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METRIC CONVERSION FACTORS

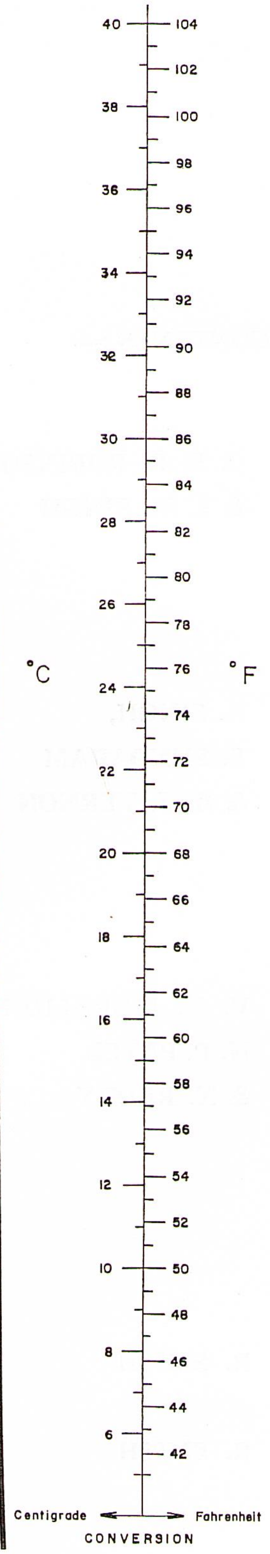
A	B	To convert A to B multiply by	To convert B to A multiply by
inches (in)	centimetres (cm)	2.54	0.394
feet (ft)	metres (m)	0.305	3.28
yards (yd)	metres	0.914	1.09
chains	metres	20.1	*
chains	kilometres (km)	0.0201	49.8
miles	kilometres	1.609	0.621
ounces (oz)	grams (g)	28.35	0.035
pounds (lb)	grams	454	*
pounds	kilograms (kg)	0.454	2.205
hundred-weights (cwt)	kilograms	50.8	*
tons	kilograms	1016	*
tons	metric tons (tonnes) (mt)	1.016	0.984
square in (sq in)	square cm (cm^2)	6.45	0.155
square ft (sq ft)	square metres (m^2)	0.0929	10.8
square yd (sq yd)	square metres	0.836	1.196
square chains	square metres	405	*
square chains	hectares (ha)	0.0405	24.7
acres (ac)	hectares	0.405	2.47
square miles	hectares	259	*
square miles	square km (km^2)	2.59	0.386
fluid ounces	millilitres (ml) †	28.4	*
pints	litres (l)	0.568	1.76
gallons	litres	4.55	0.22
cubic feet	cubic metres (m^3)	0.0283	35.3
cubic yards	cubic metres	0.765	1.31
lb/ac	kg/ha	1.12	0.89
cwt/ac	kg/ha	125.5	*
ton/ac	mt/ha	2.51	0.398
pint/ac	l/ha	1.40	0.712
gall/ac	l/ha	11.2	0.089

$$°C = 5\,(°F - 32)/9$$

$$°F = [9\,(°C)/5] + 32$$

* These factors will seldom be needed.

† For practical purposes 1 ml = 1 cubic centimetre.



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EFFECT OF SPACING ON BANANA YIELD IN FIJI

by

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SUMMARY

Increasing the population of banana stools per hectare from 815 to 2445 increased the total and the export quality yields over a period of 34 months. The mean bunch weights were generally reduced at the closer spacings but the proportion of export quality crop was not. The current spacing recommendation for bananas in Fiji of 3.35 x 1.83m (1630 stools/ha) yielded at an intermediate level.

INTRODUCTION

Banana spacing throughout the world is very variable. Simmonds (1) quotes a general range of 370-4942 stool/ha giving 28-2sq m/stool, with medium spacings of 5.6-11.1 sq m per stool as being most general. The present recommendation in Fiji is 3.35 x 1.83m (11 x 6ft) giving 1631 stools/ha (660 stools/ac.).

Some of the factors which influence the selection of a particular spacing are the type of clone whether large or small, crop economics, large fruit size versus total weight of fruit and seasonal production, the system of pruning, whether one or two bearing stems per stool, soil fertility level, using wider spacings on poorer soils, management requirements with regard to layout, intercropping, spraying, the probability of wind damage and topography.

METHODS

Four spacings by three fertilizer treatments were combined factorially and there were two absolute replications. The trial was sited on an alluvial soil, on Waidradra Research Sttaion. Bunchy-top virus free, uniformly sized suckers (Viemama cv.) were planted in January 1970.

The spacing treatments were:

A. 3.35x3.66m (11x12ft) giving 815 st/ha (330 st/ac).

B. 3.35x1.83m (11x6ft) giving 1630 st/ha 660 st/ac).

C. 3.35x1.22m (11x4ft) giving 245 st/ha (990 st/ac).

D. 3.35x1.22m Plant crop, thinned for the first ratoon to 3.35x2.44m (11x8ft) giving 1223 st/ha (495 st/ac).

The net plot size was 10.2 x 11.0m (33 x 36ft) giving 9, 18, 27 and 27 thinned to 13 in the ratoon crop, recorded stools per treatment respectively.

The fertilizer treatments were:

F1	N56	P0	K168	Kg/ha	(50 : 0 : 150lb/ac)
F2	N112	P56	K336	Kg/ha	(100 : 50 : 300lb/ac)
F3	N168	P84	K504	Kg/ha	(150 : 75 : 450lb/ac)

applied in the form of urea (45%N), superphosphate (20% P_2O_5) and sulphate of potash (50% K_2O).

Basic culture operations were the same for the whole trial, i.e. regular leaf (disease control) spraying, regular monthly desuckering, de-leafing, weeding, bunchy-top virus rogueing and scab moth control.

The number of suckers produced by each stool was recorded since spacing appeared to influence this. Crop was recorded as total weight of the bunch and the weight of the export quality portion of each bunch i.e. fingers measuring 14cm (5.5in) or greater in length. The data were analysed statistically for total crop yield, export quality yield, mean bunch weight, proportion of export quality crop, proportion of ratoon to total crop and sucker production in the plant crop phase.

