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CONTENTS

THE DEVELOPMENT OF A POPULATION OF *PANTORHYTES SZENTIVANYI* MARSHALL (COLEOPTERA: CURCULIONIDAE) WITHIN A CACAO PLANTING IN PAPUA NEW GUINEA

G. L. BAKER*, F. ARNDT†, AND D. W. LOH‡

ABSTRACT

The early stages of a population of Pantorhytes szentivanyi *within a* Theobroma cacao *planting are briefly described. The cacao, when four years old, was only lightly infested in border areas by the larval progeny of immigrant adults. Seven months later, the first generation of adults to arise within the trial area appeared. This event was followed by a rapid expansion of the population throughout the entire trial area. A second generation of adults emerged six months later, and was followed by a further increase in the number of larvae. Because of continued oviposition by adults of all former generations the emergences of subsequent generations were indistinguishable.*

INTRODUCTION

PANTORHYTES szentivanyi Marsh. is a serious pest of *Theobroma cacao* L. in the Northern District of Papua New Guinea. The larvae bore channels in the sapwood of the cacao tree and cause serious damage by structurally weakening the trees. Damage also includes ringbarking of branches and, less frequently, of the trunk. Prolonged infestation causes a general debilitation which frequently results in the death of trees. The apterous adults (Lamb *et al.* 1971) cause damage through feeding on hardening flush growth.

Extensive planting of cacao took place in the Northern District between 1960 and 1964 following the implementation of several Rural Development Schemes. By 1965 many of these new plantings had begun to show signs of infestation, the adults having entered the plantings from primary host plants in surrounding areas of secondary forest. By 1967 it was considered a major threat to the success of the cacao industry in the Sangara, Popondetta and Oro Bay areas.

*Entomologist, Department of Agriculture, Stock and Fisheries, Popondetta. Present address: Kuk Tea Research Station, Department of Agriculture, Stock and Fisheries, Mount Hagen, Western Highlands District.

†Rural Development Officer, Department of Agriculture, Stock and Fisheries, Popondetta. Present address: Department of Agriculture, Stock and Fisheries, Vudal, East New Britain District.

‡Experimentalist, Department of Agriculture, Stock and Fisheries, Popondetta. Present address: Lowlands Agricultural Experiment Station, Keravat, East New Britain District.

METHOD

The data on which this study is based were collected from an area of cacao on "Manaba" Plantation, one of the Soldier Settlement Scheme Plantations in the Northern District. The area under observation consisted of 0.61 ha. of cacao planted under *Leucaena* shade which had been subsequently thinned. The cacao and shade were planted in May 1963.

The area was originally chosen for studies of the incidence of *Oncobasidium theobroma* Talbot and Keane dieback and for this purpose the cacao trees in the trial area were plotted in September 1966. At the time of plotting, *P. szentivanyi* adults and larvae, if present, were at an unobservable level. In March 1967, a few larval channels were noted and the collection of data on the numbers of adults and larvae in the area was begun. To simplify data recording, each row was assigned a letter and each tree in each row a number (see *Figure* 1). Thereafter, and at irregular intervals until the cacao dieback trial was abandoned in October 1968, the numbers of adults and larvae were recorded for each tree.

Semi-skilled labour was used to collect the adults and to locate larval channels. Both adults and larvae were killed at the time of scoring. Larval channels were then treated by painting the surface of the tree over the channel with a 1.5 per cent a.i. solution of fenthion in water.

Removal of adults would have had little effect on the overall population trends as only between 10 and 20 per cent of the total adults

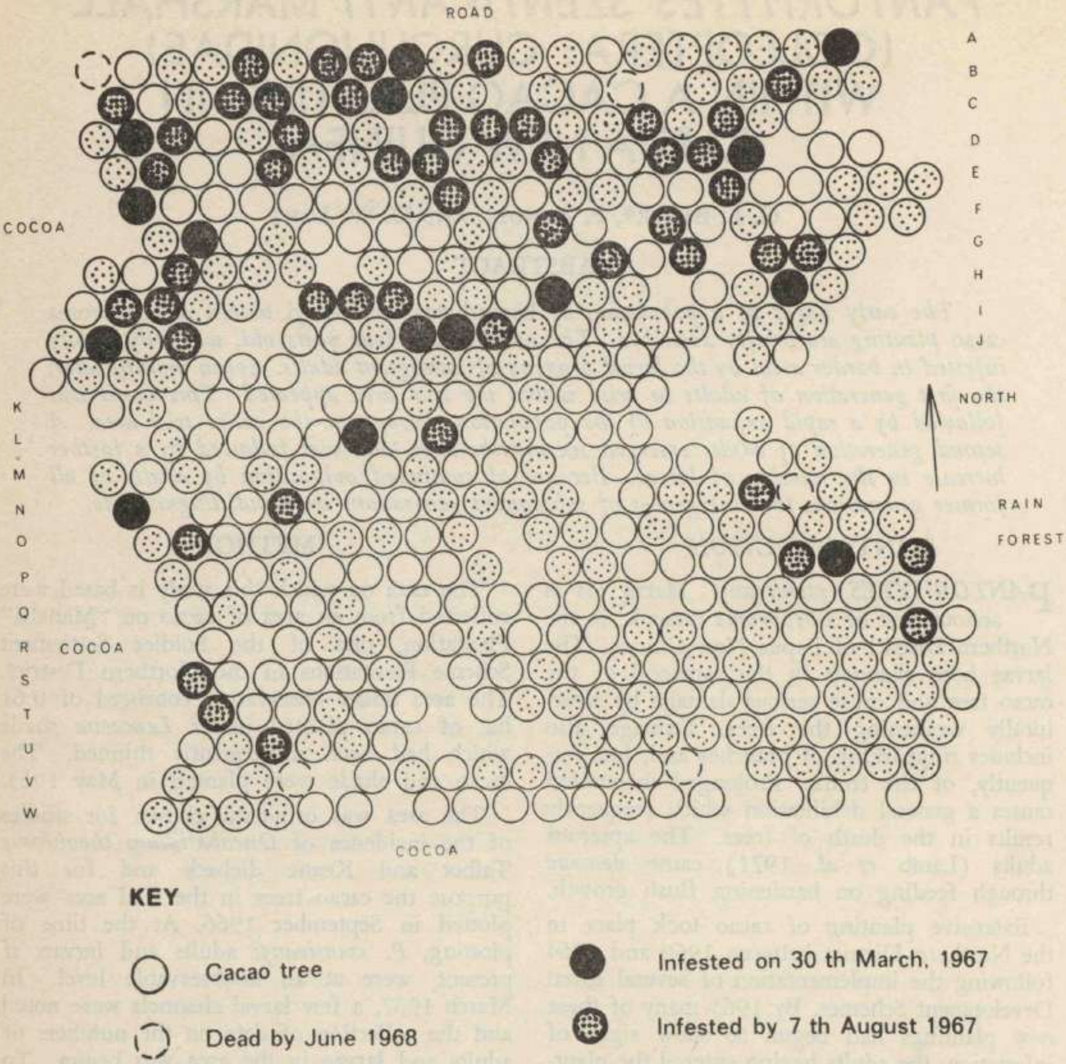

Figure 1—A plot of the trial area showing the spread of *Pantorhytes szentivanyi* between March 1967 and December 1967. Rows A to J are referred to in the text as the upper portion and rows K to W as the lower portion of the trial area

are removed at any one scoring (Baker, unpub. data). With larvae, a proportion was never removed or treated for a variety of reasons—e.g., many were inaccessible, those channels containing very young larvae were not detected, and those containing prepupae and pupae may have been confused with old, unoccupied channels. As a fairly constant proportion of the total larvae present escaped detection during scoring, the treatment, although reducing absolute numbers of adults which subsequently emerged, had little effect on the overall population trend.

