COCOA GROWERS' BULLETIN

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Contents

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Editorial

To Plant or not to plant?
In our last issue the usual review of production, consumption and prices gave figures for the current year's production which proved to be wide of the mark long before the issue was in the hands of many of its readers. We make no apology for this; the figures are official F.A.O. estimates and we do not attempt to be up to date in this respect. The efforts of the Cocoa Producers' Alliance to raise prices have been overwhelmed by an increase in production of remarkable proportions. The increase came as a surprise to consumers and probably to the producing countries themselves. The result has been an inevitable fall in prices, and we can well understand the feelings of those who are just beginning to gather the first harvests after years of development.

We do not pretend to foretell the future of cocoa prices, but it has been our belief for many years that cocoa is a profitable crop to grow, and the events of the past few months have not led us to alter this view. Cocoa is obviously a long-term crop which one does not plant on the basis of today's price but on an estimation of its profitability over a number of years.

At Ikiliwindi—our plantation in Cameroun—a yield of 700 lb. per acre would result in a cost of production of about £100 per ton. (Cost of production means annual running cost without financial charges or depreciation.) Although today's prices would not cover these additional items, we believe that this plantation will prove to be a profitable enterprise in the long run and we are continuing to plant at our younger plantation in Sabah.

G. A. R. Wood.

Rowntree and Company Limited

This is the third in a series of articles on the larger cocoa and chocolate manufacturers. The first two dealt with Cadbury and with Nestle.

Rowntree and Company Limited is based at York, and its roots in the city can be traced back over the course of two centuries to a small grocer's shop. Today, the company's factory on the northern edge of the city is the headquarters of a group of companies which together employ some 20,000 people, whilst the Cocoa Works, as the factory is called, is itself one of the largest single confectionery manufacturing units in the world, employing some 9,000 people from York and the surrounding district.

York is an ancient cathedral and military city known for its fortified walls, the "Shambles"—the medieval street of butchers—and many other historical associations. The city is an important centre of communication, and the River Ouse, which flows through its centre, is still a transport artery of some significance. For example, many of the commodities which are vital to the prosperity of the company, such as cocoa beans from West Africa, come to the factory premises by water; from the ocean-going ships at Hull they are transshipped by lighter and river barge to York.

The backbone of the Rowntree business is in the chocolate and confectionery trade in the United Kingdom, although the company also manufactures cocoa powder, both for family consumption in small packs and for the bakery trade, as well as the leading brand of table jellies in the country.

Rowntree's policy is to sell a small range of branded nationally-promoted goods and to establish each one as an independent major business. In this way it can inisist on the high standards of quality in production, in market research, in advertising and in presentation, which only widely distributed lines can afford. It has been one of the leading advertisers and has been in the forefront of the growth of such media as Independent Television in the United Kingdom, and, incidentally, in new media overseas.

The company's marketing policy has established many products as household names. Amongst the oldest of these are Rowntree's Fruit Gums and Rowntree's Fruit Pastilles; "Kit Kat," a chocolate-covered wafer, is about to celebrate 30 successful years on the market; "Black Magic" is the market leader amongst plain chocolate assortments, and "After Eight" is a recent and dramatically successful introduction of a plain chocolate-covered wafer-thin mint. "Smarties" —small sugar-coated chocolate beans—have a dominant position in the children's market, and "Polo . . . the Mint with the Hole" is one of the most successful postwar launches.

These examples demonstrate the unique position, acquired by Rowntree brands, of leadership in each of the sections of the market in which they appear.

However, members of the Rowntree Group do not necessarily bear the Rowntree name. The slogan "Duncan's the Scots word for Chocolate" exemplifies the position of our Edinburgh subsidiary W. & M. Duncan Ltd. in the Scottish confectionery market, and our interest in the biscuit industry is well demonstrated by Gray Dunn & Co. Ltd. of Glasgow. W. S. Shuttleworth & Co. Ltd. of London—another Rowntree company—is one of the leading United Kingdom manufacturers of couvertures for the biscuit and allied industries. The Group's other activities in the United Kingdom include transport

An aerial view of the Cocoa Works, York. *Photo: Aerofilms and Aero Pictorial.*

The new Rowntree factory, Melbourne, Australia.

and warehousing companies. Overseas, its associated companies operate chocolate and confectionery factories in Commonwealth countries and in Germany, and the companies in the United Kingdom are also active in the export trade, especially to countries in the Far East.

It is, however, with the development of "Kit Kat" over recent years that there is to be found the best example of the effort which the company makes to give new and wider uses for its products. "Kit Kat" is promoted under the slogan "Have a break . . . Have a 'Kit Kat' ", a campaign which shows people at work or at home stopping what they are doing for a short break and enjoying a "Kit Kat," very often with a cup of tea. In this way "Kit Kat" has almost become a national habit. Indeed, it is typical of the company's intention to make its products play a significant part in people's daily lives. In this way also, Rowntree's actively contribute to increasing chocolate consumption.

Many of the products made at York enjoy popularity abroad; "Smarties," for example, are manufactured by every Rowntree overseas company, as well as being a significant part of our growing export business, readily acceptable in places as far apart as Lima and Bangkok, and "Black Magic" must now be one of the world's best-selling plain chocolate assortments. Indeed, overseas activities play an increasingly important part in the development of the group. Recently, a modern factory has been constructed in Australia and the acquisition last year of Stockmann-Rowntree G.m.b.H. in Hamburg provided an important entry into the European economic community.

The procurement of the raw materials of the industry is as fascinating as it is important. Fresh fruit is one major requirement, as are sugar and milk, and the company is the most important confectionery user of gum arabic in the world. However, the chocolate confectionery section of the Group's business relies ultimately upon a steady and reliable source of cocoa beans as its basic raw material.

The growth of the company's chocolate business has been closely associated with the development of the West African cocoa-growing industry because it is from this part of the world that the greater part of the Group's requirements are drawn. However, for those of the company's lines which use a proportion of fine or flavour beans, the company is actively encouraging cultivation in areas such as the West Indies and New Guinea.

The company makes extensive use of the London Cocoa Market, but it has always been part of its policy to maintain direct contact with producing countries. Frequent visits are made by Rowntree representatives overseas, particularly in connection with the production of raw cocoa. Manufacturers' requirements can therefore be directly discussed with producers, and the producing industries can be guided towards those standards of cocoa preparation which will lead to the increased acceptability of chocolate as an exciting and enjoyable flavour as well as a food.

Review of Production and Consumption

Production and Consumption

In our last issue we quoted the F.A.O. estimate of production and grindings that was published in January. We now quote some of the figures that were issued by F.A.O. in April following a meeting of the Statistical Committee of the F.A.O. Cocoa Study Group.

These figures show the enormous increase in the crops from Ghana, Nigeria and Ivory Coast. These increases, which amount to 38-39 per cent over the previous year in each case, are not easy to account for. Whereas 10 years ago fluctuations in the crop were due to the weather, nowadays other factors—control of mirids and new planting—play a part, but it is impossible to determine their relative importance. New plantings can only make a relatively small annual increase in production; there has been no sudden increase in spraying against mirids, so it would seem that the weather has possibly been the major factor in producing the increases in the 1964-5 crop. The fact that the increases are common to all three countries reinforces this view.

On the consumption side the grinding figures show no such dramatic change. There is a forecast of considerable increase in grindings in Africa and this is largely due to opening of new factories in Ghana for production of cocoa butter.

WORLD COCOA PRODUCTION AND GRINDING FIGURES
issued by FAO in April 1965
(Thousand metric tons)

PRODUCTION

	1962–63	1963–64	1964–65 (estimate)
A. North and Central America ..	97·4	100·0	101·0
B. South America	186·5	201·3	220·0
C. Africa..	853·6	900·1	1,198·9
D. Asia	7·4	7·1	7·6
E. Oceania	18·4	22·0	29·1
World total	1,163	1,230	1,557
Principal countries:			
A. Dominican Republic	38·8	43·0	40·0
Mexico	30·0	30·1	32·0
B. Brazil	109·0	125·0	135·0
Ecuador	38·0	36·0	40·0
C. Cameroon	76·0	85·0	95·0
Ghana	428·4	427·7	590·0
Ivory Coast	102·7	97·2	135·0
Nigeria	178·8	220·3	305·0
Spanish Equatorial Region ..	31·1	33·8	34·0

GRINDINGS

	1963	1964	1965 (forecast)
Europe	592·3	589·9	628·6
U.S.S.R.	54·0	65·0	90·0
North and Central America	314·0	335·8	342·9
South America	86·3	88·5	94·2
Asia	37·6	41·4	52·8
Africa	41·1	49·4	90·3
Oceania	16·7	16·9	17·2
World total	1,142	1,187	1,316

During the past few months there has been much talk of sales of cocoa beans for "non-conventional use," i.e. for the manufacture of soap or margarine. Normally cocoa is sold at prices far in excess of those paid for the fats used for this purpose, and it is estimated that cocoa would have to be sold at a third of current prices for "non-conventional use." There is little doubt that cocoa, or rather the cocoa butter portion, could be used as an alternative fat, but equally there is little doubt that this would involve some trials and adjustments to existing processes, which take time. So far there has been little cocoa used for "non-conventional use," and prices would have to fall much further for cocoa to be a competitor in the oils and fats market.

G. A. R. W.

THE WORLD'S COCOA ORGANISATIONS:

2. The Role of FAO in Cocoa Production

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INTRODUCTION

The Food and Agriculture Organization (FAO) is one of the Specialized Agencies of the United Nations and has its headquarters in Rome, Italy. Supported by 107 Member Nations and two Associate Member Nations, the Organization is charged with the responsibility of promoting the development of agriculture including related activities like forestry, fisheries and rural welfare. It seeks to achieve its aims by encouraging greater production and better distribution of food and, in the less developed regions of the world, the improvement of nutritional standards. Among its departments are those which deal with technical matters related to agricultural production, protection and processing, food and nutrition, research, training and extension, economics and marketing, and agricultural information. The Organization also gives, on request, technical assistance by providing specialists to help governments in all branches of agriculture.

