COCOA GROWERS' BULLETIN

Number 4 February 1965

Contents

Cadbury Brothers Limited
Publication Department Bournville

Editorial

Yields

In this issue we publish an article on cocoa in Fernando Po. This is one of the oldest cocoa areas in West Africa, and in contrast with the rest of West Africa most of the cocoa is grown on estates of more than 100 acres. The average yield over the island is about 500 lb. per acre, which puts it higher than most other cocoa-growing countries. As elsewhere, this bare figure conceals wide variation, but it is clear that yields on estates are generally higher than on small-holdings; yields of 1,000 lb. per acre are not uncommon.

This comparatively high level of yield is achieved simply by good estate maintenance and control of black-pod disease. It is not the result of new planting material or any new method of cultivation. We have no knowledge of the costs and returns on estates in Fernando Po—although one might comment that the method of Black-pod control appears expensive—but on general principles it is only by achieving yields of 800–1,000 lb. per acre that estates can be run at a profit. It is heartening to hear of a country where yields are commonly of this order.

Organisations connected with cocoa

Cocoa growers will be familiar with initials like WACRI and ICTA, which refer to the research stations most closely connected with cocoa, but there are other initials and other organisations, some less directly connected with cocoa, with which cocoa growers in some parts of the world may be less familiar. We refer to ACRI, the American Cocoa Research Institute, IFCC, the Institut Français du Café et Cacao, the International Office and others. In order to explain the functions of these organisations we intend to publish a series of articles about them, and in this issue we start with an article on the International Office of Cocoa and Chocolate.

G. A. R. Wood.

Nestlé and Chocolate

We are publishing in this issue the second of the series of articles on the larger cocoa and chocolate manufacturers. The first, dealing with Cadbury Brothers Limited, appeared in the August 1964 Bulletin. The aim of the series is to strengthen the contact between growers and manufacturers.

Nestlé as it is today, a Swiss company with international ramifications, almost 100 years old, developed from a small business started in the little Swiss town of Vevey by Henri Nestlé, who in 1867 had invented his milk food for babies, and another modest Swiss company manufacturing condensed milk.

The two companies merged in 1905, and since then the range of Nestlé products has grown continuously. The original condensed milk and milk food were completed by a wide range of powdered milk products for infant nutrition. An assortment of other dietetic products was gradually added.

New products

Apart from chocolate, in which we are most interested here, Nestlé's production has been extended over the years to include cheese, butter, cream, fruit juices and canned tomatoes. The company also pursued research into new products, with the result that in 1938 Nestlé marketed the first instant coffee, Nescafé, to be followed later by instant tea—Nestea, and cocoa-based instants such as Nesquik, Milo, etc.

After the merger with Maggi and Crosse & Blackwell, the product range was enlarged still further by a variety of liquid and dried soups, canned fruit, vegetables, meat, fish, pickles, seasoning, sauces and spices. Today it is easy to prepare a complete and varied meal using nothing but products made in Nestlé's factories.

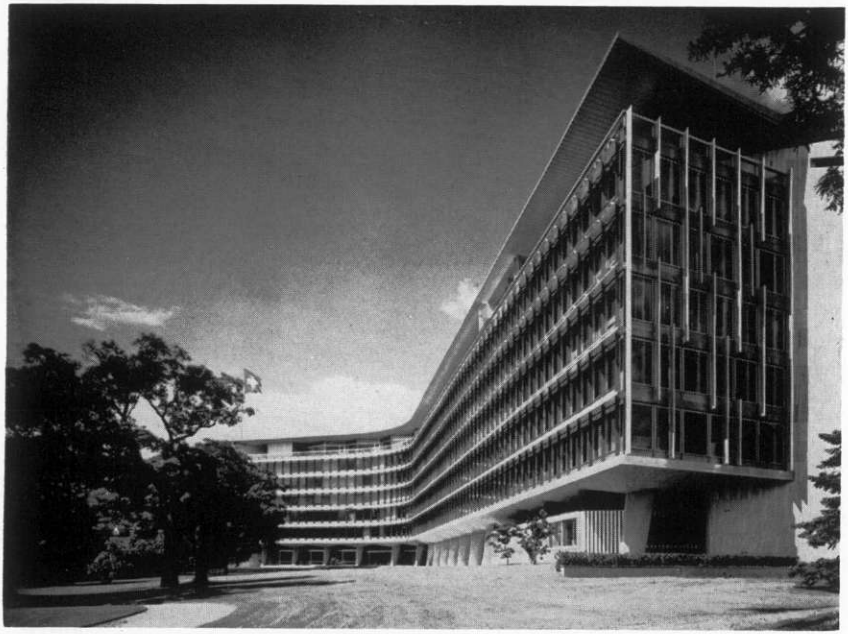
This claim has been emphasised since 1960 when Nestlé branched out into the frozen-food field by joining the Swedish/Norwegian group Marabou-Freia to form a new company: Findus International Ltd., for production and marketing of a very wide range of frozen products.

Nestlé has played a pioneering role in developing countries, where the setting up of Nestlé factories in one or two-crop countries (e.g. Brazil, Colombia) has helped direct the development of farm production towards more appropriate and rewarding patterns.

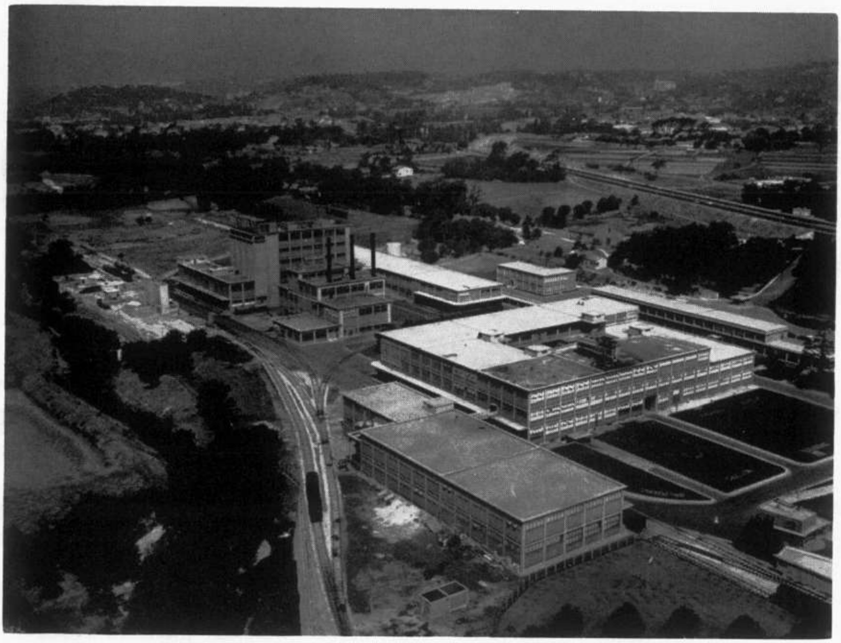
Nestlé operates over 210 factories and employs more than 85,000 people throughout the world. The company, however, does not own plantations, cattle or retail outlets, but performs all operations from manufacturing to distribution.

Nestle's long-standing interest in chocolate

The first Swiss chocolate factory was started in Vevey by F. L. Cailler in 1819. It was in the same small town on Lake Geneva that Daniel Peter invented milk chocolate in 1875. Henri Nestlé, as a manufacturer of condensed milk, naturally established close relations with the chocolate makers at a very early date. In 1904, the Société Henri Nestlé signed an agreement with the Société des Chocolats Peter et Kohler, whereby the originators of milk chocolate were to manufacture and market this product under the Nestlé brand. After the merger of the chocolate manufacturers Peter, Cailler and Kohler in 1911, Nestlé entered into



Nestlés Headquarters in Vevey, Switzerland.



*Sopad's plant at St. Menet, near Marseilles, France:
one of the many factories around the world producing Nestlé chocolate.*

closer co-operation with the three in 1912. In 1929 the union of the Nestlé and the Peter-Cailler-Kohler group became complete, and a substantial force of specialists and male and female operatives joined Nestlé's forces.

The manufacture of traditional lines under the Nestlé, Peter, Cailler and Kohler trade marks is still based on formulae handed down by pioneers who considered quality as their first problem, but actual production processes have, under the influence of technological evolution, considerably progressed over the years.

Since the end of the second world war, in particular, a long-term programme of plant modernisation and automation has been undertaken. Throughout the world, Nestlé's allied companies have spent a great deal both on this and on setting up new factories.

Nestlé—an international company

The outstanding feature of Nestlé's activity in the chocolate field is the policy of international expansion which the company has always followed. Twenty-four factories are operating in such different countries as Switzerland, Germany, Belgium, Denmark, Spain, France, Italy, Turkey, Great Britain, South Africa, Australia, New Zealand, Argentina, Brazil and the United States. The labour force of these chocolate factories represents over 20 per cent of all employees engaged in actual production in Nestlé factories.

Confidence in the goodwill of the Nestlé brand was obviously one of the essential reasons which led management to supplement the milk product range with chocolate. In all objectivity, it must be acknowledged that a decision of this kind demanded considerable courage; no other food company with world-wide interests has branched out into chocolate on such an international basis. Most of the 161 companies and agencies associated with Nestlé have chocolate products on their price list.

Nestlé in the world of chocolate

Nestlé has certainly done its share in the effort of generalising throughout the world the habit of eating chocolate. The company has been among the pioneers of chocolate production in Latin America (especially Argentina), the antipodes (Australia and New Zealand) and the Middle East (Turkey).

Very early, the company successfully started marketing chocolate through the five continents, often in countries where chocolate had been practically unknown previously. Today, Nestlé's chocolate can be found in the heart of Amazonia, the forests of Malaya or the bazaars of Baghdad. Such a degree of distribution would not have been possible without the widespread sales network which the company has established over several generations, and which today covers practically the whole free world, with thousands of salesmen co-ordinated by the 161 companies and agencies mentioned earlier.