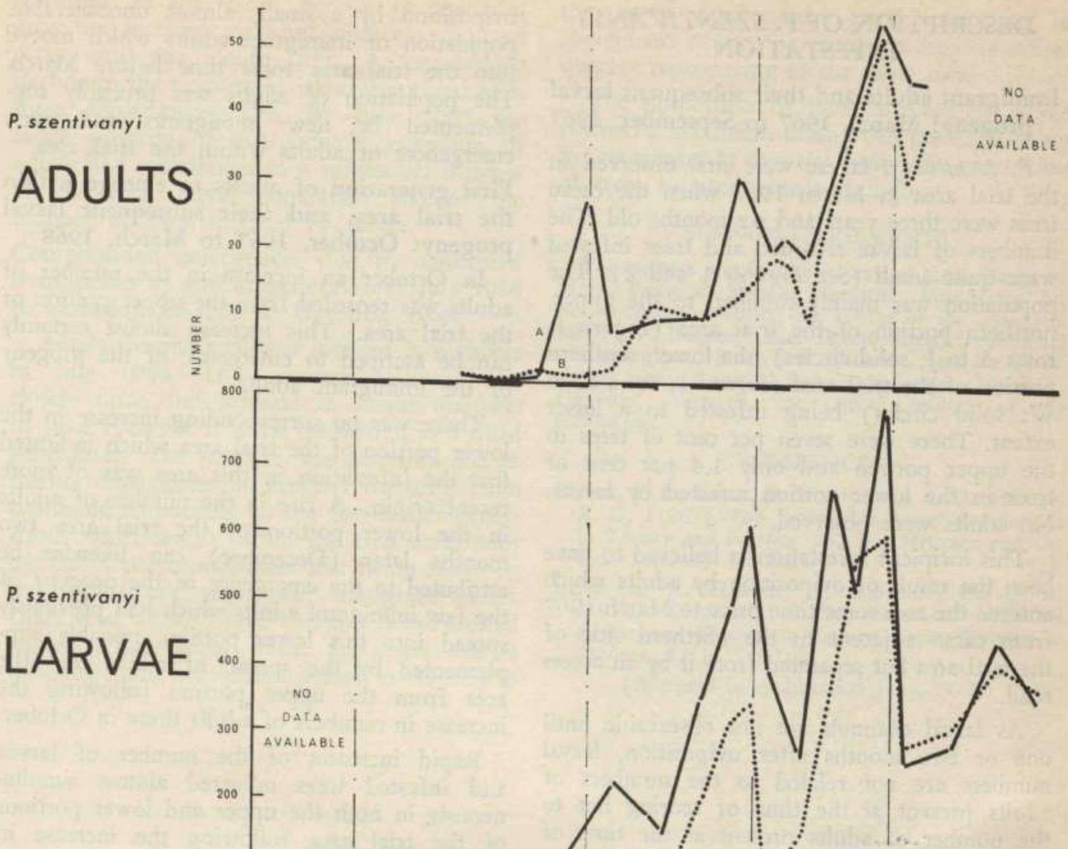

Figure 2—Changes in the numbers of ***Pantorhytes szentivanyi*** adults, larvae and infested cacao trees in two contiguous areas of cacao over a period of two years. A—solid lines represent data from upper portion of trial area; B—broken lines, data from lower portion (Refer *Figure* 1). The small loss of trees shown was due mainly to death caused by cacao root rots (*Fomes* spp.)

DESCRIPTION OF *P. SZENTIVANYI* INFESTATION

Immigrant adults and their subsequent larval progeny: March, 1967 to September, 1967

P. szentivanyi larvae were first observed in the trial area in March 1967 when the cacao trees were three years and six months old. The numbers of larvae recorded and trees infested were quite small (See *Figures* 1 and 2). The population was mainly confined to the upper, northern portion of the trial area (*Figure* 1, rows A to J; solid circles), the lower, southern portion of the trial area (*Figure* 1, rows K to W; solid circles) being infested to a lesser extent. There were seven per cent of trees in the upper portion and only 1.4 per cent of trees in the lower portion infested by larvae. No adults were observed.

This incipient infestation is believed to have been the result of oviposition by adults which entered the area some time prior to March 1967 from cacao adjacent to the northern side of the trial area but separated from it by an access road.

As larval channels are not observable until one or two months after oviposition, larval numbers are not related to the numbers of adults present at the time of scoring but to the number of adults present at the time of oviposition some months previously.

During the following six months the numbers of larvae and infested trees in the upper portion of the trial area fluctuated only slightly; very little change occurred in the lower portion.

Adults were not observed in the area until July 1967 (one in the upper portion and one in the lower portion). No adults were recorded during the August scoring and very few were recorded at the September scoring (one in the upper portion and two in the lower portion). At the August scoring both the number of trees infested by larvae and the number of larvae recorded were similar to the figures for March. However the proportion of trees that had been recorded as infested by larvae up until August was 28 per cent in the upper portion and 6 per cent in the lower portion, indicating that there had been an expansion of the infestation in the upper portion (*Figure* 1, solid circles and heavily stippled circles). This expansion of the infestation in the upper portion of the trial probably resulted from oviposition by a small, almost unobservable, population of immigrant adults which moved into the trial area some time before March. The population of adults was probably supplemented by new immigrants and early emergences of adults within the trial area.

First generation of adults to emerge within the trial area, and their subsequent larval progeny: October, 1967 to March, 1968

In October an increase in the number of adults was recorded from the upper portion of the trial area. This increase almost certainly can be ascribed to emergence of the progeny of the immigrant adults.

There was no corresponding increase in the lower portion of the trial area which indicated that the infestation in this area was of more recent origin. A rise in the number of adults in the lower portion of the trial area two months later (December) can likewise be attributed to the emergence of the progeny of the few immigrant adults which had previously spread into this lower portion, possibly supplemented by the spread of adults into the area from the upper portion following the increase in numbers of adults there in October.

Rapid increases of the number of larvae and infested trees occurred almost simultaneously in both the upper and lower portions of the trial area following the increase in adult numbers. The proportion of trees recorded as infested by larvae up until December 1967 was 70 per cent in the upper portion, and 49 per cent in the lower portion (*Figure* 1, solid, heavily and lightly stippled circles), an increase of 43 per cent and 44 per cent of trees in the upper and lower portions of the trial area respectively since August 1967. The impetus given to the infestation by the generation of adults which emerged in October 1967 was therefore considerable.

The number of larvae and trees infested by larvae continued to increase in both the upper and lower portions of the trial area and reached a peak some four months after the October adult emergences.

Second generation of adults to emerge within the trial area, and their subsequent larval progeny: March, 1968 to July, 1968

In March 1968 a further generation of adults began to emerge in the upper portion, giving an increase in the number of adults recorded. In the lower portion of the trial area the increase in adult numbers did not occur until one month later. A considerable decline in the number of larvae coincided with these adult emergences. By June 1968 the larval progeny of this second generation of adults had contributed to a substantial increase of the total larval population and of the number of trees infested by larvae.

Compounded emergences due to continued oviposition by earlier generations: July 1968 to cessation of trial in October, 1968

Adults showed a further increase in numbers in July 1968. This increase followed too closely upon the increase in larval numbers in June 1968 for it to be considered as a third generation. The increase was probably due to further emergences of progeny resulting from continued oviposition by the two earlier generations which arose within the trial area, with perhaps some contribution still being made by the original and subsequent immigrant adults. Clark *et al.* (1967) state that this is the normal sequence of events when an insect has a relatively long oviposition period in relation to the larval development period resulting in individuals of two or more generations subsequently reproducing at the same time.

The proportion of trees infested by larvae reached a maximum during this period. During the remainder of the trial period the proportion of trees infested remained high.

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PHYTOPHTHORA LEAF BLIGHT OF *COLOCASIA ESCULENTA**

IN THE BRITISH SOLOMON ISLANDS

D. E. GOLLIFER† AND J. F. BROWN‡

ABSTRACT

Leaf blight of Colocasia esculenta *(L.) Schott, caused by* Phytophthora colocasiae *Rac. is the most widespread disease of dryland taro on the larger volcanic islands of the British Solomon Islands. None of the* 181 *local cultivars tested proved to be immune or highly resistant to the disease. A small proportion of cultivars however, failed to develop high levels of disease. The application of copper fungicides as foliar sprays, although giving poor control of the disease, resulted in yield increases of up to* 25 *per cent compared with unsprayed controls.*

INTRODUCTION

COLOCASIA esculenta, commonly known as taro, dasheen or cocoyam, is an edible aroid which is one of the staple subsistence foods in the British Solomon Islands Protectorate. Taro is of great importance to many inland dwellers and to the inhabitants of outlying Polynesian islands. In some coastal districts however, taro is being replaced in the diet by sweet potato and rice.

