ANNUAL RESEARCH REPORT

OF THE

PAPUA NEW GUINEA OIL PALM RESEARCH ASSOCIATION

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I. ISLANDS REGION AGRONOMY TRIALS

(I.Orrell)

Trial 107 RESPONSE TO FERTILISER OF MATURE SECOND GENERATION PALMS AT BEBERE PLANTATION.

PURPOSE

To provide information about the responses of oil palm to fertiliser, that will be used in making fertiliser recommendations.

DESCRIPTION

Site Fields D8 and D9, Bebere Plantation.

Soil Young, coarse textured, freely draining, formed on alluvially redeposited pumiceous sands, gravel and volcanic ash.

Palms Dami commercial DxP crosses.
Planted in January 1983 at 135 palms/ha.
Treatments started in January 1984.

DESIGN

There are 72 treatments, comprising all factorial combinations of N and P at three levels and K, Mg, and Cl each at two levels (Table 1).

Table 1. Rates of fertilizer used in trial 107

	Feb 85 -Dec 88			From Jan 89		
	Level			Level		
	0	1	2	0	1	2
	(kg/palm/yr)			(kg/palm/yr)		
Ammonium sulphate (SoA)	0.0	1.0	2.0	0.0	2.0	4.0
Triple Superphosphate (TSP)	0.0	0.5	1.0	0.0	1.0	2.0
Sulphate of Potash (SoP)	0.0	1.8	-	0.0	3.6	-
Kieserite (Kies)	0.0	2.0	-	0.0	3.0	-
Sodium chloride (NaCl)	-	-	-	0.0	4.0	-

Note: Treatments are factorial combinations of levels of these fertilisers.
Ammonium sulphate & sulphate of potash are applied as two equal doses per year.

There are 72 plots, each consisting of 36 palms of which the central 16 are recorded. The recorded palms are of 16 identified progenies arranged in a fixed spatial configuration in each plot.

The 72 treatments are replicated only once and are randomised amongst the 72 plots. High order interactions provide the error term in the statistical analysis.

At three months after planting all palms received 0.25 kg ammonium sulphate and nothing else during the first twelve months.

At 12 months (January 1984) half of the plots were given an application of ammonium sulphate (1 kg/palm) as a treatment (establishment nitrogen).

The treatments that are described in Table 1 were started in February 1985 and modified in 1989. The sodium chloride treatment that was started in 1989 is applied orthogonally over the earlier establishment nitrogen treatment. Its purpose is to see whether a deficiency of chlorine is limiting the yield or affecting the response to other fertilisers.

Frond 17 Leaflet and rachis tissue was sampled for chemical analysis in August 1994.

RESULTS

The average plot yield in Trial 107 in 1994 was 23.4 tonnes FFB/ha. This is considerably lower than the average plot yield in 1993 which was 27.0 tonnes FFB/ha. Other trial sites in this area tended to produce higher yields in 1994 than previously.

The FFB yield in 1994 was increased by application of ammonium sulphate (Table 2), however this is a trend only and is not significant at $p<0.05$. The marked response to application of ammonium sulphate that had developed since 1991 has decreased (Table 3). The reason for the lower yields and reduced response to ammonium sulphate application is not apparent, however it is unlikely to be due to nutritional factors.

The aggregated data from January 1992 to December 1994 reflects the significant increase in FFB yield brought about by ammonium sulphate application (Table 4).

Leaflet and rachis tissue were sampled for analysis in August 1994.

Leaflet and rachis nitrogen concentrations were increased by application of ammonium sulphate (Table 5 and 6). Over the full range of application rates, there was an increase in leaflet nitrogen concentration of 0.04 percentage points nitrogen per kg ammonium sulphate applied. No other fertiliser type affected the leaflet or rachis nitrogen concentration.

The concentration of phosphorus in rachis tissue was increased by application of triple superphosphate, however there was no significant increase in the concentration of phosphorus in leaflet tissue. The concentration of phosphorus in leaflet tissue was increased by application of ammonium sulphate whereas the concentration of phosphorus in rachis tissue was markedly reduced.

Table 2. Main effects of N, P, K and Mg on yield and yield components in 1994 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	22.6	23.5	24.1		0.812	12.0
Bunches/ha	1749	1714	1805		92.7	18.3
Bunch weight (kg)	13.2	14.0	13.6		0.639	16.3
	P0	P1	P2			
Yield (t/ha/yr)	23.2	23.0	24.0		0.812	12.0
Bunches/ha	1801	1716	1750		92.7	18.3
Bunch weight (kg)	13.2	13.6	14.0		0.639	16.3
	K0	K1				
Yield (t/ha/yr)	23.2	23.6			0.663	12.0
Bunches/ha	1734	1777			75.7	18.3
Bunch weight (kg)	13.6	13.5			0.552	16.3
	Mg0	Mg1				
Yield (t/ha/yr)	23.5	23.2			0.663	12.0
Bunches/ha	1791	1720			75.7	18.3
Bunch weight (kg)	13.5	13.7			0.552	16.3
	Cl0	Cl1				
Yield (t/ha/yr)	23.2	23.5			0.663	12.0
Bunches/ha	1783	1728			75.7	18.3
Bunch weight (kg)	13.3	13.9			0.552	16.3

Table 3. FFB yield response to nitrogen application from 1986 to 1993 (Trial 107).

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Age (from planting)	4	5	6	7	8	9	10	11	12
N0	17.3	24.2	25.9	26.3	27.9	23.5	24.9	24.5	22.6
N1	17.0	25.4	25.9	27.8	28.6	23.9	27.0	27.4	23.5
N2	17.8	25.3	26.1	28.0	28.1	23.4	27.0	29.0	24.1
significance	ns	ns	ns	*	ns	ns	*	***	ns

The concentration of potassium in rachis tissue was increased by application of triple superphosphate. Triple superphosphate had no significant effect on the concentration of potassium in leaflet tissue.

Application of sulphate of potash has had no statistically significant effect on the concentrations of potassium in leaflet or rachis tissue, however application of sulphate of potash appears to decrease the leaflet, and increase the rachis concentrations of potassium.

Table 4. Main effects of N, P, K, Mg and Cl on yield and yield components from 1992 to 1994 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	24.0	26.0	26.8	***	0.660	8.9
Bunches/ha	1301	1355	1400	*L	43.8	11.2
Bunch weight (kg)	18.5	19.2	19.2		0.492	9.0
	P0	P1	P2			
Yield (t/ha/yr)	25.1	25.7	25.8		0.660	8.9
Bunches/ha	1357	1353	1346		43.8	11.2
Bunch weight (kg)	18.6	19.1	19.3		0.492	9.0
	K0	K1				
Yield (t/ha/yr)	25.5	25.6			0.539	8.9
Bunches/ha	1349	1355			35.8	11.2
Bunch weight (kg)	19.0	19.0			0.401	9.0
	Mg0	Mg0				
Yield (t/ha/yr)	25.4	25.7			0.539	8.9
Bunches/ha	1362	1342			35.8	11.2
Bunch weight (kg)	18.8	19.2			0.401	9.0
	Cl0	Cl1				
Yield (t/ha/yr)	25.3	25.8			0.539	8.9
Bunches/ha	1361	1343			35.8	11.2
Bunch weight (kg)	18.7	19.3			0.401	9.0

The concentrations of magnesium in leaflet and rachis tissue were decreased by application of ammonium sulphate. Application of kieserite increased the concentration of magnesium in leaflet and rachis tissue. There was no significant interaction between ammonium sulphate and kieserite application, kieserite does not prevent the decrease in magnesium concentration caused by ammonium sulphate application. Application of sodium chloride increased the concentration of magnesium in rachis tissue.

The calcium concentration in leaflet and rachis tissue was increased by the application of sodium chloride. Application of kieserite reduced the concentration of calcium in rachis tissue. Kieserite also reduced the concentration of calcium in leaflet tissue but this effect was not statistically significant.

The concentration of chlorine in rachis and leaflet tissue was increased by application of sodium chloride. The concentration of chlorine in the samples from the zero chlorine plots were much higher than would be expected of palms that had never received chlorine containing fertilisers. This indicates a significant effect of interplot poaching of nutrient elements. Trial 107 along with other trials will have plot isolation trenching constructed in 1995 to help overcome interplot poaching of applied nutrients.

Table 5. Treatment main effects on leaflet nutrient concentrations in 1994 (Trial 107).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.22	2.31	2.34	***	0.024	3.6
Phosphorus	0.139	0.142	0.142	*	0.001	2.4
Potassium	0.70	0.73	0.71		0.019	9.2
Calcium	0.79	0.77	0.76		0.016	7.1
Magnesium	0.19	0.17	0.16	***	0.005	10.1
Chlorine	0.46	0.45	0.44		0.027	20.9
	P0	P1	P2			
Nitrogen	2.28	2.29	2.30		0.024	3.6
Phosphorus	0.141	0.141	0.142		0.001	2.4
Potassium	0.73	0.69	0.72		0.019	9.2
Calcium	0.77	0.75	0.79		0.016	7.1
Magnesium	0.18	0.17	0.18		0.005	10.1
Chlorine	0.43	0.47	0.46		0.027	20.9
	K0	K1				
Nitrogen	2.29	2.29			0.019	3.6
Phosphorus	0.141	0.141			0.001	2.4
Potassium	0.72	0.71			0.015	9.2
Calcium	0.76	0.79		*	0.013	7.1
Magnesium	0.17	0.18			0.004	10.1
Chlorine	0.45	0.46			0.022	20.9
	Mg0	Mg1				
Nitrogen	2.30	2.29			0.019	3.6
Phosphorus	0.141	0.142			0.001	2.4
Potassium	0.72	0.71			0.015	9.2
Calcium	0.79	0.76			0.013	7.1
Magnesium	0.16	0.19		***	0.004	10.1
Chlorine	0.44	0.47			0.022	20.9
	Cl0	Cl1				
Nitrogen	2.29	2.30			0.019	3.6
Phosphorus	0.141	0.141			0.001	2.4
Potassium	0.73	0.70			0.015	9.2
Calcium	0.75	0.80		***	0.013	7.1
Magnesium	0.17	0.18			0.004	10.1
Chlorine	0.43	0.48		*	0.022	20.9

Table 6. Treatment main effects on rachis nutrient concentrations in 1994 (Trial 107).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.22	0.24	0.25	***	0.007	9.5
Phosphorus	0.132	0.095	0.077	***	0.007	24.0
Potassium	1.58	1.51	1.51		0.038	8.5
Calcium	0.38	0.36	0.37		0.011	10.1
Magnesium	0.051	0.046	0.046	***	0.001	8.9
Chlorine	0.64	0.57	0.55		0.062	36.7
	P0	P1	P2			
Nitrogen	0.24	0.24	0.24		0.007	9.5
Phosphorus	0.093	0.099	0.113	*	0.007	24.0
Potassium	1.49	1.53	1.58	*L	0.038	8.5
Calcium	0.36	0.37	0.38		0.011	10.1
Magnesium	0.046	0.048	0.049	*L	0.001	8.9
Chlorine	0.53	0.59	0.65		0.062	36.7
	K0	K1				
Nitrogen	0.24	0.24			0.005	9.5
Phosphorus	0.099	0.104			0.006	24.0
Potassium	1.51	1.56			0.031	8.5
Calcium	0.37	0.37			0.009	10.1
Magnesium	0.048	0.047			0.001	8.9
Chlorine	0.59	0.58			0.051	36.7
	Mg0	Mg1				
Nitrogen	0.24	0.24			0.005	9.5
Phosphorus	0.098	0.105			0.006	24.0
Potassium	1.52	1.55			0.031	8.5
Calcium	0.38	0.36		*	0.009	10.1
Magnesium	0.044	0.052		***	0.001	8.9
Chlorine	0.56	0.61			0.051	36.7
	Cl0	Cl1				
Nitrogen	0.24	0.24			0.005	9.5
Phosphorus	0.098	0.104			0.006	24.0
Potassium	1.52	1.55			0.031	8.5
Calcium	0.36	0.38		**	0.009	10.1
Magnesium	0.045	0.050		***	0.001	8.9
Chlorine	0.51	0.67		**	0.051	36.7

Trial 119 NITROGEN/ANION FERTILISER TRIAL AT MALILIMI PLANTATION.

PURPOSE

To investigate the response of oil palm to the application of various combinations of inorganic fertiliser with a view to providing information that will be useful in developing fertiliser recommendations.

DESCRIPTION

Site	Malilimi Plantation, Fields A7 and A8.
Soil	Young coarse textured freely draining soils formed on alluvially reworked andesitic pumiceous sands and gravel with some intermixed volcanic ash.
Palms	Dami commercial DxP crosses. Planted in October 1985 at 135 palms/ha. Treatments started in May 1989.

DESIGN

There are twelve treatments (Table 7), made up from muriate of potash or kieserite (or neither of these) combined with nitrogen from one of three sources (or no nitrogen). The three nitrogen sources are: diammonium phosphate, ammonium sulphate, and ammonium chloride. The twelve treatments are replicated in four randomised complete blocks, giving a total of 48 plots. Each plot has 36 palms of which the central 16 are recorded.

Table 7. Rates of fertilisers, and resulting combinations of elements used in Trial 119. (Treatment numbers are in brackets.)

	Nil	Muriate of potash	Kieserite
Nil	--- (1)	K+Cl (5)	Mg+S (9)
Diammonium phosphate	N+P (2)	N+P+K+Cl (6)	N+P+Mg+S (10)
Ammonium sulphate	N+S (3)	N+S+K+Cl (7)	N+2S+Mg (11)
Ammonium chloride	N+Cl (4)	N+2Cl+K (8)	N+Cl+Mg+S (12)

Diammonium phosphate = 3.9 kg palm^{-1} year^{-1}
Ammonium sulphate = 3.8 kg palm^{-1} year^{-1}
Ammonium chloride = 3.0 kg palm^{-1} year^{-1}
Muriate of potash = 4.2 kg palm^{-1} year^{-1}
Kieserite = 3.7 kg palm^{-1} year^{-1}

RESULTS

The average plot yield in 1994 was high at 31.99 t/ha/year.

The overall treatment effects on single bunch weight was significant (Table 8), however the overall treatment effect on yield and number of bunches produced in 1994 was not significant. In the cumulative data for 1992 to 1994 the overall treatment effects were only significant for the components of yield ie number s of bunches and single bunch weight, the effect on FFB yield was not significant.

In 1994, application of kieserite in the presence of nitrogen fertilisers increased the FFB yield (Table 9). The same effect was observed in the absence of nitrogen fertiliser, however this effect was not statistically significant. The chloride containing fertilisers, ammonium chloride and muriate of potash, increased the single bunch weight. The application of muriate of potash in the absence of nitrogen fertiliser also significantly reduced the number of bunches produced.

From the cumulative yield data for 1992 to 1994, the chloride containing fertilisers, ammonium chloride and muriate of potash, increased the single bunch weight. Ammonium chloride in the absence of base fertilisers also significantly reduced the number of bunches produced. Kieserite applied in the presence of nitrogen fertiliser increased the FFB yield by increasing the single bunch weight.

Although general conclusions are difficult, it would appear that I) chlorine containing fertilisers increase the single bunch weight, possibly by increasing bunch moisture content, ii) chlorine containing fertilisers especially ammonium chloride tend to reduce the numbers of bunches produced, iii) plot yield in this trial are high even in the control plots, is unlikely that there are any limiting nutrients at this site.

Table 8. Effect of fertiliser treatments on yield and yield components in 1994 and 1992 to 1994 (Trial 119).

	Treatment	1994			1992 to 1994		
		Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)
1	Nil	30.0	1504	20.0	30.5	1810	16.9
2	DAP	33.0	1719	19.2	33.6	2048	16.4
3	SoA	30.1	1598	19.0	31.8	1965	16.3
4	AC	32.2	1509	21.4	31.8	1775	18.0
5	MoP	31.9	1431	22.3	33.9	1805	18.8
6	MoP + DAP	32.3	1549	20.9	34.5	1893	18.3
7	MoP + SoA	32.2	1536	21.1	34.6	1942	17.9
8	MoP + AC	30.2	1361	22.2	30.9	1643	18.8
9	Kies	32.1	1550	20.8	32.0	1833	17.5
10	Kies + DAP	34.3	1638	21.0	34.9	1944	18.0
11	Kies + SoA	31.6	1631	19.4	32.1	1874	17.2
12	Kies + AC	34.1	1553	22.0	33.1	1742	19.0
	significance	ns	ns	**	ns	*	**
	sed	1.826	95.8	0.841	1.414	100.2	0.677
	cv%	7.9	8.5	5.6	5.9	7.5	5.3

Table 9. Treatment contrasts for yield and yield components (Trial 119)

	CONTRAST	1994						1992 to 1994					
		Yield (t/ha/yr)		Bunch Number		SBW (kg)		Yield (t/ha/yr)		Bunch Number		SBW (kg)	
1	- N (- K & Mg)	30.0		1504		20.0		30.5		1810		16.9	
	+ N (- K & Mg)	31.8		1609		19.8		32.4		1929		16.9	
2	DAP + SoA (- K & Mg)	31.5		1659		19.1	**	32.7		2007	**	16.4	**
	AmC (- K & Mg)	32.2		1509		21.4		31.8		1775		18.0	
3	DAP (- K & Mg)	33.0		1719		19.2		33.6		2048		16.4	
	SoA (- K & Mg)	30.1		1598		19.0		31.8		1965		16.3	
4	- Mg (- N)	30.0		1504		20.0		30.5		1810		16.9	
	+ Mg (- N)	32.1		1550		20.8		32.0		1833		17.5	
5	- Mg (+ N)	31.8	*	1609		19.8		32.4	*	1929		16.9	**
	+ Mg (+ N)	33.3		1607		20.8		33.4		1853		18.1	
6	- K (- N)	30.0		1504	*	20.0	**	30.5		1810		16.9	*
	+ K (- N)	31.9		1431		22.3		33.9		1805		18.8	
7	- K (+ N)	31.8		1609		19.8	*	32.4		1929		16.9	*
	+ K (+ N)	31.5		1482		21.4		33.4		1826		18.3	

The overall treatment effects on all measured frond 17 leaflet (Table 10) and rachis (Table 11) nutrient concentrations, except for rachis nitrogen, were significant.

The application of ammonium nitrogen fertilisers increased the leaflet (Table 12) and rachis (Table 13) concentrations of nitrogen. This effect was more pronounced in the leaflet tissue.

The leaflet and rachis concentrations of phosphorus were increased by application of diammonium phosphate compared to ammonium sulphate. The application of muriate of potash in the presence of the ammonium fertilisers increased the concentration of phosphorus in rachis tissue, this effect was not evident in the leaflet tissue.

The ammonium fertilisers, especially ammonium chloride, reduced the concentration of potassium in the leaflet tissue. In contrast in the rachis tissue, ammonium chloride and ammonium sulphate increased the concentration of potassium. Similarly, muriate of potash increased the concentration of potassium in the leaflet tissue, however this could only be show to be statistically significant in the presence of the nitrogen fertilisers (this is probably a function of the analysis). Muriate of potash markedly increased the concentration of potassium in the rachis tissue.

The concentration of magnesium in the rachis tissue was increased by application of ammonium chloride. Kieserite application in the presence of the nitrogen fertilisers increased the concentration of magnesium in the leaflet and rachis tissue. The same effect was observed in the absence of nitrogen fertiliser, however this was only statistically significant in the leaflet tissue.

The concentration of calcium in the leaflet and rachis tissue was increased by application of muriate of potash. Ammonium chloride application increased the concentration of calcium in the rachis tissue. Application of kieserite decreased the concentration of calcium in the leaflet and rachis tissue.

The concentration of chlorine in leaflet and rachis tissue was increased by application of chlorine containing fertilisers.

Table 10. Effect of fertiliser treatments on frond 17 leaflet nutrient concentrations in 1994 (Trial 119).

		Element as % of leaflet dry matter					
		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	2.41	0.148	0.81	0.18	0.86	0.13
2	DAP	2.53	0.155	0.78	0.17	0.91	0.21
3	SoA	2.45	0.147	0.79	0.18	0.94	0.26
4	AC	2.53	0.149	0.67	0.17	0.95	0.54
5	MoP	2.49	0.149	0.75	0.18	1.01	0.41
6	MoP + DAP	2.54	0.153	0.68	0.15	1.03	0.53
7	MoP + SoA	2.45	0.147	0.75	0.16	1.00	0.45
8	MoP + AC	2.48	0.150	0.69	0.15	0.96	0.56
9	Kies	2.50	0.146	0.77	0.19	0.89	0.14
10	Kies + DAP	2.47	0.153	0.76	0.20	0.83	0.12
11	Kies + SoA	2.54	0.152	0.80	0.18	0.86	0.26
12	Kies + AC	2.50	0.148	0.73	0.19	0.85	0.43
	significance	*	*	**	***	**	***
	sed	0.038	0.0025	0.035	0.010	0.050	0.108
	cv%	2.2	2.4	6.6	8.4	7.7	45.4

Table 11. Effect of fertiliser treatments on frond 17 rachis nutrient concentrations in 1994 (Trial 119).

		Element as % of rachis dry matter					
		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	0.22	0.041	0.94	0.035	0.37	0.04
2	DAP	0.24	0.050	0.82	0.038	0.34	0.04
3	SoA	0.24	0.041	1.00	0.038	0.36	0.06
4	AC	0.23	0.049	1.11	0.045	0.48	0.67
5	MoP	0.23	0.048	1.40	0.038	0.45	0.68
6	MoP + DAP	0.23	0.091	1.38	0.043	0.47	0.64
7	MoP + SoA	0.23	0.047	1.48	0.040	0.46	0.77
8	MoP + AC	0.24	0.053	1.40	0.035	0.44	0.85
9	Kies	0.23	0.039	0.94	0.038	0.34	0.04
10	Kies + DAP	0.23	0.054	0.91	0.043	0.34	0.05
11	Kies + SoA	0.24	0.041	1.00	0.038	0.34	0.05
12	Kies + AC	0.21	0.046	1.18	0.053	0.43	0.63
	significance	ns	***	***	***	***	***
	sed	0.010	0.005	0.092	0.004	0.022	0.054
	cv%	6.3	12.8	11.5	12.4	7.9	20.3

Table 12. Treatment contrasts for frond 17 leaflet nutrient concentrations (Trial 119).

	CONTRAST	Element as % of leaflet dry matter											
		Nitrogen		Phosphorus		Potassium		Magnesium		Calcium		Chlorine	
1	- N (- K & Mg)	2.41	**	0.148		0.81	*	0.18		0.86		0.13	*
	+ N (- K & Mg)	2.50		0.150		0.75		0.17		0.93		0.34	
2	DAP + SoA (- K & Mg)	2.49		0.151		0.78	***	0.17		0.92		0.23	**
	AmC (- K & Mg)	2.53		0.149		0.67		0.17		0.95		0.54	
3	DAP (- K & Mg)	2.53		0.155	**	0.78		0.17		0.91		0.21	
	SoA (- K & Mg)	2.45		0.147		0.79		0.18		0.94		0.26	
4	- Mg (- N)	2.41		0.148		0.81		0.18	*	0.86		0.13	
	+ Mg (- N)	2.50		0.146		0.77		0.19		0.89		0.14	
5	- Mg (+ N)	2.50		0.150		0.75		0.17	*	0.93	*	0.34	
	+ Mg (+ N)	2.50		0.151		0.76		0.19		0.85		0.27	
6	- K (- N)	2.41		0.148		0.81		0.18		0.86	**	0.13	
	+ K (- N)	2.49		0.149		0.75		0.18		1.01		0.41	
7	- K (+ N)	2.50		0.150		0.75	**	0.17	***	0.93	***	0.34	***
	+ K (+ N)	2.49		0.150		0.71		0.15		1.00		0.51	

Table 13. Treatment contrasts for frond 17 rachis nutrient concentrations (Trial 119).

	CONTRAST	Element as % of rachis dry matter											
		Nitrogen		Phosphorus		Potassium		Magnesium		Calcium		Chlorine	
1	- N (- K & Mg)	0.22	*	0.041		0.94		0.035		0.37		0.038	***
	+ N (- K & Mg)	0.24		0.046		0.98		0.040		0.39		0.253	
2	DAP + SoA (- K & Mg)	0.24		0.045		0.91	*	0.038	*	0.35	***	0.048	***
	AmC (- K & Mg)	0.23		0.049		1.11		0.045		0.48		0.665	
3	DAP (- K & Mg)	0.24		0.050	*	0.82	*	0.038		0.34		0.038	
	SoA (- K & Mg)	0.24		0.041		1.00		0.038		0.36		0.058	
4	- Mg (- N)	0.22		0.041		0.94		0.035		0.37	*	0.038	***
	+ Mg (- N)	0.23		0.039		0.94		0.038		0.34		0.043	
5	- Mg (+ N)	0.24		0.046		0.98		0.040	**	0.39		0.253	*
	+ Mg (+ N)	0.23		0.047		1.03		0.044		0.37		0.241	
6	- K (- N)	0.22		0.041		0.94	***	0.035		0.37	***	0.038	***
	+ K (- N)	0.23		0.048		1.40		0.038		0.45		0.678	
7	- K (+ N)	0.24		0.046	***	0.98	***	0.040		0.39	***	0.253	***
	+ K (+ N)	0.23		0.064		1.42		0.039		0.46		0.752	

Trial 120 NITROGEN/ANION FERTILISER TRIAL AT DAMI PLANTATION.

PURPOSE

To investigate the response of oil palm to the application of various combinations of inorganic fertiliser with a view to providing information that will be useful in developing fertiliser recommendations.

DESCRIPTION

Site Dami Plantation, Field 9.

Soil Young very coarse textured freely draining soils formed on alluvially reworked andesitic pumiceous sands and gravel.

Palms Dami commercial DxP crosses.
Planted in 1983 at 135 palms/ha.
Treatments started in April 1989.

DESIGN

There are twelve treatments (Table 14), made up from muriate of potash or kieserite (or neither of these) combined with nitrogen from one of three sources (or no nitrogen). The three nitrogen sources are: diammonium phosphate, ammonium sulphate, and ammonium chloride. The twelve treatments are replicated in four randomised complete blocks, giving a total of 48 plots. Each plot has 25 palms of which the central 9 are recorded.

Table 14. Rates of fertiliser and resulting combinations of elements used in Trial 120. (Treatment numbers are in brackets.)

	Nil	Muriate of potash	Kieserite
Nil	--- (1)	K+Cl (5)	Mg+S (9)
Diammonium phosphate	N+P (2)	N+P+K+Cl (6)	N+P+Mg+S (10)
Ammonium sulphate	N+S (3)	N+S+K+Cl (7)	N+2S+Mg (11)
Ammonium chloride	N+Cl (4)	N+2Cl+K (8)	N+Cl+Mg+S (12)

Diammonium phosphate = 3.9 kg $palm^{-1}$ $year^{-1}$
Ammonium sulphate = 3.8 kg $palm^{-1}$ $year^{-1}$
Ammonium chloride = 3.0 kg $palm^{-1}$ $year^{-1}$
Muriate of potash = 4.2 kg $palm^{-1}$ $year^{-1}$
Kieserite = 3.7 kg $palm^{-1}$ $year^{-1}$

RESULTS

The average plot FFB yield in 1994 was high at 28.5 t/ha/year.