Cocoa and Economic Development

It is a well-known fact that the improvement of living standards and general economic development in many areas of the world are characterised by a shift from subsistence agriculture to the cultivation of cash crops. The Organization has, therefore, shown special interest in the development and improvement of such cash crops on which many developing nations depend for their foreign exchange earnings and which contribute to raising the living standards of hundreds of thousands of families. Cocoa is one of a long list of such crops.

Much of the earlier interest of the Organization in cocoa was centred around the problems of marketing and prices and the relation between supply and demand. The FAO Cocoa Study Group, which is an inter-governmental group of producing and manufacturing countries and others interested in cocoa, has, since its formation in 1956, promoted the provision of accurate statistical information regarding the supply of and demand for cocoa. It has also interested itself in the scientific techniques of cocoa forecasting, in the improvement of grading standards and practices and in methods of promoting consumption. It pioneered discussions and arrangements towards an International Cocoa Agreement on Price Stablization. FAO has issued commodity reviews and studies on the production and demand situations.

Technical Working Party on Cocoa Production and Protection

In addition to FAO's work on the analysis of the commodity situation and outlook in the cocoa trade, much emphasis is now placed on technical production and protection problems. Following upon the suggestion of the FAO-sponsored Technical Cocoa Meeting held in Accra, Ghana, in 1959, a Technical

Working Party on Cocoa Production and Protection was established. This Working Party assists the Director-General of FAO in the implementation of the Organization's programme on cocoa production and protection by promoting the interchange of experience among specialists and other workers on cocoa, and by facilitating the initiation and conduct of co-operative studies on problems of common interest. Membership is open to all countries interested in cocoa production. An Advisory Committee of highly-qualified specialists functions within the Working Party.

At its first session in Rome in 1964 the Working Party discussed cocoa breeding and selection; seed production, its storage, packing and transportation; establishment, maintenance and rehabilitation problems. Much attention was given to problems like the fertilizer, shade and water requirements of cocoa, and the major pests and diseases of the crop in various parts of the world. The session also discussed the production of good quality cocoa, cocoa extension and the training of agricultural workers.

Cocoa Projects

The 1964 meeting reviewed project proposals on research and in other fields which had been put forward at the Accra meeting, and priorities were established for implementation. Very briefly, these projects concern:

(a) *Germplasm collection and quarantine measures:* This would involve the collection of plant material, clearance through quarantine and establishment at three locations—(a) Latin America and the West Indies; (b) Africa, and (c) the Far East. Much valuable work in this respect is already being done by the American Cocoa Research Institute, the United States Department of Agriculture and by the Cocoa Research Stations in West Africa. Existing national collections could be considerably strengthened to make plant material available to a larger number of breeders. It is desirable in this connection to prepare an international register of existing cocoa cultivars and clonal breeding material which would help to assess the present position of material available for breeding, and to determine long-term germplasm requirements. Such a register has been started at the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica.

(b) *Cocoa collecting expeditions:* Wild species of *Theobroma* are now exposed to the risk of destruction through development of agriculture, and explorations for new collections are necessary both on a national and international scale. Indeed, the Government of Brazil, through the initiative and promotion of the Centro de Pesquisas do Cacau, Itabuna, planned an expedition to the Amazon Valley to take place in June, 1965.

(c) *Research on black-pod disease:* This disease, caused by *Phytophthora palmivora*, and known in some areas as brown-pod, is almost of universal occurrence. It accounts for heavy losses of crop in many countries, and a research project with an international coverage has been recommended. The fungus is being studied by Dr. Haasis, Professor of Plant Pathology, University of North Carolina, Raleigh, and Dr. Nelson, Pathologist of United States Department of Agriculture. A scientific monograph on this subject may be possible in the future.

Active interest by FAO in research on physiological and technological problems and the production of technical monographs on specific subjects were recommended.

Other Activities on Cocoa

One of the aims of FAO is to disseminate information on matters of agricultural interest, and for this purpose a number of agricultural studies and surveys have been or are being published. Two of these studies on cocoa are "Processing of Raw Cocoa for the Market" and "World Cocoa Survey."

In addition to the offer of advice on matters affecting the production, protection and processing of cocoa, FAO, on the request of Member Governments, arranges for experts to give technical assistance under their field programmes. It is desirable under these programmes for each expert to have a country counterpart in order to ensure continuity of the programme when the expert's assignment is completed. In some of the programmes fellowships are available for advanced training or personnel selected by the governments and approved by the Organization.

Conclusion

It is realized that much work remains to be done in a venture of cocoa improvement which requires the goodwill and co-operation of all. FAO provides an international forum for nations interested in cocoa to meet and exchange information and ideas, knowledge and experience, and also discuss problems of common concern and work out solutions which will lead to a general improvement in the efficiency of cocoa production, protection and processing. This pooling of knowledge promotes the co-ordination of research activities and fosters expanded international co-operation and collaboration among cocoa workers in various parts of the world.

The publication of studies on the crop within the field of competence of FAO will, it is hoped, prove of value, while the servicing of experts who provide technical assistance to requesting Member Countries will help to accelerate economic development of which those countries stand in need.

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Note: A complete "List of documents prepared for the Cocoa Study Group," 1956-1963, may be found in FAO 1963a, App. 2.

Chemical Weed Control in Cocoa

L. Kasasian, Herbicide Agronomist, Regional Research Centre, University of the West Indies, Trinidad

Editor's note: The use of herbicides in cocoa growing has scarcely begun but they will clearly become important. Their use should not be judged solely on the possibilities of saving labour but also on the effect of removing weed competition on the growth of cocoa; little work has been done on this, but attention is drawn to an abstract of a report by Walmsley.

It must be emphasised that Mr. Kasasian's article is based on his work in Trinidad and the suggested treatments are intended for the Caribbean area.

Introduction

The speed of plant growth in the wet tropics is such that very frequent weeding is necessary if weed competition is to be prevented. There is increasing evidence that conventional methods of weed control, as carried out at present, are inadequate for optimum crop growth; thus, even if chemical weed control does not offer any obvious economic advantages, it may well result in better weed control and hence better crop growth. As the need for greater efficiency increases there can be little doubt that chemical weed control will become much more widely used, and there is much to be said for making oneself and one's labour familiar with this new technique on a small scale before its use becomes a "must."

Although the main weed problems in cocoa occur during establishment, weeds do occur frequently enough in established areas to warrant the spot or overall application of weedkillers. Weedkillers may also have a place in the reduction or removal of both ground and top shade and in clearing new land.

There was very little published work on the use of weedkillers when the Herbicide Research Unit was set up in Trinidad in 1960. For this reason an extensive programme of work on cocoa was started in 1961 and is continuing at present.

Weed control in Young Cocoa

In the West Indies it is usual for women to "round-weed" an area of 3-6 ft. diameter around young plants to avoid the extensive injury which occurs to them when gangs of men cutlass without prior "round-weeding." Even so, young plants are not infrequently damaged, thus providing points of entry for pests and diseases. In the early trials carried out by the Herbicide Research Unit, 18 of the more important herbicides were applied to the vegetation or soil surrounding nine-month-old cocoa plants (mainly ICS 95). In these preliminary trials, little or no crop injury and good weed control were given by atrazine (Gesaprim), prometone, diuron (Karmex), PCP (Shell Q and QT), paraquat (Gramoxone), diquat (Reglone) and dalapon (Dowpon); marked crop injury was caused by amitrol, sodium chlorate, 2,3,6-TBA and fenac, while negligible injury but poor weed control was given by amiben, TCA, neburon, ametryne and prometryne.

These initial field trials were followed up with "pot trials" (see Fig. 1) in which young cocoa plants were grown in 4-gallon oil tins. The herbicides were applied exclusively to the soil (by watering can) and the effects on growth were determined by measuring the increase in diameter, or girth, of the stems. In the

General view of herbicide "pot" experiment.

first pot trial, atrazine was rejected as being too toxic to the crop, and prometone as having a low margin of safety without any compensating advantages in the form of greater herbicidal activity or persistence. In a further trial, bromacil (Hyvar–X) and isocil (Hyvar) were found to be highly toxic to young cocoa. In two or more pot trials no significant reduction in growth was caused by simazine, linuron (Lorox), diuron, paraquat, 2,4–D, 2,4,5–T, MCPA or dalapon at rates twice those normally used for weed control, thus showing a reasonable margin of safety. A second application of simazine, linuron or diuron six months after the first also caused no injury. At higher rates diuron is more prone to cause symptoms (see Figs. 2, 3 and 4) than linuron and simazine. However, observations have shown no correlation between the presence of symptoms and growth [growth can be affected in the absence of symptoms, and the presence of symptoms (unless severe) does not necessarily mean growth is affected].

These trials suggest that the most useful treatments for round-weeding are simazine, linuron and diuron. As the action of simazine and linuron is mainly through the roots, a foliage spray such as paraquat must be added if weeds have emerged at the time of spraying; the addition of paraquat to diuron is not essential but it permits lower rates to be used. Suitable mixtures in Trinidad are 1 pint of Gramoxone + 5-6 lb. of simazine or Lorox or 2-4 lb. of Karmex per acre of ground actually sprayed. In easily leached soils or in very high rainfall areas, diuron is likely to prove too toxic for use in young cocoa.

Simazine, linuron, diuron and paraquat may be sprayed on the stems of cocoa, but must be kept off the leaves and growing points. It is therefore helpful to use some sort of shield when spraying round young trees. The Allman Arbogard is particularly useful, as it not only protects the trees but the hand

Symptoms produced by substituted urea and triazine herbicides (atrazine, simazine, prometone, diuron and linuron). All herbicides in both groups produce all the types of symptoms.

pump delivers a predetermined amount of spray and simultaneously moves the wide-angle nozzle through a fixed arc, spraying a fixed area, thus preventing over- or under-dosing. Shields may also be mounted on the spray lance. Alternatively, if a pneumatic sprayer is used (thus leaving one hand free) a stick may be used to lift up low-lying branches, or a piece of light metal may be nailed onto a stick and held against the tree to keep the spray off the leaves; it is of course important always to hold the same side against the tree.