Phytophthora leaf blight was first recorded in the Solomon Islands by Parham (1947). Johnston (1960) and Trujillo (1967) suggested that the fungus was introduced into the Protectorate from Indonesia via Papua New Guinea. This appears likely because local farmers say that the disease first appeared towards the end of the second world war and spread through the Protectorate in a south-easterly direction. The disease is now widespread on all the larger volcanic Melanesian islands but is less prevalent and is of minor importance on wetland and dryland taro grown on the smaller Polynesian islands of low elevation. This difference in disease incidence is probably related to differences in environment between the larger and smaller islands.

Leaf blight or "Abasao" as it is called in the Kwara'ae language is now considered to be the most widespread disease of taro on the larger volcanic islands in the Protectorate. The word "Abasao" literally means drying-up or blight of leaves and is used to describe leaf diseases of a number of hosts.

Plucknett, de la Pena and Obrero (1970) suggested that it might be possible to control leaf blight by incorporating factors for resistance into taro cultivars by means of a breeding programme. There have been several reports of resistance to leaf blight in some cultivars of taro. These include those by Barrau (1958), Deshmukh and Chhibber (1960), Hicks (1967) and Paharia and Mathur (1964).

However, most workers have failed to observe immunity or high levels of resistance in taro cultivars. Some cultivars however appear to be less susceptible than others to the disease under field conditions. The success of any plant breeding programme will depend upon suitable resistant breeding material becoming available.

In some regions, adequate control of leaf blight has been achieved through the application of foliar fungicides. This has been reported by Berquist (1972), Gomez (1925) and Trujillo and Aragaki (1964). However, it is uncertain whether fungicides would be effective in controlling the disease in the Solomon Islands. The climatic conditions in the British Solomons favour disease development and are not conducive to long term residual activity of protective fungicides. At Dala Experiment Station for example, the mean minimum temperature is 22.7° C, the mean maximum

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†General Crops Agronomist, Dala Experiment Station, Malaita, British Solomon Islands.

‡Plant Pathologist seconded to the British Solomon Islands under the Australian South Pacific Aid Programme. Present address: Department of Botany, University of New England, Armidale, New South Wales. 2351, Australia.

temperature is 30.1° C, the mean relative humidity at 0900 hrs is 79.1 per cent and the mean annual rainfall is 3900 mm. This environment approaches that which Trujillo (1965) considered to be optimal for development of leaf blight. Experiments by Brown and Friend (1974) with Phytophthora pod rot of cocoa indicated that the residual activity of copper fungicides is poor under the environmental conditions which exist in the Solomon Islands. However, no information is available on the effectiveness of protective fungicides in the control of leaf blight of taro.

This paper reports the results of investigations, conducted at Dala Experiment Station, on differences in susceptibility to *P. colocasiae* among Solomon Island cultivars of taro, on the effect of leaf blight on taro yields and on the effectiveness of fungicides in controlling leaf blight of taro.

EXPERIMENTAL

Description of the disease

Leaf blight causes large, more-or-less circular brown to purple lesions on the leaves of taro (*Plate* I). Young lesions are characteristically water-soaked and zonate in appearance and often exude a clear, yellow to red liquid.
The lesions are normally surrounded by a chlorotic margin. One or more whitish rings of sporangia can often be seen on the lesions, particularly in the morning before they have been dried out by the sun. As the disease progresses, individual lesions coalesce and severe defoliation occurs (*Plate* I).

Cultivar susceptibility

Field trials involving 181 cultivars, some of which were reputed to be resistant to leaf blight, were planted to compare their relative resistance to *P. colocasiae*. Discrimination among cultivars was made by local growers. The taro cultivars used in this trial had been collected from various districts within the Solomon Islands. Taro tops consisting of about 43 cm of petiole and 0.5 cm of the upper part of the corm were planted in 76 cm squares. The amount of disease resulting from natural infection was assessed on each fully expanded leaf arising from the central corm of each cultivar and was determined at 3, 4 and 5 months after planting. Disease assessments were made using the key shown in *Figure* 1 which is based on the percentage of leaf area affected by the disease. Nine plants of each cultivar were examined and the mean disease rating for each plant was calculated by dividing the sum of the assessment for each leaf by the total number of leaves examined. The assessment for each cultivar was obtained by dividing the sum of the assessments for each plant by

Plate I.—Typical lesions of Phytophthora leaf blight of *Colocasia esculenta*. (*a*) young lesions, (*b*) advanced lesions the total number (nine) of plants examined. Plants were harvested at 175 days after planting and the yield for each cultivar recorded.

None of the 181 cultivars examined showed an immune or highly resistant reaction to *P. colocasiae*. However, the disease ratings varied among cultivars. Most cultivars showed blight assessments of between 20 and 50 per cent at all recording times (*Table* 1). The proportion of cultivars showing less than 20 per cent of the leaf surface infected increased as the plants matured. At 3 months after planting only one cultivar showed a low level of disease (less than 20 per cent disease) whereas 12 per cent of the cultivars showed disease ratings of less than 20 per cent at 5 months after planting.

The apparent shift in resistance with plant age could have been due to an adult resistance mechanism, or it might have been related to changes in the microenvironment on the surfaces of leaves during the maturation period of plant growth. Plucknett and de la Pena (1971) considered that, during the maturation period, each successive leaf produced by taro was smaller than its predecessor and that very little canopy existed in mature plants. This change in plant morphology may have produced a microenvironment which was less favourable for the development and dispersal of *P. colocasiae*.

In general there was no correlation between disease severity and the yield obtained from cultivars in each disease rating group. The cultivars showing high levels of disease did not necessarily produce lower yields than those showing a low disease score (*Table* 1). There was however a positive correlation between corm yield and mean number of leaves produced per plant. Similarly, a positive correlation existed between mean number of leaves per plant and disease rating.

Because the disease ratings used in this study were based on the percentage of leaf tissue destroyed, a plant with small leaves would score a similar disease rating as one with large leaves if the percentage of leaf tissue destroyed was similar. However, plants with larger leaves would have more absolute photosynthetic area than those with smaller leaves. This factor, together with the possibility mentioned by Schafer (1971) that some cultivars are more tolerant to the effects of *P. colocasiae* in terms of yield, may explain the lack of correlation between disease incidence and yield.

The reduced levels of infection in some taro cultivars appeared to have been due to the presence of fewer individual lesions rather than to differences in the rate of development of individual lesions.

Effect of fungicides on disease incidence and yield

Several fungicidal sprays including cuprous oxide (4.5 kg/ha of 50 per cent w/w a.i.), copper oxychloride (4.5 kg/ha of 50 per cent

Table 1.—Phytophthora leaf blight assessment and yields in 181 Solomon Island cultivars of *Colocasia esculenta*

Leaf Blight Assessment (percentage of leaf affected)	Period between Planting and Disease Assessment								
	3 months			4 months			5 months		
	Number of Cultivars	% of Cultivars	Mean Yield t/ha	Number of Cultivars	% of Cultivars	Mean Yield t/ha	Number of Cultivars	% of Cultivars	Mean Yield t/ha
11-20	1	0.6	3.51 b*	3	1.7	2.44 c	22	12.2	4.47 a
21-30	14	7.7	4.17 ab	32	17.7	4.67 a	102	56.4	4.47 a
31-40	70	36.7	4.95 a	99	54.7	4.64 a	52	28.7	4.87 a
41-50	80	44.2	4.78 a	45	24.9	5.35 a	5	2.7	5.27 a
51-60	16	8.8	4.59 a	2	1.0	3.39 b	0	0	0
	r = −0.00309			r = 0.1526			r = 0.08258		

* Figures with the same small letter are not significantly different at 0.05 probability level (Duncan's multiple range test).

w/w a.i.), Bordeaux mixture (1:1:100), Maneb[1] (2.2 kg/ha of 80 per cent w/w a.i.), Zineb[2] (1.7 kg/ha of 80 per cent w/w a.i.), Mancozeb[3] (3.4 kg/ha of 80 per cent Zn ion and maneb), Ziram[4] (1.7 kg/ha of 80 per cent w/w a.i.), Benomyl[5] (0.6 kg/ha of 50 per cent w/w a.i.), and copper oxychloride plus Zineb (4.5 kg/ha of 33.5 per cent copper oxychloride—15 per cent zineb) were applied to developing taro plants as foliar sprays at weekly intervals. The fungicides were applied with a knapsack spray fitted with a cone nozzle at the rate of 843 1/ha. A wetting and sticking agent ("Agral 60") was added to each fungicide mixture at a concentration of 0.04 per cent.