The overall treatment effects for 1994 and the 1992 to 1994 cumulative data were not significant (Table 15). Despite this, partitioning of the treatment variance suggests that application of kieserite in the presence of the nitrogen fertilisers increased the FFB yield by increasing the number of bunches produced (Table 16).

Table 15. Effect of fertiliser treatments on yield and yield components in 1994 and 1992 to 1994 (Trial 120).

		1994			1992 to 1994		
	Treatment	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
1	Nil	27.6	1187	23.1	28.8	1354	21.2
2	DAP	28.0	1172	23.9	27.6	1309	21.1
3	SoA	24.0	1021	23.4	27.0	1235	21.9
4	AC	27.9	1168	23.8	30.0	1329	22.5
5	MoP	24.4	1066	23.0	28.9	1351	21.4
6	MoP + DAP	31.2	1250	25.0	30.7	1365	22.5
7	MoP + SoA	31.6	1350	23.4	30.2	1395	21.7
8	MoP + AC	28.3	1224	23.1	30.2	1416	21.4
9	Kies	28.0	1149	24.4	28.9	1333	21.8
10	Kies + DAP	30.1	1363	22.1	30.6	1468	20.9
11	Kies + SoA	30.3	1321	22.9	30.5	1402	21.8
12	Kies + AC	30.6	1236	24.6	30.8	1361	22.7
	significance	ns	ns	ns	ns	ns	ns
	sed	3.415	134.4	0.819	1.824	86.1	0.882
	cv%	16.7	15.5	4.9	8.6	8.8	5.7

The overall treatment variance had a significant effect on the concentrations of leaflet nitrogen, phosphorus, and chlorine (Table 17), and on the rachis phosphorus and chlorine concentrations (Table 18).

The leaflet and rachis concentrations of nitrogen was increased by the application of the ammonium nitrogen fertilisers. Application of kieserite in the presence of nitrogen fertilisers increased the concentration of nitrogen in the leaflet tissue.

The concentration of phosphorus in the rachis tissue was increased by application of diammonium phosphate.

The concentration of potassium in rachis tissue was increased by application of ammonium chloride and by application of muriate of potash. There were no significant treatment effects on leaflet potassium concentration.

The concentration of chlorine in leaflet and rachis tissue was increased by application of chlorine containing fertilisers.

Table 16. Treatment contrasts for yield and yield components (Trial 120)

	Contrast	1994 Yield (t/ha/yr)	1994 Bunch Number	1994 SBW (kg)	1992 to 1994 Yield (t/ha/yr)	1992 to 1994 Bunch Number	1992 to 1994 SBW (kg)
1	- N (- K & Mg)	27.6	1187	23.1	28.8	1354	21.2
	+ N (- K & Mg)	26.6	1120	23.7	28.2	1291	21.8
2	DAP + SoA (- K & Mg)	26.0	1097	23.7	27.3	1272	21.5
	AmC (- K & Mg)	27.9	1168	23.8	30.0	1329	22.5
3	DAP (- K & Mg)	28.0	1172	23.9	27.6	1309	21.1
	SoA (- K & Mg)	24.0	1021	23.4	27.0	1235	21.9
4	- Mg (- N)	27.6	1187	23.1	28.8	1354	21.2
	+ Mg (- N)	28.0	1149	24.4	28.9	1333	21.8
5	- Mg (+ N)	26.6	1120 *	23.7	28.2 *	1291 *	21.8
	+ Mg (+ N)	30.3	1307	23.2	30.6	1410	21.8
6	- K (- N)	27.6	1187	23.1	28.8	1354	21.2
	+ K (- N)	24.4	1066	23.0	28.9	1351	21.4
7	- K (+ N)	26.6	1120	23.7	28.2	1291	21.8
	+ K (+ N)	30.4	1275	23.9	30.4	1392	21.8

The application of muriate of potash increased the concentration of calcium in the leaflet and rachis tissue. The concentration of calcium in the rachis tissue was increased by application of ammonium sulphate. The application of kieserite in the presence of nitrogen fertiliser decreased the concentration of calcium in leaflet tissue.

Table 17. Effect of fertiliser treatments on frond 17 leaflet nutrient concentrations in 1994 (Trial 120).

		Element as % of leaflet dry matter					
		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	2.22	0.139	0.79	0.14	0.73	0.43
2	DAP	2.38	0.142	0.71	0.16	0.79	0.41
3	SoA	2.33	0.139	0.78	0.14	0.73	0.43
4	AC	2.35	0.144	0.76	0.13	0.75	0.52
5	MoP	2.29	0.138	0.71	0.13	0.78	0.56
6	MoP + DAP	2.42	0.144	0.81	0.14	0.77	0.56
7	MoP + SoA	2.33	0.138	0.80	0.13	0.76	0.55
8	MoP + AC	2.34	0.142	0.70	0.13	0.83	0.57
9	Kies	2.29	0.137	0.76	0.15	0.74	0.45
10	Kies + DAP	2.41	0.144	0.78	0.15	0.65	0.44
11	Kies + SoA	2.35	0.140	0.81	0.15	0.70	0.46
12	Kies + AC	2.35	0.139	0.73	0.14	0.68	0.52
	significance	*	*	ns	ns	ns	***
	sed	0.051	0.0026	0.050	0.014	0.052	0.042
	cv%	3.1	2.6	9.4	14.1	9.8	12.0

Table 18. Effect of fertiliser treatments on frond 17 rachis nutrient concentrations in 1994 (Trial 120).

		Element as % of rachis dry matter					
		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	0.23	0.063	1.62	0.045	0.41	0.53
2	DAP	0.26	0.086	1.51	0.043	0.40	0.54
3	SoA	0.28	0.063	1.71	0.040	0.43	0.60
4	AC	0.27	0.084	1.90	0.043	0.48	1.07
5	MoP	0.25	0.074	1.94	0.048	0.47	0.99
6	MoP + DAP	0.26	0.090	1.73	0.043	0.44	0.96
7	MoP + SoA	0.26	0.059	1.83	0.045	0.46	0.96
8	MoP + AC	0.27	0.074	1.73	0.045	0.45	1.01
9	Kies	0.25	0.073	1.65	0.048	0.42	0.61
10	Kies + DAP	0.27	0.085	1.75	0.048	0.39	0.69
11	Kies + SoA	0.27	0.066	1.88	0.045	0.41	0.87
12	Kies + AC	0.26	0.057	1.69	0.048	0.40	0.93
	significance	ns	**	ns	ns	ns	***
	sed	0.015	0.008	0.137	0.004	0.033	0.142
	cv%	8.0	16.0	11.1	11.5	10.8	24.7

Table 19. Treatment contrasts for frond 17 leaflet nutrient concentrations (Trial 120).

		Element as % of leaflet dry matter					
CONTRAST		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	- N (- K & Mg)	2.22 **	0.139	0.79	0.14	0.73	0.43
	+ N (- K & Mg)	2.35	0.142	0.75	0.14	0.76	0.45
2	DAP + SoA (- K & Mg)	2.35	0.141	0.74	0.15	0.76	0.42 **
	AmC (- K & Mg)	2.35	0.144	0.76	0.13	0.75	0.52
3	DAP (- K & Mg)	2.38	0.142	0.71	0.16	0.79	0.41
	SoA (- K & Mg)	2.33	0.139	0.78	0.14	0.73	0.43
4	- Mg (- N)	2.22	0.139 *	0.79	0.14	0.73	0.43
	+ Mg (- N)	2.29	0.137	0.76	0.15	0.74	0.45
5	- Mg (+ N)	2.35 *	0.142	0.75	0.14	0.76 **	0.45
	+ Mg (+ N)	2.37	0.141	0.77	0.15	0.67	0.47
6	- K (- N)	2.22	0.139	0.79	0.14	0.73	0.43 **
	+ K (- N)	2.29	0.138	0.71	0.13	0.78	0.56
7	- K (+ N)	2.35	0.142	0.75	0.14	0.76 *	0.45 ***
	+ K (+ N)	2.36	0.141	0.77	0.14	0.79	0.56

Table 20. Treatment contrasts for frond 17 rachis nutrient concentrations (Trial 120).

CONTRAST		Element as % of rachis dry matter											
		Nitrogen		Phosphorus		Potassium		Magnesium		Calcium		Chlorine	
1	- N (- K & Mg)	0.23	**	0.063	*	1.62		0.045		0.41		0.533	
	+ N (- K & Mg)	0.27		0.078		1.71		0.042		0.44		0.736	
2	DAP + SoA (- K & Mg)	0.27		0.074		1.61	*	0.041		0.41	*	0.568	***
	AmC (- K & Mg)	0.27		0.084		1.90		0.043		0.48		1.073	
3	DAP (- K & Mg)	0.26		0.086	**	1.51		0.043		0.40		0.540	
	SoA (- K & Mg)	0.28		0.063		1.71		0.040		0.43		0.595	
4	- Mg (- N)	0.23		0.063		1.62		0.045		0.41		0.533	
	+ Mg (- N)	0.25		0.073		1.65		0.048		0.42		0.608	
5	- Mg (+ N)	0.27		0.078		1.71		0.042		0.44		0.736	*
	+ Mg (+ N)	0.27		0.069		1.77		0.047		0.40		0.829	
6	- K (- N)	0.23		0.063		1.62	*	0.045		0.41	*	0.533	*
	+ K (- N)	0.25		0.074		1.94		0.048		0.47		0.990	
7	- K (+ N)	0.27		0.078		1.71		0.042		0.44		0.736	**
	+ K (+ N)	0.26		0.074		1.76		0.044		0.45		0.975	

Trial 122 NITROGEN AND CROP RESIDUE TRIAL AT KUMBANGO PLANTATION.

PURPOSE

To investigate the response of Oil Palm to applications of Empty Fruit Bunches (EFB), Palm Kernel Cake (PKC), pruned fronds and the combined application of these crop residues and inorganic nitrogen fertilizer. It is hoped that by integrating the application of inorganic fertilizer nitrogen and crop residue, the efficacy of fertilizer nitrogen application will be increased.

DESCRIPTION

Site Field number E12, Division II, Kumbango Plantation, Nr Kimbe, WNBP. The trial is situated about 1.5 km west of the Dagi River on its flat alluvial plain and about 6 km from the coast.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and gravel with intermixed volcanic ash.

Palms Dami commercial DxP crosses.
Planted in 1978 at 120 palms/ha.
Trial was initiated in November 1991, treatment applications started in July 1992.

DESIGN

The trial consists of 13 treatments (Table 21) in 4 randomised complete blocks. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 21. Treatments used in Trial 122.

Treatment Number	Crop Residue	Fertilizer Applied (kg/palm/yr)	Fertilizer Placement
1	Nil	3.0kg SoA & 3.0kg Kies	Weeded Circle
2	fronds	3.0kg SoA & 3.0kg Kies	Weeded Circle
3	fronds	3.0kg SoA & 3.0kg Kies	Frond Pile
4	fronds & EFB	3.0kg SoA & 3.0kg Kies	Weeded Circle
5	fronds & EFB	3.0kg SoA & 3.0kg Kies	Frond Pile
6	fronds & EFB	3.0kg SoA & 3.0kg Kies	EFB
7	fronds & PKC	3.0kg SoA & 3.0kg Kies	Weeded Circle
8	fronds & PKC	3.0kg SoA & 3.0kg Kies	Frond Pile
9	fronds & PKC	3.0kg SoA & 3.0kg Kies	PKC
10	Nil	Nil	Nil
11	fronds	Nil	Nil
12	fronds & EFB	Nil	Nil
13	fronds & PKC	Nil	Nil

The EFB is applied with a Giltrap EFB applicator at approximately 50 t/ha. The PKC is applied with a Kuhn spinning disc fertilizer spreader at a rate of 1.8 t/ha.

RESULTS

The overall treatment effect was statistically significant for FFB yield and single bunch weight in 1994 (Table 22).

The only trend emerging from the applied treatments in 1994 was that application of EFB produced the highest FFB yields (Table 24). The increase in yield brought about by application of EFB is largely due to increased single bunch weight (Table 26). The first treatment applications were made in July 1992, it is probably too early to expect treatments to cause significant changes in the numbers of bunches produced in 1994.

Table 22. Effects of treatments on yield and yield components in 1994 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	Number of Bunches/ha	Bunch weight (kg)
1	Nil	N + Mg	Weeded Circle	23.7	872	27.6
2	fronds	N + Mg	Weeded Circle	26.5	978	27.1
3	fronds	N + Mg	Frond Pile	24.6	866	28.4
4	fronds & EFB	N + Mg	Weeded Circle	28.8	914	31.6
5	fronds & EFB	N + Mg	Frond Pile	29.3	997	29.4
6	fronds & EFB	N + Mg	EFB	26.4	926	28.5
7	fronds & PKC	N + Mg	Weeded Circle	24.9	949	26.2
8	fronds & PKC	N + Mg	Frond Pile	23.6	804	29.4
9	fronds & PKC	N + Mg	PKC	27.6	947	29.2
10	Nil	Nil	Nil	27.0	987	27.2
11	fronds	Nil	Nil	25.1	884	28.6
12	fronds & EFB	Nil	Nil	29.9	965	31.0
13	fronds & PKC	Nil	Nil	23.9	924	26.1
			significance	**	ns	**
			sed	1.804	74.0	1.264
			cv%	9.7	11.3	6.3

Table 23. Effects of treatments on yield and yield components for 1993 and 1994 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	Number of Bunches/ha	Bunch weight (kg)
1	Nil	N + Mg	Weeded Circle	23.5	865	27.4
2	fronds	N + Mg	Weeded Circle	26.1	936	28.0
3	fronds	N + Mg	Frond Pile	23.5	831	28.3
4	fronds & EFB	N + Mg	Weeded Circle	28.0	896	31.3
5	fronds & EFB	N + Mg	Frond Pile	28.0	943	29.8
6	fronds & EFB	N + Mg	EFB	27.1	936	29.0
7	fronds & PKC	N + Mg	Weeded Circle	26.6	984	27.2
8	fronds & PKC	N + Mg	Frond Pile	24.7	832	29.7
9	fronds & PKC	N + Mg	PKC	27.4	929	29.6
10	Nil	Nil	Nil	26.8	965	27.7
11	fronds	Nil	Nil	25.1	879	28.6
12	fronds & EFB	Nil	Nil	28.0	922	30.5
13	fronds & PKC	Nil	Nil	25.8	951	27.4
			significance	*	ns	*
			sed	1.455	66.2	1.119
			cv%	7.9	10.3	5.5

Table 24. LSD pairwise comparisons of treatment means of FFB yield in 1994 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	
12	EFB + fronds	-	---	29.86	a
5	EFB + fronds	+	frond pile	29.33	a
4	EFB + fronds	+	weeded circle	28.79	a
9	PKC + fronds	+	PKC	27.55	a b
10	---	-	---	27.04	a b c
2	fronds	+	weeded circle	26.46	a b c
6	EFB + fronds	+	EFB	26.43	a b c
11	fronds	-	---	25.13	b c
7	PKC + fronds	+	weeded circle	24.90	b c
3	fronds	+	frond pile	24.60	b c
13	PKC + fronds	-	---	23.87	c
1	---	+	weeded circle	23.69	c
8	PKC + fronds	+	frond pile	23.62	c

Critical value for comparison: 3.658

Standard error for comparison: 1.8036

Rejection level: 0.05

There are 3 groups (a,b,& c) in which the means are not significantly different from one another.

Table 25. LSD pairwise comparisons of treatment means of numbers of bunches produced in 1994 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Number of Bunches/h a	
5	EFB + fronds	+	frond pile	997	a
10	---	-	---	987	a
2	fronds	+	weeded circle	978	a
12	EFB + fronds	-	---	965	a
7	PKC + fronds	+	weeded circle	949	a b
9	PKC + fronds	+	PKC	947	a b
6	EFB + fronds	+	EFB	926	a b
13	PKC + fronds	-	---	924	a b
4	EFB + fronds	+	weeded circle	914	a b
11	fronds	-	---	884	a b
1	---	+	weeded circle	872	a b
3	fronds	+	frond pile	866	a b
8	PKC + fronds	+	frond pile	804	b

Critical value for comparison: 150
Standard error for comparison: 74.04
Rejection level: 0.05
There are 2 groups (a & b) in which the means are not significantly different from one another.

Table 26. LSD pairwise comparisons of treatment means of single bunch weight in 1994 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Single Bunch Weight (kg)	
4	EFB + fronds	+	weeded circle	31.61	a
12	EFB + fronds	-	---	31.04	a b
5	EFB + fronds	+	frond pile	29.43	a b c
8	PKC + fronds	+	frond pile	29.39	a b c
9	PKC + fronds	+	PKC	29.16	a b c
11	fronds	-	---	28.64	b c d
6	EFB + fronds	+	EFB	28.53	b c d e
3	fronds	+	frond pile	28.44	c d e
1	---	+	weeded circle	27.55	c d e
10	---	-	---	27.24	c d e
2	fronds	+	weeded circle	27.13	c d e
7	PKC + fronds	+	weeded circle	26.21	d e
13	PKC + fronds	-	---	26.05	e

Critical value for comparison: 2.56
Standard error for comparison: 1.264
Rejection level: 0.05
There are 5 groups (a,b,c,d & e) in which the means are not significantly different from one another.

Trial 125 SOURCES OF NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.

PURPOSE

To investigate the relative effects of different types of nitrogen fertiliser available in PNG, on Oil Palm. Of particular interest is the effects of the various nitrogen fertilisers on potassium and magnesium nutrition. The results of the trial will be direct use in formulating fertiliser recommendations.

DESCRIPTION

Site: One or more of field numbers c4, c5 or c6 , Division ii, Kumbango Plantation, Nr Kimbe, WNBP.

Soil: Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and gravel with intermixed volcanic ash.

Palms: Dami commercial DxP crosses.
Planted in April & May 1993 at 135 palms/ha.
Treatment applications will start 36 months after planting.

DESIGN

The trial consists of 8 treatments (Table 27) with 8 replicates in 4 randomised complete blocks. Each block will contain 2 randomly allocated replicates, this allows the later inclusion a further treatment to one of the replicates. The provision to include a further treatment over the nitrogen fertiliser treatments is necessary to be able to extend the trial to accommodate any other nutrient deficiency that may occur. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 27. Fertiliser treatments to be used in Trial 125.

Treatment Number	Fertiliser Rate (kg/palm/yr)	Fertilizer Applied
1	0.00	Nil
2	0.00	Nil
3	4.00	Ammonium sulphate
4	3.00	Ammonium chloride
5	2.54	Ammonium nitrate
6	4.00	Diammonium phosphate
7	1.83	Urea
8	1.83 *plus* 3.00	Urea *plus* sodium chloride

Note: All nitrogen fertiliser rates apply the quantity of nitrogen element. The sodium chloride treatment applies the same quantity of chlorine as the ammonium chloride treatment.

PROGRESS

This trial was approved in the PNGOPRA Scientific Advisory Board meeting in November 1993.

The trial was physically initiated in 1994. Site selection, a detailed site survey and site mapping was carried out in May 1994. Plot and palm labelling was carried out in June 1994.

Experimental fertiliser treatments will only be started at 36 months after planting. Until this time the palms will receive a standard immature palm fertiliser input.

Frond 17 leaflet sampling was carried out for each plot in October 1994, and subsequently analysed for nutrient element content (Table 28). This analysis will be used as pre-treatment data for the control of residual variance in later statistical analysis. It should be noted that the whole site has been receiving an immature palm fertiliser schedule which comprises nitrogen and magnesium amelioration.

Table 28. Summary statistics for pre-treatment frond 17 leaflet tissue analysis (Trial 125).

Element	Values	Minimum	Mean	Maximum	Standard Deviation
Nitrogen	64	2.12	2.31	2.51	0.079
Phosphorus	64	0.132	0.143	0.156	0.004
Potassium	64	0.79	0.92	1.07	0.070
Magnesium	64	0.14	0.17	0.23	0.019
Calcium	64	0.84	1.01	1.22	0.083
Chlorine	64	0.24	0.35	0.48	0.054

Trial 126 FACTORIAL FERTILISER TRIAL AT MALILIMI PLANTATION.

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage. This trial was also designed to investigate further the yield responses seen in Trial 119, was the response to potassium or chlorine ?

DESCRIPTION

Site Malilimi Plantation, WNBP.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sand and volcanic ash. Palaeosols are common.

Palms Dami commercial DxP crosses.
Planted in 1985 at 120 palms/ha.
Treatments are to be started in May 1996.

DESIGN

There are 72 treatments comprising all factorial combinations of sulphate of potash (K), sulphate of ammonia (N) each at three levels and triple superphosphate (P), kieserite (Mg) and sodium chloride (Cl) each at two levels (Table 29). The 72 treatments will be replicated only once and will be divided among two blocks. The 3 factor interaction '2x2x2' will be partially confounded with blocks. Third and higher order interactions will provide the error term in the statistical analysis. Each of the 72 plots consists of 36 palms (6x6) of which the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 29. Fertiliser rates to be used in Trial 126.

Fertiliser	Level		
	0	1	2
	(kg/palm/year)		
Sulphate of potash	0.0	3	6.0
Sulphate of ammonia	0.0	3.0	6.0
Triple superphosphate	0.0	4.0	---
Kieserite	0.0	4.0	---
Sodium chloride	0.0	4.0	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The sulphate of ammonium and sulphate of potash will be split into two applications per year, while the other fertilisers are applied once per year.

PROGRESS

This trial was approved in the PNGOPRA Scientific Advisory Board meeting in November 1993.

The trial was physically initiated in 1994. Site selection, a detailed site survey and site mapping was carried out in May and June 1994. Plot selection was carried out in June 1994.

Experimental fertiliser treatments will start in May 1996.

Frond 17 leaflet sampling was carried out for each plot in December 1994, and subsequently analysed for nutrient element content (Table 30). This analysis will be used as pre-treatment data for the control of residual variance in later statistical analysis. It should be noted that the whole site has been receiving an immature palm fertiliser schedule which comprises nitrogen and magnesium amelioration.

Table 30. Summary statistics for pre-treatment frond 17 leaflet tissue analysis (Trial 126).

Element	Values	Minimum	Mean	Maximum	Standard Deviation
Nitrogen	72	2.26	2.39	2.58	0.057
Phosphorus	72	0.138	0.146	0.152	0.003
Potassium	72	0.65	0.81	0.95	0.065
Magnesium	72	0.09	0.13	0.18	0.018
Calcium	72	0.68	0.85	1.04	0.075
Chlorine	72	0.28	0.34	0.45	0.037

Trial 129 **SULPHATE OF AMMONIA AND UREA RATE RESPONSE TRIAL AT KUMBANGO PLANTATION.**

PURPOSE

This trial is a supplementary trial to Trial 125. Because of high ammonia volatilisation losses from applied urea and a rather different rate response on FFB yield, it was felt that the comparison of urea with other nitrogen fertilisers at a single application rate in Trial 125 could be difficult to interpret. This trial is designed to compare the rate response of urea on yield and other biological parameters with that of a standard inorganic nitrogen fertiliser (sulphate of ammonia).

DESCRIPTION

Site — One or more of field numbers c4, c5 or c6 , Division ii, Kumbango Plantation, Nr Kimbe, WNBP.

Soil — Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and gravel with intermixed volcanic ash.

Palms — Dami commercial DxP crosses.
Planted in April & May 1993 at 135 palms/ha.
Treatments will be started 36 months after planting.

DESIGN

Trial 129 consists of 8 treatments (Table 31) replicated in 5 randomised complete blocks. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 31. Fertiliser treatments used in Trial 129.

Treatment Number	Fertiliser Applied	Fertiliser Rate (kg/palm/year)
1	Nil	0.0
2	Nil	0.0
3	Urea	1.37
4	Urea	2.74
5	Urea	4.11
6	Sulphate of ammonia	3.0
7	Sulphate of ammonia	6.0
8	Sulphate of ammonia	9.0

Note: treatment 3 and 6 apply the quantity of nitrogen (as N) as do treatments 4 & 7 and 5 & 8.

PROGRESS

This trial was approved in the PNGOPRA Scientific Advisory Board meeting in November 1993.

The trial was physically initiated in 1994. Site selection, a detailed site survey and site mapping was carried out in May 1994. Plot and palm labelling was carried out in June 1994.

Experimental fertiliser treatments will only be started at 36 months after planting. Until this time the palms will receive a standard immature palm fertiliser input, comprising nitrogen and magnesium amelioration.

Frond 17 leaflet sampling was carried out for each plot in November 1994, and subsequently analysed for nutrient element content (Table 32). This analysis will be used as pre-treatment data for the control of residual variance in later statistical analysis.

Table 32. Summary statistics for pre-treatment frond 17 leaflet tissue analysis (Trial 129).

Element	Values	Minimum	Mean	Maximum	Standard Deviation
Nitrogen	40	2.29	2.46	2.63	0.070
Phosphorus	40	0.142	0.148	0.160	0.004
Potassium	40	0.79	1.00	1.14	0.098
Magnesium	40	0.14	0.19	0.24	0.024
Calcium	40	0.85	0.98	1.08	0.052
Chlorine	40	0.24	0.40	0.49	0.051

Trial 204 FACTORIAL FERTILISER TRIAL AT NAVO PLANTATION.

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site	Navo Plantation, Area 8, Blocks 10 and 11.
Soil	Very young coarse textured freely draining soils formed on air fall volcanic scoria.
Palms	Dami commercial DxP crosses. Planted in 1986 at 120 palms/ha. Treatments started in May 1989.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 33).

Table 33. Rates of fertiliser used in trial 204.

	Level		
	0	1	2
		(kg /palm/year)	
Ammonium chloride	0.0	3.0	6.0
Triple superphosphate	0.0	2.0	4.0
Muriate of potash	0.0	3.0	---
Kieserite	0.0	3.0	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied once per year.

There are 72 plots, each plot consisting of 36 palms (6x6), of which the central 16 are recorded. The 36 treatments are replicated twice and are grouped into two blocks. The trial was designed as a 3x3x2x2x2 factorial trial, but one 'x2' factor has been left "vacant" and is regarded as replication for the time being. The "vacant" treatment will be used later. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average plot yield in this trial was relatively low at 23.3 t/ha/year. However this yield is higher than the average plot yield recorded in the preceding two years, 20.6 t/ha in 1992 and 20.2 t/ha in 1993.

Ammonium chloride application increased FFB yield (Tables 34 and 35). This increase was due to increases in both the number of bunches produced and the single bunch weight. The increase in yield due to ammonium chloride application is greater in 1994 than in the preceding two years.

Muriate of potash application increased the FFB yield in the cumulative data from 1992 to 1994, due to an increase in number of bunches produced. However this yield response to muriate of potash application which occurred in the 1992 and 1993 data, and had disappeared in the 1994 data.