At the same time, Nestlé's influence has been strong in the general improvement of the quality of chocolate products. Nestlé has not only helped to make chocolate popular at all social levels, including the most sophisticated type of consumer, but has won wider acceptance for products which have a higher cocoa content than some traditional cocoa-based products; Nestlé has played an appreciable part in gradually winning the Spanish and Latin American consumer over from the older-type chocolate "a la taza" (mixed with flour or other additives) to pure chocolate.

We have already said that Nestlé was the pioneer in the field of milk chocolate.

It is highly probable that without the invention of milk chocolate, chocolate in general would not have risen to the place it now occupies in the estimation of nutritional experts.

Nor has Nestlé been content merely to popularise chocolate-eating throughout the world. An unremitting research effort has enabled the company to develop for industrial production new products which are opening up new areas of consumption for cocoa. One example is Nesquik, which has for years been making milk more acceptable to millions of children, and accounts for thousands of tons of cocoa powder. Another is Semi-Sweet Chocolate Morsels, the chocolate chips which, aided by the efforts of Nestlé's home economics services, have given millions of American housewives an easy way to use chocolate in home baking.

Winning customers through diversity

Nestlé has also helped to increase consumption through the multiplicity of the varieties it markets. The consumer is constantly tempted by a wide range of attractive products, from the most sophisticated boxed chocolates to the smallest Neapolitan. Nestlé's Swiss and German factories take particular pains to keep thousands of different articles in production, despite the complications and expense involved, in order to win consumers through diversity. Since chocolate buying is largely a matter of impulse, there is no doubt that this helps to increase demand.

Nestlé has been consistent in the marketing of pure chocolate products and still holds that, in the interest of consumers, chocolate substitutes should be clearly differentiated from, and certainly not be assimilated with, chocolate. This is also in the interest of cocoa producers.

Price policy, raw materials

As for the vital question of raw material prices, Nestlé has also followed a clear policy over the last 10 years, as evidenced by various addresses by President Max Petitpierre:

> "We also believe that stabilization of the prices of raw materials supplied by developing countries would help their development and we are glad to see that discussions are being held on coffee and cocoa between producer and consumer countries. We hope that formal agreements will result".
> (Address at Ordinary General Meeting, Nestlé Alimentana Co. S.A., 10th May, 1963 at Zug, Switzerland).

And again, in 1964:

> "I am thinking of the stabilization of prices of raw materials produced by countries for which they constitute the principal source of revenue. Our Company has always advocated such stabilization"

Review of Production, Consumption and Prices

S. L. Hale, Cadbury Brothers Limited

Production and consumption

The latest F.A.O. estimate of grindings during 1965 is 1,203,000 tons, while production during 1964–65 is estimated at 1,256,000 tons. These figures indicate an excess production of approximately 53,000 tons. However, West African crops are coming in very well and are likely to be better than the F.A.O. estimates, leading to an excess production amounting to about 250,000 tons.

Prices

Reference was made in the previous issue of this bulletin to a meeting of the Cocoa Producers' Alliance in Lomé, Togoland. At this meeting the Alliance agreed the following basic quotas for its six members:—

Brazil	199,000 tons
Cameroun	90,000 ,,
Ivory Coast.. ..	103,000 ,,
Ghana	439,000 ,,
Nigeria	220,000 ,,
Togo	15,000 ,,

The Alliance also agreed the following procedure:—

(1) At the beginning of each cocoa year the Board shall determine an indicator price.

(2) The indicator price shall not be fixed below the average price of the twelve months preceding each cocoa year for which figures are available.

(3) In exceptional circumstances affecting supply and demand, the Board may adopt other criteria in establishing the indicator price of cocoa.

(4) Reference to the price of cocoa shall be to an average taken daily and converted to pounds sterling per long ton at the official currency rate of the quotations for cocoa beans of the nearest three active futures trading months on the New York Cocoa Exchange at noon and the London Terminal Market at closing time, or whichever of the two quotations is available. The time for shift to the next three-months' period is the fifteenth of the month immediately preceding the nearest active maturing month.

(5) If the Board at any time considers that there is a more satisfactory method of determining the daily price of cocoa than the one given in paragraph (4), it may decide to use such a method.

(6) Any reference to the price of cocoa being at, below, or above any figure means that the average price over the period of 10 consecutive market days has been at, below, or above that figure.

(7) In order to attain the price objectives of this Agreement, the Board may adopt whatever measures it deems necessary and proper, and in particular the introduction, revisions or suspension of export quotas.

At a subsequent meeting in Rio de Janeiro in September, the Lomé Agreement was confirmed. An indicator price of 190s. was agreed and an export quota of 90 per cent of basic was fixed.

Reduction of quotas

Prices drifted downwards and, as they were below the indicator price, the Alliance withdrew from the market. Further meetings were held in Lagos and Accra; quotas were reduced to 80 per cent; the possibility of storing cocoa in consuming countries was considered and rejected; Ghana offered 25,000 tons of space to other members of the Alliance; the destruction of some cocoa is to be considered and there is a possibility of the indicator price being revised upwards to make up for financial losses through destruction.

These measures helped market prices to rise to 187s. 6d. per cwt. c.i.f. U.K. for Ghana—but this was still below the indicator price. Meanwhile there were several rumours of sales by Ivory Coast and Cameroun Republic, who for various reasons are unable to store cocoa for any length of time.

A token quantity of down-graded cocoa was burnt in Ghana on 10th December. In view of the present world supply position it would be necessary to destroy a much larger quantity—about 50,000 tons—to have any real effect on prices, but such action would be disastrous. It certainly would not encourage expansion of consumption and it could lead to increased use of substitutes. The real solution to the problem is the finding of new markets, and with the continued increase in world population, and taking into account the millions of people on a low diet, this should not be an insuperable problem.

POSTSCRIPT

At a meeting in Lagos in January of this year, the Alliance decided to divert 250,000 tons of cocoa beans for non-conventional uses, mainly oils and fats. The Alliance believes that its withdrawal from the market since the middle of last October has led to a reduction of stocks in consumers' hands, and agreed for its members to re-enter the market. The clauses in their agreement regarding withdrawal from the market if prices fell below the indicator price were not to be applied. Following their re-entry into the market, prices dropped sharply to 155s. per cwt. c.i.f. for Ghana.

THE WORLD'S COCOA ORGANISATIONS :

1. The International Office of Cocoa and Chocolate

J. E. Chapman, Director-General, I.O.

The International Office of Cocoa and Chocolate is the international trade association of the chocolate manufacturing industry. It was founded in Antwerp in 1930, on the initiative of the Belgian Chocolate Manufacturers' Association, for the purpose of providing the various national chocolate manufacturing industries with a point of contact and a forum for exchanging views and information on matters of common interest. Although officially described since its foundation as "an organisation for scientific purposes", it is as much concerned with economic and social problems affecting the chocolate manufacturing industry as it is with technical and scientific matters. In fact, there is nothing in its constitution to debar it from considering any matter of concern or interest to chocolate manufacturers.

The headquarters of the International Office have always been in Brussels. The reasons for this are traditional and constitutional. The International Office was constituted under Belgian law. In addition, the first President of the International Office, M. Alfred Martougin, was President of the Belgian Chocolate Manufacturers' Association, and the first Director-General, M. Albert Bourgaux, was also Director-General of the Belgian Federation of Food Industries. It was natural, therefore, that the Belgian Federation should put its facilities and services at the disposal of the newly-founded organisation. Although both the Presidency and the office of Director-General have changed twice since 1930, and neither of the present holders of these offices is Belgian*, the International Office has continued to enjoy the facilities provided by the Belgian Federation at its headquarters at 55 rue de la Loi, in Brussels.

Administrative Structure

The International Office has a simple administrative structure. Its governing body is its council, which meets once a year under the chairmanship of the President. The council, which deals with matters of policy, is assisted by an administrative committee which meets twice a year under the chairmanship of the Director-General and deals with detailed matters of administration. The secretarial work of these two bodies is carried out by the Secretary-General, who is permanently resident at the headquarters in Brussels. There is also a technical committee, comprising chemists and other scientists from member associations, which meets once every two years or so and deals with a wide variety of technical and scientific matters. In order to advance the work of the technical committee in the intervals between its meetings, the Chairman of the committee is assisted by a "bureau" of chemists from some of the major chocolate firms in Switzerland who devote a great deal of their private time to this work.

---

*Dr. C. del Boca, of the Swiss Nestlé Company, has been President of the International Office since 1959, and Mr. J. E. Chapman (the Secretary of the Cocoa, Chocolate and Confectionery Alliance of the United Kingdon) has been Director-General since 1961.

Like most other trade associations, the International Office is a voluntary organisation. It has no jurisdiction over the activities of the various national industries which are its members, and any decisions it may take depend for their execution on the voluntary acceptance of those concerned. The principal link between the International Office and its members is the Periodic Circular, a bulletin issued from the headquarters in Brussels four times a year, which seeks to convey the general policy of the International Office towards the various matters with which it is concerned. In addition, there is a regular statistical service whereby member associations are kept informed of the progress of production and consumption of chocolate and cocoa products in the principal member countries.

Cocoa Research

It would be difficult in the scope of this short article to give a comprehensive picture of the activities of the International Office. In any case, a good many of these activities—such as the determination of international methods of analysis for the raw materials and finished goods of the chocolate manufacturing industry—lie in specialised fields, of interest only to those directly engaged in chocolate manufacture. Perhaps, therefore, as this bulletin is addressed to cocoa growers, it would be appropriate to refer particularly to the International Office's activities in the field of cocoa research.