Weed control in established cocoa

While well-grown, established plants generally shade out most weed growth, patches of weeds frequently establish themselves where the canopy is thin. A contact spray such as Gramoxone (at 2 pints/ac as an overall spray) or at 1 per cent as a spot spray will "burn" off the tops of grasses and herbaceous broadleaf weeds, but regrowth will follow unless they have a poorly developed root system. If the root system is well developed, systemic weedkillers such as 2,4–D and 2,4,5–T for broadleaf weeds and dalapon for grasses can be expected to give the best results, as they affect both roots and shoots. 2,4–D is safest when used as a salt formulation (amine, sodium or potassium); about 2 lb. (active ingredient) per acre is usually adequate as an overall spray or about 0·5 per cent–1 per cent (active ingredient) as a spot spray. 2,4,5–T, at the same rate as 2,4–D, will control certain woody broadleaf species which are not susceptible to 2,4–D but it is less safe on cocoa and more expensive. For the most resistant woody weeds a 1 per cent solution of 2,4,5–T in a thin oil, such as dieselene or kerosene, gives the best results but when formulated in this way it must be kept off the stems of cocoa as well as the leaves and growing points. Dalapon at 5–10 lb./ac as an overall spray or 1 per cent as a spot spray is highly effective on most grasses. For overall applications of 2,4–D, 2,4,5–T and dalapon a low-drift nozzle such as the Dorman No-Drift Hollow Cone nozzle should be used to prevent the spray drifting up onto the leaves of the cocoa trees.

Mixtures of two or more herbicides have given very promising results. Dalapon + 2,4–D will control many established grasses and broadleaf weeds, although grass control is usually better if dalapon is applied separately a month or two before the 2,4–D. The addition of diuron, linuron or simazine will inhibit the germination of new weed seeds. A suitable mixture is 1 lb. (active ingredient) 2,4–D+2 lb. diuron (or 3–4 lb. simazine or linuron) +3 lb. dalapon.

The removal of undesirable shade and clearing new land

In the West Indies, ground shade is provided by bananas, cassava and pigeon peas, while Immortelle is used (mainly) as top shade. Pigeon peas present no problem when the time for removal comes, but bananas and cassava are less easily killed. Bananas are fairly susceptible to 2,4–D and 2,4,5–T but regrowth usually follows. In Trinidad much better results have been obtained with Tordon. 5 ml. (=about one-sixth of a fluid oz.) of a 1 per cent active ingredient solution (=4 per cent of Tordon 22K) injected into each stem (either standing or cut) has given complete control. It may be injected with a soil injector or squirted into holes with an oil can. Cassava is fairly susceptible to foliage sprays of 2,4–D but more so to 2,4,5–T: it is advisable to cut the plants and spray regrowth when 1-2 ft. tall, so as to avoid spraying too high in the air. Immortelle and Glyricidia are susceptible to basal bark sprays of a 1 per cent solution of 2,4,5–T in a thin oil such as dieselene. In making basal bark applications the spray should be applied liberally right round the bottom foot or so of the stem, allowing some of the spray to run off into the soil.

Land clearance by the use of weedkillers is a slow process, some species taking over a year to die; hence, long-term advance planning is necessary. Several species are susceptible to basal bark sprays. On resistant species "frill" or stump treatments may be tried. In frilling, a series of overlapping axe cuts are made right round the stem and the bark prised back; the herbicide is then applied into the cut—suitable mixtures are 1-3 per cent 2,4–D or 2,4,5–T in oil, 0·5 per cent Tordon in water, 25 per cent sodium arsenite in water. Sodium arsenite is highly toxic but all the other compounds are safe.

The application of weedkillers

All forms of knapsack sprayer are suitable but the "constant-pumping" knapsack and the pneumatic types are the easiest to use. Particular attention should be given to the nozzle as with a good jet it is unnecessary to use more than 10 gallons per acre of spray instead of the 30-40 gallons or more usually used. For the application of true solutions (paraquat, 2,4–D, 2,4,5–T and dalapon) the Dorman No-Drift jet is especially good as it minimises drift up into the trees. For wettable powders (diuron, linuron and simazine) the Allman 2·3/5·8 is better as it has a larger orifice than the Dorman jet and is consequently less easily blocked. This nozzle maintains its low throughput by giving smaller droplets, which are more prone to drift, and for this reason it is better not to use it for the foliage sprays except under very still conditions.

SUGGESTED TREATMENTS

Weeds Controlled	Chemical	Rate	Usual period of control (weeks)	Remarks
Annual and perennial broadleaf weeds and grasses.	Paraquat	1 – 2 pts.	3 – 6	Keep off leaves and growing points.
	Paraquat + Atrazine or Diuron	1 pt. 3 – 4 lb. 1 – 2 lb.	6 – 12	
Perennial grasses mixed with broadleaf weeds.	Dalapon + 2.4 D + Atrazine or Diuron	3 lb. 1 pt. 3 lb. 2 lb.	10 – 20	Keep off leaves and growing points. Take great care to avoid spray drift.
	Dalapon + 2.4 – D	5 lb. 1 – 2 pts.	8 – 16	
Annual and perennial herbaceous broadleaf weeds.	2.4 – D	2 – 3 pts.	6 – 12	
Annual and perennial woody broadleaf weeds.	2.4.5 – T	2 – 4 pts.	6 – 12	
Annual and perennial grasses	Dalapon	5 – 10 lb.	8 – 16	

Adapted from *Weedkillers for Caribbean Agriculture.*

List of Herbicides

Editor's note: This list includes only those chemicals and products which are mentioned in Mr. Kasasian's article. There are of course numerous other chemicals, and furthermore those mentioned will be sold under a number of additional trade names.

Chemical Group	Common or abbreviated name	Trade name mentioned in article
Inorganic	sodium arsenite	
Phenoxy-acetic acids	2.4 – D 2.4.5. – T M C P A	
Phenols	P C P	Shell Q and Q_1T
Halogenated aliphatic acids	Dalapon T C A	Dowpon
Ureas	Diuron Linuron	Karmex Lorox
Triazines	Atrazine Prometone Simazine	Gesaprim
Quarternary ammonium compounds	Diquat Paraquat	Reglone Gramoxone

Cocoa Mirids

Part I. A World Review of Biology and Ecology

P. F. Entwistle
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Introduction

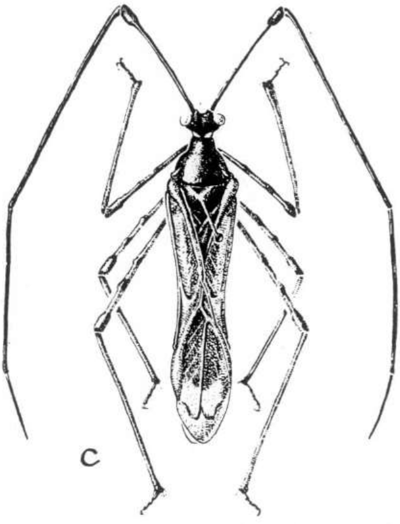
Not many cultivated plants are subject to attack by such a large number of different insect pests as is cocoa. Foremost amongst these pests are capsids, more correctly called mirids. These fragile insects, of which there are many species, are global in distribution and are known in temperate regions as pests of such crops as clover, potatoes and tree fruits.

The history and distribution of attack

Attack on cocoa by a mirid, *Helopeltis antonii*, was first seen in Ceylon in 1863. In West Africa, currently the world's largest producer area, attack by *Sahlbergella singularis* had started by 1902 in the French Congo and was followed in the Gold Coast (1908), the Belgian Congo (1911), Nigeria (1913) and Sierra Leone (1918); it also occurs in the Ivory Coast and Togo. Finally, an attack took place in 1930 in the island of Fernando Po, where it is fairly certain *S. singularis* had not been a pest in 1928.

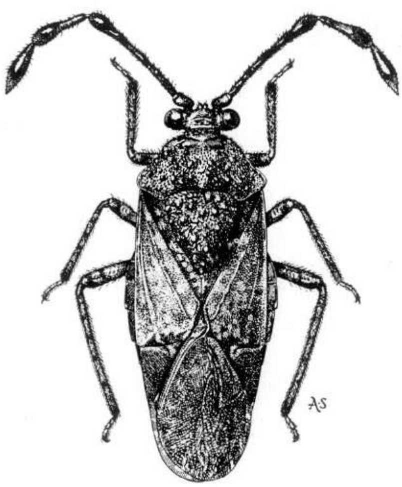
Another mirid, *Distantiella theobroma*, is also a serious pest in West Africa, but is not as widespread as *S. singularis*. It was first seen in the Gold Coast in 1909 and in Nigeria in 1913 but, apart from the Cameroons, where it is very scarce, occurs on cocoa elsewhere only in the Ivory Coast.

In East Africa, including Zanzibar, mirids of the genus *Helopeltis* occasionally attack cocoa, whilst in Madagascar *Boxiopsis madagascariensis* was first seen in 1960.



Papua and New Guinea Ag. J.

Adult Helopeltis clavifer.



C.R.I.G.

Adult female Sahlbergella singularis.

World Distribution of Mirid Attack on Cocoa
(For a more detailed account see Entwistle and Youdeowei, 1964)

Area	Main Species	Date first recorded
SOUTH AMERICA		
Brazil Venezuela Ecuador Peru Colombia	*Monalonion* species	1909 onwards
CENTRAL AMERICA		
Panama Costa Rica	*Monalonion* species	?
WEST AFRICA		
Sierra Leone	*Sahlbergella singularis*	1918
Ivory Coast Ghana Togo Nigeria Cameroun	*S. singularis* and *Distantiella theobroma*	? 1908 ? 1913 1902
French Congo Belgian Congo Fernando Po	*S. singularis*	? 1911 1930
EAST AFRICA AND ZANZIBAR	*Helopeltis* species	?
MADAGASCAR	*Boxiopsis madagascariensis*	1960
CEYLON	Originally *Helopeltis antonii* but now replaced *H. ceylonensis*	1863 1961
EASTERN ARCHIPELAGO		
Malaya	*H. theobromae*	1939
Sabah	*H. clavifer* and *Platyngomiriodes apiformis*	1963
New Guinea New Britain	*Pseudodoniella* species	1947
Philippines	*Helopeltis* species	?