Table 34. Main effects of N, P, K and Mg on yield and yield components in 1994 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	20.5	24.4	25.0	***	0.722	10.7
Bunches/ha	1353	1452	1491	*	46.9	11.3
Bunch weight (kg)	15.2	17.0	16.8	***	0.318	6.7
	P0	P1	P2			
Yield (t/ha/yr)	23.7	22.6	23.6		0.722	10.7
Bunches/ha	1429	1415	1453		46.9	11.3
Bunch weight (kg)	16.6	16.1	16.3		0.318	6.7
	K0	K1				
Yield (t/ha/yr)	23.1	23.5			0.590	10.7
Bunches/ha	1437	1427			38.3	11.3
Bunch weight (kg)	16.1	16.6			0.260	6.7
	Mg0	Mg1				
Yield (t/ha/yr)	23.4	23.2			0.590	10.7
Bunches/ha	1443	1421			38.3	11.3
Bunch weight (kg)	16.3	16.4			0.260	6.7

Table 35 Main effects of N, P, K and Mg on yield and yield components for 1992 to 1994 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	19.4	22.2	22.5	***	0.522	8.5
Bunches/ha	1438	1505	1552	**	33.2	7.7
Bunch weight (kg)	13.5	14.8	14.6	***	0.263	6.4
	P0	P1	P2			
Yield (t/ha/yr)	21.8	21.2	21.1		0.522	8.5
Bunches/ha	1505	1488	1503		33.2	7.7
Bunch weight (kg)	14.5	14.3	14.1		0.263	6.4
	K0	K1				
Yield (t/ha/yr)	20.9	21.9		*	0.426	8.5
Bunches/ha	1469	1528		*	27.1	7.7
Bunch weight (kg)	14.2	14.4			0.215	6.4
	Mg0	Mg1				
Yield (t/ha/yr)	21.3	21.4			0.426	8.5
Bunches/ha	1501	1497			27.1	7.7
Bunch weight (kg)	14.3	14.3			0.215	6.4

The concentration of nitrogen in leaflet and rachis tissue was increased by application of muriate of potash (Tables 36 and 37). The application of triple superphosphate caused a small but significant increase in the concentration of nitrogen in rachis tissue. Application of kieserite slightly reduced the concentration of nitrogen in rachis tissue.

The concentration of phosphorus in rachis tissue was increased by application of triple superphosphate. Triple superphosphate did not have a statistically significant effect on leaflet phosphorus.

The concentration of potassium in rachis tissue was increased by application of muriate of potash. Muriate of potash application did not have a statistically significant effect on leaflet potassium.

The concentration of calcium in rachis tissue was increased by application of ammonium chloride. Application of muriate of potash increased the concentration of calcium in leaflet tissue.

Application of ammonium chloride increased the concentration of magnesium in the rachis tissue, but reduced the leaflet magnesium.

The chlorine containing fertilisers, ammonium chloride and muriate of potash, increased the concentration of chlorine in leaflet and rachis tissue.

In conclusion, the main yield limiting nutrient is nitrogen. There is an indication of a background potassium deficiency. In this situation, ammonium sulphate would normally be recommended as a nitrogen source because of the commonly observed depressive effect of ammonium chloride on leaflet potassium concentration. Such an effect is observed in this trial, however we also see a corresponding increase in the concentration of potassium in rachis tissue. At the present time it is not clear whether application of ammonium chloride has a detrimental affect on the palms potassium nutrition.

Table 36. Treatment main effects on leaflet nutrient concentrations in 1994 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.31	2.43	2.49	***	0.035	5.0
Phosphorus	0.137	0.141	0.143	**	0.002	3.8
Potassium	0.74	0.72	0.71		0.015	7.0
Calcium	0.89	0.91	0.88		0.023	9.0
Magnesium	0.19	0.16	0.15	***	0.006	13.3
Chlorine	0.33	0.52	0.55	***	0.021	15.8
	P0	P1	P2			
Nitrogen	2.42	2.41	2.40		0.035	5.0
Phosphorus	0.139	0.141	0.141		0.002	3.8
Potassium	0.73	0.72	0.72		0.015	7.0
Calcium	0.88	0.89	0.91		0.023	9.0
Magnesium	0.16	0.17	0.17		0.006	13.3
Chlorine	0.46	0.47	0.48		0.021	15.8
	K0	K1				
Nitrogen	2.41	2.41			0.028	5.0
Phosphorus	0.140	0.140			0.001	3.8
Potassium	0.72	0.73			0.012	7.0
Calcium	0.86	0.93		**	0.019	9.0
Magnesium	0.17	0.17			0.005	13.3
Chlorine	0.43	0.51		***	0.017	15.8
	Mg0	Mg1				
Nitrogen	2.42	2.39			0.028	5.0
Phosphorus	0.141	0.139			0.001	3.8
Potassium	0.72	0.73			0.012	7.0
Calcium	0.91	0.88			0.019	9.0
Magnesium	0.16	0.17			0.005	13.3
Chlorine	0.46	0.48			0.017	15.8

Table 37. Treatment main effects on rachis nutrient concentrations in 1994 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.21	0.22	0.24	***	0.005	7.0
Phosphorus	0.067	0.059	0.056	*	0.004	23.1
Potassium	1.30	1.34	1.36		0.034	8.7
Calcium	0.39	0.44	0.46	***	0.012	9.9
Magnesium	0.050	0.057	0.057	**	0.002	12.8
Chlorine	0.33	0.66	0.77	***	0.048	28.6
	P0	P1	P2			
Nitrogen	0.22	0.22	0.23	*	0.005	7.0
Phosphorus	0.044	0.069	0.069	***	0.004	23.1
Potassium	1.36	1.30	1.34		0.034	8.7
Calcium	0.43	0.42	0.43		0.012	9.9
Magnesium	0.052	0.056	0.057		0.002	12.8
Chlorine	0.61	0.55	0.60		0.048	28.6
	K0	K1				
Nitrogen	0.22	0.23			0.004	7.0
Phosphorus	0.060	0.061			0.003	23.1
Potassium	1.26	1.41		***	0.027	8.7
Calcium	0.42	0.44			0.010	9.9
Magnesium	0.055	0.054			0.002	12.8
Chlorine	0.51	0.66		***	0.040	28.6
	Mg0	Mg1				
Nitrogen	0.23	0.22		*	0.004	7.0
Phosphorus	0.059	0.062			0.003	23.1
Potassium	1.32	1.35			0.027	8.7
Calcium	0.43	0.42			0.010	9.9
Magnesium	0.053	0.056			0.002	12.8
Chlorine	0.58	0.60			0.040	28.6

Trial 205 **EFB/FERTILISER TRIAL AT HARGY PLANTATION.**

PURPOSE

To investigate the response of Oil Palm to applications of Empty Fruit Bunches (EFB), and to investigate whether the uptake of phosphorus and magnesium from triple superphosphate and kieserite can be improved by applying the fertiliser in conjunction with EFB.

DESCRIPTION

Site Blocks 7 and 8, Area 9, Hargy Plantation, Bialla, WNBP.

Soil Freely draining andosol formed on intermediate to basic volcanic ash.

Palms Dami identified DxP crosses.
Planted in July and August 1993 at 135 palms/ha.
Treatments to start 36 months after planting.

DESIGN

There are eight treatments comprising all factorial combinations of EFB, triple superphosphate and kieserite each at two levels (Table 38). The treatments are replicated six times, with each replicate comprising one block. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms. The recorded palms comprise 16 different identified Dami DxP progenies which have been arranged in a random spatial configuration in each plot. The 16 progenies are as follows;

Code	Progeny Number
A	9004093E
B	9009030E
C	9009149E
D	9102109E
E	9010040E
F	4091
G	9008022E
H	5148

Code	Progeny Number
I	9009127E
J	9103073E
K	9103136E
L	9010217E
M	9010190E
N	9009110E
O	9101100E
P	9007130E

Table 38. Fertiliser and EFB treatments used in Trial 205.

Treatment	EFB (kg/palm/yr)	Triple superphosphate (kg/palm/yr)	Kieserite (kg/palm/yr)
1	Nil	Nil	Nil
2	Nil	Nil	3.0
3	Nil	3.0	Nil
4	Nil	3.0	3.0
5	230	Nil	Nil
6	230	Nil	3.0
7	230	3.0	Nil
8	230	3.0	3.0

Where application of EFB and the inorganic fertilisers coincide, they will be applied together.

PROGRESS

The trial was planted in July and August 1993. The site was surveyed and mapped, and plot and palm labelling was carried out in 1993.

For the first 36 months, the palm will receive a standard immature palm fertiliser input. Experimental treatments will be applied after this time.

Trials 251 and 252 **FACTORIAL FERTILISER TRIALS AT MARAMAKAS AND LUBURUA PLANTATIONS.**

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Sites: Trial 251: Fields 2B, 2C, 2D and 3A, Maramakas Plantation.
Trial 252: Block 4, Luburua Plantation.

Soils: Reddish brown clay soil overlying raised coral and showing great variability in depth. The soils are shallow on terrace margins and low ridges and moderately deep in depressions. The soil is freely draining.

Palms: Dami commercial DxP crosses.
Planted in March 1989 (251) and September 1989 (252) at 120 palms/ha.
Treatments started in April 1991.

DESIGN

There are 36 treatments at both sites, comprising all factorial combinations of N and K at three levels and P and Mg each at two levels (Table 39).

Table 39. Rates of fertiliser used in trials 251 and 252.

	Level		
	0	1	2
		(kg /palm/year)	
Ammonium sulphate	0.0	2.5	5.0
Muriate of potash	0.0	2.5	5.0
Triple superphosphate	0.0	2.0	---
Kieserite	0.0	2.0	---

Note: Treatments are factorial combinations of levels of these fertiliser

Annual fertiliser application rates are split into three applications.

These two trials were originally planned as a single 3x3x2x2 factorial trial with two replicates, but because of restricted availability of land, the two replicates were located on two separate sites and regarded as two trials. A site factor is therefore included in the single analysis for these two trials.

There are 36 plots at each site, each plot consisting of 36 palms (6x6), of which the central 16 are recorded.

High order interactions provide the error term in the statistical analysis.

Pre-treatment petiole WxT measurements are used as a concomitant variable in an analysis of covariance of the yield data. This analysis of covariance significantly reduces the residual variance.

RESULTS

The data recording of these trials commenced in June 1992. This report is based on data recorded from January 1993 to December 1994. As this represents only on two years recording, caution should be used in interpreting the results.

The yield in these trials was relatively low with the average plot yields being 18.7 t FFB/ha in 1993 and 21.9 t FFB/ha in 1994.

The site (Trial 251 & Trial 252) x fertiliser treatment interaction was not statistically significant for either year.

The application of sulphate of ammonia had no effect on FFB yield or yield components in 1994 (Table 40) or for the two years 1993 and 1994 combined (Table 41).

Table 40. Main effects of N, P, K and Mg on yield and yield components for 1994 (Trials 251 and 252).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	21.9	21.7	22.2		1.045	16.2
Bunches/ha	2070	2073	2082		87.8	14.4
Bunch weight (kg)	10.5	10.4	10.6		0.200	6.5
	K0	K1	K2			
Yield (t/ha)	20.4	22.2	23.1	$*_1$	1.028	16.2
Bunches/ha	1996	2113	2116		86.4	14.4
Bunch weight (kg)	10.2	10.5	10.9	$**_1$	0.197	6.5
	P0	P1				
Yield (t/ha)	21.6	22.2			0.84	16.2
Bunches/ha	2046	2104			70.6	14.4
Bunch weight (kg)	10.5	10.5			0.161	6.5
	Mg0	Mg1				
Yield (t/ha/yr)	22.1	21.7			0.837	16.2
Bunches/ha	2099	2051			70.4	14.4
Bunch weight (kg)	10.5	10.5			0.160	6.5
	Trial 251	Trial 252				
Yield (t/ha/yr)	23.7	20.2		**	1.064	16.2
Bunches/ha	2149	2000			89.4	14.4
Bunch weight (kg)	11.0	10.1		***	0.204	6.5

Table 41. Main effects of N, P, K and Mg on yield and yield components for January 1993 to December 1994 (Trials 251 and 252).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	20.6	20.0	20.3		0.976	16.3
Bunches/ha	2207	2176	2145		95.6	14.9
Bunch weight (kg)	9.4	9.2	9.5		0.166	6.0
	K0	K1	K2			
Yield (t/ha)	19.2	20.4	21.3	$*_l$	0.960	16.3
Bunches/ha	2106	2194	2229		94.1	14.9
Bunch weight (kg)	9.2	9.3	9.6	$*_l$	0.163	6.0
	P0	P1				
Yield (t/ha)	20.2	20.5			0.784	16.3
Bunches/ha	2154	2198			76.8	14.9
Bunch weight (kg)	9.4	9.3			0.133	6.0
	Mg0	Mg1				
Yield (t/ha/yr)	20.5	20.1			0.782	16.3
Bunches/ha	2206	2146			76.6	14.9
Bunch weight (kg)	9.3	9.4			0.133	6.0
	Trial 251	Trial 252				
Yield (t/ha/yr)	21.7	18.9		**	0.994	16.3
Bunches/ha	2224	2129			97.3	14.9
Bunch weight (kg)	9.8	8.9		***	0.169	6.0

The application of muriate of potash increased the FFB yield by increasing the single bunch weight and the number of bunches produced, however the effect on bunch number was not statistically significant. Although the SITE x K interaction is not statistically significant, the two way table (Table 42) shows that the yield response to muriate of potash was much greater at the Trial 251 site compared to the Trial 252 site. The reason for this is not entirely clear, however a suggestion would be that another yield limiting factor is suppressing the K response (soil depth ?).

Sulphate of ammonia application had no effect on FFB yield. This was not surprising as the concentration of nitrogen in the leaflet tissue was relatively high (Table 43). The nitrogen concentration of the leaflet tissue in these trials was typical of those seen following the routine tissue sampling and analysis of Poliamba Estates. The data suggest that there is no need to apply nitrogen fertiliser to much of Poliamba estates for the time being. This conclusion probably applies to the smallholder growers as well.

Muriate of potash increased the concentration of potassium in leaflet and rachis tissue (Tables 43 and 44). The increase in potassium concentration seen in rachis tissue is much more pronounced than in the leaflet tissue. Muriate of potash decreased the concentration of magnesium in leaflet and rachis tissue and increased the concentration of chlorine in leaflet and rachis tissue.

The application of sulphate of ammonia increased the concentration of nitrogen in the leaflet and rachis tissue, however these increases were very small over base levels that were relatively high.

The application of kieserite increased the concentration of magnesium in leaflet tissue.

Table 42. MoP by trial interactions, yield from January 1993 to December 1994, and tissue sampled in October 1994 (Trials 251 & 252).

	Yield (t/ha)		Rachis K %		Leaflet K %	
	Trial 251	Trial 252	Trial 251	Trial 252	Trial 251	Trial 252
K0	19.72	18.65	0.31	0.41	0.68	0.77
K1	21.94	18.91	1.15	1.23	0.86	0.89
K2	23.35	19.26	1.42	1.41	0.87	0.91
Interaction significance	ns		ns		ns	
sed	1.440		0.064		0.029	
cv%	16.3		16.0		8.7	

Table 43. **Treatment main effects on leaflet nutrient concentrations in 1994 (Trial 251 and Trial 252).**

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.70	2.75	2.75	*	0.020	2.6
Phosphorus	0.167	0.167	0.169		0.001	2.3
Potassium	0.82	0.83	0.83		0.021	8.7
Calcium	1.17	1.16	1.19		0.029	8.7
Magnesium	0.31	0.30	0.30		0.007	7.9
Chlorine	0.65	0.67	0.68		0.017	8.7
	K0	K1	K2			
Nitrogen	2.72	2.72	2.76	$*_{l}$	0.020	2.6
Phosphorus	0.167	0.167	0.168		0.001	2.3
Potassium	0.72	0.87	0.89	***	0.021	8.7
Calcium	1.14	1.19	1.20		0.029	8.7
Magnesium	0.35	0.28	0.27	***	0.007	7.9
Chlorine	0.58	0.70	0.72	***	0.017	8.7
	P0	P1				
Nitrogen	2.72	2.74			0.017	2.6
Phosphorus	0.167	0.168			0.001	2.3
Potassium	0.82	0.84			0.017	8.7
Calcium	1.17	1.18			0.024	8.7
Magnesium	0.30	0.30			0.006	7.9
Chlorine	0.66	0.68			0.014	8.7
	Mg0	Mg1				
Nitrogen	2.74	2.73			0.017	2.6
Phosphorus	0.168	0.167			0.001	2.3
Potassium	0.84	0.82			0.017	8.7
Calcium	1.18	1.17			0.024	8.7
Magnesium	0.29	0.31		***	0.006	7.9
Chlorine	0.66	0.67			0.014	8.7
	Trial 251	Trial 252				
Nitrogen	2.70	2.77		***	0.017	2.6
Phosphorus	0.165	0.170		***	0.001	2.3
Potassium	0.80	0.86		**	0.017	8.7
Calcium	1.16	1.19			0.024	8.7
Magnesium	0.30	0.31			0.006	7.9
Chlorine	0.64	0.70		***	0.014	8.7

Table 44. Treatment main effects on rachis nutrient concentrations in 1994 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.28	0.28	0.29	**	0.004	4.5
Phosphorus	0.094	0.084	0.090		0.005	18.8
Potassium	0.95	0.99	1.02		0.046	16.0
Calcium	0.49	0.49	0.49		0.014	10.1
Magnesium	0.10	0.09	0.09		0.008	29.5
Chlorine	0.61	0.67	0.64		0.026	14.2
	K0	K1	K2			
Nitrogen	0.27	0.29	0.29	***	0.004	4.5
Phosphorus	0.063	0.093	0.112		0.005	18.8
Potassium	0.36	1.19	1.42	***	0.046	16.0
Calcium	0.49	0.50	0.48		0.014	10.1
Magnesium	0.12	0.08	0.07	***	0.008	29.5
Chlorine	0.30	0.74	0.89	***	0.026	14.2
	P0	P1				
Nitrogen	0.28	0.28			0.003	4.5
Phosphorus	0.082	0.097			0.004	18.8
Potassium	0.98	1.00			0.037	16.0
Calcium	0.49	0.49			0.012	10.1
Magnesium	0.09	0.09			0.006	29.5
Chlorine	0.63	0.65			0.021	14.2
	Mg0	Mg1				
Nitrogen	0.29	0.28			0.003	4.5
Phosphorus	0.093	0.086			0.004	18.8
Potassium	1.02	0.96			0.037	16.0
Calcium	0.49	0.49			0.012	10.1
Magnesium	0.09	0.10			0.006	29.5
Chlorine	0.65	0.63			0.021	14.2
	Trial 251	Trial 252				
Nitrogen	0.29	0.28			0.003	4.5
Phosphorus	0.088	0.091			0.004	18.8
Potassium	0.96	1.02			0.037	16.0
Calcium	0.50	0.48			0.012	10.1
Magnesium	0.09	0.09			0.006	29.5
Chlorine	0.63	0.65			0.021	14.2

Trial 401 FACTORIAL FERTILISER TRIAL AT KAUTU PLANTATION.

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site Kapiura Estates, Kautu Plantation, Fields 1F and 1G.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and volcanic ash.

Palms Dami commercial DxP crosses.
Planted in 1986 at 135 palms/ha.
Treatments started in May 1989.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 45).

Table 45. Rates of fertiliser used in trial 401.

	Level		
	0	1	2
		(kg /palm/year)	
Ammonium chloride	0	3	6
Triple superphosphate	0	2	4
Muriate of potash	0	3	---
Kieserite	0	3	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied once per year.

There are 72 plots, each plot consisting of 36 palms (6x6), of which the central 16 are recorded.

The 36 treatments are replicated twice and are grouped into two blocks. The trial was designed as a 3x3x2x2x2 factorial trial, but one 'x2' factor has been left "vacant" and is regarded as replication for the time being. The "vacant" treatment will be used later. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average FFB yield in 1994 was 23.0 t/ha/year. The yield in 1994 was considerably lower than in the preceding two years, where in 1992 the average plot yield was 26.2 t/ha/yr and in 1993 28.0 t/ha/yr.

There appears to be a yield increase due to ammonium chloride application (Tables 46 and 47), however this effect is only statistically significant in the cumulative data from 1992 to 1994 . This response was due to an increase in the single bunch weight.

Application of kieserite increased the FFB yield in the 1994 data and the 1992 to 1994 cumulative data. This response to kieserite was due to an increased single bunch weight.

In the cumulative data for 1992 to 1994, muriate of potash application increased the FFB yield by increasing the number of bunches produced.

Table 46. Main effects of N, P, K and Mg on yield and yield components in 1994 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	22.6	23.3	23.0		0.562	8.5
Bunches/ha	1213	1218	1143		35.7	10.4
Bunch weight (kg)	18.7	19.3	20.2	**	0.777	8.0
	P0	P1	P2			
Yield (t/ha/yr)	22.5	23.0	23.4			
Bunches/ha	1157	1200	1218			
Bunch weight (kg)	19.6	19.2	19.3			
	K0	K1				
Yield (t/ha/yr)	22.7	23.2			0.459	8.5
Bunches/ha	1175	1208			29.1	10.4
Bunch weight (kg)	19.4	19.3			0.634	8.0
	Mg0	Mg1				
Yield (t/ha/yr)	22.4	23.5		*		
Bunches/ha	1190	1193				
Bunch weight (kg)	18.9	19.8		*		

Table 47. Main effects of N, P, K and Mg on yield and yield components for 1992 to 1994 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	25.1	26.1	26.0	*	0.042	5.7
Bunches/ha	1571	1600	1522		40.3	8.9
Bunch weight (kg)	16.0	16.4	17.1	**	0.303	6.3
	P0	P1	P2			
Yield (t/ha/yr)	25.3	26.1	25.8		0.042	5.7
Bunches/ha	1536	1574	1584		40.3	8.9
Bunch weight (kg)	16.6	16.6	16.4		0.303	6.3
	K0	K1				
Yield (t/ha/yr)	25.3	26.1		*	0.343	5.7
Bunches/ha	1535	1594			32.9	8.9
Bunch weight (kg)	16.5	16.5			0.247	6.3
	Mg0	Mg1				
Yield (t/ha/yr)	25.3	26.1		*	0.343	5.7
Bunches/ha	1585	1544			32.9	8.9
Bunch weight (kg)	16.0	17.0		***	0.247	6.3

The concentration of phosphorus in rachis tissue was increased by the application of ammonium chloride (Table 49). The concentration of phosphorus in leaflet (Table 48) and rachis tissue was decreased by applying kieserite

The concentration of potassium in rachis tissue was increased by applying muriate of potash. There was no corresponding increase in the concentration of potassium in leaflet tissue. The concentration of potassium in leaflet tissue was reduced by applying ammonium chloride, rachis tissue potassium was not reduced.

The concentration of calcium in leaflet tissue was increased by triple superphosphate application. Rachis calcium was increased by applying ammonium chloride and by applying muriate of potash.

Both chloride containing fertilisers, ammonium chloride and muriate of potash, increased the concentration of magnesium in the rachis tissue. Triple superphosphate produced a small increased leaflet and rachis magnesium. Application of kieserite increased the concentration of magnesium in leaflet tissue.

The chlorine containing fertilisers markedly increased the chlorine concentration in leaflet and rachis tissue.

Table 48. Treatment main effects on leaflet nutrient concentrations in 1994 (Trial 401).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.48	2.48	2.49		0.016	2.3
Phosphorus	0.153	0.152	0.152		0.001	2.5
Potassium	0.80	0.76	0.75	***	0.012	5.6
Calcium	0.93	0.94	0.93		0.011	4.2
Magnesium	0.17	0.17	0.17		0.005	9.5
Chlorine	0.36	0.44	0.47	***	0.013	10.9
	P0	P1	P2			
Nitrogen	2.49	2.49	2.47		0.016	2.3
Phosphorus	0.151	0.153	0.153		0.001	2.5
Potassium	0.78	0.77	0.76		0.012	5.6
Calcium	0.92	0.95	0.94	*	0.011	4.2
Magnesium	0.16	0.17	0.17	*	0.005	9.5
Chlorine	0.43	0.41	0.42		0.013	10.9
	K0	K1				
Nitrogen	2.49	2.48			0.013	2.3
Phosphorus	0.152	0.152			0.001	2.3
Potassium	0.77	0.77			0.010	5.6
Calcium	0.93	0.94			0.009	4.2
Magnesium	0.17	0.17			0.004	9.5
Chlorine	0.40	0.44		***	0.011	10.9
	Mg0	Mg1				
Nitrogen	2.49	2.48			0.013	2.3
Phosphorus	0.154	0.151		**	0.001	2.3
Potassium	0.77	0.77			0.010	5.6
Calcium	0.94	0.93			0.009	4.2
Magnesium	0.16	0.18		***	0.004	9.5
Chlorine	0.42	0.42			0.011	10.9

Table 49. Treatment main effects on rachis nutrient concentrations in 1994 (Trial 401).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.25	0.25	0.25		0.003	4.2
Phosphorus	0.066	0.070	0.069	*	0.003	14.4
Potassium	1.38	1.45	1.45		0.038	9.2
Calcium	0.40	0.44	0.43	*	0.011	9.1
Magnesium	0.046	0.052	0.051	***	0.001	10.0
Chlorine	0.40	0.64	0.68	***	0.051	31.0
	P0	P1	P2			
Nitrogen	0.25	0.25	0.25		0.003	4.2
Phosphorus	0.063	0.070	0.071		0.003	14.4
Potassium	1.47	1.40	1.40		0.038	9.2
Calcium	0.42	0.42	0.42		0.011	9.1
Magnesium	0.049	0.049	0.052	*L	0.001	10.0
Chlorine	0.62	0.55	0.55		0.051	31.0
	K0	K1				
Nitrogen	0.25	0.25			0.002	4.2
Phosphorus	0.067	0.069			0.002	14.4
Potassium	1.36	1.48		***	0.031	9.2
Calcium	0.41	0.43		*	0.009	9.1
Magnesium	0.048	0.051		*	0.001	10.0
Chlorine	0.49	0.65		***	0.042	31.0
	Mg0	Mg1				
Nitrogen	0.25	0.25			0.002	4.2
Phosphorus	0.071	0.065		*	0.002	14.4
Potassium	1.43	1.42			0.031	9.2
Calcium	0.43	0.42			0.009	9.1
Magnesium	0.049	0.051			0.001	10.0
Chlorine	0.57	0.58			0.042	31.0

Trial 402 FACTORIAL FERTILISER TRIAL AT BILOMI PLANTATION.

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site Kapiura Estates, Bilomi Plantation, Division 2, Field 11C.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and volcanic ash.

Palms Dami commercial DxP crosses.
Planted in early 1987 at 120 palms/ha.
Treatments started in May 1990.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 50).

Table 50. Rates of fertiliser used in trial 402.