As the international organisation of the chocolate manufacturing industry, the International Office could not fail to be interested in, and concerned with, any activity designed to improve the quantity and quality of the industry's main raw material—cocoa: and consequently over the years it has maintained a continuing interest in the question of raw cocoa research. For example, the International Office was closely associated with all the London cocoa conferences organised by the Cocoa, Chocolate and Confectionery Alliance of the United Kingdom in the post-war years. More recently, again in association with the Cocoa, Chocolate and Confectionery Alliance, the International Office has agreed to sponsor an international scheme for encouraging cocoa research under which particular projects receive financial backing and assistance from the manufacturing industry. Although the scheme is still in its formative stages, the first project has been planned and considerable progress has been made towards its realisation. This project envisages the creation of an international team of scientists to carry out research into the capsid problem in West Africa, and the progress made so far suggests that the team may well be fully operational in West Africa in 1965.

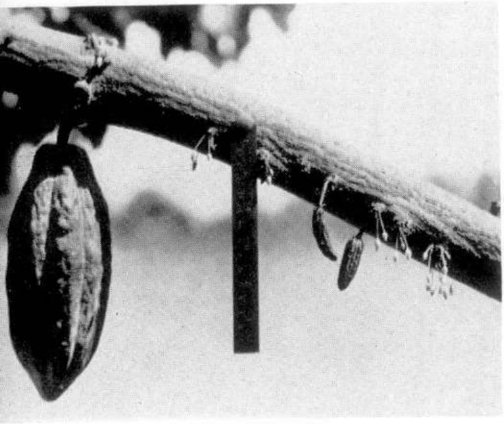
It seems probable that, through this international scheme for the encouragement of cocoa research, the name of the International Office of Cocoa and Chocolate will become increasingly well known in the producing countries in the future. It is hoped, therefore, that this short article will have served in some small measure to explain to cocoa producers the nature of the organisation.

Cherelle (Fruit) Wilt of Cocoa

R. Nichols, Glasshouse Crops Research Institute, Larkfield, Kent (formerly at I.C.T.A., Trinidad)

Introduction

The shrivelling and mummifying of a proportion of young cocoa fruits is a phenomenon familiar to all cocoa growers—Fig. 1. Various names have been used to describe it, such as fruit wilt and pod wilt, but the generally recognised expression is cherelle wilt and will be used here. Essentially, the names describe the early stages of the disorder, when the fruit loses its bloom and becomes flaccid. The whole process, from the time of the appearance of the first symptoms to the shrivelled stage, takes from four to seven days. In fact, growth of the pod ceases for about a week before visible symptoms appear. Once the process has started it is irreversible. The important questions are: what causes it and what effect does it have on yield?



On the right of the scale is a shrivelled and dried pod which had wilted earlier. At this stage it is heavily infected with fungi and will remain on the tree until knocked off. At the right of the wilted pod is a healthy young fruit (cherelle) which may wilt later.

Some of the Causes

A clue to the possible cause of cherelle wilt can be obtained by a survey of the fruiting behaviour of other perennial dicotyledonous trees. In many fruit trees—for example, the apple, plum, avocado and citrus—shedding of fruits is common and well recognised, but in cocoa there is no comparable mechanism. The fruits may wilt but they do not absciss. There is an exception, since very young fruits may absciss, and whereas this has been attributed to incomplete fertilisation, once normal development has begun the fruits stay on the tree. It is generally held that the shedding of fruits in the trees mentioned is the result of competition for nutrients. A consideration of the flowering and fruiting behaviour of cocoa would suggest that some comparable mechanism might be expected. Thus it seems reasonable to suppose that the wilting of cocoa fruits is analogous to fruit shedding, and many workers have used this interpretation as a working hypothesis (3, 4, 5).

The point is that, in general, more fruits are set than can be carried to maturity. Some figures from River Estate, Trinidad, illustrate the point(1). A self-compatible tree bearing about 4,000 flowers annually sets 220 fruits of which only eight were harvested, the loss of the remainder being attributed to cherelle wilt. At a rough approximation, if all the pods set had been harvested, the equivalent yield of dry cocoa would have been in the order of 9,000 lb. per acre; a very good estate yield in Trinidad is about 1,500 lb.

The percentage of pods lost by cherelle wilt varies from tree to tree and from place to place. A comparison of figures from Trinidad, Nigeria and Ghana puts the range from 20 to 90 per cent. This is a substantial proportion of the young fruits, and it is worth while finding out whether this phenomenon effects the potential crop, bearing in mind that some thinning is likely in order to compensate for the "over-setting" mentioned previously. There are several ways of doing this. One is to remove by hand a given fraction of the pods at convenient intervals, and the other is to leave a fixed number of pods attached to the tree, taking off the remainder. The latter method has the advantage that the expected yield can be forecast, and it was used recently in Trinidad to determine the effect of fruit thinning on the wilting behaviour of ICS1 and ICS60.

Ten trees were selected of each clone and stripped of all pods except one which was marked. Each week all new pods were removed. When the marked pod wilted or was harvested another was left on to take its place. Similarly, ten trees were selected on which two marked pods were left, and a further set of ten trees were selected on which ten pods were left. The three treatments were compared with unthinned control trees. The results are shown in Table 1.

TABLE 1*

Effect of thinning trees to 1, 2 or 10 pods each; duration of observation 16 months, 10 trees per treatment.

Clone	Treatment, number of pods remaining on tree	Total wilted	Total pods harvested	Percentage wilted of total set
ICS1	1	11	25	30
	2	42	39	51
	10	226	113	66
	controls (unthinned)	1,386	141	90
ICS60	1	13	19	40
	2	18	36	32
	10	132	85	60
	controls (unthinned)	649	130	83

*Table 1 abstracted from the *Annual Report on Cacao Research*, 1963, University of the West Indies, Trinidad.

When the trees were thinned to one or two pods per tree, the percentage of wilted pods compared with the unthinned controls was reduced. On the other hand the number of pods harvested was also much reduced. It is to be noted, however, that with drastic thinning the number of pods remaining should have been within the bearing capacity of the tree, but nonetheless a considerable percentage of the marked pods still wilted. It follows that in the absence of practically all competition from other pods wilting still occurred. Thus it must be concluded that factors other than nutrient competition,-probably of biotic origin, were involved.

The role that insects and fungi play in cherelle wilt has been reviewed recently (2) but it has been difficult to reconcile some of the observed facts of wilting phenomena with, say, infection by fungi. For example, pods wilt only during the first half of their life cycle, that is until they are about 80 to 90 days old, although they may become infected with a whole range of fungi throughout. The answer may lie in the physiological and anatomical changes which take place in the pod about half way through its development, when it enters its maturation phase(6).

Outlined above are by no means all of the factors which have been claimed to cause wilting. It is believed that cherelle wilt should be thought of as the expression of a sequence of events that take place in the pod. They may be initiated in a number of different ways although the result, the shrivelling of the pod, is the same. From the commercial point of view, it is more important to see what effects wilting may have on yields.

Effect on Yield

It has already been illustrated in Table I that the highest yields were obtained on unthinned trees and that the percentage of wilting pods was also the highest. These results can be explained by assuming that under conditions of high natural setting there is a number of pods set in excess of the bearing capacity of the tree. The excess can be thought of as a reserve. The bearing capacity of the tree will be determined by its vigour, which is in turn a reflection of its genetic constitution, leaf-canopy efficiency, nutrient status of the soil, and so on. The reserve of pods will behave as a buffer in the sense that a considerable proportion of the total fruits can be lost by fungi, and perhaps insects, without affecting the yield. If they are not lost in this way then they will wilt because of physiological causes. This assumes that pods wilted by fungal infection have the same effect on the nutrient status of the tree as those lost by physiological wilt or removed by hand. This is a reasonable interpretation since the physical expression of wilting appears to be the same regardless of the cause. It follows that provided infection is low, the yield will be determined by the environmental factors as they affect the tree. However, the reserve will be rapidly used up when infection rates are high, and then wilting from whatever cause will reduce yields. The effects of wilt can then be summarised as follows:—

Under conditions favouring flowering and fruit setting:

(i) with low biotic attack, yield is determined by the vigour of the tree.

(ii) with high infection rates, the reserve of pods can be used up, and then any further wilting will reduce yield.

Under conditions not favouring flowering and fruit setting:

(iii) the full yield may not be realised.

Only under situation (i) can it be said that cherelle wilt will not effect yield. In (iii), perhaps where there is a surplus of incompatible trees or the pollen vectors are absent, additional wilting will depress yields even more. In this case, the immediate answer would be to improve setting by whatever means are practicable. Situation (ii) may be met with more frequently than supposed and may account for some of the spectacular results obtained with copper-based fungicide sprays on cocoa. The fungicides protect the young pods which would otherwise wilt due to fungal infection, an effect additional to any improvement the fungicide may make to the leaf-canopy. It is believed that the increased yields which have been obtained at River Estate and on commercial estates in Trinidad can be accounted for in this way.

Briefly, field practice should aim at conditions that favour maximum fruit setting: yields are more likely to be reduced by under-setting than over-setting.

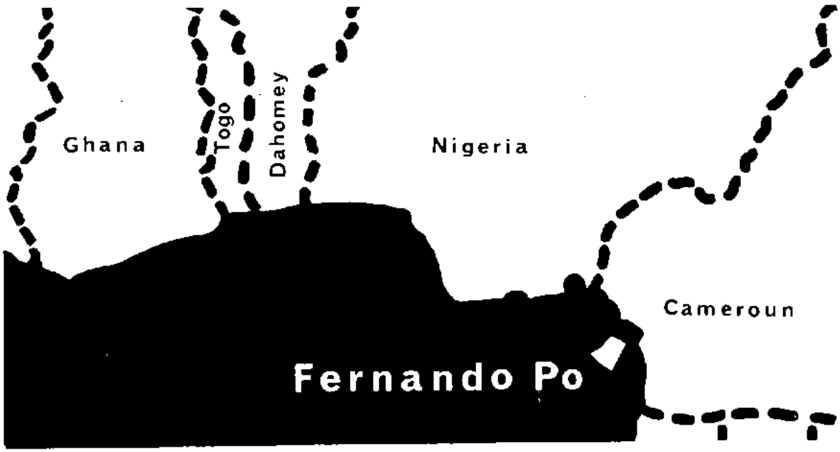
REFERENCES

1. Cope, F. W. *Ninth Ann. Rep. on Cocoa Research*, I.C.T.A., Trinidad, p. 6 (1940).
2. Hardy, F. *Cacao Manual*, Turrialba, Costa Rica (1960).
3. Humphries, E. C. *Ann. Bot*, *7*, 31, 45 (1943).
4. McKelvie, A. D. *J. Exp. Bot. 7*, 252 (1956); *11*, 413 (1960).
5. Nichols, R. *Ann. Bot. 25*, 463 (1961).
6. Nichols, R. *Ann. Bot.* in press (1964, 1965).