RESULTS

The plant and the greater proportion of the first ratoon crops were harvested

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TABLE 1

EFFECTS OF SPACING ON ACTUAL TOTAL YIELD EXPORT QUALITY YIELD AND BUNCH WEIGHT OF PLANT AND FIRST RATOON CROP BANANAS

YIELD FACTOR		SPACING TREATMENT					
		A	B	C	D	S.E.D.	C.V. (%)
PLANT CROP							
Total Yield	(mt/ha)	21.4	29.4	40.3	34.7	3.01	16.6
Mean Bunch Weight	(kg)	26.2	22.1	21.8	21.3	1.08	8.2
Export Quality Yield	(mt/ha)	13.4	20.1	25.0	20.3	2.16	19.0
Mean Bunch Weight	(kg)	16.3	14.2	13.4	12.5	1.10	13.5
Proportion of Export Crop	(%)	62	69	62	59	2.2	6.3
Proportion of Stools Harvested*	(%)	100	82	76	67†	—	—
RATOON CROP							
Total Yield	(mt/ha)	26.4	35.1	43.1	30.5	1.94	10.0
Mean Bunch Weight	(kg)	32.4	26.4	23.3	26.8	1.41	9.0
Export Quality Yield	(mt/ha)	16.3	25.6	30.9	22.4	2.26	16.4
Mean Bunch Weight	(kg)	20.0	19.5	16.7	19.7	2.20	20.3
Proportion of Export Crop	(%)	61	73	72	74	5.7	14.1
Proportion of Stools Harvested*	(%)	100	82	75	92†	—	—
PLANT & RATOON CROP							
Total Yield	(mt/ha)	47.8	64.5	83.4	65.1	4.57	12.1
Mean Bunch Weight	(kg)	58.7	48.5	45.0	48.1	2.00	6.9
Export Quality Yield	(mt/ha)	29.6	45.8	55.9	42.8	3.75	14.9
Mean Bunch Weight	(kg)	36.3	33.7	30.1	32.3	2.99	15.7
Proportion Ratoon of Total crop	(%)	55	55	52	47	1.7	5.7

Note * = Based on mean of 6 plots. † = Population halved by thinning for Ratoon crop.
Factor for conversion of export yield as mt/ha to 56lb cases/ac = X 15.92

before hurricane Bebe destroyed the trial in late October 1972, 34 months after planting.

Fertilizer:

The only statistically significant effect recorded for the fertilizer treatments at all was an increase in the total yield of the first ratoon crop. There were no other simple effects, no significant interactions with spacing in terms of yield and no effect of fertilizer on sucker production in the plant crop.

The mean total ratoon crop yields for fertilizer treatments were:

	mt/ha
F1	32.6
F2	31.8
F3	36.9
S.E.D.	± 1.68

This response to the high F3 fertilizer treatment was not found in the export quality crop nor was there any significant effect on the proportion of export quality fruit.

No further reference will be made here to the fertilizer treatments (2) since they had so little significant effect on crop performance.

Spacing:

The effects of spacing on crop yield are summarised in Table 1.

Treatment B is currently the standard recommended spacing in Fiji. Significant spacing differences were found for total and export quality yields of both crops individually and for the combined data. Spacing treatments also significantly effected the mean bunch weights of the total and export quality plant crop and the total bunch weight only of the ratoon crop. The proportion of the total plant and ratoon crops that were of export quality were also influenced significantly by the spacing treatments.

The actual yields obtained with the spacing treatments that are shown in Table 1 may be compared with the theoretical yields obtained from the mean bunch weights assuming one hundred per cent cropping at one bunch stool. The latter values are shown in Table 2.

There was an apparent effect of spacing upon sucker production in the plant crop which is summarised below:

Spacing Treatments—

	A	B	C	D	S.E.D.	C.V.
Suckers per hectare-	21,310	25,446	25,803	32,220	3,000	19.8
Suckers per Banana Stool-	26	19	14	20	—	—

Since treatments C and D were identical in the plant crop little significance can be placed upon these figures.

DISCUSSION

The recorded total yield of bananas increased significantly from 815 through 1630 to 2445 stools/ha (treatment A, B and C) in the plant crop, the first ratoon crop and the total crop, over the 34 month experimental period. This, despite a decrease in the number of fruiting stools as the plant population increased. There is an anomally in that treatment D is the same spacing as treatment C in the plant crop but it produced a significantly lower yield, and one which did not differ from treatment B. A possible explanation for this may be the smaller number of fruit bearing stools (Table 1) and the significantly greater number of suckers produced in this treatment. The theoretical yields for treatments C and D (Table 2) do not differ very much and the mean weight of the banana bunch is virtually identical (Table 1).

TABLE 2
THEORETICAL BANANA YIELDS FOR SPACING TREATMENTS

YIELD FACTOR		SPACING TREATMENT A	B	C	D
Total Yield (mt/ha)	Plant Crop	21.4	36.0	53.2	52.0
	1st Ratoon	26.4	43.1	56.9	32.8
	Total	47.8	79.1	110.1	84.8
Export Yield (mt/ha)	Plant Crop	13.4	23.2	32.8	30.7
	1st Ratoon	16.3	31.8	40.9	24.2
	Total	29.7	55.0	73.7	54.9

It was determined that the spacing relationship with total yield was principally composed of significant linear and quadratic components.

Reducing the population of treatment D (from 2445 to 1223 stools/ha) for the first ratoon crop reduced the total yield to a level intermediate between 815 and 1630 stools/ha (treatments A and B Table 1).

If the total yield of bananas from the standard spacing B (1630 stools/ha) is taken as 100 per cent, treatments A and C (815 and 2445 stools/ha) yield 73 and 137 per cent and 75 and 123 per cent plant and ratoon crops respectively.

The total weight of the export quality banana crop increased significantly in both the plant and ratoon crops from a population of 815 through 1630 to 2445 stools/ha (treatments A, B and C), despite significant differences in the proportion of the total crop yield that made export grade and the proportion of the stools that were harvested. Treatment D yielded at a level similar to treatment B in the first ratoon crop which is the present standard spacing.

The comparable percentage yield figures for export quality bananas (treatments A and C) taking the standard spacing treatment B yield as 100 per cent are 67 and 124 per cent and 64 and 121 per cent for the plant and ratoon crops respectively.

The mean banana bunch weight, both total and export quality, was highest at the widest spacing (treatment A) but did not differ between the standard and the closer plant spacings (treatments B, C and D). This difference was observed in the plant crop and for the total but not for the export quality mean bunch weight in the first ratoon crop. The aggregate analysis for the two crops (Table 1) confirms this.

The proportion of the total crop over 34 months that was harvested as ratoon crop from spacing treatments A, B and C did not differ significantly.