	Level		
	0	1	2
		(kg /palm/year)	
Ammonium chloride	0.0	3.0	6.0
Triple superphosphate	0.0	2.0	4.0
Muriate of potash	0.0	3.0	---
Kieserite	0.0	3.0	---
		(Tonnes/ha/yr)	
EFB	0	50	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied only once.

EFB applications started in mid 1993. EFB is applied with a Giltrap EFB applicator.

There are 72 plots, each plot consisting of 36 palms (6x6) of which the central 16 are recorded.

The 36 treatments are replicated twice and are grouped into two blocks. The trial was designed as a 3x3x2x2x2 factorial trial, but one 'x2' factor has been left "vacant" and is regarded as replication for the time being. The "vacant" treatment will be used later. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average plot yield in 1994 was 25.7 t/ha/year. The 1994 average plot yield was lower than in the preceding two year. In 1992 the average plot yield was 31.0 t/ha/yr and in 1993 was 28.2 t/ha/yr.

Ammonium chloride application increased the single bunch weight in 1994.

Kieserite application produced a small but statistically significant increase in single bunch weight in the 1992 to 1994 cumulative data.

Treatment application of EFB started in mid 1993. It would be too early to expect significant yield responses to EFB application in 1994.

Table 51. Main effects of N, P, K and Mg on yield and yield components in 1994 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	25.2	26.0	25.8		0.925	12.5
Bunches/ha	1530	1521	1488		66.3	15.2
Bunch weight (kg)	16.5	17.1	17.5	*	0.320	6.5
	P0	P1	P2			
Yield (t/ha/yr)	25.3	25.9	25.8		0.925	12.5
Bunches/ha	1509	1514	1517		66.3	15.2
Bunch weight (kg)	16.8	17.2	17.1		0.320	6.5
	K0	K1				
Yield (t/ha/yr)	25.8	25.5			0.755	12.5
Bunches/ha	1532	1494			54.2	15.2
Bunch weight (kg)	16.9	17.2			0.261	6.5
	Mg0	Mg1				
Yield (t/ha/yr)	25.7	25.6			0.755	12.5
Bunches/ha	1523	1503			54.2	15.2
Bunch weight (kg)	16.9	17.1			0.261	6.5
	EFB0	EFB1				
Yield (t/ha/yr)	25.7	25.6			0.755	12.5
Bunches/ha	1499	1527			54.2	15.2
Bunch weight (kg)	17.2	16.8			0.261	6.5

Table 52. Main effects of N, P, K and Mg on yield and yield components from 1992 to 1994 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	27.5	28.7	28.7		0.456	5.6
Bunches/ha	1954	1950	1937		44.4	7.9
Bunch weight (kg)	14.1	14.7	14.9		0.217	5.2
	P0	P1	P2			
Yield (t/ha/yr)	28.1	28.5	28.3		0.456	5.6
Bunches/ha	1962	1938	1942		44.4	7.9
Bunch weight (kg)	14.4	14.7	14.6		0.217	5.2
	K0	K1				
Yield (t/ha/yr)	28.1	28.5			0.372	5.6
Bunches/ha	1952	1942			36.2	7.9
Bunch weight (kg)	14.4	14.7			0.177	5.2
	Mg0	Mg1				
Yield (t/ha/yr)	28.3	28.3			0.372	5.6
Bunches/ha	1961	1933			36.2	7.9
Bunch weight (kg)	14.5	14.7		*	0.177	5.2

Other than EFB application increasing the chlorine concentration, treatments had little affect on frond 17 leaflet nutrient concentrations.

The concentrations of calcium, magnesium and chlorine in rachis tissue was increased by application of ammonium chloride.

The application of triple superphosphate increased the concentration of phosphorus in rachis tissue.

The concentrations of potassium and chlorine were increased by application of muriate of potash.

The concentration of magnesium was increased by application of kieserite.

The application of EFB increased the concentrations of all elements analysed in the rachis tissue. However the increase in magnesium was not statistically significant.

Table 53. Treatment main effects on leaflet nutrient concentrations in 1994 (Trial 402).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.48	2.51	2.51		0.022	3.0
Phosphorus	0.148	0.149	0.150		0.001	2.7
Potassium	0.80	0.79	0.79		0.016	7.0
Calcium	0.92	0.92	0.93		0.014	5.4
Magnesium	0.14	0.15	0.14		0.007	17.0
Chlorine	0.45	0.50	0.46		0.024	17.5
	P0	P1	P2			
Nitrogen	2.51	2.49	2.50		0.022	3.0
Phosphorus	0.148	0.149	0.150		0.001	2.7
Potassium	0.79	0.81	0.78		0.016	7.0
Calcium	0.93	0.92	0.93		0.014	5.4
Magnesium	0.14	0.15	0.14		0.007	17.0
Chlorine	0.48	0.50	0.43	*	0.024	17.5
	K0	K1				
Nitrogen	2.50	2.50			0.018	3.0
Phosphorus	0.149	0.149			0.001	2.7
Potassium	0.81	0.78			0.013	7.0
Calcium	0.92	0.93			0.012	5.4
Magnesium	0.15	0.14			0.006	17.0
Chlorine	0.47	0.47			0.019	17.5
	Mg0	Mg1				
Nitrogen	2.51	2.49			0.018	3.0
Phosphorus	0.149	0.149			0.001	2.7
Potassium	0.80	0.79			0.013	7.0
Calcium	0.93	0.92			0.012	5.4
Magnesium	0.14	0.15			0.006	17.0
Chlorine	0.48	0.46			0.019	17.5
	EFB0	EFB1				
Nitrogen	2.49	2.51			0.018	3.0
Phosphorus	0.148	0.149			0.001	2.7
Potassium	0.80	0.79			0.013	7.0
Calcium	0.92	0.93			0.012	5.4
Magnesium	0.14	0.15			0.006	17.0
Chlorine	0.43	0.51		***	0.019	17.5

Table 54. Treatment main effects on rachis nutrient concentrations in 1994 (Trial 402).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.25	0.25	0.25		0.004	5.9
Phosphorus	0.064	0.066	0.066		0.004	19.7
Potassium	1.50	1.54	1.53		0.037	8.4
Calcium	0.43	0.47	0.48	***[1]	0.014	10.2
Magnesium	0.043	0.049	0.049	*	0.002	16.4
Chlorine	0.46	0.69	0.73	***	0.052	28.5
	P0	P1	P2			
Nitrogen	0.25	0.25	0.25		0.004	5.9
Phosphorus	0.060	0.068	0.069	*	0.004	19.7
Potassium	1.54	1.54	1.49		0.037	8.4
Calcium	0.47	0.46	0.45		0.014	10.2
Magnesium	0.048	0.047	0.047		0.002	16.4
Chlorine	0.65	0.63	0.60		0.052	28.5
	K0	K1				
Nitrogen	0.25	0.25			0.003	5.9
Phosphorus	0.064	0.067			0.003	19.7
Potassium	1.49	1.56		*	0.030	8.4
Calcium	0.45	0.47			0.011	10.2
Magnesium	0.047	0.047			0.002	16.4
Chlorine	0.57	0.68		*	0.042	28.5
	Mg0	Mg1				
Nitrogen	0.25	0.25		*	0.003	5.9
Phosphorus	0.065	0.066			0.003	19.7
Potassium	1.51	1.54			0.030	8.4
Calcium	0.46	0.46			0.011	10.2
Magnesium	0.045	0.049		*	0.002	16.4
Chlorine	0.62	0.63			0.042	28.5
	EFB0	EFB1				
Nitrogen	0.24	0.26		***	0.003	5.9
Phosphorus	0.060	0.070		**	0.003	19.7
Potassium	1.45	1.60		***	0.030	8.4
Calcium	0.45	0.47		*	0.011	10.2
Magnesium	0.046	0.048			0.002	16.4
Chlorine	0.52	0.73		***	0.042	28.5

II. ISLANDS REGION SMALLHOLDER TRIALS AND DEMONSTRATION.

(P. Navus)

Fertiliser demonstration trials were continued and their number increased on selected smallholder blocks in West New Britain and New Ireland Provinces. There are 170 hectares of on-farm research related activities involving 65 different blocks including schools.

The first 25 farmers detailed in Table 55 are part of the initial group of investigation series (Trials 121, 124, 207, 208, & 403) comprising the 40 hectares including New Ireland (Trials 253) up to 1994.

In West New Britain the remaining 40 individual farmers are part of the additional demonstration series (Trial 128 & 210) covering 120 hectares. Twenty eight blocks (96 hectares) are located in Hoskins (Trial 128) and twelve (24 hectares) in Bialla (Trial 210) Project.

These are whole blocks located in twin pairs of same local conditions receiving uniform treatments. A trench is used to demarcate the block into two halves. The yields from these blocks recorded and used show how much fruit would be produced if fertiliser were not used at all, and how much would be produced using the recommended amount (pair 1). How much fruit would be produced if again fertiliser were not used at all, and how much is the maximum that could be produced if a generous amounts of all four (N, P, K, Mg) main types of fertilizer was used (pair 2). The results are used in the calculation of the economic optimum amount of fertiliser, and to demonstrate the smallholder the economic benefits to them of using fertiliser. The whole block harvested in the normal way for a smallholder block and the weight of the fruit recorded by the transport company in each project at the time of pickup.

Table 55 Summarised details of Smallholder trials (121, 124, 207, 208, 253, & 403) involving 22 blocks in the Bialla, Hoskins and Kavieng oil palm project areas of West New Britain and New Ireland Provinces.

TRIAL Nº	AREA NAME	BLOCK Nº	SCHEME (LSS/VOP)	PLANTED	TRIAL LIFE
121	TAMAMBU	190020	VOP	1982	5
121	TAMBA	020565	LSS	1983	5
121	KAPORE	010396	LSS	1985	5
121	GALAI	051538	LSS	1984	5
121	KAUS	080754	LSS	1982	5
121	SIKI	101066	LSS	1984	5
121	GALILO	270005	VOP	1985	5
121	GULE	105	VOP	1980	5
121	MAI	140089	VOP	1986	5
121	SARAKOLOK	030920	LSS	1983	5
121	KAVUI	061692	LSS	1985	5
121	GALAI	051564	LSS	1985	5
121	MAI	140087	VOP	1984	5
207	SILANGA	550438	LSS	1985	4
207	UASILAU	500176	LSS	1984	4
403	MAMOTA	240921	LSS	1990	4
124	POININI	SCHOOL	AGRICULTURE	1987	3
124	HOSKINS	SCHOOL	SECONDARY	1991	3
124	MORAMORA	SCHOOL	TECHNICAL	1985	3
208	BIALLA	SCHOOL	PROVINCIAL	1983	2
253	LOSSU	NA	VOP	1992	2
253	PARUAI	NA	VOP	1993	2

Abbreviations;

LSS means land settlement scheme
VOP means village oil palm,
NA means not available.

EXPERIMENT 121 DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS (HOSKINS).

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 121 is located on OPIC's Hoskins Smallholder Oil Palm Project (Table 57) at Kapore, Tamambu, Tamba, Sarakolok,, Galai 1 & 2, Siki, Mai 1 & 2, Gule, Galilo, Kavui, and Kaus.

Palms Dami commercial D X P planting material.
Planted between 1982 and 1986 at 120 palms/ha.
Treatments started in April/May 1989.

DESIGN

Each of the fifteen smallholder blocks provides a single replicate within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 56). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 56. Treatments used in Trial 121.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	0	0
4	2	0	2	0
5	2	0	0	2
6	3	0	0	0

Treatments were started in April/May 1989. Fertiliser is applied twice a year in May and November.

RESULTS

The application of ammonium chloride (treatment 2 and 6), ammonium chloride (AC) plus triple superphosphate (treatment 3), AC plus muriate of potash (treatment 4), AC plus kieserite (treatment 5), increased the mean yield (Table 57). The response from the application of AC plus triple superphosphate (TSP), AC plus muriate of potash (MOP), and AC plus kieserite were very variable. It is possible the increase in the mean yield in the fresh fruit bunch was due to increased single bunch weight (Table 59).

The concentrations of nitrogen and chlorine in frond 17 leaflet tissue were higher in plots that received ammonium chloride (treatments 2, 3, 4, 5 & 6), and concentrations of potassium were lower (Table 60). The concentrations of phosphorous and magnesium were low except calcium. What would be regarded as adequate concentration of chlorine is 0.3 - 0.4%. There appear to be an improvement in the average concentration of chlorine from 0.31 to 0.43 since 1992 in the plots that received ammonium chloride. In plots that did not received any fertiliser (treatment 1), the concentration of potassium in the leaflets was relatively high, while in plots that received fertiliser treatments, including muriate of potash, the average concentration of potassium in the leaflets was reduced.

The concentrations of nitrogen and chlorine in the rachis of frond 17 (Table 61) was higher in the plots that received ammonium chloride. The concentrations of potassium is higher in the rachis than the leaflets tissue. The concentrations of potassium also was higher in the plot that received MOP only while phosphorous and calcium appear to be significantly increased by the application of fertiliser.

Table 57. Effect of fertiliser treatments on yield of thirteen blocks in the Hoskins project area between 1992 - 1994 (Trial 121).

	Yield of FFB (t/ha/yr)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	32.7	23.7	33.6	31.0	34.2	31.6	31.1
020565	15.2	21.2	15.8	14.9	16.2	19.8	17.1
010396	9.2	20.0	16.2	16.9	20.7	12.7	16.0
051538	17.1	15.9	24.0	19.5	19.7	18.9	19.2
080754	11.7	15.3	16.5	14.5	14.1	10.9	13.8
101066	16.7	25.0	16.3	15.3	19.9	21.9	19.2
270005	11.8	18.4	16.4	13.6	16.6	11.5	14.7
105	17.6	22.1	22.1	21.2	31.1	23.0	22.9
140089	28.0	27.0	31.0	29.5	27.1	28.6	28.5
030920	10.2	13.7	14.8	11.7	17.2	11.4	13.2
061692	14.2	16.1	14.8	19.0	17.4	13.5	15.8
051564	16.0	20.2	18.5	15.1	14.0	21.6	17.6
140087	20.8	22.1	21.5	24.8	20.2	20.0	21.6
Mean	17.0	**20.1**	**20.1**	19.0	**20.7**	18.9	19.3
lsd $_{5\%}$				2.25			
cv %				14.9			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 58 Effect of fertiliser treatments on number of bunches on thirteen blocks in the Hoskins project area, between 1992 - 1994 (Trial 121)

	Bunches (number/ha)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	1321	869	1355	1271	1315	1256	1231
020565	741	960	823	1146	608	720	823
010396	856	1151	933	976	1304	789	1002
051538	908	808	1158	1039	984	1040	990
080754	524	734	715	645	629	500	625
101066	1008	1251	1080	771	862	1013	998
270005	865	1167	984	850	974	741	930
105	878	1025	977	947	1388	972	1031
140089	1860	1688	1974	1876	1895	1733	1838
030920	628	622	736	591	808	591	663
061692	914	1013	828	1057	997	838	941
051564	1077	1034	1123	948	872	1275	1055
140087	1261	1140	1219	1768	1112	1048	1258
Mean	988	1036	1070	1042	1065	978	1030
$lsd_{5\%}$				121			
cv %				14.9			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 59 Effect of fertiliser treatments on single bunch weights on thirteen blocks in the Hoskins project area, between 1992 - 1994 (Trial 121)

	Single bunch weight (kg)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	25.5	27.7	24.9	24.4	26.1	25.3	25.6
020565	20.6	21.9	18.9	18.6	23.6	21.6	20.9
010396	10.6	17.6	15.0	17.7	16.7	16.5	15.7
051538	18.9	21.7	22.4	21.4	20.5	19.2	20.7
080754	23.2	22.3	23.1	23.0	22.7	22.1	22.7
101066	16.7	20.2	20.3	20.1	22.4	21.4	20.2
270005	14.2	15.8	16.9	16.2	17.3	15.7	16.0
105	19.8	22.4	22.9	23.3	23.3	23.9	22.6
140089	15.5	16.2	15.9	16.1	16.8	16.7	16.2
030920	17.6	22.2	21.1	19.2	21.0	19.3	20.1
061692	16.1	16.3	17.4	18.2	17.5	16.5	17.0
051564	16.1	18.1	17.5	17.2	17.5	17.7	17.4
140087	16.2	19.4	17.6	18.1	18.0	19.4	18.1
Mean	17.0	**20.1**	**19.5**	**19.5**	**20.3**	19.6	19.5
$lsd_{5\%}$				0.9			
cv %				6.0			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 60 Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets on thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Nitrogen (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	2.23	2.34	2.47	2.32	2.36	2.43	2.36
020565	2.12	2.24	2.33	2.19	2.25	2.31	2.24
010396	1.86	2.00	2.18	2.36	2.35	2.27	2.18
051538	2.08	2.23	2.24	2.29	2.28	2.21	2.22
080754	2.28	2.29	2.34	2.31	2.34	2.36	2.32
101066	2.06	2.22	2.27	2.22	2.31	2.43	2.25
270005	2.13	2.42	2.33	2.23	2.24	2.30	2.28
105	1.92	2.03	2.19	2.17	2.21	2.18	2.12
140089	2.21	2.29	2.19	2.34	2.24	2.38	2.28
030920	1.87	2.05	2.31	2.15	2.28	2.17	2.14
061692	2.12	2.35	2.30	2.29	2.44	2.31	2.30
051564	2.10	2.33	2.32	2.30	2.26	2.26	2.26
140087	2.15	2.33	2.19	2.36	2.27	2.32	2.27
Mean	2.09	**2.24**	**2.28**	**2.27**	**2.29**	**2.30**	2.25
lsd $_{5\%}$				0.06			
cv %				3.4			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 61 Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets on thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Phosphorus (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.134	0.136	0.144	0.138	0.136	0.141	0.138
020565	0.127	0.135	0.139	0.130	0.135	0.135	0.134
010396	0.125	0.133	0.138	0.138	0.140	0.136	0.135
051538	0.127	0.138	0.131	0.131	0.136	0.134	0.133
080754	0.140	0.134	0.140	0.138	0.133	0.134	0.137
101066	0.131	0.133	0.141	0.131	0.133	0.141	0.135
270005	0.129	0.135	0.136	0.134	0.143	0.135	0.135
105	0.120	0.126	0.131	0.121	0.125	0.131	0.126
140089	0.131	0.134	0.135	0.136	0.131	0.141	0.135
030920	0.120	0.124	0.141	0.127	0.133	0.127	0.129
061692	0.138	0.147	0.144	0.143	0.149	0.149	0.145
051564	0.133	0.138	0.139	0.135	0.133	0.136	0.136
140087	0.136	0.139	0.136	0.140	0.136	0.147	0.139
Mean	0.130	0.135	0.138	0.134	0.136	0.138	0.135
$lsd_{5\%}$				0.003			
cv %				2.7			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 62 **Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).**

	Potassium (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.69	0.55	0.57	0.63	0.75	0.73	0.65
020565	0.81	0.53	0.75	0.61	0.75	0.69	0.69
010396	0.79	0.77	0.66	0.55	0.77	0.57	0.69
051538	0.81	0.63	0.67	0.69	0.73	0.75	0.71
080754	0.73	0.53	0.51	0.69	0.63	0.57	0.61
101066	0.85	0.69	0.59	0.57	0.69	0.69	0.68
270005	0.95	0.85	0.69	0.81	0.75	0.67	0.79
105	0.59	0.67	0.51	0.51	0.55	0.59	0.57
140089	0.79	0.75	0.65	0.53	0.73	0.61	0.68
030920	0.71	0.71	0.73	0.67	0.65	0.57	0.67
061692	0.79	0.79	0.75	0.75	0.77	0.79	0.77
051564	0.83	0.75	0.73	0.69	0.73	0.65	0.73
140087	0.81	0.77	0.75	0.67	0.65	0.71	0.73
Mean	0.78	**0.69**	**0.66**	**0.61**	**0.70**	**0.66**	0.68
lsd $_{5\%}$				0.068			
cv %				12.6			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 63 Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Calcium (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.72	0.76	0.81	0.84	0.86	0.83	0.80
020565	0.71	0.79	0.81	0.77	0.85	0.82	0.79
010396	0.92	0.94	0.89	0.84	0.81	0.70	0.85
051538	0.86	0.97	0.95	0.96	1.10	0.95	0.97
080754	0.90	0.91	0.86	0.88	0.73	0.95	0.87
101066	0.86	0.93	0.94	1.01	0.74	0.87	0.89
270005	0.67	0.90	0.89	0.91	0.79	0.93	0.85
105	0.84	0.90	0.83	0.77	0.80	0.83	0.83
140089	0.81	1.01	1.09	1.03	0.93	0.87	0.96
030920	0.73	1.03	0.86	1.07	0.77	0.89	0.89
061692	0.88	0.99	0.88	1.05	0.89	1.01	0.95
051564	1.05	1.06	0.89	0.93	0.86	0.93	0.95
140087	0.77	0.85	0.91	0.92	0.83	0.82	0.85
Mean	0.83	0.93	0.89	0.92	0.84	0.88	0.88
$lsd_{5\%}$				0.059			
cv %				8.6			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 64 Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

Block Nº	Magnesium (%) Treatment number 1	2	3	4	5	6	Mean
190020	0.09	0.10	0.11	0.12	0.13	0.12	0.11
020565	0.15	0.10	0.16	0.10	0.18	0.14	0.14
010396	0.24	0.19	0.15	0.13	0. 21	0.14	0.18
051538	0.16	0.13	0.12	0.12	0.13	0.16	0.14
080754	0.17	0.18	0.16	0.19	0.18	0.18	0.18
101066	0.15	0.14	0.15	0.11	0.13	0.13	0.14
270005	0.17	0.16	0.15	0.16	0.15	0.14	0.16
105	0.08	0.12	0.09	0.09	0.12	0.09	0.10
140089	0.19	0.19	0.20	0.17	0.18	0.15	0.18
030920	0.11	0.14	0.12	0.12	0.14	0.14	0.13
061692	0.17	0.15	0.16	0.13	0.17	0.21	0.17
051564	0.14	0.15	0.14	0.14	0.14	0.12	0.14
140087	0.15	0.18	0.17	0.18	0.13	0.16	0.16
Mean	0.152	0.149	0.145	0.135	0.153	0.145	0.146
lsd $_{5\%}$				0.017			
cv %				14.5			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 65 Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Chlorine (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.21	0.47	0.43	0.48	0.45	0.46	0.42
020565	0.17	0.38	0.40	0.41	0.42	0.46	0.37
010396	0.42	0.51	0.46	0.49	0.53	0.58	0.50
051538	0.17	0.43	0.51	0.48	0.55	0.45	0.43
080754	0.49	0.54	0.49	0.40	0.345	0.51	0.48
101066	0.22	0.48	0.48	0.46	0.46	0.45	0.43
270005	0.24	0.49	0.46	0.51	0.45	0.50	0.44
105	0.14	0.38	0.38	0.42	0.42	0.39	0.36
140089	0.35	0.52	0.53	0.60	0.51	0.60	0.52
030920	0.22	0.46	0.43	0.42	0.43	0.41	0.40
061692	0.17	0.45	0.52	0.53	0.43	0.58	0.45
051564	0.07	0.42	0.44	0.50	0.42	0.47	0.39
140087	0.12	0.39	0.40	0.54	0.41	0.48	0.39
Mean	0.23	**0.46**	**0.46**	**0.48**	**0.46**	**0.49**	0.43
$lsd_{5\%}$				0.043			
cv %				12.8			

Treatments: 1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 66 Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Nitrogen (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.24	0.25	0.27	0.27	0.26	0.25	0.26
020565	0.24	0.26	0.25	0.26	0.26	0.26	0.26
010396	0.19	0.19	0.20	0.22	0.21	0.21	0.20
051538	0.22	0.23	0.26	0.22	0.25	0.25	0.24
080754	0.24	0.26	0.24	0.25	0.23	0.27	0.25
101066	0.20	0.23	0.21	0.23	0.22	0.25	0.22
270005	0.22	0.25	0.21	0.23	0.23	0.24	0.23
105	0.22	0.21	0.21	0.23	0.20	0.25	0.22
140089	0.21	0.23	0.22	0.23	0.24	0.26	0.23
030920	0.18	0.24	0.21	0.21	0.24	0.22	0.22
061692	0.21	0.23	0.22	0.24	0.23	0.24	0.23
051564	0.21	0.21	0.22	0.20	0.19	0.25	0.21
140087	0.24	0.23	0.21	0.22	0.21	0.21	0.22
Mean	0.22	**0.23**	**0.23**	**0.23**	**0.23**	**0.24**	0.23
lsd $_{5\%}$				0.01			
cv %				13.0			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 67 Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Phosphorus (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.060	0.065	0.075	0.064	0.060	0..076	0.067
020565	0.050	0.042	0.061	0.044	0.036	0.041	0.046
010396	0.112	0.053	0.057	0.043	0.043	0.037	0.058
051538	0.041	0.032	0.063	0.032	0.039	0.036	0.041
080754	0.036	0.045	0.064	0.038	0.034	0.034	0.042
101066	0.041	0.035	0.043	0.034	0.039	0.047	0.040
270005	0.039	0.035	0.048	0.037	0.032	0.037	0.038
105	0.042	0.029	0.059	0.030	0.029	0.038	0.038
140089	0.046	0.040	0.062	0.058	0.055	0.066	0.055
030920	0.034	0.041	0.036	0.057	0.049	0.031	0.041
061692	0.069	0.078	0.093	0.093	0.065	0.070	0.078
051564	0.030	0.027	0.043	0.029	0.027	0.035	0.032
140087	0.074	0.058	0.067	0.048	0.046	0.055	0.058
Mean	0.052	**0.045**	**0.059**	**0.047**	**0.043**	**0.046**	0.049
lsd $_{5\%}$				0.008			
cv %				22.0			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 68 Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Potassium (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	1.18	1.37	1.28	1.62	1.37	1.28	1.35
020565	1.34	1.52	1.47	1.72	1.12	1.28	1.41
010396	1.42	1.37	1.40	1.42	1.37	1.42	1.40
051538	1.24	1.01	1.24	1.30	1.03	1.20	1.17
080754	1.05	1.10	0.99	1.16	1.07	0.97	1.06
101066	1.05	1.12	0.95	1.37	1.30	1.32	1.19
270005	1.24	1.42	1.18	1.28	1.24	1.37	1.29
105	1.37	1.07	1.07	1.57	1.18	1.32	1.26
140089	1.20	1.32	1.24	1.52	1.47	1.57	1.39
030920	0.97	1.20	1.57	1.67	1.10	1.34	1.31
061692	1.03	1.28	1.20	1.62	1.18	1.14	1.24
051564	0.99	0.93	1.12	1.14	1.05	1.10	1.06
140087	1.22	1.20	1.07	1.12	1.18	1.07	1.14
Mean	1.18	1.22	1.21	**1.42**	1.20	1.26	1.25
$lsd_{5\%}$				0.103			
cv %				10.5			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 69 Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Calcium (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.38	0.46	0.48	0.43	0.46	0.42	0.44
020565	0.35	0.51	0.56	0.50	0.43	0.50	0.48
010396	0.29	0.43	0.37	0.45	0.35	0.35	0.37
051538	0.44	0.54	0.53	0.45	0.39	0.52	0.48
080754	0.36	0.46	0.44	0.47	0.45	0.50	0.45
101066	0.34	0.52	0.40	0.46	0.44	0.43	0.43
270005	0.30	0.45	0.43	0.51	0.41	0.48	0.43
105	0.43	0.48	0.60	0.57	0.52	0.57	0.53
140089	0.36	0.36	0.47	0.45	0.45	0.45	0.42
030920	0.33	0.63	0.51	0.52	0.48	0.52	0.50
061692	0.32	0.40	0.40	0.54	0.38	0.43	0.41
051564	0.35	0.42	0.39	0.46	0.38	0.53	0.42
140087	0.32	0.35	0.35	0.39	0.36	0.36	0.36
Mean	0.35	**0.46**	**0.46**	**0.48**	**0.42**	**0.47**	0.44
lsd $_{5\%}$				0.034			
cv %				9.9			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 70 Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Magnesium (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.04	0.04	0.05	0.04	0.05	0.05	0.05
020565	0.03	0.04	0.05	0.04	0.04	0.05	0.04
010396	0.05	0.05	0.05	0.04	0.06	0.05	0.05
051538	0.04	0.04	0.04	0.04	0.03	0.03	0.04
080754	0.03	0.04	0.04	0.04	0.04	0.05	0.04
101066	0.03	0.04	0.04	0.03	0.04	0.04	0.04
270005	0.03	0.04	0.05	0.05	0.04	0.04	0.04
105	0.03	0.04	0.04	0.04	0.04	0.04	0.04
140089	0.04	0.04	0.04	0.04	0.05	0.04	0.04
030920	0.03	0.04	0.04	0.04	0.05	0.04	0.04
061692	0.03	0.05	0.04	0.05	0.05	0.04	0.04
051564	0.03	0.03	0.03	0.03	0.03	0.04	0.03
140087	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Mean	0.03	0.04	0.04	**0.04**	**0.05**	**0.04**	0.04
lsd $_{5\%}$				0.004			
cv %				22.6			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 71 Effect of fertilizer treatments on frond 17 rachis nutrient content on thirteen blocks in the Hoskins Project area in 1994 (Trial 121).