Three trials were conducted during 1970 and 1971 and were arranged according to a randomised block design consisting of 4 or 5 replicates. The harvestable plot size for each replicate consisted of 24 plants. The weekly spray schedules were commenced at either 56, 63, or 29 days after planting depending on the trial, and corms were harvested at 165 days after planting. The amount of disease resulting from natural infection was assessed at 2, 3, 4 and 5 months after planting using the assessment key shown in *Figure* 1. In these trials

[1]Maneb (manganese ethylene bisdithiocarbamate)

[2]Zineb (Zinc ethylene bisdithiocarbamate)

[3]Mancozeb (Zinc ion and manganese ethylene bisdithiocarbamate)

[4]Ziram (Zinc dimethyl dithiocarbamate)

[5]Benomyl (Methyl 1-(butrylcarbomyl)-2-benzimidazolecarbamate)

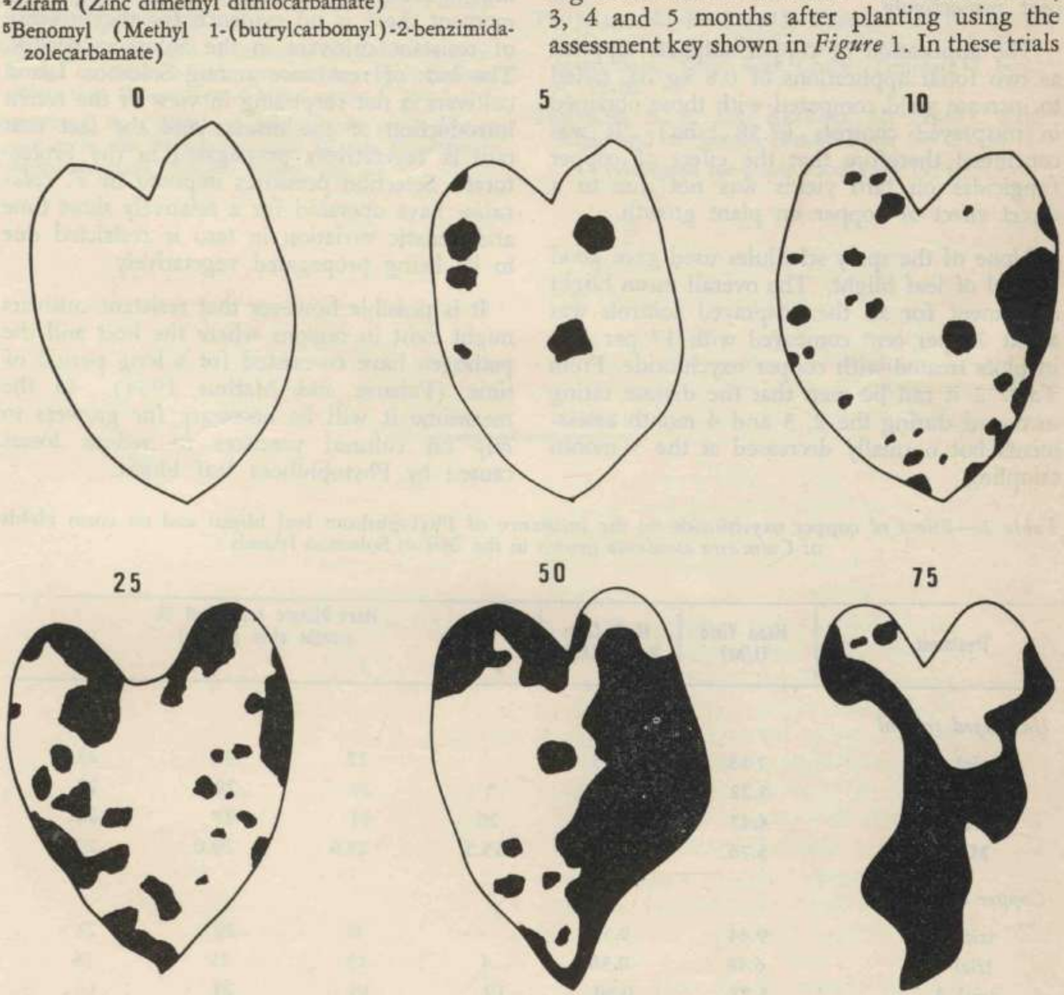

Figure 1.—Field assessment key for estimating the percentage of leaf area damaged by Phytophthora leaf blight of taro the susceptible cultivar, known as "Akolomale initoa" in the Kwara'ae district of Malaita, was used because of its resistance to the lethal virus disease known locally as "Alomae" (Gollifer and Brown 1972).

In all three trials, only applications of copper oxychloride resulted in significant ($P > 0.05$) yield increases compared with those in unsprayed controls. The yields of corms from plots sprayed with copper oxychloride in the three trials were 9.44, 6.48 and 5.27 t/ha and from the unsprayed controls were 7.58, 5.22 and 4.47 t/ha respectively (*Table* 2). Thus the application of copper oxychloride resulted in yield increases of about 25, 24 and 18 per cent respectively.

The application of copper sulphate, applied as two foliar applications of 0.8 kg/ha, failed to increase yield compared with those obtained in unsprayed controls (7.58 t/ha). It was concluded therefore that the effect of copper fungicides on taro yields was not due to a direct effect of copper on plant growth.

None of the spray schedules used gave good control of leaf blight. The overall mean blight assessment for all the unsprayed controls was about 24 per cent compared with 17 per cent in plots treated with copper oxychloride. From *Table* 2 it can be seen that the disease rating increased during the 2, 3 and 4 month assessments but normally decreased at the 5 month sampling.

DISCUSSION

The poor control of leaf blight obtained by weekly application of copper and dithiocarbamate fungicides indicates that protective fungicides show little potential as a means of economically controlling *P. colocasiae* in the British Solomon Islands. It is possible however that future development of improved fungicides (either protectants or chemotherapeutants) and methods of application might make chemical control of leaf blight an economically feasible proposition.

The most promising means of controlling the disease in the future might be through the use of resistant cultivars. However, at the moment there is no evidence for the presence of resistant cultivars in the Solomon Islands. The lack of resistance among Solomon Island cultivars is not surprising in view of the recent introduction of the disease and the fact that taro is vegetatively propagated in the Protectorate. Selection pressures imposed by *P. colocasiae* have operated for a relatively short time and genetic variation in taro is restricted due to its being propagated vegetatively.

It is possible however that resistant cultivars might exist in regions where the host and the pathogen have co-existed for a long period of time (Paharia and Mathur 1964). In the meantime it will be necessary for growers to rely on cultural practices to reduce losses caused by Phytophthora leaf blight.

Table 2.—Effect of copper oxychloride on the incidence of Phytophthora leaf blight and on corm yields of *Colocasia esculenta* grown in the British Solomon Islands

Treatment	Mean Yield (t/ha)	Mean Corm Weight (Kg)	Mean Disease Assessment % months after planting 2	3	4	5
Unsprayed control						
trial 1	7.58	0.45		22	32	23
trial 2	5.22	0.30	5	28	28	28
trial 3	4.47	0.25	26	31	27	20
Mean	5.76	0.33	15.5	27.0	29.0	23.6
Copper oxychloride						
trial 1	9.44	0.55	—	8	29	23
trial 2	6.48	0.38	4	13	25	18
trial 3	5.27	0.30	19	14	24	14
Mean	7.06	0.41	11.5	11.6	26	17.6

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THE EFFECT OF ADDING *LEUCAENA LEUCOCEPHALA* MEAL TO COMMERCIAL RATIONS FOR GROWING PIGS

GEORGE MALYNICZ*

ABSTRACT

Thirty weaned crossbred pigs were used in an experiment to study the effect of including Leucaena leucocephala *in rations for growing pigs.*

Leucaena meal was substituted for a commercial grower ration at levels of 0, 10, 20, 30, 40 *and* 50 *per cent of the rations. The rations were balanced for vitamins and minerals.*

The results showed that weight gain and food conversion ratio were adversely affected at levels higher than 20 *per cent. The possible reasons for these adverse effects are discussed.*

INTRODUCTION

LEUCAENA leucocephala (Lam) de Wit., (formerly *Leucaena glauca*) is a tropical leguminous shrub belonging to the Mimosaceae family. It originated in Mexico but is now widely distributed throughout the tropics including Papua New Guinea.