Attack in the New World, the home of cocoa, is exclusively by members of the genus *Monalonion* and does not seem to have been noted until 1909. This late date may reflect a lack of trained observers rather than a genuine occurrence. Attack was first seen in Bahia (Brazil) and later in Colombia, Peru, Ecuador and Venezuela and in Panama and Costa Rica in Central America, but not in Mexico. Cocoa mirids have never been seen in the West Indian islands, even in Trinidad, close as it is to the Venezuelan mainland.

Attack in the Eastern Archipelago genuinely seems to be of very recent origin, apparently starting in Malaya in 1939 (*Helopeltis theobromae*). In Papua, New Guinea and New Britain, attack by *Pseudodoniella* species was first seen in 1949 and by *Helopeltis clavifer* in 1954. The latter species began, along with *Platyngomiriodes apiformis*, to attack cocoa in Sabah (North Borneo) in 1963, and these two are the most recent records of new adaptations of mirids

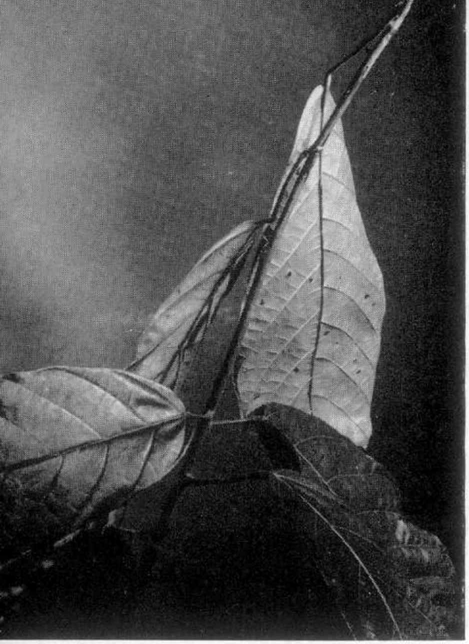


Photo: Accra Information Services.

Shoot attack by mirids.

to cocoa. Attack in the Philippines is by members of the very widely distributed genus *Helopeltis*.

Altogether about 35 species of mirid are known to attack cocoa.

The dynamic nature of attack

The behaviour of mirids on cocoa is mercurial in all respects; not only is their initial appearance without apparent pattern, but their behaviour on the crop may change with time.

For instance, the first mirid to attack cocoa in Ceylon, *H. antonii*, was of considerable economic importance but appears to have vanished at some time before 1961 when cocoa was found to be attacked by a less virulent species, *H. ceylonensis*.

Zhentener (4) visited Bahia in 1909 and found mirids attacking pods only, but on a second visit three years later he found severe stem damage. Similarly, *Pseudodoniella laensis* in New Guinea attacked only pods when first found in 1949, but by 1957 stem attack was severe.

In West Africa there is good evidence that *Distantiella theobroma* was originally restricted to seedling cocoa and *S. singularis* to mature trees. The situation has changed considerably and both species attack all stages of the cocoa tree. Indeed, insecticide-resistant *D. theobroma* is currently the main pest in Ghana, where numbers of *S. singularis*, until recently a very important pest, have diminished greatly.

Mirid feeding

Mirids feed on unhardened stems and green pods and also on quite hard, woody tissue. It has been suggested that high-pressure injection of saliva through the stylet-like mouthparts induces an acidity which causes the plant tissues to collapse locally. The insect draws up the released plant tissue fluids leaving behind a small water-soaked area. This area is known as a lesion and, as a post-mortem effect, it rapidly turns dark brown. Lesions are particularly obvious on green stems, where they are generally lenticular in shape, and on pods, where they are circular. The majority of mirid species do not attack leaf blades, but some may feed on the leaf stalk.

The number of lesions made each day varies greatly, but 50 is probably a fair average. In West Africa the position of lesions on pods is a guide to the species of mirid concerned. The West African mirids feed mainly at night, but in sheltered situations, such as the back of pods, may also feed during the day.

Mirid biology

Eggs are laid in the wood of stems and pod stalks and sometimes in pod husks and, except for two very fine terminal hair-like filaments, are completely buried and hidden from sight.

There are five juvenile stages (the nymphs) at the end of each of which the skin is cast, and the insect increases in size before the new skin hardens. During the last three nymphal stages the wings, which are not fully developed until the adult stage is achieved, begin to appear.

Good data on the duration of the life history is curiously lacking, but the incubation period seems to vary from 12-17 days, whilst each of the nymphal stages may last from 3-6 days. The adult is sexually mature after 4-7 days and may live up to 28 days in captivity. In general, a generation covers from 35-40 days, but may be less in some species of *Helopeltis* (27 days) and *Monalonion* (21 days).

Little is known about the number of eggs laid; *D. theobroma* has been recorded as laying 91, *S. singularis* 30 (surely an underestimate) and *Bryocoropsis laticollis*, another West African mirid, 64.

Ants, assasin bugs (Reduviidae) and praying mantids are amongst the predators of mirids, whilst a few internally parasitic wasps, mainly Braconidae, have been recorded attacking the nymphal stages, as have nematode worms and at least one species of fungus. No egg parasites have been seen.

Mirid distribution and numbers

The study of the factors controlling the occurrence and numerical levels of mirids has always been of considerable interest because of the possibility of embodying mirid-negative factors into plantation practice. This is particularly attractive now that resistance to insecticides has appeared and the prospects for easy control by chemicals have been questioned.

Light, or the factors light controls, appears to play a big part in mirid attack. In Ghana, where most cocoa is grown beneath the shade of forest trees, mirid attack commonly starts where breaks occur in the shade-tree canopy. Such localised attack results in groups of intensively damaged trees referred to as "capsid pockets." Where overhead shade is sparse, as in Nigeria, a more diffuse type of attack called "capsid blast" is common, though pocket-type attack may still occur where there are breaks in the cocoa canopy itself. The destruction of trees within a capsid pocket allows more light to reach adjacent trees, which in turn may be attacked.

Such a preference for lighter conditions appears to be fairly general, though *Helopeltis ceylonensis* seems to flourish more in the shade.

Mirid numbers follow clear seasonal patterns. In West Africa, peak populations occur between September and the following January, the position of the peak varying somewhat from year to year. Numbers are lowest from April to June. Populations of *Monalonion* in Costa Rica follow very much the same pattern, with peak numbers in September following abating rains. In Ceylon the peak is reached from December to January, with lowest numbers in August, and in Java in March to April, with a decline in the second half of the east monsoon and in the beginning of the rainy season. It has been suggested that humidity has a direct influence on population changes in West Africa and there is no doubt that predators and parasites together have some effect.

To the peasant farmer, and sometimes also to the plantation man, it is often a source of perplexity that such low numbers of mirids should be associated with so much damage. This confusion arises partly because the damage is most impressive after peak numbers have passed and partly because peak numbers are genuinely small compared with many other types of insect pests. This is because capsid feeding is of such a destructive nature that the tree is incapable of supporting large numbers. It has been estimated that 1,000 mirids on an acre of cocoa (perhaps of 500 to 600 trees) must be considered dangerously high. Furthermore, some capsid species have both a cryptic colouration and form and are very difficult to see.

Effects of attack and crop loss

Losses from the purely mechanical effects of feeding on pods and pod stalks occur in some countries; for example, Papua with 70-80 per cent losses; in New Britain a loss of 60-70 per cent has been recorded, but invasion of lesions by the fungus *Gleosporium* increases wilt there. Elsewhere, attack on pods is of importance mainly in the cherelle stage.

In West Africa there is no evidence for the oft-reiterated statement that mirid lesions allow the entry of pathogenic fungi into the pod. However, it is reliably reported that invasion of pods by *Phytophthora palmivora*, the black-pod fungus, follows mirid attack in Ceylon.

Most crop loss is caused indirectly by stem feeding. In West Africa, lesions are generally quickly invaded by the weakly pathogenic fungus *Calonectria rigidiuscula*. This, in trees weakened by attack, causes considerable die-back of branches and eventually death of the main trunk. Whilst this fungus is said to have a tropicopolitan distribution it does not seem to be associated with mirid attack in other parts of the world. Infection by an unnamed fungus follows attack by *P. apiformis* in Sabah.

Attempts to estimate crop losses are always complicated by the inadequacy of records and the complexity of losses from other causes such as fungus and virus diseases. In Ghana it was calculated (2) that 60,000 to 80,000 tons of dry beans were lost annually when production was of the order of 200–250,000 tons. Since then there has been a steep increase in production, much of which is attributed to the control of mirids. In Nigeria it has been stated that "capsid attack causes losses in production far in excess of any other pest or disease" (3). Recent studies on the interaction of mirid attack and cocoa swollen shoot viruses in Nigeria suggest that viruses are rather less important than was at first supposed. Hence losses attributed to them may to some extent be added to the mirid balance sheet. In Ghana, where the cocoa viruses are rather more virulent, the same may be true to a lesser degree.

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Storage of Raw Cocoa

G. A. R. Wood, Cadbury Brothers Limited

Storage conditions for cocoa must be such that flavour and quality are preserved. In temperate climates, taking reasonable care, cocoa beans will keep almost indefinitely. In the tropics storage is subject to two severe handicaps: first, the ready development of mould due to high relative humidity, and second, the high level of infestation. In the past these two factors have limited the time for which cocoa can be stored in the tropics without undue deterioration in quality, but recent developments have reduced the damage from mould and insects and allowed longer periods of storage.