It is of practical interest to determine whether there is appreciably more export reject quality crop for local disposal at the different spacings. Considering treatments A, B and C in Table 1, subtracting the export quality crop yields from total crop yields, shows that at spacings A and B there is very little difference between them in the quantity of this grade of fruit whereas at spacing C there is considerably more of this fruit grade; for the ratoon crop the difference between A or B and C is not nearly so marked. Actual difference values, giving export reject quality bananas are:

Spacing treatments —	A	B	C	D
Plant Crop (mt/ha) —	8.0	9.3	15.3	14.4
Ratoon Crop (mt/ha) —	10.1	9.5	12.2	8.1
Both Crops (mt/ha) —	18.1	18.8	27.5	22.5

There are several practical points to be considered in any comparison between the closest spacing of 3.35 x 1.22m and the widest spacing 3.35 x 3.66m. At the widest spacing the stems grew faster and taller and suffered less from leaf diseases; the crop was easier to harvest, to spray for leaf disease control and required less planting material per unit area. But the lack of canopy necessitated very frequent weeding. At the closest spacing the reverse of all these was true; the stools appeared to be crowded, uneven and late emerging stems suffered from competition (for light). The standard spacing (3.35 x 1.83m) was intermediate between these two extremes.

It appears that in the plant crop period more suckers per stool may be produced at the widest spacing but that more suckers are produced per unit area at the closest spacing (mean of treatments C and D compared with A or B); the evidence for this is by no means conclusive.

Harvesting of the plant crop was completed one month earlier at the widest spacing than it was at the closest spacing (16.11.71 vs. 30.12.71). For the first ratoon crop the time difference to completion between these same spacing treatments had extended to two months (4.11.72 vs. 9.9.72) and was even then not quite complete at the closest spacing.

The number of bunches harvested from the overlapping second ratoon crop was similar for all treatments at 3.11.72 and hence proportionately smaller in the denser spacings. There does not seem to be a great difference in the time of crop maturity at different spacings in this trial.

CONCLUSIONS

Decreasing the banana stool density below the presently recommended spacing of 3.35 x 1.83m (1630 stools/ha or 660 stools/ac) has reduced the total and the export quality yield of bananas in the plant and first ratoon crops by for the plant crop, 27&33 and, for the ratoon crop, 125&36 per cent respectively.

Increasing the banana stool density above the presently recommended spacing has increased the total and the export quality yield of bananas in both the plant and the first ratoon crops by for the plant crop +37 & +24 and for the ratoon crop +23 & +21 per cent respectively.

Decreasing the banana stool density below the presently recommended spacing gives a heavier total and export quality bunch weight but only increases the total bunch weight in the first ratoon crop. Increasing the banana stool density above the standard spacing has not affected bunch weights significantly i.e. they have not in general been reduced.

The proportion of fruiting stools apparently decreases as the planting density increases.

In terms of the maximum possible total or export quality banana yields per unit area the closest spacing in this trial appears advantageous. There is little to be said for the fourth treatment wherein the dense plant crop spacing was thinned prior to taking the ratoon crop.

There is a need for more detailed study of banana spacing under Fiji conditions. Particular attention should be paid to populations per unit area greater than the present standard of 1630 stools/ha where monoculture is practised. However, on less fertile soils than the one on which this trial was carried out note should be made of possible planting density by fertilizer interaction effects.

ACKNOWLEDGMENT

The trial reported here was planned and initiated by Mr P. Hoskin whilst he was Research Officer (Bananas), Department of Agriculture, Fiji. Mr C. R. Baines, Statistics Section, Long Ashton Research Station, kindly handled the statistical analysis.

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1. Simmonds, N.W. (1959) *Banana*, Pub. Longmans Green & Co. Ltd., London, 158-161.

2. Robinson, J.B.D. and Singh, J.M. (1973.) Fiji agric. J. (8), **35**.

FERTILIZER TRIALS ON YOUNG COCOA

by

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SUMMARY

In manurial trials on young cocoa in Wainibuka and Cakaudrove neither trunk growth nor yields during the third and fourth year responded to P or K. This was in accord with relatively high values of P and K content of soil (72 ppm and 0.40 m.e.% respectively) and foliage (0.22 and 1.7% d.m. respectively). There were slight, but statistically significant, responses of both trunk growth and yield to N, in Cakaudrove Province (where all the trial cocoa was growing under unfertilized coconuts). This was in accord with the somewhat marginal average soil and leaf content of N (0.20% and 1.98% d.m. respectively in Cakaudrove) but the responses varied appreciably and inexplicably between sites.

INTRODUCTION

According to Urquhart (8) the old West Indian practice was to manure cocoa heavily at planting, and at frequent intervals during the early years of growth. This practice was copied elsewhere, and recommendations to that effect made in advisory writings in several countries, although generally without reference to supporting experiments. McPaul (4), in advising Fiji cocoa growers to follow this practice, stressed that his recommendations were tentative, pending experimental verification; but paucity of young bearing cocoa suitable for extensive fertilizer trials precluded such research in the 1960s.

Since then the results of a few trials in West Africa have been published by Smith and Akrofi (7) and Wessell (11, 12). In some of these, fertilizer applied at planting was deleterious to growth; but in one of Wessell's trials (11) monthly urea applications during the first two years had a beneficial effect on growth and stimulated jorquetting, while in another of his trials mulching promoted early growth and yield (12). Wessell (12) based his recommendations for the manuring of pre-bearing cocoa in Nigeria on this very slight evidence. Apparently he knew of no other relevant published work: certainly we have traced none.

As more cocoa became available for trials in Fiji, it was possible to resume McPaul's work with the series of extensive trials now described.

METHODS

Sites

With some difficulty and little choice, eight plantings of cocoa were found in Wainibuka Province (Viti Levu) and eight in Cakaudrove (Vanua Levu) of sufficient size (about 0.5 ha.), regularity, uniformity of age (about 16 to 24 months from field planting), and accessibility to be used for these trials. All the Wainibuka plantings were beside the Nasau feeder road or the nearby section of King's Road, and all were under bananas, (a year or two older than the cocoa) which had received liberal NPK dressings during their plant crop. All the Cakaudrove plantings were under 30-50 year old unfertilized coconuts on coastal alluvial soils; one within 300m of Savusavu Bay and six within 0.5-1.0 km of Buca Bay.

The spacing of the cocoa was generally about 2.5-3.0m square i.e. 1,100-1,600 trees/ha. At the Cakaudrove sites, growth was generally a little more advanced. It was later realized that this was because the cocoa at these sites was not pure Amelonado but partially, at least, Trinitario.

Layout

At each site 27 plots were marked out, each comprising a 'square' of four trees. These plots were divided into three blocks to accommodate a conventional 3Nx3Px3K design, one replicate per site. There were thus eight replications on Viti Levu and eight on Vanua Levu.

Treatments

The following total amounts of fertilizer per treatment were applied over the period October 1970 to April 1973.

Level	0	1	2
		g element per plant	
N (as urea)	0	140	280
P*	0	185	370
K (as K_2SO_4)	0	140	280

*As single superphosphate to two trees in each plot and as Lauphosphate (a derivative of local deposits) to the other two.