Estate Cocoa in Fernando Po

J. T. Swarbrick, West of Scotland Agricultural College, Ayr (formerly at WACRI, Ibadan)

Fernando Po is a small, mountainous Spanish island lying about 20 miles from the mainland of West Africa in the Gulf of Guinea. Cocoa is grown both on a small-farm and on an estate-scale in the accessible areas of suitable soil below 1,500 ft. in altitude and with less than 100 in. of rainfall per year. These areas are near the west, north and east coasts of the island. The soil types on which the crop is grown range from deep, stone-free, fertile soils, derived largely from volcanic ash and alluvial deposition at the coast, to shallow stony or rocky soils of limited root room and variable drainage which have been developed from the underlying volcanic rock on the slopes.



Rainfall varies considerably over the island from 80 in. a year in the north-west to over 200 in. in the south-west, but the steep and broken topography leads to great local variation in the total rainfall. It is the local combination of soil, rainfall, slope and accessibility that largely determines the suitability of any area for the growth of cocoa on an estate-scale, and causes the great variation in average yields between estates of from 500 to 1,800 lb. of dry cocoa per acre per annum. The rainy season in the coastal areas extends from March to October, the other four months being comparatively dry but seldom rainless, while there are appreciable amounts of rain throughout the year above 1,000 ft.

The principal export of the island is cocoa, though both Liberica coffee and bananas are also exported. In 1960 the total cocoa export from the island was 26,890 long tons. In 1962 the total area of cocoa over five years old was 108,559 acres, the area of immature cocoa being 11,324 acres. Production in 1961 averaged 441 lb. per acre over the island, but is much higher on the larger and more efficiently managed estates than on the mixed small farms of the peasants.

The date and source of the original cocoa introduction to the island is not known, but it was most likely to have been from San Thomé or Principe, to which islands the Portuguese had introduced cocoa from Bahia, Brazil in 1822 and 1830 respectively. As the present cocoa population is largely Amelonado, this introduction is held to be that from which most of the cocoa on the island is derived.

The only other introduction of importance was made in 1920 when about 20 plants of a good Criollo variety were brought from Venezuela and planted on the Drumen estate in the south-west of the island. This has led to an expanding Trinitario population of wide variability which is now found on some estates with pod types covering the whole range between Amelonado and Criollo and bean colour varying from white to purple. Great variations in yield are also found, and have resulted in independent selection programmes at several estates.

Shade

Virtually all of the cocoa grown on the island is shaded, usually with a mixture of relict forest trees and planted shade trees. Most of the cocoa estates were developed between the wars, and as there has been little new cocoa planting for many years (although there has been considerable replanting) the general effect is of mature, established estates with large well-grown shade trees. Few of the naturally-occurring trees are favoured as shade, particularly undesirable being the palms, and those trees with shallow root systems, or with long leafless periods. The most commonly-planted permanent shade trees are *Erythrina* spp., *Albizzia lebbeck* (L.) Benth. and a fast-growing tree locally known as Teca, while *Leucaena glauca* (L.) Benth. and bananas are planted as temporary shade during establishment. *Erythrina* is planted as cuttings and the others as seedlings, at a spacing of 6-8m. square. Large rubber trees are common on the cocoa estates of the island, but are not liked as shade.

The Servicio Agronomico maintains at its headquarters at Santa Isabel, on the north coast of the island, a collection of introduced shade trees for evaluation, and some of these, particularly *Samanea saman* (Jacq.) Merrill are already being used on estates as shade for both cocoa and coffee.

Establishment and Maintenance

Planting in the field may be done either by seed at stake or with bareroot seedlings raised through the previous dry season in a nursery. When the second method is preferred the seeds are taken from pods selected by eye only and sown in beds more or less raised above ground level, the seedlings frequently being both sown and planted out in pairs. At planting, most of the leaves are stripped off by hand; the poorer seedling is removed two years after planting out.

When seedlings raised in the nursery are used to replace moribund or dead trees they may be planted at the bottom of pits about a foot deep and wide, the soil being filled in later when the seedlings are established.

Many estates are changing over from coffee to cocoa, with the result that the export of coffee from Fernando Po is declining while that of cocoa increases. Coffee fields are converted to cocoa over a period of five years by sowing two or three cocoa beans at stake below each coffee bush. The cocoa is allowed to grow up at the expense of the coffee, which is gradually pruned back and finally cut out.

Pruning is a generally-accepted practice, and the development of a firmly closed canopy is thought to be essential for an efficient orchard. Soon after

Pods on a hybrid tree, Hacienda rosita.

Cocoa tree pruned to one jorquette of three branches, Servicio Agronomico, Santa Isabel.

Water storage pit used to supply water for spraying.

the jorquette has been formed the number of fan branches is reduced to three, and when these have grown out about a foot the tip is removed to encourage secondary branching. All trees are restricted to the first jorquette, and the stems kept clean of chupons. This pruning method aims at a closed canopy shading the point of jorquette and eases harvesting and Black-pod control.

Harvesting and Processing

The main cocoa season on Fernando Po extends from August to December, with the peak in October. Harvesting is done at three-weekly intervals, the pods being cut with a cutlass. They are collected in a central heap in each field where they are broken. The beans are transported in bulk by lorry or tractor to the fermentaries, and the empty pods left to rot between the trees.

Each estate has a central fermentary and drying floors. The fermenting boxes are about 12 ft. long and 8 ft. wide by 5 ft. deep, and are usually raised well above ground level over one end or at one side of a drying floor. A removable central partition in each box allows easy turning of the fermenting beans. The boxes are always under a roof but the beans in them are left exposed to the air during fermentation. Three days' fermentation is allowed, the beans being turned after 24 and 48 hours. By opening a door in the side of the box the beans are then easily shovelled out directly onto the drying floor.

The entire estate cocoa crop of Fernando Po is artificially dried on large covered floors heated by wood fires. They are usually 5m. wide by 25 or 30m. long, and each produces about three tons of dry cocoa after 48 hours' drying. The actual floors are made up of slate tiles $1\frac{1}{2}$ in. thick, resting on girders. The slates are not cemented down, but rely on the dried mucilage that becomes

Slate drying floor with mechanical rake.

tightly packed between them for sealing. The girders are supported by dwarf walls at the sides and ends of the floors which also serve to retain the smoke from the wood fire that heats each floor. The fire is made in a short firebox leading into a flue, from which the smoke escapes into the entire space under the drying floor before being drawn out through a flue and chimney at the other end.

On the larger estates each floor is mechanically raked during the whole drying period. The wooden rakes are mounted on a light steel bridge that spans the floor and rests on trolley wheels at each end, these wheels running on rails along each side of the floor. The rakes are thus free to move along the whole length of the floor and are drawn back and forth by continuous wire ropes powered by diesel engines through a system of belts and gear wheels, the rakes being automatically reversed when they reach each end of the floor. Each bridge carries two rakes at a time, that of the leading edge being lifted above the cocoa on the floor while that of the trailing edge rakes it. When the direction of motion is reversed the other rake comes into action, turning the ridges of drying beans left by the first rake. The rakes are stopped at the ends of the floors for cleaning as necessary.

After drying has been completed the beans are taken from the floors and spread out under cover to cool before being transferred to the store. Here they are sieved and winnowed by machine to remove doubles, flats, broken beans and dust. They are then bagged, weighed, sealed and stored till inspected by the Servicio Agronomico for grading before export.

The short period of fermentation leaves the cocoa rather bitter and it is not therefore popular outside Spain. The beans, however, are of very good appearance, clean, plump and polished, with none mouldy among them.

Diseases and Pests

Undoubtedly Black-pod disease is the most serious disorder of cocoa on the island. While the loss on those estates that carry out regular Black-pod control spraying is usually below 10 per cent, it can rise to more than 60 per cent if no control is exercised. Control of the disease has been effected by regular spraying with Bordeaux mixture, both the copper sulphate and the lime being imported from Europe. Part of the rainfall in the wet season is conserved in small reservoirs in the cocoa fields for the preparation of the spray, which is applied to the entire trees by hand with simple syringe-type pumps at 100–200 gal. per acre. The timing of the sprays and the concentrations used vary throughout the wet season with each estate, the very close supervision of the fields by the estate managers and their staff allowing the spray to be applied where and when it is needed. For example, on an estate where cocoa is grown at elevations ranging from sea level to 1,500 ft., four or five applications of 2 or $2\frac{1}{2}$ per cent Bordeaux may be made to the higher fields, while only two applications of 1 or 2 per cent spray are made at the lower levels. Most estates start spraying in mid-May and cease in September or October, the concentration of the spray rising to a maximum and falling off again in this period.

The well-maintained line-planted cocoa of the estates lends itself to mechanised spraying, but unfortunately the steep, hilly nature of many estates and the prevalence of rock outcrops on others largely prevents the movement of tractors. The Servicio Agronomico has made several attempts to introduce motorised sprayers but so far with little success, although some estates are now using shoulder-mounted low-volume sprayers to apply Bordeaux mixture at high concentrations. With this method the time needed to spray an acre has been more than halved, and the quantity of chemicals applied considerably reduced. Besides spraying there can be no doubt that the high standard of plantation management and regular pruning are also important in keeping the disease under control.