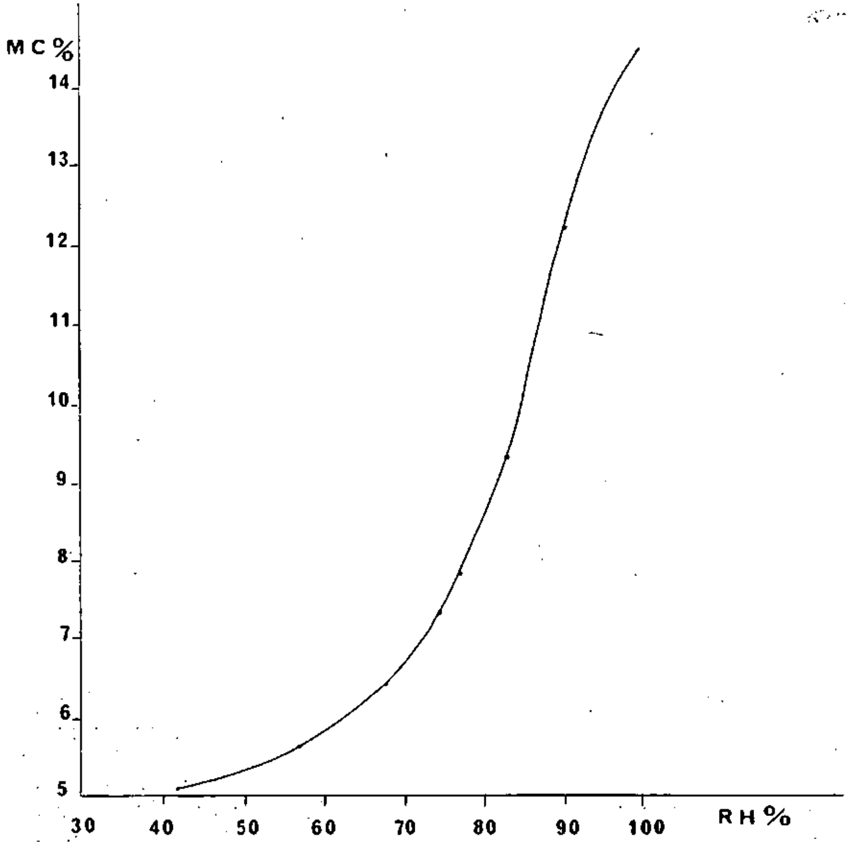
Mould

Internal mould has been described as "by far the worst defect" of commercial cocoa. Mould growth on the cotyledons has various effects, but the most objectionable is the effect on flavour, and samples with as little as 4 per cent mouldy beans can give a chocolate with a detectable off-flavour.

Numerous species of moulds will develop on beans during fermentation and drying, and the shells of dried beans are inevitably covered with mould spores which will invade the beans, given the right conditions. Germinated beans, or those whose testa is cut during harvesting, are liable to attack by many moulds, but only a few species are capable of penetrating the unbroken testa. Internal mould does not often develop during fermentation; it is unlikely to arise from box fermentation, but may develop when beans are fermented in heaps. Internal mould is more likely to result from prolonged drying, but in most cases it develops during storage.

What are the right conditions for mould growth and hence the wrong conditions for storage? This was studied in the '20s by Dade and Scott, who showed: first, that cocoa beans with a moisture content less than 8 per cent are unlikely to develop mould; second, that the relative humidity at which beans of 8 per cent moisture content are in equilibrium is 82 per cent (1, 5). It is well known that cocoa beans are hygroscopic and will gain or lose moisture to attain an equilibrium with their environment; if beans are kept in an atmosphere with R.H. of 90 per cent they will absorb moisture until they hold 11·6 per cent moisture and at this level would rapidly become mouldy, whereas at an R.H. of 75 per cent the equilibrium moisture content is 7·3 per cent. Figure 1 shows the equilibrium moisture content at various relative humidities. The original work was done at ambient temperatures; more recent work, from which this curve is taken, has confirmed the expectation that there is no difference in equilibrium moisture contents between 25°C and 31°C. (3) Other workers have investigated the equilibrium moisture content of beans and there is evidence that different types of beans vary to some extent, Sanchez cocoa being more hygroscopic than other types (6). Although this might infer varying criteria for storage, it seems to be safe to accept the general conclusion from West African experience that the relative humidity in a store must not exceed 82 per cent for any length of time.

In most parts of the tropics storage conditions are on the right side of these limits but in some areas, Cameroun, for instance, conditions are not suitable for long storage. The rate of uptake of moisture under such conditions was studied at Kumba in West Cameroun (2). In these experiments fully dried beans



Relationship of moisture content of cocoa beans and relative humidity of air.

with a moisture content of 4·5 per cent were kept in free-standing bags placed in a number of stores; in all cases moisture uptake was the same, the moisture content rising to 8 per cent in three weeks; the beans became mouldy after a month.

The conditions for this experiment were severe, and generally moisture uptake will be more gradual. It will depend on the size of stack, the number of hours during the day at which relative humidity is over 80 per cent and the initial moisture content of the beans.

On this last point it should be stated that cocoa beans should be dried to a moisture content of 6-7 per cent; at a higher moisture content of 8 per cent the beans may turn mouldy; lower moisture contents result in brittle beans which when broken—as they easily are—allow penetration by insects. There is also an unnecessary loss in weight for the producer.

Construction and Operation of Stores

Stores for cocoa beans should be designed so that the bags of cocoa can be handled easily, the store kept clean and some control over atmospheric conditions is possible.

The extent to which conditions inside a store can be controlled is limited, but it is desirable to control the ventilation as far as possible. This may be done simply by closing doors and windows, thus preventing damp humid air from entering. Louvres or gratings are sometimes fitted at the eaves; they are not necessary and may be a disadvantage.

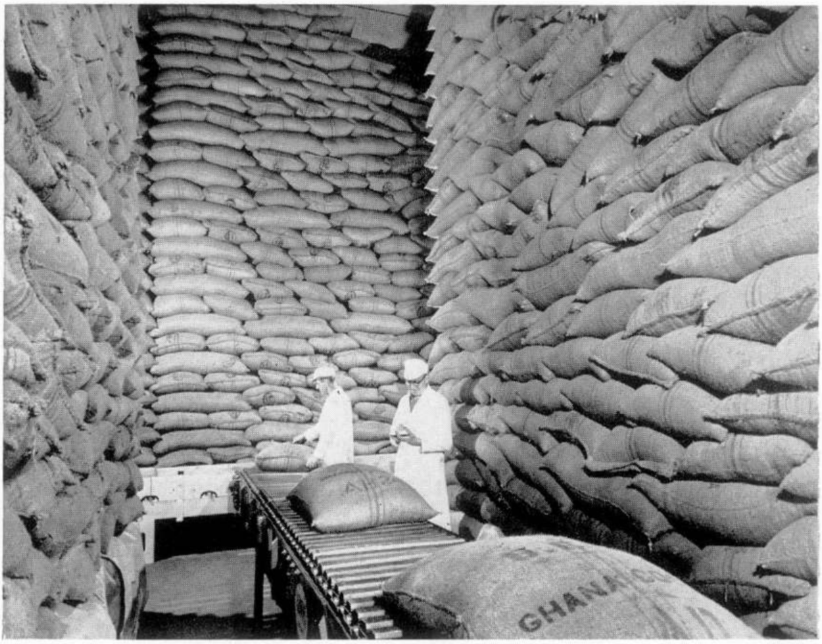
Roofs and walls should be a light colour so that radiant heat is reflected during the day. This will make working conditions better and will reduce temperature variations in the store to a minimum.

The walls and floor should be built of concrete in preference to wood, which is liable to harbour insects, but a concrete floor must be allowed to dry out fully before being used, and it is always wise to stack cocoa beans on scantlings.

In areas of high humidity the doors and windows should be opened during working hours and closed during the afternoon when the relative humidity starts to rise. This will help to maintain suitable conditions inside the store; insulation would lead to further improvement, but might be impractical or too expensive.

Polythene Liners

Where cocoa beans have to be stored under unsuitable climatic conditions, the simplest means of protecting them is to use jute bags with polythene liners. The experiments at Kumba showed that polythene liners prevent the uptake of



A cocoa bean store, Bournville.

moisture, and can thus prevent the dry cocoa going mouldy. There is one vital proviso—the cocoa must be properly dried in the first place. Cocoa with more than 8 per cent moisture is just as likely to become mouldy if bagged with a polythene liner as without.

A thin liner of 150 gauge (·04 mm.) is thick enough to protect the beans and is suitable for use where beans are to be stored and shipped in polythene liners. They cannot be used a second time, and where this is necessary a thicker grade of polythene would be required. This means of protection can be provided for a modest sum, less than £1 per ton. Where storage conditions are marginal, quick shipment may be arranged as an alternative, but where a cocoa estate is coming into production and harvests are small, it may be necessary to accumulate stocks. In this case polythene liners are useful.

Infestation

Cocoa beans are not severely affected by stored product pests, and this is due to their low moisture content. Only a few species will readily attack cocoa although it is liable to become infested with insects which infest other stored products.

The most important of the insects infesting cocoa beans is the moth *Cadra cautella*. Its importance lies in the fact that not only can it thrive on cocoa in the tropics but can also continue to breed in temperate climates. Thus it can damage stocks in consuming countries and, worse, forms a source of infestation of cocoa and chocolate factories.

It is not proposed to deal in detail with the subject of infestation and measures taken to combat it. (These subjects will be dealt with in a later article.) Suffice it to say that elaborate measures to control infestation are generally only necessary where cocoa is stored for a long time in the tropics and where large quantities are involved. In other circumstances cleanliness in stores and prompt shipment should prevent infestation.

Storage and Flavour

It has been shown that cocoa can be stored in temperate climates for some years without detriment to flavour; in the tropics, storage time has been limited by other factors and changes of flavour have not been investigated. There was a report that storage in the tropics led to a decline in the proportion of purple beans, but this was later discounted (4). There is, however, one change that may well take place more quickly in the tropics than elsewhere, namely, a reduction of acidity. Acidity in beans is due to acetic acid, which is volatile, and it is reasonable to suppose that at tropical temperatures this acidity will steadily diminish. This point has not, however, been studied.

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Notes

Tray Fermentation at Ikiliwindi

In the first issue of the *Bulletin* there was an article by T. A. Rohan on the tray method of fermentation in which mention was made of trials conducted at Ikiliwindi. This method has been adopted there because it has proved to be convenient for estate management, and also because it requires less floor space than normal box fermentation. The quality of the cocoa is satisfactory.

Although the tray method has not been widely adopted, some planters have tried it and some notes on our experience at Ikiliwindi might be helpful.