The level '2' plots received the same dressing as the level '1' during the first year (1970-1971), the P and K as single dressings, and the N split into two dressings of 70g/plant with a six-month interval. While the level '1' plots received nothing further, the level '2' plots had these dressings repeated during 1971-1972.

Field Operations

During Sept. — Oct. 1970 the Wainibuka sites were selected, plots marked, fertilizer applied, stem diameters recorded, and soil samples taken. This was repeated in Cakaudrove during November-December. The second urea application was in April 1971, at both sites. The level '2' dressings were made at about the same times during the the second year, and in October-December 1972 the final stem measurements made. Leaf samples for chemical analysis were collected from Wainibuka in December 1971 and from Cakaudrove in February 1972. Second and third fully green leaves from the latest flush were taken from all sides of one tree in each plot, the method recommended by Loue (3) and used also by Wessell (12).

Somewhat unexpectedly an appreciable yield appeared at several of the Cakaudrove sites during the first year. It seems that, contrary to recommendations, the cocoa at these sites was not pure Amelonado, but part-Trinitario, which is quicker into bearing. Yield was recorded by pod counting at 11 week intervals. Counts included all the fruit that had passed the cherelle wilt stage. As a pod passes from this stage to fully ripe (hence, presumably, picked) in about 11 weeks, in the course of a year a good estimate of the yield of each plot is obtained.

It had been intended to continue the yield observations for another two years; but the general lack of response to any fertilizer (see 'Results') discouraged this, and the damage caused by hurricane Bebe ruled it out in Wainibuka. In Cakaudrove, recording was continued at four sites where there had been a response to N; but irregularities caused by hurricane Juliet in April 1973, and growing irregularity caused by severe canker attack to many trees at the part Trinitario sites, led to the termination of all recording later in 1973. The results presented are those to the end of the second year.

Laboratory Work

The soil pH was determined in 2:5 soil: water suspension after equilibrating for one hour. Total N was determined by semi-micro Kjeldahl method and the organic carbon according to Walkley and Black (10). Available P was extracted with 0.05N sulphuric acid and exchangeable cations, Ca, Mg, and K with 2.5% acetic acid.

Leaf samples were first digested with concentrated nitric acid, evaporated to dryness, and then dry-ashed in a muffle furnace at 400 °C for P and K determinations. For further details of methods see (6).

RESULTS

Statistical analysis

From each stem diameter or girth measurement the stem cross-section area was calculated (assuming this to be circular) and plot averages of these cross-section areas calculated for the start of the trial, the end of the first year and the end of the second year.

TABLE : 1 EFECT OF NITROGEN AT CAKAUDROVE

UREA APPLICATION	MEAN STEM CROSS-SECTION AREA CM²	MEAN LOGARITHMIC TRANSFORM OF YIELD PLOT	MEAN ACTUAL YIELD PODS/TREE	KG/HA*
None	63.2	1.74	18.8	940
2 times	66.4	1.77	19.2	960
4 times	69.5	1.85	21.6	1080
S.E.	± 1.3	±0.033		

*Approx, calculated assuming 42 gm/pod, 1200 trees/ha.

Yields of cocoa just coming into bearing are notoriously non-normal. In an area where most trees have no yield, and a few bear 1-4 pods, a very few may bear 5-15 pods. No analysis therefore was made of the yields at those sites (four at Wainibuka) with a mean yield of less than 15 pods per plot. For the other sites, the yields were analysed* in logarithmically transformed form, as has been recommended for such data (1). Analyses were by co-variance, using initial stem measurement as the calibratory factor. The analyses of the stem measurements, and some yields, to the end of the first year have been presented elsewhere (9). The only noteworthy point was a suggestion of response to N. The results of the analyses of the stem areas at the end of the second year, and the second year yields were as follows.

The Wainibuka series of trials

Neither the stem-area nor yield analyses disclosed any suggestion of any appreciable, or statistically significant, response to any element.

The Cakaudrove series

Again there was no suggestion of response to P or K, but to N there were small but highly significant responses of both stem area and yield over all sites (Table 1). Actual yield per tree is shown in Table 1 as being more readily intelligible than the log-transformed yield; but the statistical analysis of the latter is more reliable, hence the SE is shown for that and not for actual yield.

Correlation of response with soil and foliar analysis

Table 2a shows the results of the soil analyses compared with the values that Hardy (2) has said are indicative of high, medium and low fertility soils. Table 2b shows those of the foliar analyses, compared with the 'critical values' that Loue (3) and Murray (5) say to be the threshold of deficiency. The results of foliar analysis are presented summarized in three alternative ways to display, in particular, the N content of trees receiving no N fertilizer, the P content of trees receiving no P, and similarly for K.

The P content of both soil and foliage was well above critical at every site, in accord with the lack of response to P. The very high P values at Wainibuka were presumably due to the residual effect of fertilizer applied to the bananas.

K content of soil, and of foliage also according to Loue (3) was also generally well above critical, again in good accord with the lack of response. Murray (5), however, gives a wide range of criticality for foliar K. Presumably the higher end of this range is more applicable to bearing cocoa, which has a higher demand for K. If so, it may be that responses to K on

*By electronic computer, thanks to Rothamsted Experimental Station, England.

TABLE : 2 CHEMICAL CONTENT OF SOIL AND LEAVES

Compared with values said to be normal or critical by various authorities.

(a) SOIL CONTENT

		pH	N %	C/N ratio	P ppm	K m.e.%	Ca m.e.%	Mg m.e.%
Trial site	Wainibuka	5.1	0.23	12.0	90	0.30	10.0	7.0
analyses	Cakaudrove	6.5	0.20	11.0	54	0.50	11.0	7.0
Normal values	high fertility	7.5	0.35	11.5	50	0.45	17.0	3.6
according to	medium "	6.5	0.20	9.5	25	0.30	8.6	1.8
Hardy (2)	low "	5.0	0.05	7.5	10	0.17	3.0	0.6

(b) LEAF CONTENT

	N as % d.m.			P as % d.m.			K as % d.m.		
Treatments:—	N: 0	1	2	P: 0	1	2	K: 0	1	2
Trial Wainibuka	1.84	1.86	1.91	0.24	0.24	0.24	1.70	1.74	1.75
Cakaudrove	1.98	1.98	1.99	0.20	0.21	0.21	1.71	1.74	1.88
Critical values according to: Loue	1.8 — 2.0			0.10 — 0.13			1.0 — 1.2		
Murray	1.8 — 2.0			0.13 — 0.20			1.2 — 2.0		

these soils will be found later in the life of the cocoa. Application of K increased the K content of the leaves appreciably.