Virus diseases of cocoa are apparently absent from the island, and the strict quarantine of plants introduced from the mainland should prevent the entry of swollen shoot disease. Although fungal root rots are present throughout Fernando Po they are seldom if ever serious.

Capsids are present, but are not a serious threat to the cocoa except where it has been allowed to degenerate. Thrips are also to be found, but seldom cause severe damage by themselves, though they may be a contributory cause of die-back if the shade is removed. Pod-mining larvae (*Marmara* spp.) are abundant, attacking young chupons, cherelles and pods, but causing little if any loss of crop.

ACKNOWLEDGMENT

The author wishes to thank the Editor of *World Crops* Magazine for permission to publish this shortened version of a longer article written in collaboration with H. Toxopeus and E. C. Hislop and published in that magazine. (Vol. 16.2.35. June 1964).

The Selection of Spraying Equipment

A. E. H. Higgins, Imperial College Field Station, Silwood Park

PART 2

In part 1 (Bulletin No. 3) *Mr. Higgins described the various types of nozzles used in spraying equipment; part* 2 *deals with knapsack sprayers and shoulder-mounted mistblowers.*

The many kinds of spraying equipment using the nozzles referred to in part I are described in various ways, but are best categorised first of all by the manner of operation, i.e. hand or power-operated. They are then further grouped by the method of carriage during use (i.e. hand-carried, shoulder-slung, knapsack-carried, stretcher- or pole-carried, etc.). These secondary groups are then further sub-divided to describe the sprayer according to the type of construction and principal use.

As most pesticidal applications in cocoa are made with shoulder-slung or knapsack equipment, only these types will be discussed. They are considered together, as basically the sprayer units are identical, only the method of suspension from the body being different, according to whether the harness is worn slung over the shoulder or bandolier fashion, or worn knapsack fashion. They fall into six sub-divisions.

1. *Sprayers with lance, trombone or slide-type pump (hydraulic nozzles).*

This is a simple type of pump, rather similar in appearance to a bicycle pump, and operated in a similar manner. It is connected by a short length of rubber or plastic hose to a container in which is usually incorporated a valve and strainer. The pumps are generally double-acting, i.e. pressure to the liquid is applied on both the forward and backward strokes and is therefore continuous in action. The containers may be constructed from plastic materials, or from metal, may be either flexible or rigid, and may even be improvised locally. They are available as inexpensive items intended to last only a limited period (approximately one season) and replaced when required. Most of them, however, are more robustly constructed and intended to withstand constant use over long periods. They are simple in construction and minimum maintenance is required.

2. *Sprayers with a lever-operated plunger pump (hydraulic nozzles).*

A conventional plunger pump is either mounted on the outside of the container or placed within the container and immersed in the liquid contents. The pump is operated by a hand lever. In use it may be positioned under the arm and moved up and down by hand, or it may be positioned over the shoulder and provided with a short chain or rod which is then pulled and released to operate the pump. An air vessel is provided to even out the pulsations caused by the pumping and also to ensure that constant spraying pressure is maintained during operation.

3. *Sprayers with a lever-operated diaphragm pump (hydraulic nozzles).*

Once again, the pump may be mounted externally on the container, when it is positioned within the protective skirt at the bottom, or it may be inside and immersed in the liquid contents. The operating lever in this type is invariably the underarm pattern. An air vessel is also provided to even out pulsations and maintain pressure.

In both these types of sprayers, whether they employ a plunger pump or a diaphragm pump, the materials used for construction vary widely. Brass is most commonly used, but where the sprayer is designed for use with copper solutions, it is made from copper or a high copper-content brass. Plated and galvanised steel as well as stainless steel are also employed. Recently, increasing use is being made of plastic materials in the construction of some of these sprayers.

Means of agitation are provided in some but not all of them, and usually consist of a plate or paddle which is attached to the pump lever and moves up and down within the liquid contents of the sprayer as the lever is operated. A few models have hydraulic agitation provided by a jet inside the container and operated from the pump itself. Where the use of water-dispersible powders are contemplated, adequate agitation is often of importance; furthermore, less pump wear is frequently experienced with the diaphragm pump than with the plunger pump. The principal limitation of this type of equipment is that both hands are occupied in the operation. One hand is required for the pumping and the other for the direction of the spray from the nozzle. This is mounted at the end of a short lance provided with a cut-off valve to control the flow of liquid. In some of these sprayers, provision is sometimes made for the operating lever to be changed for either right- or left-handed use.

4. *Compression sprayers* (*hydraulic nozzles*).

The essential feature of this sprayer is that air under compression is used to propel the liquid, and the container must therefore be regarded as essentially a pressure vessel. For normal operation, it is filled with the spray liquid to approximately three-quarters of its total capacity, and after closing the remaining air space is compressed by means of a plunger-type pump which is an integral part of the sprayer. According to the method employed to recharge these sprayers they can be further sub-divided into two classes. In the first, or conventional compression sprayer, the equipment is recharged in the manner just described. In the second class, or the pressure-retaining sprayer, the initial air charge is retained within the tank and the refilling of the liquid is accomplished by pumping liquid only. Two such types are in common use. In the first, the liquid and air are separated by a bag made from a solvent-resistant rubber placed within the container. The air space between the container and the rubber bag is then initially compressed by means of the attached pump or a suitable source of compressed air. The spray liquid is then pumped into the rubber bag which results in the air within the container being further compressed. When the full liquid contents of the bag have been discharged, all that is necessary for recharging is the replacement of further liquid. In the second type of pressure-retaining sprayer, a floating valve in the base of the container is used instead of the bag, and this valve is so arranged as to allow the flow of liquid as long as any remains within the container, but as this becomes exhausted the valve closes and prevents the loss of any air, thus retaining the initial pressure. These sprayers operate at higher pressures than the conventional type and are often somewhat heavier as the containers have to be constructed of stouter material.

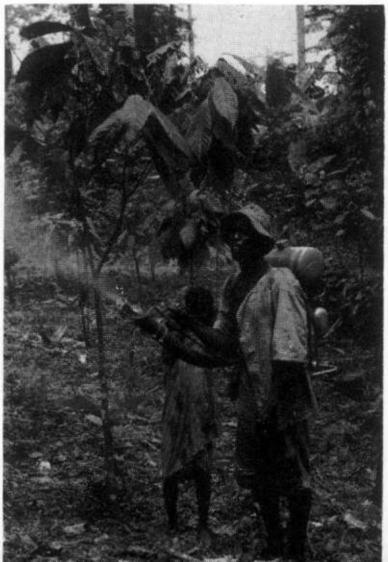
From a practical point of view each type has certain advantages, the main

1

2

3

4



5

1. *Sprayer with lance, trombone or slide-type pump.*

2. *Sprayer with lever-operated plunger pump.*

3. *Conventional shoulder-strung compression sprayer.*

4. *Power-driven rotary nozzle mistblower.*

5. *Shoulder-mounted mistblower, as used by farmers in Ghana.*

difference being that the conventional type nearly always requires repumping before the entire contents of the container have been discharged. This is due to the increase in the air space as the liquid level falls. The trouble is overcome in the pressure-retaining type by constant air pressure. A possible disadvantage of the pressure-retaining type is that the pressure on the liquid with a full container is always much greater than with the conventional type. This can be overcome by the use of a pressure regulator in the liquid supply to the hand lance, to ensure constant pressure at the nozzle within any range above the initial pressure.

The pressure containers for both types of sprayer are made from various metals, and it is essential that both the material and the construction are such that failures or bursts do not occur during the normal life of the sprayer. From a safety aspect this is of such importance to the user that official bodies, such as the World Health Organisation, not only lay down specifications for such equipment but also prescribe stringent tests which have to be made before the equipment is regarded as acceptable. A simple hydraulic pressure test can, however, be carried out with the use of any pump suitable for liquid which will attain a pressure twice that of the stated working pressure of the sprayer. For any such test *it is essential that the whole system is filled with water* and then the sprayer container under test can be safely brought up to twice its working pressure to observe whether it is in a satisfactory condition. Such a test should always be carried out for compression sprayers, at least, before they are put into use at the beginning of a season, and more frequently if the sprayers are in constant use over periods of three months or longer.

The material used for construction must be resistant to chemicals commonly used in spraying, thus eliminating the danger of corrosion. For this reason containers are being made of stainless steels. It should be remembered that most damage from corrosion occurs during storage. Any sprayer should be washed out and cleaned each time after use, and the job must be carried out with particular care at the end of each season before storage. The equipment should not only be thoroughly cleaned to remove any chemical residues, but should also be dried and stored under dry conditions. It is recommended that compression sprayers in particular should be stored so that they rest upside down, with the filler lid and hose connections left open to ensure proper drainage, and to prevent moisture from condensation collecting at the bottom of the container. After cleaning and drying a careful inspection should be made for accidental damage which may have weakened the container, and if any is suspected it must be checked by the hydraulic test.

5. *Power-driven sprayers of the air-blast or mistblower type (gaseous energy nozzles).*

These consist basically of a lightweight 2-stroke engine running on a petrol-oil mixture. The engine drives a fan or blower to give a powerful air blast which emerges from a nozzle at the end of a discharge tube. The liquid feed from the container to the nozzle flows via a flexible pipe, usually attached externally to the air tube, and is forced under slight positive pressure to the nozzle, by means of air obtained from the fan, into the container. The whole of the equipment is built into a frame provided with a backrest and carrying straps. The air blast can be controlled by the throttle setting of the engine, but the general practice is to operate these sprayers with the throttle fully open. The air discharge tube is held and directed by the hand.