1. **The Trays**—These are $3' \times 2' \times 5''$ deep. 3-4 battens are fixed across the bottom of the tray and on these a piece of palm matting is laid; the depth of the layer of beans is $4''$. There is, therefore, a small air space between the trays.

2. **Routine**—The wet beans are placed in a large fermenting box immediately after the pods are opened. The beans remain in the box for 1-2 hours before being moved to trays; this was done originally for convenience, but it has been found that much of the sweatings comes off during this brief period and that fermentation takes place more rapidly as a result of this treatment.

The trays are stacked one on top of the other in tiers of 12, the bottom tray being left empty and the whole tier raised slightly to allow sweatings to drain away and air to circulate. The tier is covered with sacking after 24 hours and after four days the beans are put on the drier. The period of four days was chosen after trials of three- and four-day tray fermentations compared with six-day box fermentations. (More extensive trials at Tafo showed no significant difference between three-, four-, five- and six-day fermentations.)

3. **Temperature pattern**—The rate at which the temperature rises is sometimes disappointing in initial trials. In 1959 three trials were conducted at Ikiliwindi; in the first the temperature rose to 47 degrees C after 60 hours; in the second, 49 degrees C was reached in 40 hours, and in the third, 50 degrees C in 30 hours. The last is comparable to the temperature rise described by Rohan. These changes in the rate of temperature increase may be due to the trays becoming infected with micro-organisms.

4. **Effect of season**—During the cooler, wetter months, cocoa does not ferment as readily as in the warmer months. This is not peculiar to Ikiliwindi but is a fairly common experience, and has been described by Allison and Kenten (*Trop. Agric.* 40.3.217, 1963). Their trials in Ghana showed that fermentations during the mid-crop were usually cooler than fermentations during main crop, the temperature after 24 hours in a tray being 5-6 degrees C lower during mid-crop.

At Ikiliwindi this is countered by leaving the beans in the box for a longer period—up to six hours—before loading the trays.

5. **Appearance of beans and quality of product**—When the beans are turned out onto the drying platform their appearance is not as uniform as that of beans fermented in a box. The surface layer in some trays appears to dry out and the beans in the bottom tray may be covered with external mould. By the time the beans are dry these differences have disappeared and, by the important criterion of flavour, there is nothing to choose between tray and box fermentation.

Notes on Contributors

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Graduated from the Royal College of Science, London, in 1953. On joining the Colonial Research Service spent from 1955 to 1959 as entomologist at the West African Cocoa Research Institute, Ghana, and from 1960-64 at its sub-station in Nigeria (now Nigerian Cocoa Research Institute). In 1964 joined the Unit of Insect Pathology, School of Forestry, Oxford.

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After graduating in botany at Birmingham, U.K., in 1952, he joined the Agricultural Research Council's Unit of Experimental Agronomy at Oxford, where he was in charge of the Technical Information Section on Herbicides. Started and edited *Weed Abstracts* and was joint editor of *Pesticides Abstracts and News Summary* (Section C). Went to the Regional Research Centre of the University of the West Indies in 1960 as Herbicide Agronomist, in which position he has been carrying out field experiments with herbicides in Trinidad and in the Leeward and Windward Islands.

Cocoa Abstracts

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

December, 1964

Iserentant, R. Observations écophysiologiques sur le bilan d'eau du cacaoyer (Theobroma cacao L.) (Ecophysiological observations on the water budget of the cacao tree). Bull. Séanc. Acad. Roy. Sci. Outre-Mer 2, p. 382, 401 (1964).

Pot experiments with 3- to 5-year-old cacao trees, conducted in Belgium, demonstrated the typical hygrophytic character of the crop. The plants retained their normal water content until the available water in the soil dropped to a level near the wilting point; further loss of water from the soil resulted in sudden wilting without leaf abscission. Isolated leaves kept at a temperature of 22°C and a relative humidity of 55% lost a great part of their water during the first days; light-green leaves below 5 months old were more resistant to dessication than older leaves. Raising the osmotic pressure of the soil by addition of KNO_3 did not appreciably affect the moisture content of the plants. Plants in pots kept under water with a pH above 7 during 1 year remained perfectly healthy. Table. Graphs. 13 refs.

Ascenso, J. C. Outlines of the cacao selection and breeding programme in San Thomé. Econ. Botany 18, 2, p. 132-6 (1964).

Cacao exports from Sâo Tomé declined steadily from 1921 onwards, to only 9,000 tons per year at present, owing to a decline in soil fertility, a low level of management, and senility of the plantations. A cacao experiment station was established in 1960 to study and improve the situation. An outline is given of the selection and breeding programme. Selection criteria are: yield, vigour and earliness, and resistance to black pod (*Phytophthora palmivora*), the main disease in Sâo Tomé. The programme includes single plant selections in the local cacao population, introduction of selected parents and hybrid seed, and crosses between selected local and imported clones. Incompatibility studies in relation to seed production and interspecific and intergeneric (with *Herrania* species) crosses are also to be undertaken. 16 refs.

Cabrera Villa, L. Pruebas para ampliar el periodo de viabilidad de semillas de cacao. (Trials to prolong the viability of cacao seed). Agricultura Tecn. México 2, 3, p. 133-6 (1963-64).

Experiments on the storage of cacao seed were conducted in Mexico. Very few among the several treatments tried were successful. The best results were obtained by treating beans taken out of the pods with lime-water in order to coagulate the mucilage, removing the testa, and storage in CO_2; 76% of the beans so treated retained their viability for 45 days. The next best method was to remove the mucilage by means of a detergent followed by washing and superficial drying, and storage in plastic bags. Tables. 5 refs.

Mabey, S. E. The bud-grafting of cacao in Uganda. E. Afr. Agr. Forestry J. 30, 1, p. 49-53 (1964).

A description is presented of a new technique of grafting cacao onto 18- to 24-month-old trees, developed in Uganda. This method of budding is based on the relation of early vigour and a good yielding capacity of cacao; its success has been found to be dependent not on the grafting technique but on the physiological condition of stock and scion. Hardwood dormant chupon buds of vigorously growing trees are patch-budded onto chupon stocks about 10 cm. above the collar, using a very simple technique that can be practised by any farmer. Emphasis is placed on the time of budding in relation to the condition of the stocks and of the mother trees from which the budwood is taken. Photos. 7 refs.

Asomaning, E. J. A. Varietal resistance of young clones and seedlings of cocoa (Theobroma cacao L.) to root infection by Phytophthora palmivora. Trop. Agr., Trinidad 41, 3, p. 251-6 (1964).

The roots of young cuttings of a number of cacao clones in Ghana were inoculated with a sporangial suspension of *Phytophthora palmivora*, the pathogen causing black pod disease, and its effect on the growth of the cuttings was observed. In general, the growth of clones susceptible to black pod was severely reduced while resistant clones suffered relatively little and a few clones appeared to benefit from infection. It is concluded that the mechanism conferring resistance is systemic within the whole plant and not restricted to the pod tissues alone. The root infection technique may be of practical value in developing varieties resistant to *Ph. palmivora*. Tables. 8 refs.

Die Klassifizierung des Rohkakaos in den Anbauländern. (Grading of commercial cocoa in the producing countries). Gordian 64, 1528, p. 545-7 (1964).

An outline of the criteria for grades of commercial cocoa, and of systems of marking cocoa bags according to grades, currently used in Brazil, Ghana, Nigeria, Cameroon, and the Ivory Coast, compared with uniform systems of grading proposed by the Cocoa Association of London and the FAO Cocoa Study Group.

January, 1965

Ascenso, J. C. Inheritance and relationships among growth characters of young cacao seedlings. Estud., Ensaios e Doc., Junta Invest Ultramar 105, p. 13-89 (1963).

Studies of the growth rate of young cacao seedlings were made in Trinidad. Generally, second generation progenies of clone ICS 1 obtained by self-pollination were more variable than similar progenies resulting from the cross M 8 × ICS 1. Diallel crosses between and selfings of 7 parents showed that, on the whole, hybrid progenies grew more vigorously and were less variable than selfed progenies; some of the hybrid progenies exhibited a certain degree of heterosis. The most efficient criterion in selecting for vigour of growth was found to be the stem height, because this character is easy to measure and is strongly associated with stem diameter, fresh weight, and leaf area. French and Portuguese summaries. Tables. Graphs. 51 refs.

Allison, H. W. S., and Smith, R. W. Economics of cacao establishment on clear-felled land. World Crops 16, 3, p. 31-6 (1964).

The economics of modern systems of cacao planting under Ghana conditions are compared with those of the customary method of planting under forest. After clearing, a wide range of modern planting practices becomes possible, such as the planting of temporary and permanent shade, and the use of high yielding varieties and fertilizers. The comparison indicates that modern planting systems require more capital outlay, but give a much quicker return of capital and higher profits. Because all cost factors in producing countries have increased while the price of cacao has declined, producing countries must concentrate on modern methods to improve yields of both farmers' co-operatives and plantations. French and Spanish summaries p. 4. Tables. Graph. Photos. 14 refs.

Smith, R. W. The establishment of cocoa under different soil-moisture régimes. Emp. J. Exp. Agr. 32, 127, p. 249-56 (1964).

The effect of soil moisture on the early development and first yield of cacao was studied in an irrigation experiment with 3 soil moisture levels conducted in Ghana. The dry treatment received only natural rainfall; in the medium treatment the soil moisture content of the upper 30 cm. was kept at a minimum of 12%, whereas it was not allowed to fall below 18% in the wet treatment. These levels are equivalent to 35% and 65% of the total available soil moisture. Irrigation increased the growth rate and flower production, but did not affect the percentage setting of flowers or wilting of cherelles. The interval between the growth flushes of individual trees remained unchanged, but irrigated trees ceased to flush in phase with each other. Tables. Graphs. 19 refs.

Entwistle, P. F. Mirids and other insect pests of cocoa. Nature 203, 4948, p. 922-4 (1964).