As to N, Table 2 shows a situation that, on average of all sites ,is somewhat marginal with soil N only a little above 'medium' and foliar N (in the absence of N application) in the critical range. This is in accord with the overall significant response to N. But in detail the situation is confusing, At Wainibuka the response to N was less than at Cakaudrove, although the soil and foliar analyses suggest that the need for N at Wainibuka was greater; and between sites, in provinces, there was no correlation whatsoever between response to N and foliar content of the No plots.

DISCUSSION

Responses

It seems quite clear that on these geologically 'recent' soils of coastal and river-bank flats the application of P and K to cocoa, during the establishment years is entirely without benefit. Under some circumstances there is a good response to N; but no definition of these circumstances is evident. Foliar analysis does not seem to help.

It is well known that the less the shade the greater the need for N manuring of cocoa; and the lack of response to N at Wainibuka, despite marginal soil and foliar N status, might be because several of these sites were more heavily shaded (by large trees) than any other Cakaudrove sites. But this would not explain the variation between sites in Cakaudrove. Very careful inspection of these sites, with this factor in mind, disclosed no suggestion that the sites of least response to N were the more heavily shaded.

Economics

At the time the trials were in progress the cost to the farmer (the subsidized price) of the high rate of N would have been about $50/ha and the value of the average response of the four most responsive sites was about $73/ha. Since then the cost of urea, and the world market price of cocoa, have both risen dramatically; but the latter is unstable and it seems that in future the immediate yield response is unlikely to pay the full cost of the fertilizer.

But the immediate yield response is only part, perhaps only a small part, of the benefit. Stem area is merely a conveinient measurement of tree size. A corollary of increased stem area will be increase in branch-spread and total leaf area, hence speed of canopy closure, and reduction in weeding costs. Also the yield response, although diminishing in time, may be appreciable for some years. Thus it is possible that even at a urea price of $400 per ton the response may be economic at those sites where N is most needed.

General

Much of the interest of the trial results lies in the average yields per site. These show clearly the greater speed into bearing of Trinitario cocoa; but the defect of this Trinitario was also clearly apparent. By the end of the trial, many trees at the hitherto higher-yielding sites at Nawi were dying of canker, and others producing little but black pods. By this time many of the Amelonado sites had come into good bearing, giving over 20 pods/tree (equivalent to about 1,000 kg/ha) in the fourth year: an excellent yield by world standards.

CONCLUSIONS

Strictly speaking these results apply only to the cocoa growing under conditions similar to those at the trial sites; but as much current cocoa planting is on somewhat similar alluvial soils, and taking into account the current high price of fertilizer, and the lack of any evidence to support the previous recommendations, these are rescinded. Pending further trials P and K fertilizer should not be applied to young cocoa in Fiji, and N only to correct known deficiencies.

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DRY-LAND RICE FIELD EXPERIMENTS, 1969—1972

by

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SUMMARY

Variety trials at Koronivia, Dobuilevu, and Sigatoka Research Stations during 1969-1972 confirmed that IR5 is over 25% higher yielding than the previous standard dry-land variety, BG79(75). The more recently introduced C4-63 appeared to have a 23% higher yield than IR5 and was also preferable in being quicker maturing. Renamed 'Sautu' for use in Fiji it is now being multiplied and distributed to farmers. Mahsuri appeared lower yielding than IR5 but 20% higher than BG79(75) and is recommended for use if a traditionally tall variety is preferred. Of the quicker maturing varieties, more suited to catch cropping between sugar cane crops, no recent introduction convincingly out yielded the traditional Saraya 3 Month and Matmuria varieties.

Manuring trials confirmed that there is generally an economic response to 56 Kg N/ha, but showed no extra response to a double-rate of application. Early application (3-4 weeks after sowing) gave better results than application at the panicle initiation stage.

INTRODUCTION

This paper continues to 1972 the reviews of dry-land rice variety, weed control, and manurial trials which were taken to 1968, 1969, and 1969 respectively in an earlier series of papers (2, 7, 9).

The position in 1968-69 as regards varieties was that the short photo-insensitive IR5 became recommended despite its rather poor grain quality and its need for closer spacing, fertilizer, and chemical weed control. Its higher yield when under good management offset these defects but overall the gain was a slight. For catch cropping in rotation with sugar cane, where a quick maturing variety was needed, Saraya 3 M was recommended (2). The study of cultural practices had been conducted mainly at Koronivia, and was applicable only to longer term varieties, not to the catch cropping in sugar cane type of rice cultivation. The best results had been achieved with IR5 drilled at 23cm, or broadcast, with post — emergence application of propanil to control weeds (8).

Top dressing with 50-60 Kg N/ha generally gave a 360 Kg/ha increase in yield. On alluvial soils there was generally no response to P, but on red hill soils, there was generally a substantial response, particularly in the presence of N (8).

This paper brings together and reviews the results of the trials that continued these lines of study during 1969-1972. Detailed results have already been given in the Research Division Annual Reports for 1969 (5, 10) 1970 (1, 6), 1971 (3), and 1972 (4, 9). The date given for any trial, is that of the year of harvest: e.g. a trial said to be of '1969' may have been planted in December 1968 or January 1969. All yields are of dry paddy.

METHODS

Seasons and sites

All the trials now described were main season (i.e. November-May) and were sited at either Koronivia, Sigatoka, or Dobuilevu Research Stations, always on well drained soils.

Varietal study methods

The varieties tested are listed in Appendix 1. All the variety trials were of randomised block design usually with three replications. They were sown with a tractor-mounted seed drill at 23 cm spacing between rows except one trial at Sigatoka which was drilled at 46 cm spacing.

The seed rate was 90 Kg/ha for all varieties except Blue Belle and Belle Patna which were sown at 135 Kg/ha. Weeds were controlled by propanil, applied at the rate of 3.4 Kg ai/ha when weeds were at the 2-3 leaf stage. When this failed to give good control, trials were also hand-weeded. Urea was top-dressed, usually at 56 Kg/ha in splitdose, half at 3-4 weeks after sowing and the rest at panicle initiation stage.

Plot size depended on the area of the field, the seed available and the number of varieties in a trial. Net plot size in most of the variety trials at Sigatoka ranged from 8 to 42 m^2, at Dobuilevu it was 10.5 m^2 in all trials and at Koronivia 31.5 m^2 for 1969-71 trials and 6.25 m^2 for 1972 trials.

Fertilizer trials

These were all of a factorial type some with N-P-K as the factors, and some with rates of N and time of application. Randomized block designs with three or four full replications were always used. Sowing methods, seed rate, weed control and manuring were generally the same as for variety trials except when any one of these factors was itself the subject of the experiment. Net plot size was in the range of 30-40 m^2.