	Chlorine (%)						
	Treatment number						
Block Nº	1	2	3	4	5	6	Mean
190020	0.16	0.74	0.63	0.95	0.79	0.74	0.26
020565	0.09	0.66	0.55	0.90	0.60	0.59	0.26
010396	0.39	0.63	0.57	0.66	0.57	0.60	0.20
051538	0.49	0.45	0.43	0.69	0.06	0.64	0.24
080754	0.11	0.54	0.53	0.64	0.42	0.54	0.25
101066	0.08	0.49	0.35	0.67	0.54	0.59	0.22
270005	0.07	0.40	0.38	0.46	0.35	0.48	0.23
105	0.11	0.52	0.60	0.86	0.63	0.72	0.22
140089	0.48	0.51	0.52	0.80	0.53	0.82	0.23
030920	0.09	0.57	0.75	0.84	0.51	0.70	0.22
061692	0.05	0.54	0.45	0.80	0.41	0.43	0.23
051564	0.02	0.29	0.31	0.33	0.33	0.54	0.21
140087	0.06	0.36	0.28	0.42	0.30	0.31	0.22
Mean	0.17	**0.52**	**0.49**	**0.69**	**0.47**	**0.59**	0.49
lsd $_{5\%}$				0.09			
cv %				23.6			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

EXPERIMENT 124 **DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS IN SCHOOLS (HOSKINS).**

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Sites Experiment 124 is on OPIC's Hoskins Smallholder Oil Palm Project (Table 55) at Ponini Agricultural School, Hoskins Secondary School and MoraMora Vocational Centre.

Palms Dami commercial D X P planting material.
Planted between 1985 & 91 at 120 palms/ha and 95 palms/ha at Mora Mora.
Treatments started in July 1991.

DESIGN

Each of the three blocks provides a single replicate, within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 72). Each plot has at least 12 recorded palms, surrounded by a guard row.

Table 72 Treatments used in Trial 124.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	0	0
4	2	0	2	0
5	2	0	0	2
6	3	0	0	0

Fertiliser was applied twice a year in May and November.

The yield was recorded with the assistance of the schools. The rachis and leaflets were sampled in November 1994.

RESULTS

The components of yield (Table 73, 74, 75) were very widely variable. It is too early to make any meaningful observations.

Frond 17 leaflet and rachis were sampled and the nutrient concentrations analysed in April 1994 (Table 76, 77). The application of ammonium chloride (AC) appeared to have increased the concentration of nitrogen and chlorine in the leaflets in all plots that received fertilizer to what may be regarded as acceptable concentration (2.4%). The concentrations of chlorine was increased to more than 0.3 % while potassium and magnesium concentrations were low.

The concentration of potassium in the rachis (Table II-8B) was higher than in the leaflets in the 3 sites.

Table 73. Effect of fertiliser treatments on yield of three school blocks in the Hoskins project area in 1994 (Trial 124).

		Yield of FFB (t/ha/yr)						
		Treatment number						
Location	Area Name	1	2	3	4	5	6	Mean
School	Poinini	18.5	16.7	21.6	18.0	22.2	20.3	19.6
School	Hoskins	3.8	5.2	3.4	3.3	3.2	2.7	3.6
School	Moramora	6.6	5.8	7.7	6.2	7.2	5.3	6.5
	Mean	9.6	9.2	10.9	9.2	10.9	9.5	9.9
	$lsd_{5\%}$				2.67			
	cv %				14.8			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 74. Effect of fertiliser treatments on yield of two school blocks in the Hoskins project area in 1994 (Trial 124).

		Bunches (number/ha)						
		Treatment number						
Location	Area Name	1	2	3	4	5	6	Mean
School	Poinini	968	923	1320	1178	1296	1144	1138
School	Hoskins	968	1133	750	840	765	645	850
School	Moramora	507	428	530	418	502	396	464
	Mean	814	828	867	812	854	728	817
	lsd $_{5\%}$				298			
	cv %				20.0			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 75 Effect of fertiliser treatments on yield of three school blocks in the Hoskins project area in 1994 (Trial 124).

		Single Bunch Weight (kg)						
		Treatment number						
Location	Area Name	1	2	3	4	5	6	Mean
School	Poinini	16.9	18.1	16.5	15.5	17.3	18.0	17.1
School	Hoskins	4.0	4.6	4.5	4.0	4.2	4.2	4.3
School	Moramora	13.1	13.6	14.5	14.8	14.3	13.4	14.0
	Mean	11.3	12.1	11.8	11.4	11.9	11.9	11.8
	lsd $_{5\%}$				1.42			
	cv %				6.6			

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 75 The means of nutrient concentrations in frond 17 leaflets in three schools of Hoskins Project in November 1994 (Trial 124)

Location	Area Name	N	P	K	Ca	Mg	Cl
		% dry matter of leaflets					
School	Poinini	2.51	0.141	0.70	0.81	0.14	0.46
School	Hoskins	2.42	0.147	0.73	1.18	0.25	0.51
School	Moramora	2.27	0.138	0.76	0.76	0.19	0.52
	Mean	2.40	0.142	0.73	0.91	0.19	0.50

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 76 The means of nutrient concentrations in the rachis of frond 17 in three schools in the Hoskins Project in November 1994 (Trial 124)

Location	Area Name	N	P	K	Ca	Mg	Cl
		% dry matter of leaflets					
School	Poinini	0.25	0.165	1.51	0.36	0.04	0.53
School	Hoskins	0.27	0.172	1.27	0.66	0.10	0.62
School	Moramora	0.28	0.127	1.83	0.39	0.06	0.51
	Mean	0.27	0.155	1.53	0.47	0.07	0.55

Treatments:
1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

EXPERIMENT 207 DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS (BIALLA)

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 207 is located on OPIC's Bialla Smallholder Oil Palm Project (Table 55) at Silanga, Uasilau near NBPOD's Kapiura Plantations Pty Ltd.

Palms Dami commercial DxP planting material.
Planted between 1984 and 1985 at 120 palms/ha.
Treatments started in October 1990.

DESIGN

Each of the 2 smallholder blocks provide a single replicate within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 77). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 77 Treatments used in Trial 207.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	0	0
4	2	0	2	0
5	2	0	0	2
6	3	0	0	0

Fertiliser was applied twice a year in May and November.

The recording of yield was done in three months (February, June, & October) of the year.

RESULTS

The response to treatments was extremely variable between the two sites (Table 78, 79, 80). (Trial is highlighted in bold).

Block number 550438 (Silanga) appear to respond to the application of AC (treatment 2), AC plus TSP (treatment 3), AC plus MOP (treatment 4), AC plus kieserite (treatment 5). Block number 550176 (Uasilau) did not respond to most treatments. The response of treatments to yield components (FFB, bunch number & single bunch weights) are variable as found in the other sites.

Table 78. Effect of fertiliser treatments on yield of four blocks in the Bialla project area in 1994 (**Trial 207**, 208, 403).

			Yield of FFB (t/ha/yr)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	**550438**	**Silanga**	**9.2**	**10.3**	**13.0**	**14.3**	**9.4**	**13.9**	**11.7**
207	**500176**	**Uasilau**	**15.8**	**15.8**	**15.2**	**17.3**	**16.2**	**12.4**	**15.5**
208	School	Bialla	18.0	19.3	18.3	8.8	19.2	22.1	17.6
403	240921	Mamota	20.9	24.6	21.5	24.4	22.5	18.6	22.1
		Mean	16.0	17.5	17.0	16.2	16.8	16.8	16.7
		lsd $_{5\%}$				5.0			
		cv %				19.8			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 79. Effect of fertiliser treatments on bunch number of two blocks in the Bialla project area in 1994 (**Trial 207**, 208, 403).

			Bunches (number/ha)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	**550438**	**Silanga**	**908**	772	**932**	**1136**	**692**	**1172**	**935**
207	**500176**	**Uasilau**	**916**	**1092**	**1080**	**1184**	**888**	**960**	**1020**
208	School	Bialla	1756	1947	2105	1154	1108	1124	2078
403	240921	Mamota	1980	2250	2026	2234	2176	1800	1532
		Mean	1390	1515	1536	1427	1216	1264	1391
		lsd $_{5\%}$				409			
		cv %				19.5			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 80. Effect of fertiliser treatments on single bunch weights of two blocks in the Bialla project area in 1994 (**Trial 207**, 208, 403).

			Single Bunch Weight (kg)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	**550438**	**Silanga**	**10.2**	**13.3**	**14.0**	**12.6**	**13.6**	**11.8**	**12.6**
207	**500176**	**Uasilau**	**17.3**	**14.5**	**14.1**	**14.6**	**18.2**	**12.9**	**15.3**
208	School	Bialla	10.8	9.9	8.7	18.4	17.4	17.6	13.8
403	240921	Mamota	10.6	10.9	10.6	10.9	10.3	10.3	10.6
		Mean	12.2	12.2	11.9	14.1	14.9	13.2	13.1
		lsd $_{5\%}$				3.9			
		cv %				14.1			

EXPERIMENT 208. DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS IN SCHOOLS (BIALLA).

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Sites Experiment 208 is on OPIC's Bialla Smallholder Oil Palm Project (Table 55) at Bialla Provincial High School.

Palms Dami commercial D X P planting material.
Planted in 1985 at 120 palms per hectare.
Treatments started in 1992.

DESIGN

Each of the three blocks provides a single replicate, within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 81). Each plot has at least 12 recorded palms, surrounded by a guard row.

Table 81 Treatments used in Trial 208.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	0	2	0	0
3	2	2	0	0
4	0	2	2	0
5	0	2	0	2
6	0	3	0	0

Fertiliser was applied twice a year in May and November. The yield was recorded with the assistance of the schools.

RESULTS

Preliminary yield response appear to indicate an increase in the fresh fruit bunches by the application of triple superphosphate (TSP) plus kieserite (treatment 5) (Trial is highlighted in bold).

Table 82. Effect of fertiliser treatments on yield of one block in the Bialla project area in 1994 (**Trial** 207, **208**, 403).

			Yield of FFB (t/ha/yr)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	550438	Silanga	9.2	10.3	13.0	14.3	9.4	13.9	11.7
207	500176	Uasilau	15.8	15.8	15.2	17.3	16.2	12.4	15.5
208	**School**	**Bialla**	**18.0**	**19.3**	**18.3**	**8.8**	**19.2**	**22.1**	**17.6**
403	240921	Mamota	20.9	24.6	21.5	24.4	22.5	18.6	22.1
		Mean	16.0	17.5	17.0	16.2	16.8	16.8	16.7
		lsd $_{5\%}$				5.0			
		cv %				19.8			

Treatments:

1 = control.
2 = triple superphosphate (TSP), 2 kg/palm/yr.
3 = TSP plus ammonium chloride, 2 kg/palm/yr.
4 = TSP, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = TSP, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = TSP, at 3 kg/palm/yr.

Table 83. Effect of fertiliser treatments on bunch number of one block in the Bialla project area in 1994 (**Trial** 207, **208**, 403).

			Bunches (number/ha)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	550438	Silanga	908	772	932	1136	692	1172	935
207	500176	Uasilau	916	1092	1080	1184	888	960	1020
208	**School**	**Bialla**	**1756**	**1947**	**2105**	**1154**	**1108**	**1124**	**2078**
403	240921	Mamota	1980	2250	2026	2234	2176	1800	1532
		Mean	1390	1515	1536	1427	1216	1264	1391
		lsd $_{5\%}$				409			
		cv %				19.5			

Treatments:

1 = control.
2 = triple superphosphate (TSP), 2 kg/palm/yr.
3 = TSP plus ammonium chloride, 2 kg/palm/yr.
4 = TSP, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = TSP, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = TSP, at 3 kg/palm/yr.

Table 84. Effect of fertiliser treatments on single bunch weight of one block in the Bialla project area in 1994 (**Trial** 207, **208**, 403).

			Single Bunch Weight (kg)						
			Treatment number						
Trial Nº	Block Nº	Area Name	1	2	3	4	5	6	Mean
207	550438	Silanga	10.2	13.3	14.0	12.6	13.6	11.8	12.6
207	176	Uasilau	17.3	14.5	14.1	14.6	18.2	12.9	15.3
208	**School**	**Bialla**	**10.8**	**9.9**	**8.7**	**18.4**	**17.4**	**17.6**	**13.8**
403	240192	Mamota	10.6	10.9	10.6	10.9	10.3	10.3	10.6
		Mean	12.2	12.2	11.9	14.1	14.9	13.2	13.1
		lsd $_{5\%}$				3.9			
		cv %				14.1			

EXPERIMENT 403 DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS (BIALLA)

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 403 is located on OPIC's Bialla Smallholder Oil Palm Project (Table 55) at Mamota near Kapiura Plantations Pty Ltd.

Palms Dami commercial DxP planting material.
Planted in April 1990 at 120 palms/ha.
Treatments started in October 1991.

DESIGN

Each of the 2 smallholder blocks provide a single replicate within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 85). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 85 Treatments used in Trial 403.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	0	0
4	2	0	2	0
5	2	0	0	2
6	3	0	0	0

Fertiliser was applied twice a year in May and November.

The recording of yield was done in three months (February, June October) of the year. Leaflets and rachis of frond 17 were sampled in December 1993.

(Trial is highlighted in bold). It appears that the application of ammonium chloride (AC) (treatment 2) may increase yield (Table 86). It is possible this increase was due to high bunch number production (Table 87).

Table 86. Effect of fertiliser treatments on yield of four blocks in the Bialla project area in 1994 (**Trial** 207, 208, **403**).

Trial Nº	Block Nº	Area Name	Yield of FFB (t/ha/yr) Treatment number 1	2	3	4	5	6	Mean
207	550438	Silanga	9.2	10.3	13.0	14.3	9.4	13.9	11.7
207	500176	Uasilau	15.8	15.8	15.2	17.3	16.2	12.4	15.5
208	School	Bialla	18.0	19.3	18.3	8.8	19.2	22.1	17.6
403	**240921**	**Mamota**	**20.9**	**24.6**	**21.5**	**24.4**	**22.5**	**18.6**	**22.1**
		Mean	16.0	17.5	17.0	16.2	16.8	16.8	16.7
		lsd $_{5\%}$				5.0			
		cv %				19.8			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 87. Effect of fertiliser treatments on bunch number of four blocks in the Bialla project area in 1994 (**Trial** 207, 208, **403**).

Trial Nº	Block Nº	Area Name	Bunches (number/ha) Treatment number 1	2	3	4	5	6	Mean
207	550438	Silanga	908	772	932	1136	692	1172	935
207	500176	Uasilau	916	1092	1080	1184	888	960	1020
208	School	Bialla	1756	1947	2105	1154	1108	1124	2078
403	**240921**	**Mamota**	**1980**	**2250**	**2026**	**2234**	**2176**	**1800**	**1532**
		Mean	1390	1515	1536	1427	1216	1264	1391
		$lsd_{5\%}$				409			
		cv %				19.5			

Treatments:

1 = control.
2 = ammonium chloride (AC), 2 kg/palm/yr.
3 = AC plus triple superphosphate, 2 kg/palm/yr.
4 = AC, 2 kg/palm/yr, and muriate of potash, 2 kg/palm/yr.
5 = AC, 2 kg/palm/year, plus kieserite, 2 kg/palm/year.
6 = AC, at 3 kg/palm/yr.

Table 88. Effect of fertiliser treatments on single bunch weight of four blocks in the Bialla project area in 1994 (**Trial** 207, 208, **403**).

Trial Nº	Block Nº	Area Name	Single Bunch Weight (kg) Treatment number 1	2	3	4	5	6	Mean
207	550438	Silanga	10.2	13.3	14.0	12.6	13.6	11.8	12.6
207	176	Uasilau	17.3	14.5	14.1	14.6	18.2	12.9	15.3
208	School	Bialla	10.8	9.9	8.7	18.4	17.4	17.6	13.8
403	**240192**	**Mamota**	**10.6**	**10.9**	**10.6**	**10.9**	**10.3**	**10.3**	**10.6**
		Mean	12.2	12.2	11.9	14.1	14.9	13.2	13.1
		$lsd_{5\%}$				3.9			
		cv %				14.1			

Trial 253: DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER ON OIL PALM SMALLHOLDINGS (New Ireland).

PURPOSE

To carry out basic investigations into requirement for fertiliser input in smallholdings and if so determine he type of fertiliser required. This is a missing element trial on village oil palm.

DESCRIPTION

Sites. Experiment 253 is located on OPIC's New Ireland Smallholder Oil Palm Project covering areas (Table 55) between Kavieng town to Konos and Poliamba Plantations Pty Ltd. The two blocks identified are located at Lossu at South village oil palm (VOP), and Paruai in the North VOP area.

Palms Dami commercial DxP crosses.
Planted in 1992/93.

DESIGN

Each smallholder block provide a single replicate consisting of 2 hectares. Within this 2 ha there are 6 different treatments in 6 plots (Table II-15). The fertiliser types and rates (Table II-16) used depend on soil types and palm age.

Table 89 Fertiliser types used in Trial 253.

Fertiliser type*	Plot Nº	Treatment
AS + TSP + MOP + KIE	1	Complete: N+P+K+Mg
TSP + MOP + KIE	2	Complete minus N
AS + MOP + KIE	3	Complete minus P
AS + TSP + KIE	4	Complete minus K
AS + TSP + MOP	5	Complete minus Mg
NIL	6	NIL

* AS = ammonium sulphate,
TSP = triple superphosphate,
MOP = muriate of potash,
KIE = kieserite

Table 90 Treatments used in Trial 253.

Treatment number	Ammonium sulphate	Triple superphosphate	Muriate of potash	Kieserite
	Amount of fertiliser (kg/palm/yr)			
1	2	2	2	2
2	0	2	2	2
3	2	0	2	2
4	2	2	0	2
5	2	2	2	0
6	0	0	0	0

Treatments:

1 = ammonium sulphate plus triple superphosphate plus muriate of potash plus kieserite
2 = triple superphosphate plus muriate of potash plus kieserite
3 = ammonium sulphate plus muriate of potash plus kieserite
4 = ammonium sulphate plus triple superphosphate plus kieserite
5 = ammonium sulphate plus triple superphosphate plus muriate of potash
6 = nil

Fertiliser application currently follows plantation (Poliamba Pty Ltd) practice. The whole block is harvested in the normal way for a smallholder block and the weight of the fruitis recorded. Leaflets and rachis of frond 17 are sampled each year.

EXPERIMENT 128 DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS (HOSKINS).

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 128 is located on OPIC's Hoskins Smallholder Oil Palm Project (Table 92) covering areas west (Dire) and to the east (Galilo/Galai areas) of Kimbe town. The 28 blocks selected in pairs are located at Dire, Sarakolok, Tamba, Kapore, Kavui, Buvussi, Mai, Siki Kwalakesi and Kavutu. At Kavui and Buvusi there are 2 and 3 pairs respectively.

Palms Dami commercial DxP planting material.
Planted in various dates the between 1980 and 1990 at 120 palms/ha.
Treatments started in July 1994.

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments (Table 91). With the first pair, half of the block will receive no fertiliser at all (control) and the remaining half receive the recommended (demonstration) type and amount of fertiliser for the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control), and the remaining half will receive a generous amounts (2kg) of <u>all</u> main types (N, P, K, MG) of fertiliser.

Table 91 Treatments used in Trial 128.

Treatment number	Amount of fertiliser (kg/palm/yr)			
	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	2	2

Fertiliser will be applied twice a year in May and November. The whole block will be harvested in the normal way for a smallholder block and the weight of the fruit will be recorded by the transport company in each project at the time of pick up. Leaflets and rachis of frond 17 are sampled each year. Twenty eight blocks (Table 92) were identified each located in pairs. All the field labelling were completed in August. Pretreatment leaf tissue (Table 93) were sampled in June. Signboards were painted and fertiliser applications completed by August. Pick up of fruit (FFB) by NBPOD's Mosa Transport Company started assistance and cooperation from the Smallholder Affairs.

Table 92. List of 28 smallholder demonstration blocks in the Hoskins Smallholder Oil Palm Project areas of West New Britain Province.

HOSKINS		
Nº	AREA NAME	BLOCK Nº
1	Kapore LSS	010285
2	Kapore LSS	010386
3	Tamba LSS	020413
4	Tamba LSS	020414
5	Tamba LSS	020555
6	Tamba LSS	020556
7	Sarakolok LSS	030922
8	Sarakolok LSS	030923
9	Buvussi LSS	041160
10	Buvussi LSS	041161
11	Buvussi LSS	041193
12	Buvussi LSS	041194
13	Buvussi LSS	041399
14	Buvussi LSS	041418
15	Kavui LSS	061680
16	Kavui LSS	061681
17	Kavui LSS	061701
18	Kavui LSS	061702
19	Siki LSS	102225
20	Siki LSS	102236
21	Kwalakesi VOP	130002
22	Kwalakesi VOP	130014
23	Mai VOP	140019
24	Mai VOP	140091
25	Kavutu VOP	330012
26	Kavutu VOP	330037
27	Dire VOP	340005
28	Dire VOP	340011

RESULTS

Pretreatment leaf tissue analysis data (Table 93) indicated in 1994 that nitrogen and chlorine concentrations are low overall.

Table 93. Pretreatment nutrient concentrations of frond 17 leaflets of 14 blocks in Hoskins project area in 1994 (Trial 128).

Block	Area	N	P	K	Ca	Mg	Cl
Number	Name			% dry matter of leaflets			
61681	Kavui LSS	2.23	0.143	0.75	0.95	0.18	0.24
61682	Kavui LSS	2.16	0.134	0.55	0.94	0.14	0.14
61701	Kavui LSS	1.99	0.125	0.71	0.97	0.17	0.14
61702	Kavui LSS	1.87	0.124	0.67	0.91	0.19	0.13
30922	Sarakol LSS	2.07	0.129	0.87	0.85	0.16	0.24
30923	Sarakol LSS	2.17	0.134	0.79	0.97	0.19	0.26
20413	Tamba LSS	1.89	0.117	0.63	0.83	0.14	0.13
20414	Tamba LSS	1.87	0.126	0.71	0.85	0.16	0.21
20555	Tamba LSS	2.01	0.124	0.69	0.66	0.11	0.15
20556	Tamba LSS	2.15	0.129	0.71	0.83	0.14	0.15
340005	Dire VOP	2.45	0.133	0.79	0.88	0.14	0.17
340011	Dire VOP	2.36	0.134	0.77	0.86	0.16	0.17
41193	Buvusi LSS	2.13	0.131	0.87	0.99	0.16	0.19
41399	Buvusi LSS	2.27	0.135	0.83	1.01	0.21	0.19
14 values	Mean	2.12	0.130	0.74	0.89	0.16	0.18
14 values	Minimum	1.87	0.117	0.55	0.66	0.11	0.26
14 values	Maximum	2.45	0.143	0.87	1.01	0.21	0.26

EXPERIMENT 210 BENCHMARK/DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS (BIALLA).

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 210 is located on OPIC's Bialla Smallhlder Oil Palm Project (Table 95) covering areas between Mamota and NBPOD's Kapiura Plantations Pty Ltd in the west to Noau and Hargy's Navo Plantation east of Bialla township. The twelve selected in pairs are located at Lavege, Bereme, Silanga, Matililiu and Noau.

Palms Dami commercial DxP planting material.
Planted in various dates the between 1984 and 1991 at 120 palms/ha.
Treatments started in July 1994.

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments (Table 94). With the first pair, half of the block will receive no fertiliser at all (control) and the remaining half receive the recommended (demonstration) type and amount of fertiliser for the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control), and the remaining half will receive a generous amounts (2kg) of <u>all</u> main types (N, P, K, MG) of fertiliser.

Table 94 Treatments used in Trial 210.

	Amount of fertiliser (kg/palm/yr)			
Treatment number	Ammonium chloride	Triple superphosphate	Muriate of potash	Kieserite
1	0	0	0	0
2	2	0	0	0
3	2	2	2	2

Fertiliser is applied twice a year in May and November. The whole block is harvested in the normal way for a smallholder block and the weight of the fruit recorded by the transport company in each project at the time of pick up. Leaflets and rachis of frond 17 are sampled each year. Twelve blocks (Table 95) were identified each located in pairs. All the field labelling were completed by July including pretreatment leaf tissue sampling (Table 96). Field signboards were placed and fertiliser appl1ed in August. Pick up of fruit (FFB) by Hargy's Transport Company and Kapiura Plantations Transport Division started in September with assistance from OPIC.

RESULTS

Pretreatment leaf tissue analysis on 10 different blocks (Table 95 and Table 96) show low concentrations of nitrogen and chlorine. In the higher lying areas eg Bereme villages (300meters * a.s.l.) the concentration of potassium is higher relative to the coastal areas.

