive special training in symptom recognition and should also be able to consult specialists in cocoa virus research.

The movement of planting material

SEED

Despite a number of attempts, the known cocoa viruses have not been transmitted through seeds. Thus, there seems little danger in transporting them between countries, even if pods are unwittingly taken from infected trees. Nevertheless, obvious precautions are to collect seed only in disease-free areas and from trees which are inspected for virus symptoms at regular and frequent intervals.

Fermentation and breakdown of the pulp start immediately after the pods are broken. The discussions in Accra showed that there is no agreement on the best methods of preparing, cleaning and packing seed. Consequently, seeds are most conveniently carried in intact pods but this is dangerous because the husks of pods from infected trees contain virus which is readily available to the mealybug vectors. These and other insects together with fungi are commonly present on the surface of pods and are difficult to eradicate from the crevices and insect galleries. Thus, intact pods should be transported only when absolutely necessary. They should then be carefully selected and sterilized before and after transit and the husks destroyed as the beans are removed.

ROOTED CUTTINGS

Vegetative material of particularly valuable clones has been in demand for many years and shipments are likely to increase as vigorous hybrid or resistant selections become available. The usual practice has been to transport rooted cuttings from which the soil has been removed. This is sometimes successful but heavy losses have been experienced within West Africa through delays in transit and difficulty in re-establishing the sensitive material. Moreover, the practice of maintaining cuttings under quarantine conditions and releasing them after inspecting for symptoms over an arbitrary period is an inefficient method of detecting virus. Some material, particularly of fan cuttings, makes limited growth in quarantine and deficiency symptoms or growth mottles may obscure the effects of virus. These may be exceedingly mild with certain combinations of virus and host, and some material tolerates infection with even the most virulent strains. Symptoms are then difficult to detect by even the most skilled and experienced observers. For these reasons it is suggested that the movement of rooted cuttings should be restricted, unless supplementary graft tests are carried out. The movement of clones in the much

more convenient form of budwood provides a satisfactory alternative.

Budwood

Budwood of many different crop plants is frequently exchanged between countries and it can be sealed in polythene bags and transported much more readily than rooted cuttings or even seeds. The procedure has other advantages, as budwood can be taken from vigorous seedlings or rooted cuttings which have been grown and inspected under screened conditions in the exporting country for a sufficiently long period to indicate that they are free from virus. Furthermore, top-working the source with susceptible buds can be used as an additional check on the presence of virus and is recommended for clones which tolerate infection.

The bud sticks for transit should be cut from vigorous hardened shoots tapering from a diameter of $^3/_4$ inch. The leaves should be removed to leave the basal pulvinus of the petiole, and the bud sticks should be surface-sterilized and packed in moist filter papers inside polythene. Care should be taken to ensure that the package is not delayed in transit or exposed to extremes of heat or cold. On arrival, buds should be removed and grafted to vigorous healthy stocks at the earliest opportunity. The most satisfactory buds are those on portions of the mature stem from which the leaves have fallen naturally. However, buds in the axils of mature leaves can be used also and little difficulty should be experienced in getting a percentage of the buds to develop. The successful budlings should grow rapidly under good conditions and any infection is likely to be diagnosed by thorough and frequent inspections over a period of several months.

Some infection, particularly in tolerant material, is unlikely to be recognized in this way and top-working with a susceptible bud should be used as a final check on the presence of virus. Thus, it is suggested that all symptomless budlings which have grown to graftable size should be cut back and budded with a healthy Amelonado clone, such as West African Cocoa Research Institute selection C14. The

Figure 1. Conspicuous leaf symptoms and a stem swelling produced after grafting a healthy Amelonado cocoa bud onto a stock which was infected with cocoa swollen shoot virus.

detached shoots can be used to maintain the introduced clone by rooting hardwood cuttings or grafting buds onto healthy stocks. This material can then be released as healthy and suitable for general distribution, once the indicator shoot on the original top-worked plant has produced three or four symptomless flushes. Double working techniques of this type have already been used extensively for testing tolerant varieties of certain tree crops and they have given satisfactory results with cocoa in Ibadan (Figure 1).

Future developments

These observations are based on experience in West Africa with the three viruses occurring there. Further work may reveal additional

water supply. Under these conditions, symptoms of manganese or iron deficiency frequently mask those caused by virus, unless the plants are sprayed or the soils treated with chelate compounds.

It is also essential to keep the plants in adequately screened houses and to eliminate any insects by routine sprays. These should include a systemic insecticide particularly effective against mealybugs. Additional sprays with acaricides may also be necessary, as spider mites tend to multiply and damage the leaves of potted plants kept for a long time in screened houses.

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tests which would simplify the present arrangements and facilitate diagnosis. For example, the application of chemical or serological methods as used in potato inspection would be a considerable advance. An additional possibility is that particularly sensitive indicator clones may be selected and used as stocks or for top-working suspected material. Existing techniques may also have to be modified if new viruses are discovered.

Summary

There is an increasing demand for the exchange of cacao material between the major producing countries but viruses may be spread in this way and rigid quarantine control measures are essential. The movement of beans is relatively safe, as the known cocoa viruses are not seed-borne, although they occur in pods taken from infected trees. By comparison, the movement of rooted cuttings is dangerous and vegetative material is best handled as budwood. This can be collected from plants already growing in isolation and, after transit, should be multiplied on susceptible stocks. As a final test for the presence of virus, the budlings should be top-worked with susceptible material.

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