The high yields of protein obtainable with this plant have stimulated considerable research into its use for ruminant and non-ruminant nutrition.

Mascré (1937) first isolated a toxic principle from the plant which he called leucenol. Yoshida (1944) from a study of the chemistry of the toxic principle proposed that it was identical with mimosine.

Yoshida (1944) studied the toxic effects of mimosine and found they could be controlled by the addition of soluble iron salts to the ration. The effect of the iron salts was to reduce the absorption of mimosine. Concentrations of ferrous sulphate as low as 0.3 per cent of the ration have been shown to improve the efficiency of rations containing leucaena for growing poultry (Labadan, *et al.* 1969).

Leucaena dehydrated with a high temperature rotary drier has been used in the rations for growing swine (Iwanaga, Otagaki and Wayman 1957). The present study was undertaken to assess the effects of the addition of varying amounts of leucaena in rations for growing pigs.

*Officer-in-Charge, Tropical Pig Breeding & Research Centre, Department of Agriculture, Stock and Fisheries, Goroka.

MATERIALS AND METHODS

Sun-dried leucaena leaves were purchased from a local farmer who used the plant as coffee shade. The leaves were hammer-milled to make a meal. This was added to a commercial grower ration[1] to provide six levels of leucaena: 0, 10, 20, 30, 40 and 50 per cent by weight. Supplementary bone ash, salt, mineral and vitamin premix were added to balance the diluting effect of the leucaena. Ferrous sulphate B.P. was added to all rations at a rate of 2 g per kg.

The composition of the rations used is shown in *Table* 1. It can be seen that increasing the levels of inclusion of leucaena meal had the effect of increasing the crude protein content of the rations. This was particularly so with the higher levels of inclusion which were higher than normally recommended (Agricultural Research Council 1967).

Five litters of six crossbred weaner pigs were used in the experiment. Each litter formed a block, with pigs allocated to diets at random. Each litter of pigs stayed in the experiment for a period of 50 days.

[1]Kaiani Feed Mills, Lae.

Table 1.—Composition of experimental rations

Leucaena Meal (kg)	0	10	20	30	40	50
Bone ash (g)	0	120	120	360	480	600
Salt	0	90	180	270	360	450
Mineral premix[1] (g)	0	100	200	300	400	500
Vitamin premix[2] (g)	0	100	200	300	400	500
Ferrous sulphate (g)[3]	200	200	200	200	200	200
Commercial ration[4] (kg)	100	90	80	70	60	50
Moisture (%)	13.8	12.7	13.3	11.7	12.7	16.0
Crude protein[5] (%)	18.9	20.7	21.0	20.5	22.9	26.1

[1] Contains per 100 lb. of premix 8.8 g (C4SO$_4$, 20 g MnSO$_4$)

[2] Contains per 100 lb. of premix 1 g riboflavine, 4 g Pantothenic acid, 600,000 I.U. Vitamin A, 60,000 I.U. Vitamin D$_3$.

[3] Ferrous sulphate B.P.

[4] 18% crude protein grower rations, Kaiani Mills, Lae.

[5] Dry matter basis.

Table 2.—Effect of adding Leucena leaf meal to a commercial ration for growing pigs.

	Level of leucena meal (%)					
	0	10	20	30	40	50
Initial weight (lb)	26.6	33.6	27.4	29.6	30.2	30.0
Final weight (lb)	58.6	78.0	70.2	61.8	54.2	46.8
Av. daily gain (lb)[1]	0.62^{b}	0.89^{a}	0.86^{a}	0.66^{ab}	0.48^{bc}	0.34^{c}
Food conversion ratio	4.48^{b}	3.04^{a}	3.02^{a}	4.98^{b}	5.12^{b}	6.70

[1]Means with the same superscript are not significantly different ($P < 0.05$).

All litter blocks were commenced within a 2-month period. Feed was prepared in 100 kg lots and fresh feed made up as each lot was used up.

Pigs were housed individually in concrete pens 5 ft by 3 ft (153.5 x 91.5 cm). Feed and water were supplied *ad libitum*. Food was weighed daily while the pigs were weighed every week.

RESULTS AND DISCUSSIONS

All pigs remained healthy during the experiment. Although Alopecia was found by Yoshida (1944) to occur in rats fed rations containing 30 per cent leucaena leaf, it was not observed in this experiment. Many of the pigs fed leucaena were observed to pass red-coloured urine, due, presumably to the breakdown product of mimosine, 3, 4-dihydroxypyridine (Hegarty, Schinkel and Court 1964).

Weight gain and food conversion efficiency data are shown in *Table* 2. Analysis of variance showed that the inclusion of between 10 and 20 per cent leucaena leaf meal significantly improved growth rate over the control ration ($P < 0.05$).

Similar effects were observed for feed conversion ratio which was significantly improved by the inclusion of 10 and 20 per cent leucaena, unaffected by 30 and 40 per cent inclusion and significantly worse at the 50 per cent level.

The declining performance of pigs fed levels higher than twenty per cent might have been due to leucaena toxicity or excessive crude fibre.

It is possible that at the high levels of leucaena inclusion, insufficient ferrous sulphate was added to prevent the absorption of mimosine. Ross and Springhall (1963) have calculated on theoretical grounds that approximately 65 g ferrous sulphate per kg of leucaena are needed for detoxification. Labadan *et al.* (1969) however found 30 g per kg leucaena to be adequate for chicks.

In the present study the inclusion of 0.2 per cent ferrous sulphate was equivalent to levels of inclusion of 20, 10, 7, 5 and 4 g per kg leucaena. However there does exist the possibility of ferrous sulphate toxicity at high levels of inclusion due to phosphate binding (Ross and Springhall 1963).

Another possible reason for poor performance of pigs fed high levels of leucaena is high levels of crude fibre. Calculation of crude fibre content based on proximate analysis data of Yoshida (1944) reveals that the rations contained up to 8 per cent crude fibre.

The Agricultural Research Council (1967) in a review of the feeding requirements of pigs concluded that performance declined with increasing crude fibre. Such effects would have been particularly severe in the young pigs used in the experiment.

The incorporation of leucaena in rations for monogastric animals has been shown to reduce fertility. Wayman and Iwanaga (1957) found that a ration containing 15 per cent leucaena increased the number of services per successful conception, and reduced litter size and weight In male rats leucaena reduced libido and testis size (Joshi 1968). If leucaena is to be used in rations for growing pigs these animals might not be suitable for subsequent breeding.

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WHOLE SOYABEANS, A PROTEIN SUPPLEMENT FOR SWEET POTATO IN PIG RATIONS

G. L. MALYNICZ*

ABSTRACT

Two experiments are reported using a total of 46 pigs. In the first, raw or cooked soyabeans were fed with raw sweet potato to growing pigs and compared to a sorghum-based control ration. Performance on the control ration was superior to that on either of the soyabean rations. Cooking of soyabeans markedly improved performance. In the second experiment cooked soyabeans and cooked sweet potato were fed, either unsupplemented or supplemented, with salt or salt and bone ash and compared with a sorghum-based control ration. The pigs fed the control ration again showed superior performance. The addition of salt but not bone ash markedly improved performance over that of the unsupplemented group.

INTRODUCTION

THE two sources of high quality protein having the greatest potential in Papua New Guinea as stockfeed are fishmeal and soyabean. The present paper contains the results of two experiments designed to provide basic information on feeding whole soyabeans and sweet potato. There are no references in the literature on feeding this combination to growing pigs.