Additional to blocks selected for demonstrations, 14 leaf sampling areas were taken as part of services provided covering areas of Bialla and Kapiura. Leaf tissue analysis results (Table 96) show low nitrogen and chlorine concentrations. In the higher (300meters a.s.l.) lying areas mean potassium concentration is high (1.05%).

Table 95 List of 12 smallholder demonstration blocks in the Bialla and Kapiura areas of West New Britain Province (Trial 210).

	BIALLA	
Nº	AREA NAME	BLOCK Nº
1	Noau VOP	7014
2	Noau VOP	7023
3	Matililiu VOP	1704
4	Matililiu VOP	1707
5	Tarobi VOP	25703
6	Tarobi VOP	25707
7	Lavege VOP	25113
8	Lavege VOP	25115
9	Bereme * VOP	25404
10	Lavege VOP	25409
11	Silanga LSS	55514
12	Silanga LSS	55514

Table 96. Preatment nutrient concentrations of frond 17 of 10 blocks around Bialla and Kapiura project areas in April1994 (Trial 210).

BLOCK	AREA	N	P	K	Ca	Mg	Cl
NUMBER	NAME			% dry matter of leaflets			
25130	Lavege VOP	2.32	0.144	0.79	0.86	0.15	0.10
25133	Lavege VOP	2.43	0.149	0.79	0.80	0.16	0.17
25404	Bereme VOP *	2.23	0.144	1.10	1.03	0.31	0.20
25409	Bereme VOP*	2.39	0.150	1.32	0.98	0.28	0.21
25703	Tarobi VOP	2.32	0.136	0.89	0.92	0.17	0.20
25707	Tarobi VOP	2.18	0.129	0.87	0.81	0.17	0.18
1705	Matililiu VOP	2.28	0.130	0.89	0.86	0.12	0.14
1707	Matililiu VOP	2.11	0.131	0.91	0.96	0.14	0.19
7014	Noau VOP	2.14	0.130	0.69	0.88	0.29	0.23
7023	Noau VOP	2.25	0.129	0.69	0.88	0.21	0.24
10 values	Mean	2.27	0.137	0.89	0.90	0.20	0.19
10 values	Minimum	2.11	0.126	0.69	0.80	0.12	0.10
10 values	Maximum	2.43	0.150	1.32	1.03	0.31	0.24

Table 97. Nutrient concentrations of frond 17 leaflets taken from 14 compounded leaf sampling units (LSU) from central to the east of Bialla Smallholder Oil Palm Project areas in April 1994

BLOCK	AREA	N	P	K	Ca	Mg	Cl
NUMBER	NAME	% dry matter of leaflets					
1	Gigipuna VOP 1	2.45	0.144	0.89	1.00	0.24	0.13
2	Gigipuna VOP 2	2.53	0.142	0.83	0.87	0.18	0.14
3	Gigipuna VOP 3	2.52	0.143	0.81	0.96	0.21	0.16
4	Balima LSS 1	1.99	0.116	0.57	0.87	0.20	0.20
5	Balima LSS 2	1.94	0.117	0.67	0.82	0.18	0.18
6	Apupul VOP	2.35	0.140	0.91	0.87	0.26	0.30
7	Wilelo LSS 1	1.99	0.118	0.75	0.87	0.22	0.24
8	Wilelo LSS 2	2.13	0.124	0.71	0.81	0.12	0.22
9	Noau VOP 1	2.26	0.134	0.79	0.85	0.22	0.20
10	Noau VOP 2	1.89	0.113	0.63	0.78	0.26	0.30
11	Noau VOP 3	2.31	0.130	0.83	0.82	0.20	0.27
12	Urumaili VOP	2.24	0.137	0.83	0.96	0.19	0.20
13	Kiawa VOP	2.16	0.130	0.83	0.85	0.20	0.15
14	Sabaltepun VOP *	2.38	0.139	1.05	1.02	0.25	0.25
14 values	Mean	2.22	0.14	0.79	0.88	0.21	0.21
14 values	Minimum	1.89	0.113	0.57	0.78	0.12	0.13
14 values	Maximum	2.53	0.144	1.05	1.02	0.26	0.30

* (300meters a.s.l.)

III. MAINLAND REGION AGRONOMY TRIALS AND SMALLHOLDER TRIALS AND DEMONSTRATIONS

(A.T.Oliver)

Trial 305 FERTILISER TRIAL AT AREHE

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on the Higaturu soil.

DESCRIPTION

Site Arehe Estate block 78F

Soil Higaturu family. Deep sandy clay loam with good drainage, derived from volcanic ash.

Palms Dami commercial DxP crosses. Planted in 1978 at 130 palms/ha.
Trial started in 1981.

DESIGN

There are 72 plots, each with a core of 16 palms. The numbers and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, sometimes two.

The 72 plots are divided into two replicates of 36. In each replicate there are 36 treatments, made up from all combinations of three levels each of N and K, and two levels each of P and Mg (Table 98).

Table 98. Types of fertiliser and amounts used in trial 305.

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)		
		Level 0	Level 1	Level 2
N	SOA	0.0	2.0	4.0
P	TSP	0.0	2.0	-
K	MOP	0.0	2.0	4.0
Mg	Kies	0.0	1.0	-

RESULTS

Yield data for 1994, and for the 6 years 1989 - 1994 are summarised in Tables 2 and 4.

There was a large and statistically significant increase in yield caused by SOA, up to level 1 of about 10 tonnes, and then a smaller increase of 4 tonnes to level 2 (Table 99). This increase was made up from an increase in number of bunches per hectare, and single bunch weight

There was also an increase in yield due to Muriate of Potash (MOP), though it was not statistically significant over the 6 year period 1989-1994 (Table 101). MOP increased single bunch weights, but as the increase was accompanied by reduction in bunch numbers, the overall effect on yield was marginal.

Table 99. Main effects of N, P, K, and Mg on yield and yield components in oil palm in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	19.7	29.0	33.2	***	17.7	2.80
Bunches/ha	886	1109	1253	***	15.8	99
Bunch weight (kg)	21.7	26.4	26.7	***	10.0	1.45
	P0	P1				
Yield (t/ha/yr)	26.7	28.0		ns	17.7	-
Bunches/ha	1049	1116		ns	15.8	-
Bunch weight (kg)	25.1	24.8		ns	10.0	-
	K0	K1	K2			
Yield (t/ha/yr)	26.0	28.8	27.2	ns	17.7	-
Bunches/ha	1133	1092	1024	ns	15.8	-
Bunch weight (kg)	22.8	25.9	26.0	***	10.0	1.45
	Mg0	Mg1				
Yield (t/ha/yr)	27.2	27.4		ns	17.7	-
Bunches/ha	1082	1084		ns	15.8	-
Bunch weight (kg)	24.8	25.1		ns	10.0	-

The interaction between N and K is not significant, but the Nx K two-way table (Table 100) shows that the maximum yield of 35 t/ha/year is achieved with 4 kg SOA and 2 kg MOP per palm.

There was no response to TSP and Kieserite.

Table 100. Effect of N on yield at different levels of K in 1994.

	Yield (tonnes/ha/year)		
	N0	N1	N2
K0	19.4	28.3	30.2
K1	20.4	30.5	35.4
K2	19.2	28.3	34.1

Note: NxK interaction not significant.

Table 101. Main effects of N, P, K, and Mg on yield and yield components (mean 1987 - 1994).

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	20.6	29.9	33.0	***	15.1	2.44
Bunches/ha	958	1220	1337	***	13.3	90
Bunch wt (kg)	21.1	24.7	24.8	***	8.8	1.19
	P0	P1				
Yield (t/ha/yr)	27.5	28.2		ns	15.1	-
Bunches/ha	1157	1186		ns	13.3	-
Bunch wt (kg)	23.5	23.5		ns	8.8	-
	K0	K1	K2			
Yield (t/ha/yr)	26.6	28.8	28.2	ns	15.1	-
Bunches/ha	1217	1162	1136	ns	13.3	-
Bunch wt (kg)	21.7	24.4	24.4	***	8.8	1.19
	Mg0	Mg1				
Yield (t/ha/yr)	28.0	27.7		ns	15.1	-
Bunches/ha	1181	1162		ns	13.3	-
Bunch wt (kg)	23.4	23.6		ns	8.8	-

Table 102. Effect of N on yield at different levels of K in 1987 - 1994.

	Yield (tonnes/ha/year)		
	N0	N1	N2
K0	20.1	20.9	20.7
K1	29.2	30.8	29.8
K2	30.4	34.7	34.0

Nutrient analysis

The analysis on nutrient concentrations from sampling in 1994 of frond 17. These are presented in Tables 103 and 104.

Table 103. Main effects of N, P, K, and Mg on concentrations of elements in leaf tissues of frond 17 in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	2.02	2.11	2.20	***	5.3	0.06
P%	0.131	0.131	0.135	***	3.1	0.002
K%	0.68	0.65	0.68	ns	7.6	-
Ca%	0.72	0.70	0.68	*	7.0	0.028
Mg%	0.18	0.17	0.16	(ns)	16.9	0.017
Cl%	0.35	0.34	0.34	ns	10.8	0.02
K as % All Bases	25.6					
	P0	P1				
N%	2.12	2.10		ns	5.3	-
P%	0.130	0.135		***	3.1	0.002
K%	0.66	0.67		ns	7.6	-
Ca%	0.69	0.70		ns	7.0	-
Mg%	0.17	0.17		ns	16.9	-
Cl%	0.34	0.35		ns	10.8	-
	K0	K1	K2			
N%	2.09	2.16	2.09	(ns)	5.3	0.06
P%	0.132	0.134	0.132	*	3.1	0.002
K%	0.68	0.67	0.65	ns	7.6	-
Ca%	0.66	0.71	0.72	***	7.0	0.028
Mg%	0.18	0.17	0.17	ns	16.9	-
Cl%	0.09	0.45	0.49	***	10.8	0.02
	Mg0	Mg1				
N%	2.11	2.11		ns	5.3	-
P%	0.133	0.133		ns	3.1	-
K%	0.66	0.68		ns	7.6	-
Ca%	0.71	0.68		*	7.0	0.28
Mg%	0.17	0.18		ns	16.9	-
Cl%	0.35	0.34		ns	10.8	-

Table 104. Main effects of N, P, K, and Mg on concentrations of elements in the rachis of frond 17 in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	0.22	0.23	0.27	***	8.8	0.01
P%	0.194	0.120	0.085	***	39.1	0.03
K%	1.46	1.34	1.27	**	13.9	0.11
Ca%	0.36	0.35	0.35	ns	10.2	-
Mg%	0.07	0.07	0.06	ns	113.4	-
Cl%	0.77	0.64	0.66	ns	30.9	-
	P0	P1				
N%	0.23	0.24		ns	8.8	-
P%	0.095	0.171		***	39.1	0.02
K%	1.36	1.36		ns	13.9	-
Ca%	0.35	0.36		ns	10.2	-
Mg%	0.08	0.06		ns	113.4	-
Cl%	0.67	0.70		ns	30.9	-
	K0	K1	K2			
N%	0.23	0.24	0.23	ns	8.8	-
P%	0.106	0.149	0.145	*	39.1	0.03
K%	1.04	1.46	1.57	***	13.9	0.11
Ca%	0.30	0.37	0.39	***	10.2	0.02
Mg%	0.06	0.08	0.06	ns	113.4	-
Cl%	0.18	0.83	1.06	***	30.9	0.12
	Mg0	Mg1				
N%	0.24	0.23		ns	8.8	-
P%	0.135	0.132		ns	39.1	-
K%	1.34	1.37		ns	13.9	-
Ca%	0.36	0.35		ns	10.2	-
Mg%	0.06	0.08		ns	113.4	-
Cl%	0.65	0.72		ns	30.9	-

Table 105. Leaf analysis and yield results, 1994.

Treatment	Leaf levels - percent dry matter, leaf 17						Yield t/ha/yr	Bunch No/ha	Bunch weight
	N	P	K	Ca	Mg	Cl			
N0	2.02	0.131	0.68	0.72	0.18	0.35	19.66	886	21.7
N1	2.11	0.132	0.65	0.70	0.17	0.34	29.05	1109	26.4
N2	2.20***	0.135***	0.68	0.68**	0.16	0.34	33.25***	1253***	26.7***
P0	2.12	0.130	0.66	0.69	0.17	0.34	26.68	1049	25.1
P1	2.10	0.135***	0.67	0.70	0.17	0.35	27.96	1116	24.8
K0	2.09	0.132	0.68	0.66	0.18	0.09	25.98	1133	22.8
K1	2.16	0.134	0.67	0.71	0.17	0.45	28.75	1092	25.9
K2	2.09	0.132*	0.65	0.72***	0.17	0.49***	27.24	1024	26.0***
Mg0	2.11	0.133	0.66	0.71	0.17	0.35	27.25	1082	24.8
Mg1	2.11	0.133	0.68	0.68*	0.18	0.34	27.40	1084	25.1

Trial 306 **FERTILISER TRIAL AT AMBOGO ESTATE**

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on Ambogo and Penderetta soils.

DESCRIPTION

Site Ambogo Estate block 79B

Soil Ambogo and Penderetta families. Silt loam over sandy loam, with mottling due to seasonally high water tables, derived from alluvially deposited volcanic ash.

Palms Dami commercial DxP crosses planted in 1979 at 143 palms/ha. Trial started 1982.

DESIGN

There are 81 plots each containing 16 core palms. The number and weights of bunches for individual core palms are surrounded by at least one guard row, sometimes two.

The 81 plots are a single replicate containing 81 treatments, made up from all combinations of three levels each of N, P, K, and Mg (Table 106). The 81 treatments are divided into three blocks within the replicate, such that the effects of some high order interactions are confounded with block effects.

Table 106. Types and amount of fertiliser used in Trial 306.

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)		
		Level 0	Level 1	Level 2
N	SOA	0.0	3.0	6.0
P	TSP	0.0	0.5	1.0
K	MOP	0.0	2.5	5.0
Mg	Kies	0.0	0.75	1.5

Table 107. Main effects of N, P, K, and Mg on yield and yield components in oil palm in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	20.9	27.5	28.8	***	14.9	2.10
Bunches/ha	917	1011	1061	***	11.7	63
Bunch weight (kg)	22.7	27.2	27.2	***	8.0	1.12
	P0	P1	P2			
Yield (t/ha/yr)	25.5	25.1	26.6	ns	14.9	-
Bunches/ha	993	980	1016	ns	11.7	-
Bunch weight (kg)	25.5	25.5	26.1	ns	8.0	-
	K0	K1	K2			
Yield (t/ha/yr)	25.2	25.8	26.1	ns	14.9	-
Bunches/ha	1041	954	993	*	11.7	63
Bunch weight (kg)	24.1	26.8	26.1	***	8.0	1.12
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	24.6	26.3	26.3	ns	14.9	-
Bunches/ha	985	1004	999	ns	11.7	-
Bunch weight (kg)	24.8	26.2	26.2	ns	8.0	-

Table 108. Effect of N on yield at different levels of K in 1994.

Levels of K	Yields (tonnes/ha/year)		
	N0	N1	N2
K0	21.8	20.7	20.2
K1	27.2	26.5	28.7
K2	26.6	30.3	29.5

Note: interaction not significant.

Table 109. Main effects of N, P, K, and Mg on yield and yield components (mean 1987 - 1994).

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	21.8	27.6	28.9	***	10.6	1.50
Bunch/ha	1055	1165	1223	***	7.4	46
Bunch weight (kg)	20.6	23.7	23.6	***	7.4	0.91
	P0	P1	P2			
Yield (t/ha/yr)	25.8	25.6	26.8	ns	10.6	-
Bunch/ha	1149	1132	1162	ns	7.4	-
Bunch weight (kg)	22.4	22.5	23.0	ns	7.4	-
	K0	K1	K2			
Yield (t/ha/yr)	25.3	26.4	26.5	ns	10.6	-
Bunch/ha	1183	1120	1140	**	7.4	46
Bunch weight (kg)	21.3	23.5	23.1	***	7.4	0.91
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	25.2	26.5	26.5	ns	10.6	-
Bunch/ha	1138	1159	1146	ns	7.4	-
Bunch weight (kg)	22.0	22.8	23.1	*	7.4	0.91

Table 110. Effect of N on yield at different levels of K in 1987 - 1994.

Levels of K	Yield (tonnes/ha/year)		
	N0	N1	N2
K0	22.0	26.9	27.0
K1	22.2	27.2	29.8
K3	21.1	28.6	29.8

Table 111. Main effects of N, P, K, and Mg on concentrations of elements in leaf tissues of frond 17 in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	2.11	2.24	2.28	***	5.0	0.06
P%	0.137	0.140	0.140	**	3.1	0.002
K%	0.80	0.81	0.81	ns	6.3	-
Ca%	0.64	0.64	0.62	*	8.2	0.03
Mg%	0.24	0.22	0.22	ns	10.1	-
Cl%	0.40	0.42	0.40	ns	15.3	-
K as % All Bases						
	P0	P1	P2			
N%	2.22	2.18	2.23	ns	5.0	-
P%	0.138	0.138	0.141	*	3.1	0.002
K%	0.81	0.81	0.80	ns	6.3	-
Ca%	0.62	0.64	0.64	ns	8.2	-
Mg%	0.23	0.23	0.22	ns	10.1	-
Cl%	0.40	0.39	0.42	ns	15.3	-
K as % All Bases						
	K0	K1	K2			
N%	2.23	2.20	2.20	ns	5.0	-
P%	0.140	0.139	0.138	ns	3.1	-
K%	0.83	0.79	0.80	*	6.3	0.03
Ca%	0.59	0.65	0.66	***	8.2	0.03
Mg%	0.24	0.22	0.22	***	10.1	0.012
Cl%	0.20	0.50	0.52	***	15.3	0.03
K as % All Bases						
	Mg0	Mg1	Mg2			
N%	2.21	2.22	2.19	ns	5.0	-
P%	0.140	0.140	0.138	ns	3.1	-
K%	0.81	0.80	0.80	ns	6.3	-
Ca%	0.62	0.64	0.63	ns	8.2	-
Mg%	0.22	0.23	0.24	*	10.1	0.012
Cl%	0.39	0.42	0.40	ns	15.3	-
K as % All Bases						

Table 112. Main effects of N, P, K, and Mg on concentrations of elements in the rachis of frond 17 in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	0.23	0.25	0.28	***	8.4	0.012
P%	0.251	0.136	0.087	***	22.1	0.02
K%	1.76	1.61	1.61	**	10.8	0.1
Ca%	0.30	0.30	0.31	ns	12.8	0.02
Mg%	0.08	0.07	0.06	***	17.4	0.007
Cl%	0.78	0.69	0.74	ns	29.0	0.12
	P0	P1	P2			
N%	0.26	0.26	0.26	ns	8.4	-
P%	0.143	0.160	0.170	*	22.1	0.02
K%	1.63	1.67	1.68	ns	10.8	-
Ca%	0.29	0.31	0.31	ns	12.8	-
Mg%	0.07	0.07	0.07	ns	17.4	-
Cl%	0.71	0.75	0.76	ns	29.0	-
	K0	K1	K2			
N%	0.26	0.26	0.25	*	8.4	0.012
P%	0.133	0.167	0.173	***	22.1	0.02
K%	1.37	1.76	1.85	***	10.8	0.1
Ca%	0.26	0.33	0.32	***	12.8	0.02
Mg%	0.07	0.07	0.08	*	17.4	0.007
Cl%	0.23	0.94	1.04	***	29.0	0.12
	Mg0	Mg1	Mg2			
N%	0.26	0.26	0.25	ns	8.4	-
P%	0.164	0.151	0.158	ns	22.1	-
K%	1.66	1.63	1.68	ns	10.8	-
Ca%	0.30	0.31	0.30	ns	12.8	-
Mg%	0.07	0.07	0.07	ns	17.4	-
Cl%	0.72	0.73	0.77	ns	29.0	-

Trial 309 TO TEST THE RESPONSE TO POTASSIUM, CHLORINE, AND SULPHUR

PURPOSE

To test the response to potassium, chlorine and sulphur.

DESCRIPTION

Site Ambogo Estate block 80H

Soil Penderetta family. Thin dark sandy loam topsoil over sandy loam subsoil, derived from alluvially deposited volcanic ash. Mottling due to seasonally high water tables.

Palms Dami commercial DxP crosses planted in 1980 at 143 palms per hectare. Trial started in January 1988, but present treatments started in June 1990.

DESIGN

There are 25 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, sometimes two.

The 25 plots are divided into five replicate blocks each containing five treatments (Table 113). The trial is laid down on the site of an earlier trial, that was started in 1984, to test the effects of EFB. Each treatment used in the present trial occurs once on each treatment of the previous trial, and once in each block. Thus the trial has a latin square design.

The treatments are combinations of fertilisers, one of which is bunch ash (BA). The right hand part of Table 14 shows the amount of each element that is applied to each treatment. The effects of an element is found by comparing the yields from two treatments: for example the effect of chlorine is found by comparing the yields from treatment 4 and 5.

The treatments that were used from January 1988 to June 1990 were similar, but there are some important differences. Treatment 3 now receives N and S, but used to receive only K. Treatment 2 now receives N and Cl, but used to receive K and Cl. Thus in a comparison of a treatment with either 2 or 3 in order to test the effect of K the effect will be underestimated if there is a residual effect of the K that was given in the early part of the trial.

Table 113. Types and amounts of fertiliser given in each treatment, and corresponding amounts of nutrient element in Trial 309.

	Amount of fertiliser (kg/palm/year)				Amount of element (kg/palm/year)			
Treatment No.	MOP	BA	SOA	AMC	N	K	Cl	S
1	-	-	-	-	-	-	-	-
2	-	-	-	3.2	0.80	-	2.1	-
3	-	-	4.0	-	0.84	-	-	0.96
4	4.4	-	4.0	-	0.84	2.3	2.1	0.96
5	-	8.8	4.0	-	0.84	2.2	-	0.96

Table 114. Effects of N, S, K, and Cl in different combinations, on yield and yield components in 1993 and 1994.

Treatment	1993			1994		
	Yield (t/ha/yr)	Bunches (no/ha)	Bunch wt (Kg)	Yield (t/ha/yr)	Bunches (no/ha)	Bunch wt (Kg)
4 N S K Cl	28.4	1192	23.9	27.7	1115	24.9
5 N S K	28.7	1214	23.6	26.4	1081	24.5
3 N S	25.2	1178	21.4	24.2	992	24.3
2 N Cl	19.4	1023	19.3	18.7	878	21.4
1 Nil	9.8	665	14.2	7.1	476	14.4
Sig	***	**	***	***	***	***
cv	19.1	22.1	7.9	9.4	10.3	10.2
lsd	5.9	322	2.2	2.7	129	3.1

Table 115. Mean yield for 1991 - 1994, and difference in yield for selected comparisons.

Mean Yield 1991 - 1994		Selected Comparisons		
Treatment	Yield (t/ha/yr)	Comparisons	Difference (t/ha/yr)	Sig
4 N S K Cl	29.2	4-2 (effect of K and S)	8.9	***
5 N S K	27.9	3-2 (sustituting S for Cl)	5.4	***
3 N S	25.7	4-3 (effect of K and Cl)	3.5	**
2 N Cl	20.3	4-5 (effect of Cl)	1.3	ns
1 Nil	10.2	5-3 (effect of K)	2.2	*
		3-1 (effect of N and S)	15.5	***
		2-1 (effect of N and Cl)	10.1	***

Table 116. Leaf analysis and yield results, 1994. Effects of N, S, K, and Cl in different combinations, on concentration of elements in the leaf tissue of frond 17 in 1994.

Treatment	Leaf levels - percent dry matter. leaf 17							Yield t/ha/yr	Bunch No/ha	Bunch wt (kg)
	N	P	K	Ca	Mg	Cl	S			
4 N S K Cl	2.18	0.137	0.72	0.72	0.20	0.49	0.14	27.7	1115	24.9
5 N S K	2.15	0.138	0.81	0.63	0.19	0.34	0.13	26.2	1081	24.3
3 N S	2.07	0.132	0.78	0.62	0.21	0.23	0.13	24.2	992	24.3
2 N Cl	2.06	0.138	0.65	0.74	0.22	0.52	0.12	18.7	878	21.4
1 Nil	1.83	0.129	0.68	0.72	0.30	0.25	0.13	7.1	476	14.4
Sig	**	ns	**	**	***	***	ns	***	***	***
cv	6.5	4.5	8.5	6.9	8.2	11.8	11.7	9.4	10.3	10.2
lsd	0.18	-	0.08	0.06	0.02	0.06	-	2.7	129	3.1

Table 117. Effects of N, S, K, and Cl in different combinations, on the concentration of elements in rachis of frond 17 in 1994.

Treatment	Concentration (% dry matter)						
	N	P	K	Ca	Mg	Cl	S
4 N S K Cl	0.25	0.08	1.86	0.39	0.07	1.08	0.05
5 N S K	0.23	0.08	1.60	0.28	0.05	0.29	0.06
3 N S	0.24	0.07	1.22	0.29	0.05	0.15	0.06
2 N Cl	0.38	0.13	1.35	0.39	0.11	1.11	0.05
1 Nil	0.21	0.16	1.23	0.30	0.11	0.30	0.05
Sig	**	***	***	***	***	***	ns
cv	23.3	19.3	8.3	6.9	17.5	16.5	15.8
lsd	0.08	0.03	0.166	0.03	0.02	0.133	-

Trial 310 POTASSIUM, CHLORINE AND SULPHUR TRIAL AT AMBOGO ESTATE.

PURPOSE

To test the response to potassium, chlorine and sulphur

DESCRIPTION

Site Ambogo block 80D5.

Soil Ambogo and Penderetta families. Silt loam over sandy loam, with mottling due to seasonally high water tables, derived from alluvially deposited volcanic ash.

Palms Dami commercial DxP crosses planted in 1980 at 143 palms per hectare. Trial started in 1986, but present treatments started in November 1990.

DESIGN

There are 35 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by one guard row, and each plot is surrounded by a trench.

The 35 plots are divided into five replicate blocks, each containing seven treatments that are randomised (Table 118). The treatments are combination of fertilisers. The lower half of Table 119 shows the amount of each element that is applied to each treatment. The effect of an element is found by comparing the yields from two treatments; for example the effect of Cl in the presence of K and S is found by comparing treatments 6 and 4, and the effect of Cl in the absence of K and S is found by comparing treatments 3 and 1.

The treatments that were used before November 1991 were similar, but there are some important differences (Table 119). All treatments used to get their N from Urea, but now only treatment 1 does. The others get it from SOA or AMC. Treatment 6 now has Cl but did not before, while treatment 7 now has S but did not before.

Table 118. Amount of each type of fertiliser, and each element, used for each treatment.

Type of fertiliser	Treatment number (kg of fertiliser/palm/year)						
	1	2	3	4	5	6	7
Urea	1.8	-	-	-	-	-	-
SOA	-	4.0	-	4.0	-	4.0	2.0
AMC	-	-	3.2	-	3.2	-	1.6
BA	-	-	-	4.4	4.4	-	-
MOP	-	-	-	-	-	2.2	-
Element	(Kg of element/palm/year)						
N	0.81	0.84	0.80	0.84	0.80	0.84	0.82
K	-	-	-	1.1	1.1	1.04	-
S	-	0.96	-	0.96	-	0.96	0.48
Cl	-	-	2.1	-	2.1	1.1	1.1

Table 119. Amount of each element used in each treatment from November 1988 until May 1990.