The performance of these sprayers varies from make to make, according to the size of the engine used and the efficiency of the fan and nozzle. Under still-air conditions most of them will give an effective horizontal throw or projection of the spray of some 30 to 40 ft. and 20 to 30 ft. vertically. These figures are given as a guide, and improvised tests can always be carried out. This is especially important where dense foliage canopy has to be penetrated. The dry weight of these machines varies approximately between 16 to 40 lb., depending upon the size of the sprayer, and there is a tendency at the present time to produce either a standard high-performance pattern or a lightweight pattern with smaller engines and slightly reduced performance.

Other aspects which must be considered are again materials and construction of the equipment. There is naturally a good deal of vibration from the engine and fan during operation. It is therefore advisable to verify how much of this vibration is transmitted to the body of the user when it is worn and at full-throttle openings. This type of equipment tends to be noisy, both from the engine exhaust and also from the fan, but again, this varies from model to model. The noise level does not appear to be a serious factor with the majority of users—the main concern being the weight and comfort in use. Other points which should be examined are concerned with the rough usage the equipment is likely to meet, and the safety of the operator. The strength of the frame and the mounting of the various components such as the container, engine and fan, should be given attention. The connection between the fan and the discharge or nozzle tube should be sufficiently robust not to crack or collapse and yet be sufficiently flexible not to tire unduly the operator directing the nozzle. This is especially important where the nozzle has to be directed upwards. It will also be found that in practically all types of this sprayer, there will be a difference in the liquid-flow rate according to whether the nozzle is directed downwards, forwards or upwards. This is due to the difference in the liquid level between the nozzle and the container. In this connection it is important to ensure that the filler cap is provided with a good, airtight seal so that the air pressure supplied to the container is retained. One or two manufacturers have overcome this difficulty by adding a small liquid pump to ensure constant flow to the nozzle, but this further complicates the equipment and is usually regarded as unnecessary. This type of equipment, being both bulky and heavy, is not easy to put on to the body without assistance, and to ensure that the machine can be lifted at convenient points without causing damage, it should be tested. The engine exhaust system should be adequately protected so that it cannot be accidentally touched when hot. It is equally important to ensure that the machine can be easily and quickly removed from the body unaided, and this is essential in the event of a trip or fall when wearing the equipment.

A final caution concerning the operation of this type of equipment concerns the fuel mixture. The ratio of petrol to oil recommended for use varies according to make, and it is imperative that the correct mixture is used. Furthermore, on completion of the spraying operation, the engine should be stopped by shutting off the fuel supply to the carburetter so that the float chamber is completely drained. If the equipment is unlikely to be used again for any length of time, not only the fuel from the carburetter should be drained but also that from the fuel tank and fuel line.

6. *Power-driven sprayers with rotary nozzles (centrifugal energy nozzles).*

The basic construction of these sprayers is almost identical to that of the air-blast or mistblower type, except that a rotary nozzle is employed. There is in fact one of the powered knapsack mistblowers manufactured as such, with alternative nozzle parts including a rotary type. Virtually all the remarks made about the air-blast or mistblower apply equally to the rotary-nozzle machines. The only significant differences are that the nozzle performance often results in lighter deposits and that some of this type of equipment is mounted so that it is carried in a frame on the shoulders instead of in knapsack fashion, the liquid container in front of the body counterbalancing the weight of the engine and fan at the back. As the nozzle outlet is sometimes positioned behind the operator's back, it is not easy to direct the spray beam, and this has to be pre-set for direction before spraying, the operator then walking in a given direction to obtain the coverage required.

Before concluding the review of the various types of equipment available, mention should be made of a recent introduction of a power-driven knapsack hydraulic sprayer. This is very similar in appearance to a powered knapsack mistblower, except that the fan unit is replaced by a small hydraulic pump. This is driven by the engine and supplies the spray liquid to hydraulic-type nozzles through a conventional short length of hose and spray lance, as used on hand-operated hydraulic knapsack sprayers. This type of equipment may well have certain advantages over other types used for the control of pests and diseases of cocoa.

ACKNOWLEDGMENTS

Acknowledgment is made to the manufacturers of equipment illustrated on page 22: Messrs. Cooper, Pegler & Co. Ltd., Burgess Hill, Sussex; Messrs. Associated Sprayers Ltd., Birmingham; Messrs. Micron Sprayers Ltd., Birmingham.

Notes on Contributors

R. Nichols, M.Sc., F.L.S., M.I. Biol.

Born in London, 1929. Read botany at King's, London, and then served two years' national service in the Royal Artillery. In 1954, joined the staff of the Imperial College of Tropical Agriculture as plant physiologist on the Cocoa Research Scheme, to work principally on the problems associated with fruit development of cacao. Now on the staff of the Glasshouse Crops Research Institute, on secondment to the A.R.C. laboratory at Ditton, working on the post-harvest physiology of flowers.

John T. Swarbrick, B.Sc., D.T.A.

Graduated at the University of St. Andrew's with Honours in Botany, 1956 and took a Diploma Course at I.C.T.A., 1957-58. Spent three years, 1958-61, in the Southern Cameroons as Cocoa Agronomist, then held an appointment as Horticulturist to the Federal Department of Agricultural Research, Nigeria, 1961-62. Agronomist, West African Cocoa Research Institute, Nigeria, 1962-63. Is now lecturer in the Botany Department at the West of Scotland Agricultural College.

Notes

FAO Technical Working Party on Cocoa Production

This Working Party was set up on the recommendation of the FAO Technical Cacao Meeting held in Accra in 1959, with the object of reviewing technical problems and helping to solve them through international co-operation or by advising FAO on projects which it might promote. A number of projects were suggested at the meeting in Accra, the more important of these being the setting-up of a germ-plasm collection, a cocoa collecting expedition and research on *Phytophthora palmivora*.

The first meeting of the Technical Working Party was held in Rome in September 1964 and was attended by 28 delegates from 14 countries. A number of papers on various subjects were presented and the projects already mentioned were reviewed.

The Technical Working Party appointed a Technical Advisory Committee of nine who were charged with the task of implementing these projects. This Committee will meet again in 1965.

Cocoa Research Institute, Tafo

The Cocoa Research Institute of the Ghana Academy of Sciences has published its first report as such; it covers the period 1st April 1962 to 30th September 1963.

In a general report the Director, Mr. S. T. Quansah, explains the staffing problems which have been accentuated by the need for additional staff occasioned by the development of mirids resistant to lindane. This has been the main technical problem which has been tackled by a team of two entomologists and two technicians provided by the Canadian Government. In other fields the Institute has been assisted by secondment of three scientists from the U.K. through the Department of Technical Co-operation. The numbers of Ghanaian staff continue to increase, but recruitment is handicapped by the absence of schemes for in-service training.

This is not the place for a review of the report, but one or two points of general interest might be noted:

(a) Leaf-edge scorch. It has been found that this is due to application of nitrogen in an oxidised form either as nitrate or nitrite. Plants receiving nitrogen as urea or ammonium sulphate do not suffer from this condition.

(b) An experiment was laid down to test the effect of applying fertiliser at planting. Applications of an NPK mixture (15 : 15 : 12) were made at rates of ½ oz. and 1 oz. per seedling to the planting hole and spread on the surface a week after planting. The application of 1 oz. in the planting hole checked growth but the other application gave better growth, ½ oz. of fertiliser in the planting hole being the best.

Nigerian Cocoa Research Institute

Cocoa research in Nigeria started as a sub-station of WACRI, Tafo. Initially the number of staff was very small, but later it was built up considerably, and when the inter-territorial organisation was broken up in 1962, WACRI (Nigeria) was almost as fully staffed as its parent station Tafo. It has recently changed its name to the Cocoa Research Institute of Nigeria, and a recent report is reviewed in the abstracts.

Cocoa Abstracts

These abstracts are reprinted from "Tropical Abstracts", published by The Royal Tropical Institute, Amsterdam.

Amuh, I. K. A. The effect of methyl bromide on the fungi occurring on prepared cocoa beans. Publ. Ghana Agr. Prod. Marketing Board Insect Control Unit 17, p. 1-7 (1962; received 1964).

Because pyrethrum and methyl bromide are the only chemicals allowed to be used for the disinfection of cocoa in Ghana, all fungicidal treatments being proscribed, the effect of methyl bromide on external mould was investigated by exposing beans to concentrations of 16, 32 and 48 mg/l for 24 hours and subsequently storing them at relative humidities of 75, 80, 90 and 100%. Fumigation retarded the germination of mould spores to a degree increasing with the gas concentration. Mycelium appeared on untreated beans after 3 days' storage at a r.h. of 100%, after 14 days at a r.h. of 75%; treatment with the commercially used methyl bromide concentration of 16 mg/l increased these times to 5 and 32 days, respectively. The viability of the spores was not affected. Table. 2 refs.

Lems, G. Enkele beschouwingen over het huidige cacao-cultuursysteem en aanbevelingen ter verbetering en verhoging der produktie. (Some remarks on the present-day cacao cultivation system and recommendations to improve and increase the production). Surinaamse Landbouw 12, 1, p. 4-10 (1964).

After a consideration of the causes leading to the disappearance of the former cacao cultivation in Surinam between 1895 and 1925, mostly as a result of thrips and witchbroom disease, the author describes the new start made in 1948 with clonal cuttings of ICS 95, tolerant to witchbroom. On the basis of newly available results of experiments and soil investigations, the author outlines suitable and unsuitable soils and discusses the desirability of shade trees. On suitable soils the removal of shade is advocated at the time when the cacao canopy is completely closed, but it should be combined with more windbreak hedges and fertilizer applications. 17 refs.

Glendinning, D. R. The inheritance of bean size, pod size and number of beans per pod in cocoa (Theobroma cacao L.), with a note on bean shape. Euphytica 12, 3, p. 311-22 (1963).