The value of soyabean as a high quality leguminous supplement for pigs has been recognized for many years (Woll 1900). It was soon discovered that cooking improved the value of soyabeans for pigs (Osborne and Mendel 1917).

The mechanism by which raw soyabeans exert their growth inhibiting activity has been investigated by a number of workers. Among the factors found to be involved are inhibition of trypsin production (Kunitz 1946) a toxic haemagglutinin (Leiner and Pallansch 1952) poor digestibility of soyabean oil (Combs and Wallace 1969) and low availability of amino-acids (Guggenhein and Goldberg 1964). Other workers have suggested that poor growth is due to greatly increased pancreatic trypsin production with subsequent loss of enzymatic protein in the faeces (Guggenhein and Goldberg 1964). These authors also found that the addition of antibiotics to the ration prevented the growth depressant action of raw soyabean. Copper, widely used as a growth promotant, reduced the activity of raw soyabean (Young *et al.* 1970).

In addition to the problem of growth inhibition, feeding whole soyabeans reduces the degree of saturation of the fat depots, thus causing soft fat (Wahlstrom, Libal and Berns 1971). This in the past has reduced consumer acceptance; however with the current emphasis on meat containing unsaturated fatty acids, this could be advantageous.

The experiments described in this paper were designed to confirm the value of cooking whole soyabeans and to investigate the addition of two simple mineral supplements to cooked soyabean and sweet potato rations.

*Tropical Pig Breeding & Research Centre, D.A.S.F., Goroka.

MATERIALS AND METHODS

Experiment 1

Three litters of eight weaner pigs were used in a trial with three treatments. The treatments were: 1) control ration based on sorghum and a protein supplement; 2) raw whole soyabeans and raw sweet potato; 3) cooked soyabean and raw sweet potato. Rations two and three were fed according to a modified Lehmann regime in which sweet potatoes were offered *ad libitum* and soyabeans to a maximum of 1.2 pounds daily. Details of the rations are shown in *Table* 1.

Table 1.—Daily consumption of feeds in experiment 1 (lb)

Ration Number	Sorghum	Concentrate[1]	Soyabean[2]	Sweet potato
1	1.83	0.46	—	—
2	—	—	0.24	3.10
3	—	—	0.36	3.38

[1]Hut Mills, Melbourne, percentage composition, crude protein 55% salt 2%.

[2]Contains per pound—34.00 I.U. Vit. A; 5,800 I.U. Vit. D_3 28 I.U. Vit. E; 12 mg Vit. B2.

Pigs were housed and fed individually and records kept of daily food consumption and liveweight gain over the duration of the experiment, which was conducted over a fifty day period after weaning.

Differences between treatment means were analysed for variance (Steele and Torrie 1960). Food conversion ratios were analysed by a non-parametric method (Wilcoxon and Wilcox 1964) as very large values were found in the raw soyabean treatment.

Experiment 2

Four litters of weaner pigs were used to study the effects of supplementing a ration of cooked soyabean and cooked sweet potato with two mineral supplements. Cooked sweet potato was used in this experiment as other unpublished work had shown the value of cooking.

The two supplements were plain salt or a 1:2 mixture of salt and bone ash. Supplements were available *ad libitum*. The soyabean rations were compared to a commercial grower ration.[1] The soyabean rations consisted of one part by weight cooked soyabean to four parts cooked sweet potato and were estimated to contain 18 per cent crude protein.

RESULTS AND DISCUSSION

Experiment 1

Details of food consumption are shown in *Table* 1. Results are shown in *Table* 2. Pigs fed soyabean and raw sweet potato had a significantly inferior growth performance to those fed the control ration. This may have been caused by the soyabean or the raw sweet potato. It should be noted that the soyabean treatments were not supplemented in any way, which would in itself have reduced food consumption and weight gain. Pigs fed cooked soyabean grew significantly faster and consumed significantly more feed. The raw soyabean appeared to be quite unpalatable and relatively little was eaten. This may have been the most important factor reducing growth rate.

[1]Kaiani Feed Mills, Lae. Grower ration containing 18% crude protein.

Table 2.—The effect of raw or cooked soyabeans fed with sweet potato on growth performance of pigs

	Control	Treatment	
		Raw Soyabeans	Cooked Soyabeans
n	8	8	8
Ave. daily wt. gain (lb)[1]	0.73	0.13	0.44
Ave. daily dry matter consumption (lb)	2.08	1.28	1.54
Food conversion ratio[2]	2.93	—a	3.90[a]

[1]Means with the same superscript are not significantly different (< 0.05).

[2]Data for raw soyabeans excluded as contain infinite values.

Experiment 2

Results of the experiment are shown in *Table* 3. Pigs fed the control ration grew significantly faster and consumed more feed. The food conversion ratio of pigs on the control ration was significantly worse than that of pigs on soyabean-sweet potato rations supplemented with salt. This may have been due to the high oil content of the soyabean.

There was no difference in performance between pigs fed either salt alone or salt and bone ash, suggesting that salt was the principal factor responsible for improved performance with these rations.

Supplementation of soyabean-sweet potato rations with salt significantly improved liveweight gain. That this was not due solely to increased consumption is suggested by the significantly lower food conversion ratio of the pigs receiving salt and bone ash. Evvard *et al.* (1925) first showed that the addition of salt to pig rations could improve growth performance. The growth rate of pigs in the unsupplemented group in this experiment was higher

Table 3.—The effect of mineral supplementation of cooked soyabean/cooked sweet potato rations

	Soyabean plus sweet potato	Soyabean plus sweet potato plus salt	Soyabean plus sweet potato plus salt plus bone ash	Control ration
n	5	6	6	5
Ave. daily wt. gain (lb)[1]	0.63	0.93 [a]	0.93 [a]	1.10
Estimated Ave. daily dry matter consumption (lb)	1.92 [a]	2.50 [a]	2.30 [a]	3.56
Feed conversion ratio (dry matter basis)	3.09 [b]	2.65 [ab]	2.43 [a]	3.26 [b]

[1]Means with the same superscript are not significantly different ($P < 0.05$)

than that of treatment 3 in *Experiment* 1. This difference may be largely due to the cooking of sweet potato in *Experiment* 2. Henke (1949) found that growth performance of pigs was improved by cooking of dietary sweet potato.

The results of these findings confirm that cooking soyabean improves its utilisation and that the addition of salt can further increase utilisation to the point where performance is not greatly below that of pigs fed a fully balanced ration.

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THE EFFECT OF FEED RESTRICTION ON GROWTH PERFORMANCE ON PIGS

G. L. MALYNICZ*

ABSTRACT

Three litters of six pigs were allocated to one of six treatments. These were ad libitum *grower ration and* 90 *per cent,* 75 *per cent,* 60 *per cent,* 40 *per cent and* 25 *per cent of the consumption of the* ad libitum *group. The experiment was continued until each group reached a mean weight of* 200 *pounds. Growth rate was most rapid in the* 90 *per cent group treatment and declined according to restriction. The* ad libitum *group had the worst food conversion ratio. The time taken to reach* 200 *pounds for the groups were* 170, 161, 187, 213, 272 *and* 411 *days respectively.*

INTRODUCTION

IN developing countries, with smallholder pig enterprises, budgets are often formulated in which labour, the main item of variable costs, is considered to cost nothing. In this form of budgetary analysis, net profit is shown as a return to labour. Under these conditions the rate of throughput of an enterprise is less important than the absolute variable costs, by far the greatest proportion of which is accounted for by feed costs. With these factors in mind an experiment was designed in which pigs were subjected to varying degrees of nutritional restriction in order to study the effects, particularly on food consumption, of a given increment of body weight.

Lucas and Calder (1965) and Vanschoubroek, De Wilde, and Lampo (1967) have reviewed the literature on the effects of feed restriction in growing pigs. These authors found that restriction decreased weight gain and back fat thickness. Food conversion ratio was initially improved, but as the restriction became more severe it deteriorated due to the increasing proportion of the ration required for maintenance. Vanschoubroek *et al.* (1967) developed equations for predicting the effects of feed restriction on weight gain, feed conversion ratio and back fat thickness.