TABLE — 1

Details of Dry-land Rice Variety Trials 1968-72

Main Season	Dobuilevu	Sigatoka	Koronivia	Remarks
1968*	One trial. (Set-A, 18 Varieties)	—	—	—
1969	One trial. (Set-A, 23 Varieties)	One trial. (Set-A, 23 Varieties)	One trial (Set-B, 24 Varieties)	One dropped and six new added to Set A.
1970	One trial. (Set-A, 23 Varieties)	One trial. (Set-A, 18 Varieties)	One trial (Set-B, 24 Varieties)	At Sigatoka five dropped. At Koronivia six gave very poor germination.
1971	One trial (Set-C, 15 Varieties)	Two trial one each at 23 & 46cm spacing (Se 11 Varieties)	One trial (Set-B, 24 Varieties)	At Dobuilevu seven new and eight from Set-A, at Sigatoka seven new and four from Set-A.
1972	One trial (Set-D, 30 Varieties)	One trial (Set-D, 30 Varieties)	One trial (Set-E, 19 Varieties)	At Sigatoka 12 gave poor stand.
1972		One trial (Set-F, 18 Varieties)	—	At Sigatoka six failed to germination.

*Results from 1968 trials presented in (2). Dobuilevu trial results presented here also since same varieties were included in fertiliser trials.

Precision

Under favourable experimental conditions, with no disruptions, losses from pests, unseasonable weather, etc, the co-efficient of variation (CV) tended to depend on plot — size, varying from 6-15% for trials with relatively large plots (25-42 m^2) but from 16-20% for those with smaller (6.5-10.5 m^2) plots. Disruptions such as those mentioned above put the CV into the 25-35% range regardless of plot-size.

In the more accurate, large plot trials the standard error (SE) of treatment means was satisfactory 4 to 5%. Similar or a little lower, treatment mean SEs could be obtained using smaller plots despite their higher CVs, if the same overall are were used and the number of replications increased correspondingly. But when land shortage imposed the use of small plots with only three replications, the treatment mean SE generally rose to about ± 11%, and occasionally much higher.

But combined analysis of series of trials showed that in general the treatments x trials variance significantly exceeded pooled within-trials-error variance. This shows that, although the within-trials-error was sometimes unsatisfactory, no great gain in overall certainty would result from reducing within-trials-error. The SEs of the mean results of series of trials presented in this paper are those derived from treatment x trials variance i.e. they give a measure of the uncertainty due to the fact that there is a real variation in, e.g., the relative merit of two varieties, from trial to trial.

VARIETY TRIAL

Varieties tested

Appendix 1 lists all the varieties included in these trials, grouped according to duration (short or medium) and sub-grouped according to whether they have been (a) long grown in Fiji (b) recently introduced, included in trials during 1965-1968 (c) more recently introduced, first trial in 1969 or later. As compared with the pre-1969 trials, reviewed by Muralidharan, (2) fewer class (a) varieties were still being included in these recent trials: only four early maturing and three medium maturing.

Scheme of trials

Varieties were grouped for convenience into sets, starting with the 18 varieties of the 1968 Dobuilevu trial as Set A. With some modification this Set A was tried at both Dobuilevu and Sigatoka in 1969 and 1970. Meanwhile Set B (24 varieties) was tried at Koronivia in 1969 and 1970; and continued with a trial in 1971; and Sets C, D, E, and F were then formed for trials at these stations in 1971 and 1972, as shown in Table 1.

Results

As referenced in the 'Introduction' the trials results have been given in Annual Reports except that by oversight the result of the Set A trial at Sigatoka in 1970 was omitted from the Report for that year. This particular result is now given in Appendix 2, and the overall results of the Set A trials in Table 2. The results of the Set B trials were summarized in Table 4 of (3) in lb/ac. The mean yields over the three trials of the ten top yielding varieties, plus two others of interest (IR8 and IR5) were:

Variety	mt/ha	Variety	mt/ha
C4—63 (Sautu)	3.25	IR 140 — 136	2.22
IR 400 — 5	3.12	IR 277 — 13	2.17
IR 334 — 26	2.58	IR 160 — 25	2.16
IR 160 — 27	2.52	IR 9	2.09
IR 480 — 5	2.38	IR 8	1.93
IR 117 — 41	2.34	IR 5	1.72
		SE	±0.37

There are insufficient trials with other Sets of varieties to merit combined analysis; but the results of some particular treatment comparisons occuring in these other Sets have been averaged with corresponding Set A and Set B results to get the figures given in the following discussions.

Discussion of medium term varieties

Not all varieties of interest have occurred together in all trials; but all have occurred in certain combination in several trials. The following picture of relative merits can therefore be constructed.

TABLE 2

RESULTS OF 'SET A' TRIALS

(a) **Medium term varieties**

These all failed, due to drought at Sigatoka in 1969.

Mean yield in other four trials, mt/ha.

IR8	4.48
IR9	3.78
Mahsuri	3.72*
IR5	3.56
Taichung (N) I.	3.56
Palawan	3.10
FK 135	3.00
BG79(75)	2.46
New Guinea	1.68
Sonacalif	1.60
SE.	±0.40

*Present in 2 trials only; this figure, constructed by missing plot analysis, has SE. of ±0.56.

Other varieties not present in all trials were

Malinja	Arkrose x Blue Bonnet
Peta	Milfor 6(2)

The yields of these were generally below average.

(b) **Short term varieties**

These gave reasonable yields at Sigatoka in 1969.

Mean yield over five trials, mt/ha.

Bell Patna	1.94
Mutmuria (b)	1.92
Saraya 3 month	1.08
" 4 "	1.43
SE ±	0.21

Other varieties not present in all trials were Blue Belle and Rani, which tended to yield below average in those trials where they occurred.

From the Set A trials (see Table 2) and from previous results, it is clear that New Guinea and Sonacalif are appreciably lower yielding than BG79(75), which last can therefore be taken as the standard established variety for comparison with more recent introductions.

From a total of 4 trials in which the varieties BG79(75), IR5 and Mahsuri occurred together, and 4 trials in which two of these three occurred, a 'missing-plot' analysis gives the following results (SED = Standard Error of a difference).

	mt/ha
IR5	3.14
Mahsuri	2.94
BG79(75)	2.46
S.E.D. IR5 v. BG79(75)	± 0.30
S.E.D. involving Mahsuri	± 0.32

In seven trials in which IR5 occurred together with Taichung (N) I., Palawan, Azucena and other introduced varieties were significantly lower yielding, thus:

	mt/ha
IR5	3.43
Taichung (N) I	3.00
Palawan	2.37
Azucena	1.85
S.E.D.	± 0.26

By contrast C4-63 (Sautu) was higher yielding than IR5 on average of seven trials and IR8 and IR9 were also higher yielding than IR5, on average of four trials:

	mt/ha		mt/ha
C4—63 (Sautu)	2.88	IR8	4.48
IR5	2.35	IR9	3.78
S.E.	± 0.34	IR5	2.80
		S.E.	± 0.40

FK 135 has also appeared over several trials to be about in the same class as IR5 for yield. But of these four varieties that have appeared as good as, or better than, IR5 only one, C4-63 is of the long grain type popular with Fiji consumers.