A brief report is presented of an international conference on problems of resistance in and control of cacao pests, which was held at Ibadan, Nigeria, from 24th to 27th March 1964. The emphasis was on mirids, several papers being presented concerning the species attacking cacao in different parts of the world, their incidence in relation to the climate, development of resistance, screening of insecticides for their control, and spraying techniques. Other subjects discussed were the effect of shade on cacao pests, damage by *Toxoptera aurantii* as a result of spraying with DDT, and damage by rodents in W. Africa. 7 refs.

February

Cuatrecasas, J. Cacao and its allies. A taxonomic revision of the genus Theobroma. Contr. U.S. Nat. Herbarium Smithsonian Inst. 35, 6, p. 379-614 (1964).

The main part of this paper embraces: (1) on p. 383-415, an outline of the historical development of knowledge of the cacao tree and closely related species from a taxonomical standpoint; (2) on p. 415-49, a discussion of the morphology, ecology, geographic distribution, pollination, relationships, evolution, and economic uses of the genus *Theobroma*, followed by a section on the anatomy of the wood contributed by W. L. Stern, one on its pollen morphology by G. Erdtman, and 2 on its cytology and pollen incompatibility, respectively, by F. W. Cope; (3) on p. 449-582, a taxonomic revision of the genus, in which the author recognises 22 species. A list of artificially obtained hybrids and one of rejected species are added. Figs. Plates. Maps. 188 refs.

Naundorf, G., and Miller, R. Werkzeuge und Maschinen in der Kakaokultur. (Implements and machines in cacao cultivation.) Gordian 64, 1534, p. 789-93 (1964).

The introduction of machines in cacao cultivation is of recent date and is still limited; however, new plantings will have to be established with an eye to future mechanization. Implements and machines that can be profitably used under present conditions in several countries include: (1) mechanical saws for the felling and cutting-up of trees in forest clearing and road-building operations; (2) planting hole diggers; (3) pruning shears and saws on poles to remove diseased branches in the top of the trees; (4) sprayers, mistblowers, and dusters for disease and pest control. Colombia is the 1st country in which aircraft have been used in cacao plantations, viz., for the control of the bug *Mecistorhinus tripterus*, which transmits monilia disease. Photos.

Murray, D. B., and Maliphant, G.K. Tillage and manures [for cacao]. Ann. Rep. Cacao Res. 1963, p. 50-3 (1964).

A factorial tillage-manuring trial with cacao was established in Trinidad in 1950. The yields of clone ICS 1 over the trial period 1953-60 showed that annual shallow mechanical ploughing was deleterious, and annual hand-forking even more so. Equivalent amounts of NPK applied annually in the forms of fertilizer alone, cattle manure plus fertilizer, and grass mulch plus fertilizer, all increased the yield, the grass mulch showing the highest yield increase, and the fertilizer alone the smallest. Manuring also reduced the adverse effect of tillage. The treatments were discontinued in 1960; yields over the years 1960-63 showed that the residual effect of manuring persisted for 1 year only, and that the deleterious effect of ploughing had disappeared after 2 years, whereas that of forking was still apparent in the 3rd year. Table.

Bartley, B. G. Progency trials [with cacao]. Ann. Rep. Cacao Res. 1963. p. 16-24 (1964).

Data are recorded of several cacao variety trials conducted in Trinidad. At River Estate, the 1956-63 yields of clone ICS 6 in trial 2 were higher than those of ICS 1 and 8; the best cross of these clones, ICS 6 × ICS 8, yielded less than either parent. In trial 7, clones ICS 39-89-95-98 yielded more than their open-pollinated progenies and more than crosses with ICS 1 and 6. Trial 8 confirmed that clones ICS 8, 89 and 98 are superior parent clones. In the 1951 witchbroom resistance ICS × SCA progeny trial, progenies with ICS 6 as the Trinitario parent yielded more and were less susceptible to *Ceratocystis* than progenies of ICS 1 or ICS 60; progenies with SCA 6 or SCA 12 as the Upper Amazon parent showed equally high yields, but progenies of SCA 6 were far more resistant to witchbroom. The progeny ICS 6 × SCA 6 is now recommended for areas where both witchbroom and *Ceratocystis* are prevalent. Tables. See also ibid. p. 34-5. Murray, D.B. Clonal introductions. Table.

Murray, D. B., and Maliphant, G. K. Size of planting hole. Ann Rep. Cacao Res. 1963, p. 49-50 (1964).

The effect of planting hole size on the development of cacao cuttings was investigated in a trial established in Trinidad in 1951. Holes of 30 × 30 × 15, 60 × 60 × 30, and 90 × 90 × 60 cm. were filled with soil mixed with cattle manure at a rate of 250 kg/m^3. No significant differences in trunk girth or yield were observed between the treatments. It is possible that waterlogging as a result of sinking of the soil consequent upon the rotting of the manure had counteracted the beneficial effect of the large holes. Table.

Swarbrick, J. T. The growth and root distribution of some temporary shade plants for cocoa. Trop. Agr., Trinidad 41, 4, p. 311-23 (1964).

Descriptions are presented of the root system of cacao, of the root distribution of secondary forest, and of the growth habit, shade pattern and root distribution of 6 plant species used as temporary shade for cacao, growing in a shallow, porous, sandy clay soil in Nigeria. These studies, combined with the results of field trials, indicate that the root systems of papaya, *Manihot glaziovii* and pigeon pea do not strongly compete with the feeder roots of cacao. *Solanum verbascifolium* should not be allowed to grow within a distance of 1·2 m. from a cacao plant; on the other hand, bananas or plantains should be as near to the cacao as possible. No root nodules were found on the roots of *Gliricidia sepium* trees. Figs. Photos. 13 refs.

Walmsley, D. Irrigation and weed control [in cacao]. Ann. Rep. Cacao Res. 1963, p. 53-5 (1964).

Weed control is one of the 6 factors examined in a trial with cacao established at Las Hermanas, Trinidad, in 1960; the treatments compared are (1) slashing once a year, and (2) chemical control to keep the plots free of weeds, applying 56.1 of pentachlorophenol (commercial) per ha up to 1962 and 0·3 kg. paraquat plus 3·5 kg. atrazine (active) per ha in subsequent years. The herbicide treatment resulted in a significantly greater increase in the mean trunk diameter during the wet seasons, and in a considerably denser leaf canopy during the dry seasons. There was a positive interaction between chemical weed control and overhead irrigation during the last 2 dry seasons. Tables.

Kasasian, L. Chemical weed control [in cacao]. Ann. Rep. Cacao Res. 1963, p. 56 (1964).

Preliminary trials to determine the relative susceptibility of young cacao to several herbicides were conducted in Trinidad in 1960-61. Pot experiments carried out in 1963 confirmed the safety of simazine and linuron and the risk of injury from atrazine, diuron, and prometone. Applications of paraquat at various rates showed that under shade 0·3 kg./ha may be adequate in the wet season, but that 0·6 kg./ha is necessary in the dry season; application in 375 l water per ha was no better than spraying at a rate of 125 l/ha. The trials carried out so far suggest that young cacao fields should be treated with 0·2-0·6 kg. paraquat per ha for short-term weed control, and with 0·3 kg. paraquat plus 3·5 kg. of either simazine or linuron for longer periods of control, whereas in older fields diuron will give better results.

Rohan, T. A. Processing of raw cocoa for the market. FAO Agr. Stud. 60, p. I-XVI, 1-207 (1963).

Mr. Rohan's treatise on the processing of cocoa, originally issued in provisional form in 1960, has now been revised and published in print. An introduction outlines the history and geographical distribution of the cocoa industry, and the botany and chemical composition of the cacao fruit and seeds. Numbered chapters discuss; (1) harvesting, curing and yield; (2) changes during fermentation; (3) other aspects of fermentation; (4) drying; (5) storage; (6) sorting and grading; (7) general conclusions. They are followed by a 1-page glossary, a list of tropical cacao research institutes, and 17 pages of references. Tables. Graphs. Figs. Photos. Colour plates. Map.

Quesnel, V. C. Fermentation of small batches of cacao. Ann. Rep. Cacao Res. 1963, p. 57-8 (1964).

A double fermentation box for the processing of small quantities of cocoa in the range of 10-50 kg., was constructed in Trinidad. The inner box has a perforated bottom and a narrow air outlet pipe on top, the outer box has a chimney surrounding the outlet of the inner box so that the air entering here is warmed by its passage around the outlet and walls of the inner box. A design with a large space between the boxes filled with a fibrous material, proved more efficient than one with a narrow, unfilled space between the boxes. Temperatures of 44-49°C could be maintained for 3 days and the flavour of the best samples was acceptable commercially. Fig.

Newton, K. Cocoa drying with the Lister moisture extraction unit. Papua and New Guinea Agr. J. 16, 2-3, p. 91-102 (1963).

Detailed data are provided of the design and performance of a new type of cocoa drier tried out in the Territory of Papua and New Guinea. It is mounted on a trailer and has a 40 h.p. air-cooled diesel engine, driving a fan which forces a large volume of air through a layer of fermented cocoa; the air is warmed solely by the heat from the engine, so that its temperature is raised only a few degrees above that of the ambient atmosphere. The unit was found to have the capacity to dry 6,500 kg. of wet fermented beans, spread in a layer 38 cm. deep on a $5{\cdot}5 \times 3{\cdot}6$ m. floor, in 4 full days; the quality of the product was equal to that of sun-dried cocoa. The mass of cocoa should not be broken up until surface drying is completed through to the top layers; it may then be turned with shovels to get more even drying. The drier consumed about 300 l. of fuel and 3 l. of oil per ton of dry beans; it may be used to dry other products as well. Tables. Graphs. Photos.

March

Silva, P., et al. Considerações gerais sôbre a área do Centro de Pesquisas [do Cacau].. (General features of the area of the Cacao Research Centre). Cacau Atualidades 1, 3, p. 3-12 (1964).

A new cacao research station (CEPEC) has recently been established near Itabuna in the Brazilian State of Bahia. It disposes of an experimental area of 767 ha, formerly occupied by 21 cacao farms. The authors describe the topography and soils of the area, the genetic constitution of the present cacao population, and the main pests and diseases occurring in the area, giving some results of previous investigations on these subjects and indicating a few items for future research. Photos. Map.