MATERIALS AND METHODS

Each of the pigs from three litters of purebreed pigs, either Tamworth or Berkshire, were allocated to one of six treatments. Each treatment varied only in the degree of nutritional restriction. One group, which was fed to appetite, controlled the intake of the other groups, which were fed to provide 90, 75, 60, 40 and 25 per cent of the feed intake of the unrestricted group. Feed intakes for restricted groups were adjusted to those of the control group on a weekly basis, or more frequently if large variations occurred. Mean daily intakes expressed on a monthly basis are shown in *Table* 1. The ration consisted of a 6:1 mixture of ground sorghum and a commercial protein-vitamin-mineral supplement[1] with a calculated crude protein concentration of 16.5 per cent. Pigs were floor-fed in groups in such a way that individual intakes were more or less equivalent. The experiment lasted until each group reached a mean liveweight of 200 pounds. In

Table 1.—Feed allowance per month

Month	Feeding Level (Percentage of Ad Libitum) 100	90	75	60	40	25
1	1.54	1.38	1.12	1.04	0.70	0.55
2	2.60	2.35	2.10	1.55	1.04	0.68
3	3.52	3.02	2.21	1.83	1.31	0.99
4	5.87	5.34	4.43	3.34	2.25	1.44
5	5.47	4.73	3.99	3.28	2.14	1.45
6	6.54	5.68	4.80	3.91	2.72	1.65
7	8.01	7.60	6.22	5.03	3.43	2.08
8	—	—	5.67	4.67	3.33	2.0
9	—	—	5.67	4.67	3.33	2.0
10	—	—	—	—	3.33	2.0
11	—	—	—	—	—	2.0
12	—	—	—	—	—	2.0
13	—	—	—	—	—	2.0

*Tropical Pig Breeding and Research Centre, D.A.S.F., Goroka.

[1]Huttmills, Melbourne. Calculated composition of meal, 25% crude protein.

the case of the *ad libitum* group consumption details were recorded for several more weeks, until consumption had stabilised sufficiently to enable feeding tables to be constructed for the remaining groups.

Daily food consumption and weekly weight gain data were recorded. Weight gain data were analysed for variance and differences between treatment means were tested using Duncan's New Multiple Range Test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The results presented in *Table* 2 show that the weight gain was reduced when allowances of less than 90 per cent *ad libitum* were fed. The low sensitivity of the tests of significance between treatment means was due to the small size of the experiment and the group feeding which invariably increased experimental error. Comparison of the results with those predicted by Vanschoubroek *et al.* (1967) reveal that the fall in weight gain with increasing restriction was not nearly as severe as that predicted by these workers. For example, with 40 per cent restriction the predicted fall in liveweight gain is 38.1 per cent while in the present experiment it was 20 per cent. To a degree this effect is the result of the relatively poor weight gains of the *ad libitum* group. However, even if the weight gain data are extrapolated graphically to give a theoretical mean weight gain in the unrestricted group of 1.18 pounds per day, this only raises the fall in weight gain to 28 per cent on the 40 per cent restriction.

Three reasons to account for this difference may be advanced. The data of Vanschoubroek and co-workers was conducted under temperate conditions. Day temperatures at Goroka are well in excess of the 15-20° C suggested by Mount (1968) as optimum for pigs over 20 kg liveweight.

Secondly, the breeds used in the present trial are more primitive than those used in developing the prediction equations, which would suggest a lower potential for protein deposition and therefore a lower sensitivity to undernutrition. Thirdly, the growth of the less restricted pigs was low compared to experimental results in Northern Europe which would tend to diminish the relative decline under severe restriction.

Food conversion ratio, particularly at the more severe levels of restriction was not as severely affected as the results of Vanschoubroek would suggest. In common with these workers it was found that an allowance of 75 per cent *ad libitum* resulted in the most efficient conversion of food to liveweight gain.

It can be seen that, in terms of the amount of food required to produce the increment from 20 to 200 pounds, there was relatively little difference between treatments. Allowances of 90 and 75 per cent of *ad libitum* used least feed. This suggests that under conditions where time and labour are not important determinants, it may pay to restrict levels of feeding quite severely, particularly as this will result in the production of lean carcasses (lean carcasses, under conditions where protein is limiting and genotypes inferior, being particularly difficult to produce).

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[*continued on page* 22]

Table 2.—The effect of feed restriction on growth performance of pigs from weaning to 200 pounds live-weight

Parameter	Feeding Level (Percentage **ad libitum**) 100	90	75	60	40	25
Initial weight (lb)	19	21	19	17	18	19
Time to reach 200 lb (days)	170	161	187	213	272	411
Total food consumption per group (lb)	2064	1787	1754	1939	1932	1926
Mean daily weight gain (lbs)[1]	1.06^{ab}	1.11^{a}	0.97^{abc}	0.85^{abc}	0.67^{c}	0.44
Food conversion ratio	3.80	3.20	3.04	3.51	3.50	3.44

[1]Means with the same superscript are not significantly different. ($P < 0.05$)

PLANTATION CROP BY-PRODUCTS FOR GROWING PIGS

G. L. MALYNICZ*

ABSTRACT

Three experiments were conducted to evaluate pyrethrum marc, cocoa pod meal and dried coffee pulp as potential feedstuffs for growing pigs. All three proved to be detrimental to growth and efficiency of feed utilisation. In each case, toxicity rather than high fibre content, was considered to be the main factor responsible for the poor performance.

INTRODUCTION

THE main plantation crops in Papua New Guinea are copra, coffee, cocoa, rubber, oil palm, tea and pyrethrum.

In many cases the initial processing of the new material leaves a waste product which is at present not utilised. Of the many residues from plantation crop processing, only coconut oil meal is a recognized stockfeed (Morrison 1961).

The present report describes preliminary experiments designed to investigate the value of three waste-products of plantation crops, namely pyrethrum marc, cocoa pod meal and dried coffee pulp.

MATERIALS AND METHODS

Three trials were conducted, one for each product. The published chemical composition of the three products are shown in *Table* 1.

Table 1.—Chemical composition of some plantation by-products (%)

Product	Dry matter	Crude Protein	Crude Fibre	Fat	Ash	Reference
Pyrethrum marc	78.3	10.2	18.5	0.4	5.6	Ayre-Smith (1965)
" "	85.5	14.7	20.6	0.6	6.6	Naik, 1967
" "	71.3	14.9	24.9	2.1	7.6	Springhall (1969)
Cocoa pod meal	95.7	8.2	29.7	1.8	—	De Alba *et al.* (1954)
" " "	93.3	6.8	35.4	1.5	9.7	Bateman *et al.* (1967)
" " "	90.6	8.4	23.5	2.5	6.7	Springhall (1968)
Dried coffee pulp	87.6	10.0	19.3	—	—	This study
" " "	100.0	11.2	13.1	1.7	6.9	Branckaert (1968)

Exp. 1: *Pyrethrum Marc*

Pigs from a litter of eight pure-bred Berkshires were allocated at random to one of three treatments:

a) unsupplemented control,

b) control ration in which 10 per cent of the ration was substituted with pyrethrum marc,

c) 25 per cent substitution with marc. A standard 15 per cent crude protein control ration was used based on sorghum and an imported protein-vitamin-mineral supplement (*Table* 2). Food and water were available *ad libitum*.

Pigs were housed in groups throughout the experiment which lasted for 140 days. Food consumption and weight gains were recorded.

Exp. 2: *Cocoa Pod Meal*

Four litters of crossbred Berkshire pigs were allocated to the four replicates of a randomised block design.

Each litter contained two male and two female pigs. Pigs were housed individually throughout the experiment which lasted for 50 days from weaning at eight weeks. Rations used are shown in *Table* 2. Feed and water

*Tropical Pig Breeding and Research Centre, D.A.S.F., Goroka.

Table 2.—Formulations of experimental rations

	Percentage Composition of Ration Ingredients								
Experiment Number		1			2			3	
Ration	A	B	C	D	E	F	G	H	I
Ingredient									
Protein supplement[1]	12.5	11.3	9.4	20	20	18	18.5	19	20
Ground sorghum	87.5	78.7	65.6	80	40	82	71.5	61	50
Pyrethrum marc[2]	—	10.0	25.0	—	—	—	—	—	—
Cocoa pod meal	—	—	—	—	40	—	—	—	—
Dried coffee pulp	—	—	—	—	—	—	10	20	30

[1]Huttmills, Melbourne, contained 55% crude protein salt 2%, per kg, 750,000 I.U. Vit. A., 12,800 I.U. Vit. D3, 62 I.U. Vit. E., 26 I.U. Vit. B2.