The 'error', based on trial to trial variation (see 'Methods'), was such that its yield superiority over IR5 was not statistically significant. But the apparent magnitude of this superiority (23%) considered in conjunction with its twenty day earlier maturity than IR5, and superior grain quality was considered sufficient to warrant recommendation, multiplication, and distribution to farmers, as the best general purpose variety for dry-land rice. To expedite publicity, it has been given the Fijian name 'Sautu'.

All the varieties that have conclusively out yielded BG79(75) have been of the newer short-stemmed, photo-insensitive type needing closer spacing and more attention to weed control than the traditional varieties. But one tall strawed variety, Mahsuri, as shown above, gave a marginally significant 20% increase in yield, and is also preferable in that it is only weekly photo-sensitive and thus not so critical in sowing date as the traditional varieties. Its grain quality is good. It has, therefore, been recommended for use by farmers who prefer to retain traditional methods.

Of the varieties included only in the last year or two of the trials under review, several have out yielded IR5 in the few comparison to date, but only one (IR400-5) of rather poor quality has given about the same yield as Sautu, and none has out yielded Sautu.

Discussion of short term varieties

The only recently introduced, short term, varieties that have been tested against the traditional Saraya, Mutmuria, etc. types in several trials are Belle Patna (in 5 trials) and Blue Belle (in 3). As shown in Table 2 (the trials in question were all of Set A) Belle Patna appears only marginally higher yielding then Mutmuria (b) and Saraya 3 Month and although Blue Belle appeared a little better again this was quite without statistical significance.

Several recently introduced varieties gave excellent yields in the 1972 Koronivia trial; but the two highest yielding (over 4 mt/ha), named Hamsa and Mudgo, both have rather poor grain quality.

OTHER TRIALS

A 2N x 2P x 2K factorial trial was repeated at Sigatoka and Dobuilevu. The soil in each case was alluvial, and the variety IR5 in rows 23cm apart. Because of dry weather mean yields were low: 1.63 and 1.17 mt/ha at Sigatoka and Dobuilevu respectively. The main effects of P and K were small on average, inconsistent between sites, and statistically non-significant; but N applied at 56 Kg/ha, in the form of urea, half at 3-4 weeks after sowing and half at panicle initiation stage gave the following effects.

	Response to N, Kg/ha
Sigatoka	+ 560 (± 172)
Dobuilevu	+ 320 (± 90)

Six trials (two at Koronivia using IR5, and two at Sigatoka and one at Dobuilevu with IR5) during 1969-1972 compared three rates of N application (Nil, 56, and 112 Kg N/ha) the two higher of which were each applied at three different times (early, late, and split) to give seven treatment combinations which were fully rendomized in three blocks in each trial. The Dobuilevu trial failed. The results of the others are given in Annual Reports (5, 6, 10). Overall the higher rate of N gave significantly lower yield than the lower rate: 3.10 mt/ha as compared with 3.28 mt/ha, ± 0.065 in each case. The yields at the various times of application of the lower rate, compared with applying more are shown in Table 3. Early application is significantly better than late, with split application intermediate.

There were two spacing x variety factorial trials in the period under review. One in 1970 gave a result somewhat inconsistent with previous work, in that all the varieties in the trial, whether dwarf or tall, yielded best at the close spacing; but mean yields were low and errors high. A higher yielding, more reliable trial the next year gave results, as detailed in (3) in full conformity with previous results.

They can be summarized as follows:

	9" Rows	18" Rows	
	Yield, mt/ha		
Dwarf varieties	2.52	2.00	
			±0.053
Tall varieties	1.70	1.82	

DISCUSSION AND CONCLUSIONS

Applicability of results

Probably about half the dry-land rice in Fiji is grown as a catch crop between sugar cane crops, in the dry zone of the trials described, those at Sigatoka and Dobuilevu were on the fringe of the cane growing area but otherwise had little relevance to this category of dry-land rice cultivation. In particular, very short term varieties are essential for this catch cropping, and in the variety trials no introduced short term varieties appeared better all-round (taking quality into account) than the varieties traditionally used by cane farmers.

TABLE 3

RESULTS OF RATES AND TIMES OF N APPLICATION

Mean yield of five trials mt/ha.	
No nitrogen	2.77
56 Kg N/ha applied 3-4 weeks after sowing	3.49
56 Kg N/ha applied at panicle initiation stage.	3.05
56 Kg N/ha aplied half yearly, half late	3.30
SE ±	0.11

The trials at Sigatoka and Koronivia, however, were in conditions well representative of the second main category of dry-land rice cultivation recognized by Vernon (11) i.e. summer rice grown on well drained land by farmers, around Nausori and in the Sigatoka valley, whose main cash crop is winter vegetables. No trials were in conditions of Vernon's other two categories i.e. on badly drained soil, unsuitable for other crops, and subsistence cropping in remote areas.

Advances

The fertilizer and spacing trials substantially did little more than confirm previous results. The important advance during the period was the demonstration of the superiority of C4-63 leading to its recommendation to farmers under the name Sautu. There have been few direct comparisons of Sautu with the best of the traditional varieties, BG79(75) but the 25% superiority of IR5 over BG79(75) in one set of trials together with the 20% superiority of Sautu over IR5 in another set, tentatively suggests that Sautu may be about 50% higher yielding than the traditional varieties.

Concluding position

At the end of the period under review no changes in traditional practice were being recommended for sugar cane rice catch cropping except in so far as any of these farmers found the 130-day maturity of Sautu acceptable.

Otherwise the growing of Sautu, sown during December-January, using seed treated with Maneb or Difolotan fungicide was recommended, sowing 90 Kg seed per hectare, either by broadcasting or by drilling at 23cm row spacing, and applying 28 Kg N/ha 4 weeks after sowing, and repeating this 7 weeks later. Propanil, 2, 4-D and MCPA were recommended for weed control, Sevin to control army worms and leaf rollers, and malathion to control plant hoppers. Details of these recommendations, including some slight modifications in case of Mahsuri, an alternative recommended variety, was used or given in 'A package of practices for dry-land rice', Farmers Leaflet No. 84 of the Department of Agriculture, undated but drafted about the end of the period under review.

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APPENDIX — 1

List of varieties tested in dry-land rice variety trials at Dobuilevu, Sigatoka and and Koronivia Research Stations during 1968-72.