	Treatment number (kg element/palm/year)						
Element	1	2	3	4	5	6	7
N	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Na	-	0.87	0.79	-	-	-	-
K	-	-	-	0.83	1.3	0.83	1.3
S	-	0.61	-	0.68	-	0.68	-
Cl	-	-	1.2	-	1.2	-	1.2

Note all N was from Urea.

Before November 1988 the treatments were similar, but Mg salts were used as sources of S and Cl.

Table 120. The effects of K, Cl, and S on yield in 1994.

Treatment number	Elements supplied	Elements missing	Yield (t/ha/year)	Differences from Treatment No.6	
				t/ha/year	percentage %
6	N, K, Cl, S	None	26.9	0.0	0.0
4	N, K, S	Cl	27.4	+0.5	+1.8
7	N, Cl, S	K	28.3	+1.4	+5.2
5	N, K, Cl	S	28.0	+1.1	+4.1
2	N, S	K, Cl	30.4	+3.5	+13.0
3	N, Cl	K, S	28.9	+2.0	+7.4
1	N (Urea)	K, Cl, S	27.1	+0.2	+0.7
			Sig	ns	
			cv	10.5	
			lsd	-	

Table 121. The effect of K, Cl and S on yield for the period 1991-1994.

Treatment Number	Elements supplied	Elements missing	Yield (t/ha/year)	Differences from Treatment No.6	
				t/ha/yr	percentage %
6	N, K, Cl, S	None	28.6	0.0	0.0
4	N, K, S	Cl	27.7	-0.9	-3.1
7	N, Cl, S	K	28.4	-0.2	-0.6
5	N, K, Cl	S	28.2	-0.4	-1.4
2	N, S	K, Cl	29.5	+0.9	+3.1
3	N, Cl	K, S	29.6	+1.0	+3.5
1	N (Urea)	K, Cl, S	26.7	-1.9	-6.6
		Sig	ns		
		cv	7.1		
		lsd	-		

Table 122. Leaf analysis and yield results, 1994. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaf tissues of frond 17 in 1994.

	Leaf levels - percent dry matter, leaf 17								Yield	Bunch	Bunch
Treatment	N	P	K	K as % All Bases	Ca	Mg	Cl	S	t/ha/yr	No/ha	weight
6 N S K Cl	2.23	0.135	0.75	27.9	0.70	0.18	0.41	0.13	26.9	971	27.8
4 N S K	2.28	0.139	0.78	29.7	0.65	0.18	0.23	0.13	27.4	1039	26.4
7 N S Cl	2.21	0.138	0.76	27.1	0.72	0.20	0.48	0.13	28.3	1022	27.7
5 N K Cl	2.27	0.139	0.75	27.6	0.73	0.17	0.42	0.13	28.0	985	28.5
3 N Cl	2.21	0.141	0.72	27.0	0.70	0.18	0.53	0.13	28.9	1023	28.4
2 N S	2.26	0.136	0.78	29.4	0.65	0.19	0.12	0.13	30.4	1219	25.1
1 N (urea)	2.15	0.136	0.78	13.3	0.69	0.19	0.20	0.14	27.1	1149	23.7
Sig	ns	ns	ns		*	ns	***	ns	ns	(ns)	***
cv	3.5	2.5	5.1		5.8	10.9	24.4	7.5	10.5	13.0	4.8
lsd	-	-	-		0.05	-	0.11	-	-	180	1.69

Table 123. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in rachis on frond 17 in 1994.

	Concentration of nutrients (% dry matter)						
Treatment	N	P	K	Ca	Mg	Cl	S
6 N S K Cl	0.26	0.134	1.15	0.39	0.05	0.65	0.06
4 N S K	0.26	0.109	1.17	0.34	0.05	0.34	0.05
7 N S Cl	0.26	0.105	1.21	0.42	0.07	0.73	0.05
5 N K Cl	0.26	0.154	1.39	0.42	0.07	0.87	0.04
2 N S	0.27	0.080	0.89	0.30	0.05	0.14	0.06
3 N Cl	0.28	0.132	1.23	0.42	0.08	0.75	0.06
1 Nil (urea)	0.25	0.120	0.98	0.31	0.05	0.14	0.05
Sig	ns	**	(ns)	***	ns	***	ns
cv	6.8	22.7	21.6	13.2	22.5	34.8	24.7
lsd	-	0.04	0.32	0.06	0.018	0.23	-

Trial 311 NITROGEN, POTASSIUM, AND EMPTY FRUIT BUNCH TRIAL AT ISAVENE ESTATE.

PURPOSE

To test the response to N and K fertilisers, with and without EFB, with a view to using EFB to replace or supplement chemical fertiliser.

DESCRIPTION

Site Isavene Estate block 78A

Soil Higaturu family, Deep sandy clay loam with good drainage, derived from volcanic ash.

Palms Dami commercial DxP crosses. Planted 1978 at 128 palms/ha.

DESIGN

There are 32 plots each with a core of 16 palms. The number and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, sometimes two.

The 32 plots are a single replicate containing 32 treatments, made up from all combinations of four levels each of N and K, and two levels of EFB (Table 124). Sulphate of Ammonia (SOA) is the source of N, and Muriàte of Potash (MOP) is the source of K. The EFB is applied by hand as a mulch between the palm circles. The weights of EFB given in Table 127, are fresh weights ex-mill. When EFB was given for the first time in November 1988 the amount was 333 kg/palm. In September 1990 it was increased to 500 kg/palm and it is intended to give this amount every two years.

Table 124. Amounts of fertiliser and EFB used in Trial 311.

Type of fertiliser or EFB	Amount (kg/palm/year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	2.0	4.0	6.0
MOP	0.0	2.0	4.0	6.0
		(Kg/palm/two years)		
EFB	0.0	500	-	-

Notes: SOA and MOP have been applied twice a year since April 1988.

Table 125. Main effects of N, K, and EFB on yield and yield components for 1994.

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
Yield (t/ha/year)	25.2	33.0	31.1	32.9	***	7.8	2.74
Bunches/ha	890	1150	1063	1128	*	11.4	138
Bunch weight (kg)	28.0	28.7	29.4	29.2	ns	7.2	-
	K0	K1	K2	K3			
Yield (t/ha/year)	29.7	28.8	31.6	31.9	(ns)	7.8	2.74
Bunches/ha	1042	990	1082	1117	ns	11.4	-
Bunch weight (kg)	28.2	29.0	29.4	28.7	ns	7.2	-
	EFB 0	EFB 1					
Yield (t/ha/year)	29.1	31.9			*	7.8	1.94
Bunches/ha	1024	1092			ns	11.4	-
Bunch weight	28.3	29.3			ns	7.2	-

Table 126. Effect of combinations of N and K, N and EFB, and K and EFB on yield in 1994.

	Yield (tonnes/ha/year) Level of N			
	N0	N1	N2	N3
K0	23.6	33.8	30.1	31.4
K1	22.6	26.4	33.4	33.0
K2	28.8	36.3	30.2	31.2
K3	25.6	35.4	30.6	35.9
EFB 0	22.2	30.9	32.0	31.4
EFB 1	28.1	35.0	30.2	34.4
	K0	K1	K2	K3
EFB 0	25.8	25.4	32.1	33.1
EFB 1	33.6	32.3	31.1	30.6

Note: NxK and NxEFB interactions almost significant at (*) P< 0.05 level
KxEFB interaction significant at (**) P< 0.01level

Table 127. Main effects of N, K, EFB on yield and yield components for 1989 - 1994.

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
Yield (t/ha/yr)	2.65	32.2	32.2	34.1	***	5.6	2.03
Bunch/ha	990	1181	1149	1228	**	7.6	100
Bunch weight (kg)	26.6	27.3	28.1	27.8	ns	5.1	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.1	30.2	31.8	32.9	*	5.6	2.03
Bunch/ha	1129	1091	1135	1194	ns	7.6	-
Bunch weight (kg)	26.6	27.5	28.2	27.6	ns	5.1	-
	EFB 0	EFB 1					
Yield (t/ha/yr)	30.0	32.6			**	5.6	1.43
Bunch/ha	1109	1165			ns	7.6	-
Bunch weight (kg)	26.9	28.0			*	5.1	1.15

Table 128. Effect of combination of N and K, N and EFB and K and EFB, on yield for 1989-1994.

	Yield (tonnes/ha/year)			
	N0	N1	N2	N3
K0	25.0	31.8	31.1	32.7
K1	24.1	27.8	33.2	35.8
K2	28.9	34.4	31.5	32.5
K3	28.2	34.9	32.9	35.5
EFB 0	24.7	29.9	32.4	32.8
EFB 1	28.4	34.6	31.9	35.4
	K0	K1	K2	K3
EFB 0	27.7	26.6	32.0	33.5
EFB 1	32.6	33.8	31.6	32.3

Note: NxK and NxEFB interactions almost significant (*) at $P < 0.05$ level
KxEFB interactions significant (**) at $P < 0.01$level

Table 129. Leaf analysis and yield results, 1994.

	Leaf levels - percent dry matter, leaf 17							Yield	Bunch	Bunch
	N	P	K	Ca	Mg	Cl	S	t/ha/yr	No/ha	wt (kg)
N0	2.09	0.129	0.70	0.69	0.16	0.38	0.14	25.2	890	28.0
N1	2.24	0.135	0.72	0.72	0.15	0.43	0.14	33.0	1150	28.7
N2	2.28	0.138	0.74	0.67	0.14	0.44	0.14	31.1	1063	29.4
N3	2.41***	0.144***	0.76(ns)	0.64	0.14*	0.47***	0.14	32.9	1128	29.2
K0	2.32	0.139	0.75	0.66	0.15	0.35	0.14	29.7	1042	28.2
K1	2.20	0.132	0.70	0.67	0.15	0.44	0.14	28.8	990	29.0
K2	2.26	0.137	0.72	0.70	0.15	0.47	0.13	31.6	1082	29.4
K3	2.24**	0.137*	0.75	0.69	0.14	0.47***	0.14	31.9	1117	28.7
EFB0	2.18	0.133	0.70	0.69	0.15	0.42	0.14	29.1	1024	28.3
EFB1	2.33***	0.140***	0.76*	0.68	0.15	0.44(ns)	0.14	31.9	1092	29.3

Table 130 Effects of N, K, and EFB on the concentration of elements in the rachis of frond 17 in 1994.

	Concentrations of elements				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
N%	0.24	0.24	0.26	0.29	***	5.0	0.015
P%	0.085	0.071	0.066	0.071	(ns)	17.3	0.0015
K%	1.47	1.38	1.34	1.38	ns	11.0	-
Ca%	0.43	0.43	0.41	0.41	ns	9.3	-
Mg%	0.07	0.06	0.06	0.06	**	8.6	0.006
Cl%	0.90	0.79	0.83	0.91	ns	23.4	-
S%	0.05	0.05	0.05	0.05	ns	16.4	-
	K0	K1	K2	K3			
N%	0.26	0.25	0.25	0.27	*	5.0	0.015
P%	0.067	0.068	0.074	0.084	ns	17.3	-
K%	1.18	1.33	1.51	1.55	**	11.0	0.18
Ca%	0.40	0.41	0.42	0.44	ns	9.3	-
Mg%	0.06	0.06	0.06	0.06	ns	8.6	-
Cl%	0.62	0.78	1.00	1.04	**	23.4	0.23
S%	0.05	0.05	0.05	0.05	ns	16.4	-
	EFB 0	EFB1					
N%	0.25	0.26			*	5.0	0.01
P%	0.064	0.082			**	17.3	0.01
K%	1.33	1.46			*	11.0	0.12
Ca%	0.43	0.40			ns	9.3	-
Mg%	0.06	0.05			**	8.6	0.004
Cl%	0.83	0.88			ns	23.4	-
S	0.05	0.05			ns	16.4	-

Trial 312 NITROGEN, POTASSIUM, AND EMPTY FRUIT BUNCH TRIAL AT AMBOGO ESTATE.

PURPOSE

To test the response to N and K fertilisers, with and without EFB, with a view to using EFB to replace or supplement chemical fertiliser.

DESCRIPTION

Site Ambogo Estate block 80E2

Soil Ambogo family, which is of recent alluvially reworked volcanic origin, with silty loam topsoil and sandy loam subsoil, with seasonally high water tables.

Palms Dami commercial DxP crosses. Planted 1980 at 143 palms/ha.

DESIGN

There are 32 plots each with a core of 16 palms. The number and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, somtimes two.

The 32 plots are a single replicate containing 32 treatments, made up from all combinations of four levels each of N and K, and two levels of EFB (Table 131). Sulphate of Ammonia (SOA) is the source of N, and Muriate of Potash (MOP) is the source of K. The EFB is applied by hand as a mulch between palm circles. The weights of EFB given in Table 98 are fresh weights ex-mill. When EFB was given for the first time in November 1988 the amount was 333 kg/palm. In September 1990 it was increased to 500 kg/palm, and it is intended to give this amount every two years.

Table 131. Amounts of fertiliser and EFB used in Trial 312.

Type of fertiliser or EFB	Amounts of fertiliser (kg/palm/year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	2.0	4.0	6.0
MOP	0.0	2.0	4.0	6.0
	Amounts of EFB (kg/palm/2 years)			
EFB	0.0	500	-	-

Table 132. Main effects of N, K, and EFB on yield and yield components in 1994.

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
Yield (t/ha/yr)	24.0	29.3	31.0	33.4	***	7.8	2.65
Bunches/ha	1149	1176	1257	1386	**	6.9	99
Bunch wt (kg)	20.9	25.1	24.7	24.1	***	6.0	1.63
	K0	K1	K2	K3			
Yield (t/ha/yr)	29.8	29.4	29.6	28.8	ns	7.8	-
Bunches/ha	1273	1250	1249	1197	ns	6.9	-
Bunch wt (kg)	23.3	23.6	23.8	24.0	ns	6.0	-
	EFB0	EFB1					
Yield (t/ha/yr)	28.6	30.2			ns	7.8	-
Bunches/ha	1239	1246			ns	6.9	-
Bunch wt (kg)	23.1	24.2			(ns)	6.0	(1.15)

Table 133. Effects of combinations of N and K, N and EFB, and K and EFB on yield in 1994.

	Yield (tonnes/ha/year)			
	N0	N1	N2	N3
K0	23.6	30.2	33.5	31.8
K1	24.6	28.1	31.0	34.0
K2	23.9	30.1	29.7	34.7
K3	23.7	28.9	29.6	33.0
EFB0	22.2	29.6	29.5	33.2
EFB1	25.7	29.0	32.4	33.6
	K0	K1	K2	K3
EFB0	30.7	27.4	28.5	28.0
EFB1	28.9	31.5	30.7	29.6

Table 134. Main effects of N, K, and EFB on yield and yield components from 1989 - 1994.

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
Yield (t/ha/yr)	26.2	31.1	33.0	34.1	***	5.7	2.03
Bunch/ha	1346	1375	1472	1538	**	6.0	98
Bunch wt (kg)	19.5	22.7	22.4	22.4	***	4.9	1.22
	K0	K1	K2	K3			
Yield (t/ha/yr)	31.2	30.8	31.4	31.0	ns	5.7	-
Bunch/ha	1447	1431	1445	1408	ns	6.0	-
Bunch wt (kg)	21.5	21.5	21.8	22.1	ns	4.9	-
	EFB0	EFB1					
Yield (t/ha/yr)	30.6	31.6			ns	5.7	-
Bunch/ha	1433	1432			ns	6.0	-
Bunch wt (kg)	21.3	22.1			(ns)	4.9	(0.86)

Table 135. Effects of combinations of N and K, N and EFB and K and EFB on yield for 1989-1994.

	Yield (tonnes/ha/year) Level of N			
Level of K	N0	N1	N2	N3
K0	25.4	32.0	34.6	32.8
K1	26.4	30.6	32.8	33.4
K2	25.8	32.1	32.3	35.4
K3	27.4	29.6	32.2	34.9
Level of EFB				
EFB0	24.8	31.2	31.8	34.4
EFB1	27.7	30.9	34.1	33.9
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	31.7	29.0	30.6	31.0
EFB1	30.7	32.6	32.2	31.0

Table 136. Leaf analysis and yield results, 1994.

	Leaf levels - percent dry matter, leaf 17							Yield	Bunch	Bunch
Treatment	N	P	K	K% Bases	Ca	Mg	Cl	t/ha/yr	No/ha	weight
N0	2.11	0.140	0.74	26.1	0.76	0.19	0.43	24.0	1149	20.9
N1	2.25	0.143	0.73		0.78	0.19	0.49	29.3	1176	25.1
N2	2.33	0.143	0.70		0.74	0.15	0.52	31.0	1257	24.7
N3	2.37***	0.143	0.72		0.71	0.16*	0.51***	33.4***	1386**	24.1***
K0	2.27	0.141	0.74		0.69	0.17	0.38	29.8	1273	23.3
K1	2.28	0.143	0.72		0.76	0.18	0.52	29.4	1250	23.6
K2	2.25	0.142	0.71		0.75	0.18	0.52	29.6	1249	23.8
K3	2.26	0.143	0.73		0.78*	0.18	0.53***	28.8	1197	24.0
EFB0	2.23	0.140	0.69		0.75	0.17	0.48	28.6	1239	23.1
EFB1	2.30*	0.145**	0.75*		0.74	0.18	0.50*	30.2	1246	24.2
cv	3.5	2.7	7.0		7.1	11.9	5.5	7.8	6.9	6.0
s.e.d.	0.08	0.004	0.05		0.05	0.02	0.03	2.3	86	1.41

Table 137. Main effects of N, K, and EFB on concentrations of elements in the rachis in 1994.

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
N%	0.23	0.25	0.28	0.28	**	8.0	0.02
P%	0.173	0.120	0.100	0.090	***	12.4	0.017
K%	1.69	1.62	1.60	1.61	ns	10.2	-
Ca%	0.37	0.40	0.40	0.39	*	5.4	0.02
Mg%	0.06	0.06	0.06	0.06	ns	8.3	-
Cl%	0.91	0.94	1.03	1.08	(ns)	11.7	(1.17)
S%	0.05	0.06	0.05	0.05	ns	18.0	-
	K0	K1	K2	K3			
N%	0.26	0.26	0.25	0.26	ns	8.0	-
P%	0.113	0.117	0.123	0.130	ns	12.4	-
K%	1.35	1.60	1.69	1.88	***	10.2	0.19
Ca%	0.34	0.39	0.40	0.43	***	5.4	0.02
Mg%	0.055	0.059	0.064	0.064	*	8.3	0.006
Cl%	0.51	1.01	1.17	1.27	***	11.7	1.17
S%	0.05	0.05	0.05	0.05	ns	18.0	-
	EFB0	EFB1					
N%	0.25	0.27			*	8.0	-
P%	0.123	0.119			ns	12.4	-
K%	1.54	1.72			*	10.2	0.14
Ca%.	0.40	0.38			*	5.4	0.017
Mg%	0.062	0.059			*	8.3	0.004
Cl%	0.95	1.03			ns	11.7	-
S%	0.05	0.05			ns	18.0	

Trial 317 FERTILISER TRIAL ON LOWER TERRACE, KOMO ESTATE MAMBA.

PURPOSE

To test the response to N, P, K and Mg in factorial combination on Mamba soil, to get information that will help in making fertiliser recommendations.

DESCRIPTION

Site Komo Estate block 27

Soil Dark sandy loam, derived from airfall ash.

Palms Dami commercial DxP crosses planted in 1985 at 130 palms/ha. Trial started in May 1990.

DESIGN

There are 36 plots, each with a core of 10 palms. The numbers and weights of bunches from each individual core palms are recorded at intervals of 14 days. The core palms are surrounded by trenches (one meter deep) to separate them from adjoining plots.

The 36 plots are a single replicate containing 36 treatments, made up from all combinations of three levels of N and K and two levels of P and Mg (Table 138).

Table 138. Types of fertiliser and amounts used in Trial 317.

Element	Type of Fertiliser	Amount of fertiliser		
		Level 0	Level 1	Level 2
N	SOA	0.0	2.5	5.0
P	TSP	0.0	2.5	-
K	MOP	0.0	2.5	5.0
Mg	Kies	0.0	2.5	-

Table 139. Main effects of N, P, K, and Mg on yield and yieia components in 1994.

	Nutrient element and level				Statistics	
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	25.6	28.6	24.3	ns	21.5	-
Bunch/ha	1058	1143	1018	ns	19.9	-
Bunch wt (kg)	24.2	25.0	23.9	ns	8.0	-
	P0	P1				
Yield (t/ha/yr)	26.0	26.3		ns	21.5	-
Bunch/ha	1082	1065		ns	19.9	-
Bunch wt (kg)	24.0	24.8		ns	8.0	-
	K0	K1	K2			
Yield (t/ha/yr)	23.9	28.3	26.2	ns	21.5	-
Bunch/ha	1081	1112	1027	ns	19.9	-
Bunch wt (kg)	22.1	25.4	25.6	***	8.0	1.68
	Mg0	Mg1				
Yield (t/ha/yr)	24.9	27.3		ns	21.5	-
Bunch/ha	1078	1068		ns	19.9	-
Bunch wt (kg)	23.2	24.8		**	8.0	1.37

Table 140. Effect of K on yield at different levels of N in 1994.

	Yield (t/ha/yr)		
Levels of N	K0	K1	K2
N0	22.8	29.7	24.3
N1	25.8	32.4	27.6
N2	23.2	22.9	26.6

Table 141. Main effects of N, P, K, and Mg on yield and yield components for 1991 - 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	27.3	29.0	25.8	ns	13.5	-
Bunch/ha	1300	1330	1275	ns	12.6	-
Bunch wt (kg)	21.0	21.8	20.2	(ns)	6.9	(1.26)
	P0	P1				
Yield (t/ha/yr)	27.0	27.7		ns	13.5	-
Bunch/ha	1295	1308		ns	12.6	-
Bunch wt (kg)	20.8	21.2		ns	6.9	-
	K0	K1	K2			
Yield (t/ha/yr)	25.6	28.0	28.5	ns	13.5	-
Bunch/ha	1301	1291	1312	ns	12.6	-
Bunch wt (kg)	19.6	21.7	21.7	**	6.9	1.26
	Mg0	Mg1				
Yield (t/ha/yr)	26.5	28.2		ns	13.5	-
Bunch/ha	1308	1295		ns	12.6	-
Bunch wt (kg)	20.2	21.8		**	6.9	1.03

Table 142. Effect of K on yield at different levels of N for 1991-1994.

	Yield (t/ha/yr)		
Levels of N	K0	K1	K2
N0	19.8	22.0	21.4
N1	20.4	22.6	22.4
N2	18.7	20.5	21.4

Table 143. Leaf analysis and yield results, 1994.

	Leaf levels - percent dry matter, leaf 17							Yield	Bunch	Bunch
Treatment	N	P	K	Kas% All Bases	Ca	Mg	Cl	t/ha/yr	No/ha	weight
N0	2.43	0.147	0.72		0.94	0.17	0.42	25.6	1058	24.2
N1	2.57	0.150	0.74		1.00	0.18	0.47	28.6	1143	25.0
N2	2.50	0.154	0.77		0.97	0.15	0.46	24.3	1018	23.9
P0	2.48	0.149	0.71		0.99	0.17	0.45	26.0	1082	24.0
P1	2.53	0.152	0.78(ns)		0.95	0.16	0.45	26.3	1065	24.8
K0	2.49	0.152	0.61		1.00	0.20	0.32	23.9	1081	22.1
K1	2.52	0.150	0.80		0.90	0.14	0.50	28.3	1112	25.4
K2	2.49	0.150	0.82***		1.02	0.15*	0.54***	26.2	1027	25.6
Mg0	2.51	0.150	0.76		1.07	0.12	0.46	24.9	1078	23.2
Mg1	2.49	0.151	0.72		0.87	0.21***	0.44	27.3	1068	25.5
cv	6.7	7.0	13.7		22.3	25.0	12.0	21.5	19.9	8.0
s.e.d	0.17	0.01	0.10		0.22	0.04	0.05	5.63	213	1.94

Table 144. Main effects of N, P, K, and Mg on concentrations of elements in the rachis in 1994.

	Concentration of elements (% dry matter)			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	0.25	0.26	0.27	*	7.1	0.016
P%	0.078	0.064	0.059	***	14.0	0.008
K%	0.98	0.84	0.90	ns	19.6	-
Ca%	0.48	0.45	0.46	ns	15.9	-
Mg%	0.06	0.06	0.06	ns	23.6	-
Cl%	0.59	0.58	0.56	ns	22.7	-
	P0	P1				
N%	0.27	0.26		(ns)	7.1	(0.01)
P%	0.057	0.077		***	14.0	0.007
K%	0.90	0.92		ns	19.6	-
Ca%	0.46	0.46		ns	15.9	-
Mg%	0.06	0.06		ns	23.6	-
Cl%	0.56	0.59		ns	22.7	-
	K0	K1	K2			
N%	0.27	0.26	0.26	ns	7.1	-
P%	0.059	0.067	0.075	**	14.0	0.008
K%	0.35	1.00	1.38	***	19.6	0.15
Ca%	0.50	0.45	0.44	ns	15.9	-
Mg%	0.08	0.05	0.06	*	23.6	0.012
Cl%	0.26	0.65	0.82	***	22.7	0.113
	Mg0	Mg1				
N%	0.26	0.26		ns	7.1	-
P%	0.068	0.066		ns	14.0	-
K%	0.95	0.87		ns	19.6	-
Ca%	0.51	0.41		***	15.9	0.05
Mg%	0.04	0.08		***	23.6	0.01
Cl%	0.58	0.58		ns	22.7	-

Trial 318 FERTILISER TRIAL ON RIVER TERRACE AT KOMO ESTATE MAMBA

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on the Mamba soil.

DESCRIPTION

Site Komo Estate block 27.

Soil Dark sandy loam.

Palms Dami commercial DxP crosses planted in 1985 at 130 palms/ha.
Trial started in March 1990.

DESIGN

There are 36 plots, each with a core of 9 palms. The numbers and weights of bunches from each individual core palm are recorded at intervals of 14 days. The core palms are surrounded by trenches (one meter deep) to separate them from adjoining plots.

The 36 plots are a single replicate containing 36 treatments, made up from all combinations of three levels of N and K and two levels of P and Mg (Table 145).

Table 145. Types of fertiliser and amounts used in Trial 318.

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)		
		Level 0	Level 1	Level 2
N	SOA	0.0	2.5	5.0
P	TSP	0.0	2.5	-
K	MOP	0.0	2.5	5.0
Mg	Kies	0.0	2.5	-

RESULTS

There was almost a significant effect on yield caused by Mg and K (Table 146 and 147). There were no significant responses due to SOA and TSP. The trend is also the same for the four years 1991 to 1994.