Grangier Junior, A., and Alvim, P. de T. Crescimento de plantas jovens de cacau Catongo, Comum e hibrido Catongo × Comum. (Growth of young plants of the cacao varieties Catongo and Comum, and of hybrids of Catongo and Comum). Cacau Atualidades 1, 4, p. 5 (1964).

Trials conducted in Brazil with cacao seedlings grown in nutrient solutions showed that the growth rate, and in particular the rate of increase in leaf area, of the Comum variety was inferior to that of the Catongo variety. Hybrids of the 2 varieties grew as rapidly as the Catongo seedlings. Graphs. Condensed from a paper presented to the 15th Congress of the Botanical Society of Brazil, held in Porto Alegre in 1964.

Estimativa da incidência de "podridâo parda" (Phytophthora palmivora (Butl.) Butl.) e dos lucros resultantes de seu contrôle quimico. (Estimates of the incidence of pod rot and of the profit resulting from its chemical control). Cacau Atualidades 1, 2, p. 2-3 (1964).

The proportion of cacao pods lost as a result of pod rot on 19 estates in the State of Bahia (Brazil) which sprayed their trees against the disease was 5·5%, whereas it was 14·3% on 19 comparable estates that did not spray. At the normal yield level the difference corresponds to 200 kg. of commercial cocoa per ha, which fetches more than 3 times the cost of the 6 sprayings with a copper fungicide currently recommended for pod rot control. See also ibid. p. 6: Lellis, W. T. *Phytophthora palmivora* (Butl.) Butl. causando cancro em cacaueiros de Bahia (*Phytophthora palmivora* as a cause of canker in Bahia cacao fields); and p. 7, Medeiros, A. G. Cacau comum resistent a podridâo parda (Cacau comum resistant to pod rot). Tables. Map.

Lavabre, E. M. Note préliminaire sur quelques curculionides de Madagascar nuisibles aux cacaoyers. (Preliminary note on some weevils noxious to cacao trees in Madagascar). Café, Cacao, Thé 8, 3, p. 209-10 (1964).

A brief description is provided of the morphology and biology of *Cycloterus variegatus*, a small curculionid species occurring in Madagascar, which tunnels in the inner bark of several trees including cacao. *C. socius* probably causes the same type of damage. Two other polyphagous curculionids, *Stigmatrachelus striatogemellatus* and *S. tibalis*, consume the leaves of cacao trees but appear to be of minor importance. English, German and Spanish summaries. Figs.

Sobrinho, J. A. Influência do grau de maturação dos frutos de cacau na qualidade das amêndoas fermentadas. (Influence of the degree of ripeness of cacao pods on the quality of the fermented beans). Cacau Atualidades 1, 2, p. 8-9 (1964).

Beans from ripe and still greenish pods of Bahia (Brazil) cacao were fermented separately on trays for 4 days. The maximum temperature during fermentation was 47°C in the beans from ripe pods, 42° in those from unripe pods. The percentages of well-fermented beans were 65 and 35, respectively; the remainder of the beans were compact and violet but not slaty. Tables. 1 ref.

Marticou, H., and Muller, R. Essai de mise au point d'une méthode d'expérimentation adaptée aux conditions de la cacaoyère camerounaise traditionnelle. (An attempt to work out an experimental method adapted to the conditions of traditional cacao fields in the Cameroon Rep.). Café, Cacao, Thé 8, 3, p. 173-202 (1964).

Results of experiments in farmers' cacao fields are often inconclusive owing to the great variability in yield of the trees. Yields over 3 years of 10,000 trees in the Cameroon Rep. were used to calculate the residual variance in designs with different plot sizes; no appreciable reduction was attained by increasing the number of trees per plot beyond 20-30. The author's solution is to apply experimental treatments after preliminary yields have been determined during 1 year, and to adjust the yield of each experimental plot in the trial year by multiplication with the ratio of the mean yield of the control plots in the trial year to that in the pre-trial year. English, German and Spannish summaries. Tables. Graphs. Maps.

Nichols, R. Fruit thinning experiments. Ann. Rep. Cacao, 1963, p. 39-42 (1964).

Experiments conducted in Trinidad in which cacao trees were thinned to 1, 2 or 10 pods each, or not thinned at all, established that the proportion of pods wilting increased with the number of pods present. However, loss of pods was not only caused by a fruit thinning mechanism but also by fungal infection. High infection rates may reduce the number of pods on the tree to below the potential bearing capacity as determined by environmental factors. This condition appears to occur rather frequently in Trinidad; it may explain why spraying with copper often results in a considerable increase in yield. Table. Fig.

Lockard, R. G., and Asomaning, E. J. A. Mineral nutrition of cacao (Theobroma cacao L.) IV—Effects of nitrate and urea nitrogen on deficiency symptoms of phosphorus, potassium, calcium and magnesium in sand culture. Trop. Agr., Trinidad 42, 1, p. 55-62 (1965).

In a trial conducted in Ghana, cacao seedlings grown in sand culture in 5-litre pots exhibited severe leaf-edge scorch when the nitrogen of a complete nutrient solution was in the form of $NaNO_3$, not when it was in the form of urea. In plants receiving solutions with nitrate N deficient in K, Ca or Mg, the normal leaf symptoms of K, Ca and Mg deficiency were accompanied by and sometimes made unrecognisable by leaf scorch. P deficiency, however, prevented the development of leaf scorch by reducing the uptake of N. Plants in 10-litre pots receiving the same amount of nitrate as did those in 5-litre pots developed no leaf scorch, either because of the lower concentration or of bacterial reduction of nitrate. These results may explain the lack of uniformity of deficiency symptoms as described by various authors. Tables. Photos. 8 refs.

Spector, J. Trace elements. Ann. Rep. Cacao Res. 1963, p. 47-9 (1964).

Foliar analysis of cacao in Trinidad showed that B deficiency symptoms occurred at B levels of 8·5-11 p.p.m.; leaves of trees in the field contained from 25 to 70 p.p.m. B. The limit for Cu deficiency appeared to be around 4 p.p.m.; polyphenol oxidase activity was directly related to the Cu content of the plant; roots showed high Cu contents, in some cases exceeding 400 p.p.m. Iron deficiency symptoms were found in leaves with less than 50 p.p.m. Fe. Manganese levels in the field ranged from 28 p.p.m. on gypseous soils in Trinidad to over 400 p.p.m. on some Grenada soils; deficiency symptoms were found in plants containing 11 p.p.m. Mn. The critical level for Zn deficiency symptoms seemed to be about 20 p.p.m.; levels in normal plants in the field were 80-170 p.p.m. The highest Mo values were found on soils of high pH overlying glauconitic limestone; levels of 1-1·5 p.p.m. occurred on acid soils; no deficiency symptoms were observed even at leaf contents of 0·5 p.p.m. Mo.

Lockard, R. G., and Asomaning, E. J. A. Mineral nutrition of cacao (Theobroma cacao L.) II—Effects of swollen shoot virus on the growth and nutrient content of plants grown under nutrient deficient, excess and control conditions in sand culture.

Trop. Agr., Trinidad 42, 1, p. 39-53 (1965).

In 2 trials conducted in Ghana, healthy cacao seedlings and seedlings infected with swollen shoot virus were grown in sand culture, on a complete nutrient solution and on solutions deficient in or containing an excess of certain nutrient elements. Virus infection considerably reduced the growth of the cacao; this effect was enhanced by nutrient deficiencies and by shade. Swellings on the stems and roots of infected plants were most numerous in some treatments deficient in micronutrients, but this may have been an effect of heavier shading. The nutrient contents of different parts of the cacao plants were generally reduced by infection with virus, with the exception of K. Tables. Graphs. Photos. 23 refs.

Thrower, L. B. Parasitism of cacao by Fomes noxius in Papua—New Guinea. Trop. Agr., Trinidad 42, 1, p. 63-7 (1965).

Fomes noxius is the most important root-disease fungus of cacao in the Territory of Papua and New Guinea. Evidence is presented that this pathogen manifests two distinct sets of symptoms. One is the characteristic brown root rot; the second consists of a crust of mycelium on the lower trunk, which may extend to a height of 3 feet and is seldom connected with mycelium on the roots. Infections of the second kind have been recorded almost exclusively from the northern Gazelle Peninsula, where the light soils are derived from pumice. The reason for the unusual growth of mycelium up the trunk is unknown, but it may be associated with a soil factor. Author's summary. Photos. 10 refs.

Reyes, E. H. Control de maleza en cacaotales. (Weed control in cacao fields). Proc. Caribbean Region, Amer. Soc. Horticult. Sci., XI Ann. Meeting 7, p. 84-90 (1964).

Herbicide trials conducted in Venezuela indicated that in old cacao fields under permanent shade, with a weed flora consisting mainly of broad-leaved perennials, a mixture of 1·2 kg. 2.4-D plus 1·2 kg. 2.4.5-T per ha applied twice a year gave the best weed control at a cost considerably below that of slashing. Young fields require a different treatment because their weed flora consists predominantly of annual species including grasses, and because 2.4-D and 2.4.5-T would destroy the temporary banana shade. The most effective and cheapest weed control in young cacao was obtained by spraying with simazine at a rate of 1·5 kg. active ingredient per ha; the treatment did not damage the cacao plants. English summary. Tables.

Petzall, E. B. Cacao Venezolano. (Venezuelan cocoa.) Gordian 65, 1536, p. 880-2; 64, 1537, p. 914-5 (1964).

The total area under cacao in the 4 cacao-growing regions of Venezuela is 70,000 ha; distributed over 12,000 farms. The mean annual yield is below 200 kg/ha; the industry can only maintain itself because the product fetches a high price owing to the still considerable proportion of Criollo trees. Most plantings are in a bad condition owing to faulty management, lack of capital, and the incidence of several serious diseases; planting of inferior varieties leads to a decline in quality. Some improvement has been attained as the result of government-supervised loans made available to the farmers, and of the activities of the Estacion Experimental de Cacao (Cacao Research Station) at Caucagua (Barlovento). Farmers are recommended to ferment their cocoa in 5-10 cm. deep baskets covered with plastic sheet and exposed to the sun. Text in German. Tables. Photos. Map.

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