(A) Short Duration (Early Maturing) varieties:

(a) Standard varieties:

Saraya 3 Month	Mutmuria A
Saraya 4 Month	Mutmuria B
Rani	Mutmuria C

(b) Introduced varieties:

Blue Belle	G 50778
Belle Patna	G 51082
Blue Bonnet	G 51083
Nova	IR110-1-1-2 (2231)
Krishna	IR140-136-2 (2248)
Ratna	IR159-B-6-3-1 (2052)
Vijaya	IR159-B-6-2-1 (2051)
Bala	IR178-118-3-3-2-1B-1B (2350)
Hamsa	IR532-1-14 (2186)
Mudgo	IR579-48-1
H.7	IR747-7-2
G 50683	IR747-B2-6-3
G 50771	IR1154-243-1
G 50774	
G 50775	CP-231 x SLO-17 (2215)
G 50776	

(B) Medium Duration Varieties:

(a) Standard varieties:

BG79(75)
New Guinea
Sonacalif

(b) Introduced varieties:

Taichung (N) I	IR127-35-2-3
Milfor 6(2)	IR127-46-2-1-1
Mahsuri	IR140-136
Palawan	IR154-54-2-2
Azucena	IR154-61-1-1
FK135	IR160-25-1-1
Arkrose x Blue Bonnet	IR160-27-4-1
Malinja	IR160-34-2-2
Peta	IR184-49-1-3-3
Bahagia	IR227-13-5-1-1
B. H. Creole	IR239-149-1 (2235)
Kadinga	IR276-23-1-2-3-3
C4-63 (Sautu)	IR277-13-5-1-1
IR5	IR334-26-10
IR8	IR400-5-12-10-2
IR9	IR430-303
IR20	IR454-1-17-1
IR22	IR480-5-9-2 (Ajral)
IR48	IR532-E447 (2185)
IR61-10-6-2-2-1	IR574-100
IR117-41-3-2	IR579-80-2-1
IR127-22-1-2-2	IR580-E467-354
IR580-E470-375	IR665-58
IR589-30-2-2	IR665-8-3
IR589-42-1-1	67-1050
IR589-65-5	CR36-148
IR589-65-5-1	
IR589-66-4-2	
IR589-81-2-3	

APPENDIX — 2

RESULTS OF THE TRIAL CONDUCTED IN 1970 AT SIGATOKA RESEARCH STATION

Variety	mt/ha
IR9	3.78
IR8	3.46
IR5	2.80
Palawan	2.15
Taichung (N.) I	1.57
Blue Belle	1.52
Azucena	1.32
Saraya 3 Month	1.30
Mutmuria B	1.21
Arkrose x B. bonnet	1.09
Bella Patna	1.07
Mutmuria A	0.94
FKI 35	0.92
BG79(75)	0.85
Sonacalif	0.67
Rani	0.58
Saraya 4 Month	0.52
New Guinea	0.43
S.E. ±	0.25

TECHNICAL NOTES

THE WATER SOLUBLE CONSTITUENTS OF *SYZYGIUM CORYNOCARPUM* FROM FIJI

The small tree *Syzygium corynocarpum* (A. Gray) C. Muell (Fijian name — ulala; Tongan name — hehea) a member of the Myrtaceae family, has been reported to be used in Tongan folkmedicine as a general tonic and as a cure for breast tumours (1, 2), although no reports have been found of its use in Fijian folkmedicine.

No previous chemical studies on this plant have been reported and this work arose because during a programme of screening plants from Fiji for antibacterial activity, an aqueous extract of the leaves of *S. corynocarpum* was found to inhibit the growth of *Staphylococcus aureus* on agar plates.

Extraction of leaves (450g) with ethanol at room temperature yielded a biologically active extract (56g). Partitioning the extract by dissolving in water and extraction with n-butanol left a water soluble fraction (21g), which retained the activity.

This fraction was acidic and continuous extraction of a sample (13g) with ethyl acetate gave an acid fraction (4.4g) and left a neutral aqueous residue. The aqueous residue contained mainly sucrose, which was identified by conversion to the octaacetate and its comparison by infrared spectroscopy and thin layer chromatography with an authentic sample. Paper chromatography of the acid fraction (solvent butanol: water: acetic acid — 14:5:1) showed the presence of citric acid (R_F 0.67) as the major component together with malic acid (R_F 0.80) and lactic acid (R_F 0.98). In each case the hydroxy-acid was detected by spraying with potassium permanganate solution or by spraying with bromocresol green and the R_F values were identical with those of authentic samples.

On treatment with ether the acid fraction crystallised to give citric acid, whose structure was confirmed by nuclear magnetic resonance spectroscopy (solvent CD_3OD, chemical shift from TMS 2.89, 2.80 ppm, q,J_{AB} = 15 Hz).

Hydroxy-acids have been shown to inhibit the growth of micro-organisms by depressing the pH of the medium (3) and their concentration in these extracts is sufficient to be responsible for the positive anti-microbial bioassay.

As well as the plant from Fiji, specimens were obtained from Tonga but extracts of these showed no antibiotic activity and the extracts contained only traces of acids. Differences in the shape of the leaves suggest that the Tongan specimens could be a different variety, and the chemical differences support this.

The author wishes to thank Mrs. Siwatibau and the Tongan Department of Agriculture for botanical specimens, Dr. D. B. Nedwell for bioassays and Mr. R. W. Rickards of the Australian National University for nmr spectra.

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THE ESSENTIAL OIL OF THE MEDICINAL PLANT *COLEUS AMBOINICUS* FROM FIJI

Coleus amboinicus Lour. (Labiatae), common name Sage, has been reported to be used in folkmedicine in the Pacific and S. E. Asia (1). In particular the vapour from the leaves is recommended in cases of chest colds. Previous workers have examined plants from Java (2) and reported the presence of carvacol which they considered to be the active component. As the smell of the leaves suggested the presence of additional compounds this work was undertaken to examine the essential oil in more detail.

Leaves of *Coleus amboinicus* were steam distilled and the aqueous distillate was extracted with ether. The ethereal solution was examined by gas liquid chromatography on a column of MS 200/12500 on Chromosorb G. AW-DCMS (8:92) at 170°C using a Perkin Elmer F11 gas chromatograph fitted with dual glass columns and flame ionisation detectors.

The chromatogram showed the presence of only two major volatile components with retention times of 1.3 min and 2.3 min in roughly equal amounts. Limonene was identified from its g.l.c. properties as one of the trace components. The two major compounds were isolated by thin layer chromatography on Kieselgel GF_{254} (solvent-chloroform) and were identified respectively as camphor (R_F 0.5) and carvacol (R_F 0.6) by comparison with authentic samples by g.l.c. and infrared spectroscopy. Both compounds are well known in the treatment of chest colds.

The author wishes to thank Mrs. S. Siwatibau for the identification of plant material.

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