Studies of the F1 and F2 generations of crosses between 3 Upper Amazon cacao clones, conducted in Ghana, showed that the within-tree variability of pod size is paralleled by variation in bean number, bean size being relatively constant. In some trees, however, bean size increases in the largest pods while bean number remains constant. The average pod weight of a progeny seems to be determined by the inherent bean size and the inherent bean number. Bean breadth and bean thickness tend to be negatively correlated; bean shape is associated with pod shape. Practical implications for the breeder are : (1) bean size can be bred for directly, while large pods should be obtainable by breeding for high bean numbers and large beans; (2) when bean plumpness is a desired character, a short fat pod shape should be avoided. Tables. Graphs.

Mould, H. A. Ship inspection. Publ. Ghana Cocoa Marketing Board 18, p. 1-2 (1963).

Since 1962 the holds of all ships calling at Ghana ports to load cocoa beans are inspected for the presence of storage pests, and disinfested when necessary. Insects most frequently encountered include the moths *Cadra* (*Ephestia*) *cautella* and *Corcyra cephalonica*, and the beetles *Tribolium castaneum*, *Lasioderma serricorne*, *Sitophilus oryzae*, *Carpophilus* spp., *Necrobia rufipes*, *Ahasverus advena*, *Oryzaephilus mercator*, *O. surinamensis*, *Tenebroides mauritanicus*, and *Cryptolestes* spp. Malathion emulsion concentrate, diluted to a 2% concentration and applied by means of a motorized knapsack mistblower at a rate of 5 l/100 m^2, is highly effective against these pests; gamma-BHC smoke generators give unsatisfactory results. About 370,000 tons of cocoa were fumigated before shipping during the 1962/63 season.

Allison, H. W. S., and Kenten, R. H. Mechanical drying of cocoa. Trop. Agr., Trinidad 41, 2, p. 115-9 (1964).

A cocoa dryer, essentially consisting of a fan and an oilfired heat-exchanger coupled to a plenum chamber under a platform constructed from perforated aluminium sheets, was built at Tafo, Ghana. The dryer was housed in a closed building, and a baffle was placed between the fan and the air-intake in order to permit recirculation of the hot air within the building. A full charge of wet fermented cocoa corresponding to 1 ton of dry cocoa could be dried within 24 hours with a consumption of 155 l of diesel oil and 33 kWh of electricity. Though the cost of drying in the apparatus was not much lower than that of sun-drying, avoidance of weather risks and lower labour requirements make the installation of a dryer of this type an attractive proposition. Table. Photos. 3 refs.

Hill, P. Three types of southern Ghanaian cocoa farmer. In: African Agrarian Systems, ed. by D. Biebuyck. London, Oxford Univ. Press, 1963. p. 203-23. B.

The author describes the three main types of cacao farmers found in the Akim country of southern Ghana, viz.: (1) patrilineal immigrant farmers who bought tracts of land in company and subdivided them among the participants into narrow strips of 8-12 ha; (2) matrilineal immigrants who bought land for their families and divided the land into farms of various shapes and sizes; (3) native men and women who manage one or more farms of 0·2-1·2 ha in the vicinity of their home towns, each farm representing a single season's clearing. Contrary to what is commonly thought, the immigrants, who maintain strong ties with their regions of origin, are the groups which have made the greatest contribution to the rapid development of the Ghanaian cocoa industry by investing their savings from trade in oil palm produce and other economic activities into cacao farms. French summary. Maps. 8 refs.

Glendinning, D. R. The CRI cocoa varieties. Ghana J. Sci. 3, 2, p. 111-9 (1963).

A brief review is presented of cacao breeding and selection work performed by WACRI (now CRI) in Ghana. Though several cacao types were introduced since 1858, practically the only type grown in Ghana until a few years ago was the rather uniform amelonado. When trials planted in 1952 had shown that Upper Amazon types were more productive, seed and seedlings of these types were distributed in large quantities. Crossbreeding of Upper Amazon with amelonado and other types was started in 1951, large-scale testing of the hybrids revealed that some of them are very promising with respect to earliness of bearing, yield, quality, and resistance to diseases. Though none of these hybrid progenies have yet been finally approved about 280 ha of seed gardens have already been established. Tables. Graph. 16 refs.

Kakaobohnensäcke. (Bags for cocoa beans). Gordian 64, 1522. 319-20 (1964).

Most cocoa producing countries ship the beans in jute bags with an empty weight of 600 g. Sisal bags with a weight of 900-1,000 g. as used in some S. American countries, allow insufficiently dried beans to lose moisture during transportation, but are more prone to insect infestation. Whether plastic liners are advisable is still uncertain. The contents of a bag vary from 50 to 90 kg of beans according to the country of origin. Ghana, Nigeria, the Ivory Coast and Ecuador mark the bags according to the grade of cocoa; the meaning of the symbols and abbreviations used for this purpose is explained. Metal or plastic tags are undesirable because they may become mixed with the cocoa beans on opening the bags. The FAO Cocoa Study Group has recommended a standard weight of 50 kg beans per bag, and a uniform system of markings.

Tinsley, T. W. The ecological approach to pest and disease problems of cacao in West Africa. Trop. Sci. 6, 1, p. 38-46 (1964).

A review is presented of some of the main factors causing degeneration of cacao trees in West Africa. They include infestation by capsids leading to defoliation and shrinking of the protective tree canopy, thus paving the way for infection with virus diseases. Some effective control measures are described including cutting down a limited number of apparently healthy trees to distances ranging from 5 to 15 m around the infected trees, and spraying trees with BHC. Considerable progress has already been made both in rehabilitation and in the general improvement of standards of cultivation; however, this will be useless if capsids and the black pod fungus are not kept under permanent control. Figs. Graph. 7 refs.

Tarjot, M. De quelques facteurs favorisant le developpement pourritures de cabosse du cacaoyer en Cote d'Ivoire. (On some factors promoting the development of cacao pod rot in the Ivory Coast). Café, Cacao, Thé 8, 1, p. 32-8 (1964).

Observations on the incidence of cacao pod rot caused by the fungi *Bo-tryodiplodia theobromae*, *Trachysphaera fructigena* and *Phytophthora palmivora* were conducted in several localities in the Ivory Coast. The most important factor determining pod rot incidence was found to be the rainfall, the 2nd important factor being the number of pods in a susceptible stage present on the trees. In the northern part of the cacao-growing region losses of pods are generally only around 10%, never higher than 20%; most of the loss occurs during the minor rainy season. In the southern part, where losses are usually above 20% and occasionally much higher, the largest proportion of the total loss occurs during the main rainy season whereas the effect of the minor rainy season is relatively unimportant. English, German and Spanish summaries. Tables. Graphs. Map. 4 refs.

Smee, L. Insect pests of Theobroma cacao in the Territory of Papua and New Guinea: their habits and control. Papua and New Guinea Agr. J. 16, 1, p. 1-19 (1963).

A review article in which the main insect pests of cacao in the Territory of Papua and New Guinea are described, including their life histories and habits, the type of damage they inflict, and suitable methods of control. The various techniques employed in the application of insecticides are discussed. Low volume spraying and dusting are the most popular methods of insecticide application in the country, mainly because of inadequate water supplies and difficulties of terrain. Figs. Photos.

Szent-Ivany, J. J. H. Further records of insect pests of Theobroma cacao in the Territory of Papua and New Guinea. Papua and New Guinea Agr. J. 16, 1, p. 37-43 (1963).

A supplement to the author's paper entitled: "Insect pests of Theobroma cacao in the Territory of Papua and New Guinea" (1961), listing 76 new cacao insects and providing new information on previously recorded cacao pests. Two noctuid moths, *Tiracola plagiata* and *Achaea janata*, which were previously recorded as minor pests, are now considered major pests of cacao. 18 refs.

Smee, L. The use of mists in the application of insecticides to cacao. Papua and New Guinea Agr. J. 16, 1, p. 57-63 (1963).

Mist spraying (low volume spraying) is the generally followed method of applying insecticides to cacao in the Territory of Papua and New Guinea. A correct droplet size and high airstream velocity are essential factors affecting deposition from a mist. A test was carried out at Keravat to determine the optimum volume of application showing that spraying of 45-90 l/ha gave adequate coverage of mature cacao. Appendices. Tables. Graphs. 6 refs.

El cacao. (Cocoa). Mem. Gerente Gen. Banco Centr. Ecuador 1962, p. 20-36 (1963).

Review of the production, consumption, exports, trade, prices, and perspectives of cocoa in Ecuador. A domestic cocoa-processing industry has been developed, enabling the country to start exporting cocoa products instead of importing them. The world position of cocoa is surveyed, indicating a balanced situation between production and consumption. The position of Ecuador in the planned International Cocoa Agreement is also dealt with. Tables. Graph.

Ruinard, J. Cocoa research in West Irian (West New Guinea). Neth. J. Agr. Sci. 12, 2, p. 89-112 (1964).

A review is presented of breeding and selection of cacao in W. New Guinea up to the end of 1962. Thanks to imports from Indonesia, Australian New Guinea and the Netherlands, ample starting material was available. Particularly noticeable was the early start of production and the high yield level of both the imported material and crosses made from it. A remarkable case was revealed of cross-compatibility between self-incompatible Trinitario clones. Cacao plantations in West Irian are not seriously affected by pests and diseases.

So far no swollen shoot or cacao moth were observed. Other studies were related to the shade problem, plant spacing, the effect of stocks on scions, and processing and storage of cocoa. Tables. Photos. 41 refs.

Thomas, C. Y. Projections of cocoa output in Grenada, Trinidad and Jamaica, 1960-75. Social Econ. Stud., Jamaica 13, 1, p. 94-117 (1964).