[2]Stafford Allen (NG) Pty Ltd, Mount Hagen.

were available *ad libitum*. Feed consumption and weight gain were recorded.

Exp. 3: *Dried Coffee Pulp*

Three litters of four weaner pigs were used in the experiment. Pigs were allocated on a litter basis to one of the four treatments in a randomised block design.

Pigs were housed individually during the experiment which lasted for 50 days. Rations calculated to be isonitrogenous were fed *ad libitum* during the experiment. Details of rations are shown in *Table* 2. Food consumption and weight gain were recorded.

The data were analysed for variance, and treatment means were tested by Duncan's Multiple Range Test (Steele and Torrie 1960). Insufficient numbers precluded a statistical analysis in *Experiment* 1.

RESULTS AND DISCUSSION

The growth performance of pigs in the three experiments is shown in *Table* 3.

Pyrethrum marc inclusion reduced performance of growing pigs. The major effect was on growth rate, although food consumption was also adversely affected. The effects may have been due to reduced digestibility associated with the high crude fibre content of the marc (Agricultural Research Council 1967). This is unlikely, however, as the commonest response to increased fibre intake is increased food consumption (Agricultural Research Council 1967). The most likely explanation is that a toxic residue of the pyrethrum plant or its manufacturing process remained in the meal. No clinical symptoms were observed.

The cocoa pod meal dramatically reduced performance of growing pigs. Growth rate was particularly affected. There was no difference in the food consumption, although in the absence of toxicity, food intake might have been expected to increase in the cocoa-pod group.

The effects found in this experiment are in marked contrast to those of De Alba and

Table 3.—Growth performance of pigs fed plantation crop by-products[1]

	Experiment Number								
		1		2			3		
Ration	A	B	C	D	E	F	G	H	I
n	3	3	2	8	8	3	3	3	3
Daily wt. gain (g)	429	368	278	459^{a}	223^{b}	495^{b}	213^{a}	159^{ac}	113^{c}
Daily food cons. (kg)	1.86	1.60	1.53	1.39^{a}	1.30^{a}	165^{b}	0.95^{a}	0.96^{a}	0.76^{a}
Food conversion ratio	4.3	4.4	5.6	3.1^{a}	6.1^{b}	3.3^{a}	4.5^{ab}	6.7^{b}	7.3^{b}

[1]Treatment means in the same experiment in the same row with the same superscripts are not significantly different ($P < 0.05$).

Basadre (1952) who using a ration containing 50 per cent cocoa pod meal but based on maize found no significant differences in performance when compared to a control.

A number of the pigs fed cocoa pod meal did not appear to be entirely healthy. One animal died two days after the completion of the experiment with joint, peritoneal and pericardial effusions, muco-gelatinous fat depots, cardiac haemorrhages, congested liver, renal haemorrhages and urinary precipitates. Histopathological examinations of tissues were conducted at the Central Veterinary Laboratory, Port Moresby and revealed massive haemorrhages of the renal tubules and glomeruli, with blocking of the tubules by casts.

The symptoms were considered to support a diagnosis of theobromine poisoning from the cocoa pod. Theobromine is a potent diuretic which in excess can cause circulatory failure. (British Veterinary Codex 1965).

The inclusion of even 10 per cent coffee pulp drastically reduced growth and food consumption. Again the food consumption response suggests a toxic factor, although pigs remained healthy during the entire experiment.

Vast amounts of waste-products result from plantation crop processing. It has been suggested that these products be used as feeds for livestock (Anon 1970). The findings described above, although preliminary in nature, suggest that for pigs at least, the three waste products tested should not have any place in the diet.

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BOOK REVIEW

"PEST CONTROL IN GROUNDNUTS"

PANS Manual No. 2, London, 197 pp.

This completely revised edition on the pest control in peanuts maintains the high standard of the PANS Manual series.

The Introduction contains short notes on the distribution, botany, agronomy and breeding of the crop and is followed by a short section on weeds and herbicides.

The section on diseases is conveniently divided into air-borne and soil-borne fungal diseases, followed by bacterial, virus and physiological diseases.

The illustrations are good, and the various diseases are treated very adequately under symptoms, development and spread of the disease, resistant varieties and cultural and chemical control. The latter lists many of the common fungicides giving formulations and recommended rates of application as well as notes on their effects.

In some cases there have been name changes since the book was published, (e.g. *Cercospora personata* is now *Cercosporidium personatum*). Also, even since the book was revised in 1973, the spread of some diseases e.g. peanut rust, has increased considerably.

Some of the diseases described are not yet present in Papua New Guinea, e.g. Rosette, caused by a virus, but it is an advantage to have knowledge of these so that growers can be on the lookout for them, in case any new diseases enter this country despite quarantine restrictions.

The section dealing with insects and mites is similarly well illustrated and comprehensive, with distribution, symptoms, life cycle and control being discussed for each species treated. There is also a useful section on storage insects and their control.

Each section has a short bibliography, and there are check lists of diseases and insects as well as the index.

The booklet is written with some degree of technical language, but it will be a suitable reference book for anyone with training in agriculture.

DOROTHY E. SHAW
Chief Plant Pathologist
T. L. FENNER
Senior Entomologist

BOOK REVIEW

"ANTHROPOLOGY IN PAPUA NEW GUINEA"

Readings from the Encyclopaedia of Papua New Guinea. (Edited by Ian Hogbin, Melbourne University Press 1973 250 pp.)

In Papua New Guinea rural development is a much discussed topic. Agriculturalists are naturally deeply involved in rural development problems, but in the past they have tended to concentrate on the technical aspects of agriculture at the expense of human factors. To overcome the deficiency, agricultural training in Papua New Guinea now includes an increasing Social Science content. Unfortunately social science teachers here are hindered by the lack of suitable texts. The publication of a book of readings in "Anthropology in Papua New Guinea" should therefore be welcomed by social science teachers and agriculturists alike. I suspect, however, that both groups are likely to be disappointed with this book.

The readings have been selected by Ian Hogbin from the anthropological entries he collected for the "Encyclopaedia of Papua New Guinea" in 1967. Some of the entries have been revised for this book, but most are essentially the same as the Encyclopaedia, despite the editors claim to the contrary. Experienced teachers and professional agriculturalists will find some of the papers very useful, especially Marie de Lepervanche's "Social Structure" and Thomas Harding's "Land Tenure". However, the majority of students and field officers in Papua New Guinea will find the language and presentation of the book too difficult.

Who then will find the book useful? Judging by the concern for correct anthropological definitions shown by some of the writers, especially de Lepervanche, it seems that the book is intended as a University text. If this is so, then serious students will be concerned at the failures of many writers, including Chowning, T. Scarlett Epstein, Harding and Peter Lawrence, to give references in their texts to the sources of their material. It may be that this is due to the original use of the papers in an encyclopaedia, but it seems a pity that this omission was not corrected for this book.

The book lays itself open for a more serious criticism, however. This arises from the "Western bias" of the authors. All the writers are academics from universities in Australia, England and the United States. They have visited Papua New Guinea and worked here, but their interpretation of what they saw is determined by the language of Western Social Science. This is most obvious in the chapter on "Economy" where Western myths on the "hindrances to economic growth" caused by traditional social values and land tenure are repeated *ad nauseum* without any evidence to back the statements. This Western bias is evident, to some degree in all chapters.

Malinowski, the great pioneer anthropologist, was acutely aware of the problems of interpreting Melanesian society for Western consumption. In 1929 he wrote "to reach the reader I have to rely upon his personal experiences which are built up in our own Society . . . I have . . . to translate Melanesian conditions into our own". The contributors to this book are translating Melanesian conditions into their own; this is unavoidable. Unfortunately they seem to have lost Malinowski's awareness that they are doing this. The result is that they frequently stray from a factual description of their material into a judgement of Melanesian society in terms of their own values.

R. McKILLOP
Rural Development Officer

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