Projections are presented and motivated for the cocoa production of Grenada, Trinidad and Jamaica during the period 1960-75. In all 3 territories the production during recent years was much influenced by rehabilitation schemes aimed at replanting and enlarging the existing old areas. Considering the fact that the large majority of this high yielding planting material was only established during the last 4 years and did not yet contribute to the present production figures, and taking into consideration that the schemes have only recently been gaining momentum, the author expects an increase of the total output of the 3 islands from 12,600 tons in 1960 to 22,500 tons in 1970 and to 27,500 tons in 1975. Appendix. Tables. Graphs. 4 refs.

Murray, D. B. Morphological effects of temperature on the growth of Theobroma cacao. Nature 202, 4937, p. 1134 (1964).

Cuttings of cacao clone ICS 95 grown in Trinidad at a constant temperature of 20°C developed apical flushes of 3-4 large leaves. At a temperature of 32°C apical dominance was lost, so that the plants formed a large number of branches with small leaves. The difference in habit was similar to that between cacao grown under shade and in full sunlight; this indicates that the effect of shade on the growth habit of cacao is due to the temperature and not to the light intensity as such. Photo. 2 refs.

Lems, G. Enkele beschouwingen over het huidige cacaocultuursysteem en aanbevelingen ter verbetering en verhoging der produktie II. (Some remarks on the present-day cacao cultivation system and recommendations for improvement and increase of production II). Surinaamse Landbouw 12, 2, p. 41-9 (1964).

Continuing his article on the present status of the cocoa industry in Surinam, the author discusses the effect of temporary and permanent shade, planting density, pruning, and pests and diseases. Temporary shade was not satisfactory. As a tree for permanent shade, *Erythrina glauca* is still the best under Surinam conditions. Planting under old shade is discouraged. Higher planting densities resulted in higher yields and in earlier and better shading of the soil. Pruning should be limited to shape pruning in the first years. Although clone ICS 95 proved to be only a moderate yielder, it still remains the best under Surinam conditions. English summary. Photos. 35 refs.

Gnanaratnam, J. K. Rooting cocoa cuttings; a new technique. World Crops 16, 2, p. 61-3 (1964).

A new and simple method to enable cocoa planters to grow their own cuttings as planting material was developed in Ceylon. The method is based on the use of polythene film tubing cut into pieces long enough to contain the normal quantity of soil plus the total length of the cutting. The soil surface is covered and a core in the centre is filled with coir dust as a rooting medium. After planting and watering, the containers are closed at the top to maintain 100% humidity around the cutting. A light intensity of 15% of full sunlight proved to be a decisive factor for success. More light considerably reduced the rooting percentage. Table. Photos.

Freeman, G. H. Present nursery and establishment methods for cacao in Western Nigeria. Ann. Rep. W.Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 13-24 (1964).

Methods of raising cacao are discussed with special reference to W. Nigeria where a major problem is that of keeping the young plants healthy during the long dry season. Farmers are recommended to raise their seedlings in a nursery with artificial shade, in black plastic bags filled with top soil; excessive watering should be avoided. Five- to 6-month-old seedlings should be planted at a spacing of 1.5 × 1.5 m (which involves later thinning), preferably under temporary shade of palm fronds and *Manihot glaziovii*. Bananas and pigeon peas may be used as windbreaks but not as shade for the cacao. The ground must be kept free from weeds. Control of *Earias* caterpillars, capsids, and wood-boring insects is often necessary; fertilizers need not be applied before the trees come into bearing. When the trees have formed their primary branches, the only pruning required is that necessary to maintain access to the field.

Freeman, G. H. Nursery and establishment trials (with cacao). Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 61-5 (1964).

The 1960/61 cacao nursery trial in Nigeria was concluded in Mch. 1963. By that time survival was poor among the plants raised in an unshaded nursery and transplanted at the age of 4 or 5 months, it was good in all other plots. The size of the surviving trees was but little related to the treatments which they had undergone before transplanting. In a 2nd trial, seeds were planted in the nursery in Oct., Nov. and Dec. 1961, and seedlings of each group were transplanted to an unshaded field in May, June and July 1962. The poorest development was shown by trees transplanted in June and July when they were 8-9 months old. In both trials growth in the field was best for the plants which were youngest and smallest at the time of transplanting, provided they were growing well at that time. The use of such plants appears to minimize transplanting shock and reduces the cost of nursery maintenance. Plants from seed sown at stake also showed good development. Tables.

Iweama, V. O. A cocoa establishment trial using shade plants for economic value. Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 69-70 (1964).

A trial intended to test cacao establishment methods suitable for the peasant farmer was started in Nigeria in 1962. Amazon cacao seedlings were planted at a spacing of 1·5 × 1·5 m under 3 types of shade: papayas and plantains planted at 3 × 3 m, and natural regrowth of *Solanum verbascifolium* in rows 3 m apart. All plots had a soil cover of cowpeas. By the end of Mch. 1963 both fruit crops had already brought some revenue. The mean girth of the cacao stems under papaya shade was significantly greater than that in the other treatments; however, plants under *Solanum* shade were slightly taller and appeared more healthy than those under papayas or plantains. Cacao trees standing at a distance of less than 15 cm from a plantain stool had a significantly greater stem girth than those about equidistant from 2 stools. Tables.

(Cacao planting material in Trinidad). J. Agr. Soc. Trinidad Tobago 64, 1, p. 115, 117, 119-24 (1964).

A report on a visit to 2 cacao estates in Trinidad, presenting yield data from trials with Upper Amazon × ICS clones and seedling progenies of crosses between these hybrid clones, established on several estates. In a trial on the Poole Syndicate plantations, the best hybrid clone yielded 3·27 kg of dry cocoa per tree at the age of 5 years; in a collection of 100 clones on San Leon Grande Estate, the best clone yielded 2·84 kg per tree at the same age. Most hybrid clones start bearing at a much lower age than the old ICS clones; they are completely or almost completely resistant to witchbroom. The average yield of the seedling progenies on 4 estates was markedly lower than of the clones; the best clones considerably outyielded the best seedling progenies. Several estates now spray their trees with a mixture of copper, urea and an insecticide 4-6 times a year; this treatment in one case increased the yield of clone ICS 1 from 450 to 670-780 kg. per ha. Tables.

Swarbrick, J. T., and Iweama, V. O. Investigations into cocoa seed storage. Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 78-9 (1964).

Six methods of storing cacao seed were compared in Nigeria. The best results were obtained by packing disinfected seeds with adhering pulp in dried ground charcoal; 60% of the beans were still viable after a 5-week storage period at a temperature of 27°C. Removal of the pulp followed by washing, drying in the shade for 24 hours, and storage in sawdust yielded fairly good results; both methods were better than storage in unbroken pods. A 2nd trial indicated that some storage in the pod prior to placing the beans in polythene bags was beneficial, as was the removal of the mucilage, and that storage in sawdust and charcoal was better than storage in sand. Storage temperatures around 20°C proved to be optimal, a temperature above 25° decreasing bean viability and one of 10° being lethal. A trial comparing 7 fungicides and a bactericide for the control of bean rotting pathogens showed one to be significantly better than the rest. Tables.

Freeman, G. H. and Wessel, M. Shade and ground cover trial (with cacao). Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 65-8 (1964).

The effect of 5 types of shade and 6 soil treatments on the growth of cacao was studied in a trial established in Nigeria in 1962. At the end of the 1962/63 season no appreciable differences were observed between the 5 "inert" soil treatments: full and alternate-row grass mulches, fertilizer application, a plastic cover, and bare soil. A "living cover" of *Mucuna* failed to establish itself satisfactorily. Among the shade trees used in the trial pigeon peas caused a rather high mortality of the cacao, whereas plantains in combination with *Mucuna* resulted in a rather slow rate of growth. The best results were obtained with *Manihot glaziovii* (tree cassava). Plots under articial shade of palm fronds on bamboo poles in combination with a grass mulch showed a rather high mortality. The lowest mortality and the most rapid growth were observed in plots with bare soil in which the cacao was shaded by palm frond tripods. Tables.

Hislop, E. C. Black-pod disease control. Field studies. Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 43-8 (1964).

Further trials on the control of black-pod in cacao conducted in Nigeria showed that in 1962 spraying with 0·03-0·04% triphenyl tin acetate was less effective than spraying with 0·25% Cu in the form of Bordeaux mixtures. This was probably due to the heavy rainfall. A separate trial demonstrated that ordinary Bordeaux mixture made with lime was equally effective as the more expensive carbide Bordeaux mixture. The positive correlation between black-pod incidence and number of trees per ha, observed in the spacing trial in 1961, was absent in the much wetter season of 1962. Three blocks of cacao were sprayed with cuprous oxide by means of the 2 mistblowers tested in 1961 and by pressurized knapsack sprayers, respectively. The tractor-mounted mistblower proved to be less efficient than the other 2 implements in reducing black-pod incidence: spraying with the knapsack sprayer was much cheaper than spraying with either mistblower. Tables.

Entwistle, P. F. Earias biplaga (as a pest of cacao). Ann. Rep. W. Afr. Cocoa Res. Inst. (Nigeria) 1962-63, p. 49-55 (1964).

Further observations of *Earias biplaga* on cacao in Nigeria revealed that 87% of the eggs were laid on stems and stipules, and 13% on the leaves. The larvae migrate to an apical bud, on which they feed for 8 days, the remaining 8 days of the larval stage being passed in feeding on flush leaves. The destruction of apical buds retards primary branching and may prevent it altogether. No eggs were found on seedlings shaded with palm fronds; field populations in shade trials were consistently lower in exposed plots than in shaded plots. Parasitism by the wasp, *Trichogrammatoides lutea*, was found to fluctuate between 2·5 and more than 90%, the percentage being inversely related to the rainfall; this tends to minimize the danger from *E. biplaga* attacks in the dry season, when their consequences are worst. Pupal parasitism by 5 unidentified species also reached high levels in some periods of the year. Tables. 1 ref.

INDEX of First Four Issues

AUTHOR INDEX

SUBJECT INDEX

Printed in England by Buckler & Webb Ltd.. Birmingham, 3