The NxK interaction was not significant.

Table 146. Main effects of N, P, K, and Mg on yield and yield components in 1994.

	Nutrient element and levels			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	19.3	23.3	23.9	ns	35.7	-
Bunch/ha	914	1009	1112	ns	27.1	-
Bunch wt (kg)	20.5	22.6	21.3	ns	17.9	-
	P0	P1				
Yield (t/ha/yr)	22.8	21.5		ns	35.7	-
Bunch/ha	1038	985		ns	27.1	-
Bunch wt (kg)	21.6	21.3		ns	17.9	-
	K0	K1	K2			
Yield (t/ha/yr)	18.7	22.5	25.3	(ns)	35.7	6.85
Bunch/ha	933	976	1125	ns	27.1	-
Bunch wt (kg)	19.7	22.5	22.2	ns	17.9	-
	Mg0	Mg1				
Yield (t/ha/yr)	19.5	24.9		(ns)	35.7	5.60
Bunch/ha	921	1102		(ns)	27.1	193
Bunch wt (kg)	20.5	22.4		ns	17.9	-

Table 147. Effect of K on Yield at different levels of N in 1994.

	Yield (tonnes/ha/year) Levels of K		
Levels of N	K0	K1	K2
N0	13.3	19.7	24.9
N1	20.1	23.1	26.8
N2	22.6	24.8	24.4

Note: NxK interaction not significant.

Table 148. Main effects of N, P, K, and Mg on yield and yield components in 1991 - 1994.

	Nutrient element and levels			Statistics		
	N0	N1	N2	Sig	cv	lsd
Yield (t/ha/yr)	22.5	25.7	26.0	ns	24.0	-
Bunch/ha	1270	1280	1372	ns	15.1	-
Bunch wt (kg)	17.4	19.9	18.9	ns	14.3	-
	P0	P1				
Yield (t/ha/yr)	25.3	24.2		ns	24.0	-
Bunch/ha	1323	1291		ns	15.1	-
Bunch wt (kg)	19.0	18.5		ns	14.3	-
	K0	K1	K2			
Yield (t/ha/yr)	22.0	25.1	27.0	ns	24.0	-
Bunch/ha	1243	1293	1385	ns	15.1	-
Bunch wt (kg)	17.6	19.2	19.4	ns	14.3	-
	Mg0	Mg1				
Yield (t/ha/yr)	22.9	26.5		(ns)	24.0	(4.19)
Bunch/ha	1250	1365		ns	15.1	-
Bunch wt (kg)	18.1	19.4		ns	14.3	-

Table 149. Effect of K on yield at different levels of N, 1991-1994

	Yield (tonnes/ha/year) Levels of K		
Levels of N	K0	K1	K2
N0	17.6	22.8	27.0
N1	23.4	25.8	27.9
N2	25.1	26.6	26.1

Note: NxK interaction not significant.

The analysis of nutrient concentrations, samoled in 1994 are presented in Table 150 and 151.

SOA applications did not effect the leaf N levels. There was a small significant increase in rachis N. There was no response to TSP. MOP applications significantly increased leaf and rachis K and Cl levels, accompanied with a small depressing effect on other bases. Applications of keiserite improved the Mg status in both leaf and rachis, and significantly depressing plant Ca levels.

Table 150. Leaf analysis and yield results, 1994.

Treatment	Leaf levels - percent dry matter, leaf 17							Yield t/ha/yr	Bunch No/ha	Bunch weight
	N	P	K	Kas% All Bases	Ca	Mg	Cl			
N0	2.44	0.148	0.84	26.6	0.86	0.20	0.49	19.3	914	20.5
N1	2.53	0.147	0.91	28.8	0.79	0.22	0.55	23.3	1009	22.6
N2	2.50	0.148	0.90	28.0	0.86	0.20	0.57	23.9	1112	21.3
P0	2.49	0.146	0.94	28.6	0.89	0.19	0.52	22.8	1038	21.6
P1	2.49	0.149	0.83	27.2	0.78	0.22	0.55	21.5	985	21.3
K0	2.48	0.148	0.64	19.5	0.91	0.27	0.44	18.7	933	19.7
K1	2.51	0.149	0.95	30.4	0.82	0.18	0.57	22.5	976	22.5
K2	2.48	0.146	1.06***	33.4	0.79	0.18**	0.61*	25.3	1125	22.2
Mg0	2.49	0.149	0.97	30.2	0.92	0.14	0.54	19.5	921	20.5
Mg1	2.49	0.147	0.80	25.4	0.76*	0.27***	0.54	24.9	1102	22.4
cv	7.5	3.8	25.8		25.6	35.4	26.6	35.7	27.1	17.9
s.e.d	0.186	0.006	0.23		0.21	0.07	0.14	7.91	274	3.84

Table 151. Main effects of N, P, K, and Mg on concentrations of elements in the rachis in 1994.

	Nutrient element and level			Statistics		
	N0	N1	N2	Sig	cv	lsd
N%	0.25	0.28	0.29	*	11.9	0.028
P%	0.108	0.078	0.076	**	27.9	0.021
K%	1.04	1.10	1.09	ns	19.0	-
Ca%	0.37	0.38	0.35	ns	21.4	-
Mg%	0.07	0.07	0.07	ns	37.1	-
Cl%	0.59	0.68	0.63	ns	39.4	-
	P0	P1				
N%	0.27	0.28		ns	11.9	-
P%	0.075	0.100		**	27.9	0.017
K%	1.14	1.01		(ns)	19.0	(0.144)
Ca%	0.36	0.38		ns	21.4	-
Mg%	0.07	0.07		ns	37.1	-
Cl%	0.67	0.60		ns	39.4	-
	K0	K1	K2			
N%	0.28	0.27	0.28	ns	11.9	-
P%	0.072	0.090	0.099	*	27.9	0.021
K%	0.47	1.22	1.55	***	19.0	0.177
Ca%	0.44	0.35	0.31	**	21.4	0.068
Mg%	0.10	0.06	0.05	***	37.1	0.022
Cl%	0.41	0.67	0.82	**	39.4	0.216
	Mg0	Mg1				
N%	0.28	0.28		ns	11.9	-
P%	0.087	0.088		ns	27.9	-
K%	1.10	1.06		ns	19.0	-
Ca%	0.41	0.33		**	21.4	0.056
Mg%	0.05	0.09		***	37.1	0.018
Cl%	0.63	0.63		ns	39.4	-

Trial 502A FERTILISER TRIAL AT WAIGANI ESTATE

PURPOSE

To test the response to N, P, and K in factorial combination on the Plantation Family soil.

DESCRIPTION

Site	Waigani Estate
Soil	Plantation Family Alluvial clay loam with seasonally high watertable
Palms	Dami commercial DxP crosses. Planted 1986 at 127 palms/ha. Trial started in March 1990.

DESIGN

There are 48 plots each containing 16 core palms. The numbers and weights of bunches of each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, sometimes two.

The 48 plots were divided into two replicate blocks each containing 24 treatments made up from all combinations of three levels of N, two levels of P, and four levels of K. An additional treatment of EFB was imposed to convert the trial to a single replicate, each comprising factorial combinations of three levels of N, two levels of P, four levels of K and two levels of EFB (Table 152).

Table 152. Types of fertiliser and amounts used in Trial 502A

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)			
		Level 0	Level 1	Level 2	Level 3
N	SOA	0	2.5	5.0	-
P	TSP	0	2.0	-	-
K	MOP	0	2.5	5.0	7.5
		(Kg/palm/2 years)			
	EFB	0	500		

RESULT

Yield data for 1994, and for the period 1991-1994 are summarised in Table 153 and 155.

There was a small, but significant increase in yield due to N in 1994, and also over the three year period. The increases were mainly due to increase in bunch numbers. There was a small increase of about 2 tonnes caused by EFB in 1994. There were no responses to P. The interaction between Nand K was not significant. NxK two-way table (Table 58) shows that the maximum yield of 28 tonnes/ha was achieved with 5 kg SOA and 2.5 kg of MOP.

Table 153. Main effects of N,P,K, and EFB on yield and yield components in 1994.

	Nutrient element and level				Statistics		
	N0	N1	N2		Sig	cv	lsd
Yield (t/ha/yr)	23.8	24.1	25.8		*	8.9	1.60
Bunches/ha	1255	1342	1416		**	11.0	107
Bunch wt (kg)	19.1	18.0	18.3		*	5.7	0.76
	P0	P1					
Yield (t/ha/yr)	24.6	24.4			ns	8.9	-
Bunches/ha	1331	1345			ns	11.0	-
Bunch wt (kg)	18.6	18.3			ns	5.7	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	23.4	25.5	24.5	25.0	ns	8.9	-
Bunches/ha	1298	1376	1349	1327	ns	11.0	-
Bunch wt (kg)	18.1	18.6	18.2	19.0	**	5.7	0.88
	EFB 0	EFB 1					
Yield (t/ha/yr)	23.8	25.3			*	8.9	1.30
Bunches/ha	1302	1374			ns	11.0	-
Bunch wt (kg)	18.4	18.5			ns	5.7	-

Table 154. Effects of N at different levels of K in 1994.

Levels of N	Yield (tonnes/ha/year)			
	K0	K1	K2	K3
N0	22.9	24.1	25.0	23.4
N1	23.6	24.1	22.9	25.8
N2	23.7	28.2	25.5	25.7

Note: NxK interaction not significant.

Table 155. Main effects of N, P, K, and EFB on yield and yield components in 1991-1994.

	Nutrient element and level				Statistics		
	N0	N1	N2		Sig	cv	lsd
Yield (t/ha/yr)	25.9	26.0	27.6		**	5.9	1.15
Bunches/ha	1728	1774	1890		**	7.5	98
Bunch wt (kg)	15.0	14.7	14.6		ns	4.1	-
	P0	P1					
Yield (t/ha/yr)	26.5	25.5			ns	5.9	-
Bunches/ha	1792	1801			ns	7.5	-
Bunch wt (kg)	14.8	14.7			ns	4.1	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	25.2	27.2	26.6	27.0	*	5.9	1.33
Bunches/ha	1738	1957	1812	1780	ns	7.5	-
Bunch wt (kg)	14.4	14.6	14.7	15.2	*	4.1	0.51
	EFB 0	EFB 1					
Yield (t/ha/yr)	26.2	26.8			ns	5.9	-
Bunches/ha	1788	1806			ns	7.5	-
Bunch wt (kg)	14.6	14.8			ns	4.1	-

Table 156. Effects of N on yield at different levels of K for 1991-1994

Levels of N	Yield (tonnes/ha/year)			
	K0	K1	K2	K3
N0	25.0	26.3	26.4	25.9
N1	25.2	26.4	25.1	27.2
N2	25.2	28.8	28.3	28.0

Note: NxK interactions not significant.

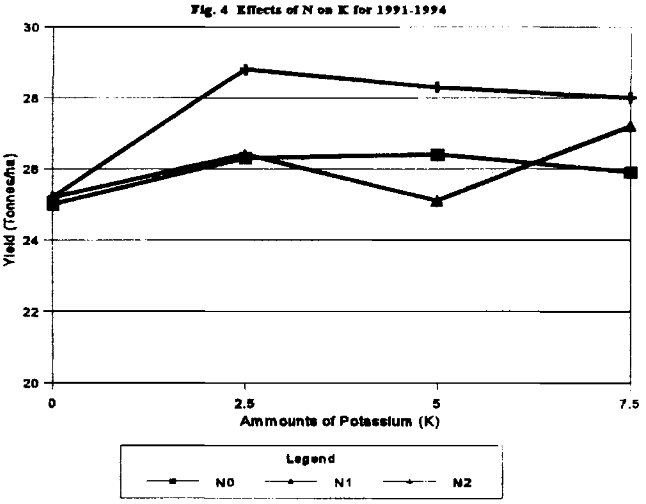


Fig. 4 Effects of N on K for 1991-1994

Table 157 shows the leaf analysis and yield results in 1994. This gives an indication of leaf nutrient levels in relation to yield data. Included in this table is the N2K1 treatment which produced a maximum yield of 28 tonnes. Although the interaction was not significant, a closer look at the leaf levels will indicate amounts required to achieve this yield. K as a percentage of total bases, is 21%.

Table 157. Leaf analysis and yield results, 1994.

Treatment	Leaf levels - percent dry matter, leaf 17						Yield	Bunch	Bunch
	N	P	K	Ca	Mg	Cl	t/ha/yr	No/ha	Weight
N0	2.44	0.146	0.67	0.84	0.30	0.54	23.8	1255	19.1
N1	2.48	0.146	0.66	0.84	0.31	0.53	24.1	1342	18.0
N2	2.52	0.147	0.67	0.82	0.29	0.54	25.8	1416	18.3
P0	2.47	0.145	0.68	0.82	0.29	0.53	24.6	1331	18.6
P1	2.48	0.147	0.65	0.84	0.31	0.54	24.4	1345	18.3
K0	2.46	0.148	0.61	0.85	0.34	0.48	23.4	1298	18.1
K1	2.45	0.146	0.66	0.82	0.30	0.55	25.5	1376	18.6
K2	2.49	0.145	0.69	0.82	0.28	0.56	24.5	1349	18.2
K3	2.51	0.147	0.72	0.85	0.29	0.56	25.0	1327	19.0
EFB0	2.45	0.146	0.66	0.84	0.32	0.55	23.8	1302	18.4
EFB1	2.51	0.146	0.68	0.83	0.29	0.52	25.3	1374	18.5
N2K1	2.42	0.147	0.69	0.83	0.30	0.55	28.2	1548	18.2

The analysis of nutrient concentrations sampled in January 1994, from frond 17 are presented in Table 62 and 63.

SOA applications had no significant effect on leaf N levels. There were no other effects on the other elements. There were no responses to TSP apart from the depressing effect it had on leaf K. MOP applications significantly improved both plant K and Cl levels, whilst having a depressing effect on all other bases. Although there were increases in leaf N and K levels, that effect was not significant. EFB significantly boosted K and Cl levels in the rachis, indicating the value of K in empty bunches. The K component of EFB, could possibly be responsible for depressing all other bases.

Table 158. Main effects of N, P, K, and Mg on concentrations of elements in the leaf of frond 17 in 1994.

	Nutrient element and level				Statistics		
	N0	N1	N2		Sig	cv	lsd
N%	2.44	2.48	2.52		ns	4.0	-
P%	0.146	0.146	0.147		ns	3.7	-
K%	0.67	0.66	0.67		ns	7.7	-
Ca%	0.84	0.84	0.82		ns	6.4	-
Mg%	0.30	0.31	0.29		ns	11.6	-
Cl%	0.54	0.53	0.54		ns	9.9	-
K as % All Bases	20.3	19.9	20.8				
	P0	P1					
N%	2.47	2.49			ns	4.0	-
P%	0.145	0.147			ns	3.7	-
K%	0.68	0.65			*	7.7	0.004
Ca%	0.82	0.84			ns	6.4	-
Mg%	0.29	0.31			ns	11.6	-
Cl%	0.53	0.54			ns	9.9	-
K as % All Bases	21.2	19.6					
	K0	K1	K2	K3			
N%	2.46	2.45	2.49	2.51	ns	4.0	-
P%	0.148	0.146	0.145	0.147	ns	3.7	-
K%	0.61	0.66	0.69	0.72	***	7.7	0.04
Ca%	0.85	0.82	0.82	0.85	ns	6.4	-
Mg%	0.34	0.30	0.28	0.29	**	11.6	0.03
Cl%	0.48	0.55	0.56	0.56	**	9.9	0.04
K as % All Bases	18.2	20.6	21.6	21.7			
	EFB0	EFB1					
N%	2.45	2.51			ns	4.0	-
P%	0.146	0.146			ns	3.7	-
K%	0.66	0.68			ns	7.7	-
Ca%	0.84	0.83			ns	6.4	-
Mg%	0.32	0.29			**	11.6	0.02
Cl%	0.55	0.52			*	9.9	0.03
K as % All Bases	19.9	21.1					

Table 159. Main effects of N, P, K, and Mg on concentrations of elements in the rachis of frond 17 in 1994.

	Nutrient element and level				Statistics		
	N0	N1	N2		Sig	cv	lsd
N%	0.30	0.31	0.30		ns	6.7	-
P%	0.098	0.078	0.078		*	29.5	0.015
K%	1.12	1.11	1.21		ns	12.8	-
Ca%	0.38	0.40	0.37		ns	9.5	-
Mg%	0.16	0.16	0.14		ns	16.8	-
Cl%	0.79	0.80	0.83		ns	11.6	-
	P0	P1					
N%	0.30	0.30			ns	6.7	-
P%	0.076	0.093			*	29.5	0.015
K%	1.12	1.17			ns	12.8	-
Ca%	0.38	0.38			ns	9.5	-
Mg%	0.15	0.16			ns	16.8	-
Cl%	0.79	0.83			ns	11.6	-
	K0	K1	K2	K3			
N%	0.31	0.29	0.30	0.30	ns	6.7	-
P%	0.075	0.089	0.088	0.086	ns	29.5	-
K%	0.61	1.15	1.39	1.44	***	12.8	0.12
Ca%	0.42	0.37	0.37	0.37	ns	9.5	-
Mg%	0.21	0.15	0.13	0.13	***	16.8	0.02
Cl%	0.44	0.82	0.93	1.04	***	11.6	0.08
	EFB 0	EFB 1					
N%	0.30	0.31			ns	6.7	-
P%	0.082	0.086			ns	29.5	-
K%	0.97	1.33			***	12.8	0.09
Ca%	0.40	0.37			**	9.5	0.02
Mg%	0.18	0.13			***	16.8	0.015
Cl%	0.77	0.84			*	11.6	0.06

Trial 502B FERTILISER TRIAL AT WAIGANI ESTATE

PURPOSE

To test the response to N, P, and K, in factorial combination, with and without EFB, with the view to use EFB to replace or supplement chemical fertiliser.

DESCRIPTION

Site	Waigani Estate, Field 6503 and 6504
Soil	Plantation family, which is of recent alluvial origin.
Palms	Dami commercial DxP crosses. Planted 1986 at 127 palms/ha. Trial started 1994.

DESIGN

Trial 502B relocation is a single replicate split into four blocks, each comprising factorial applications of 4x4x2x2 NKP and EFB treatments. There are 64 plots each containing 16 core palms. The numbers and weights of bunches of each individual core palm are recorded at intervals of 14 days. In each plot the core palms will be surrounded by at least one guard row and a trench.

The 64 treatments are made up from all combinations of four levels of N and K, and two levels each of TSP and EFB (Table 160). EFB will be applied by hand as a mulch between the palm circles.

Table 160. Amounts of fertiliser and EFB used in Trial 502B

Type of fertiliser or EFB	Amounts (kg/palm/year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	2.0	4.0	6.0
MOP	0.0	2.5	5.0	7.5
TSP	0.0	2.0	-	-
	(Kg/palm/year)			
EFB	0.0	300	-	-

Trial progress: Trial marking, numbering, Tissue sampling have been completed. Yield recording has commenced in 1995, and trenching has been completed. First dose of fertiliser applied in the fourth quarter of 1994.

Trial 504 MATURE PHASE FERTILISER TRIAL AT SAGARAI

PURPOSE

To test the response to N and K and an allowance made for one additional treatment in Sagarai Estate.

DESCRIPTION

Site Sagarai Estate, blocks, 0610, 0611 and 0612

Soil Tomanau family, which is of recent alluvial origin, with deep clay loam soils and reasonable drainage status.This is a predominant soil family on the Sagarai Estate.

Palm Special Dami DxP crosses of 16 progenies that were randomised within each plot. The palms were planted in January, 1991 at 127 palms/ha.

DESIGN

Trial 504 is a mature phase trial. There were 16 selected elite crosses which were established in a recorded random allocation on 104 plots at planting. The selected crosses were received at Sagarai nursery on 5th, May 1990, and planted out in January 1991.

There are 64 plots, each with a core of 16 palms. The numbers and weights of bunches from each individual core palm will be recorded at intervals of 14 days. In each plot the core palms will be surrounded by a guard row, which are also trenched.

The 64 plots are divided into two replicates of 32 plots each. In each replicate there are 32 treatments, made up from all combinations of four levels each of N and K, and two levels of an additional treatment, which currently is vacant (Table 161).

Table 161. Types of fertiliser and amounts used in Trial 504.

Element	Type of fertiliser	Amount and levels of fertiliser (kg/palm/year)			
		Level 0	Level 1	Level 2	Level 3
N	SOA	0.0	2.0	4.0	6.0
K	MOP	0.0	2.5	5.0	7.5

Trial mapping, Trial marking and numbering completed. Trenching and renumbering of plots completed. Yield recording will commence in March 1995.

Trial 511 FERTILISER TRIAL ON INTERFLUVE TERRACES SOILS AT WAIGANI ESTATE

PURPOSE

To investigate the response of oil palm to applications of ammonium sulphate, Triple superphosphate, muriate of potash and empty fruit bunch on interfluve terraces soils.

DESCRIPTIONS

Sites Waigani Estate, Field 8501 and 8502

Soil Hagita family, texture contrast soils with very slowly pemeable clay to heavy clay subsoil and very gravelly loam top soil. Gravel may be cemented into massive blocks of laterite. Soil dominantly poorly drained. Although these soils are dominantly poorly drained, somewhat imperfectly drained variants with olive grey subsoil have been included into this family. Mostly on gently sloping terraces, but also found on spur crest of hilly terrain.

Palms Dami commercial DxP crosses. Planted in 1988 at 127 palms/ha. Trial started 1994.

DESIGN

There are 64 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palm will be recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, and also trenched.

The 64 plots are in a single replicate split into four blocks, comprising factorial applications of 4x4x2x2 of NKP and EFB treatments. The treatments are made up from all combinations of four levels each of N and K and two levels each of P and EFB (Table 162). EFB will be applied by hand as mulch between palm circles.

Table 162. Amounts of fertiliser and EFB used in Trial 511

Type of fertiliser or EFB	Amounts of fertiliser (kg/palm/year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	2.0	4.0	6.0
MOP	0.0	2.5	5.0	7.5
TSP	0.0	2.0	-	-
		(Kg/palm/year)		
EFB	0.0	300	-	-

Trial Progress: Trial Mapping, Trial marking, Plot and palm numbering, Tissue sampling have all been completed. Trenching of trial has been completed in 1995. Yield recording also has commenced.

IV. ENTOMOLOGY AND PATHOLOGY

(T.M. Solulu)

INVESTIGATION 603 THE POLLINATING WEEVIL, *ELAEIDOBIUS KAMERUNICUS*

Purpose

To introduce the pollinating weevil *Elaeidobius kamerunicus* to areas of oil palm in Papua New Guinea and to measure its effect on fruitset.

Background

The weevil was first released in Papua New Guinea in 1981, in West New Britain and Oro Provinces. In April 1989 it was released in Milne Bay Province, and in April 1991 in Poliamba (New Ireland). These later releases are being followed with some detailed observations.

Observations are made in Hagita and Waigani Estates (Milne Bay Estates, Milne Bay) and Bolegila, Baia, and Maramakas Estates (Poliamba, New Ireland). In each estate a group of 100 palms is used and the following parameters are observed:

Numbers of *Elaeidobius* emerging from 20 male spikelets.
Numbers of male and female infloresences at anthesis. (As a rule of thumb ten anthesing males are required per hectare to achieve good pollination).
Percentage fruitset on 20 bunches (less than 50% is considered poor).

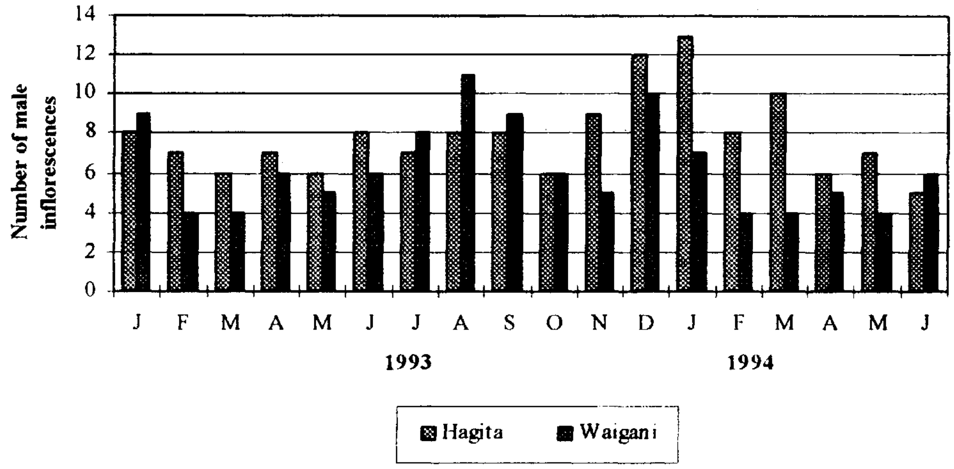
Further observations and data collection on above parameters at Milne Bay and New Ireland Provinces was discontinued in June of this year.

Milne Bay

Flower Census

The number of anthesing male inflorescences (AMI) and receptive females were recorded weekly on 100 palms each at Hagita and Waigani estates. Figure 2 shows the number of anthesing male inflorescences per 100 palms from July 1993 to June 1994. There was a low occurrence of male inflorescences (less than 10 AMI/ha) at both Hagita and Waigani. This was more marked at Waigani than Hagita. While there appeared to be a low number of male inflorescences the number of female inflorescences were recorded to be even lower hence, adequate pollen supply would have been available for pollination. However, generally there appeared to be fewer male inflorescences throughout Milne Bay Estates.

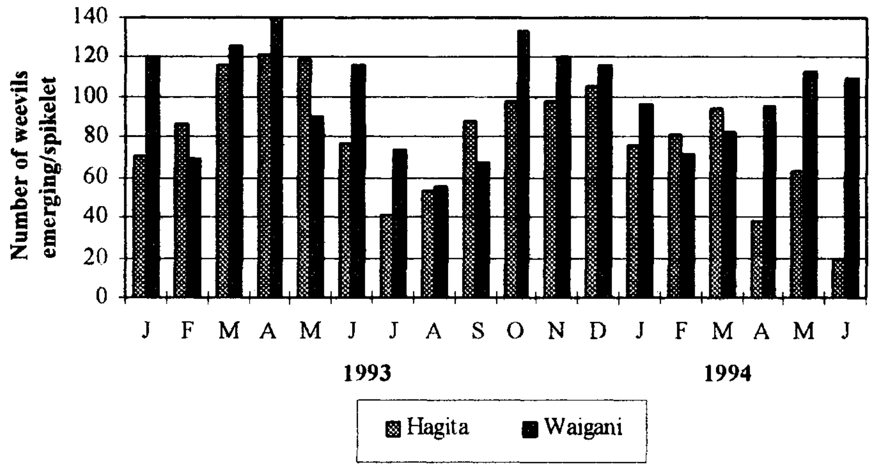
Figure 2: Number of anthesing male inflorescences (average per day in 100 palms) at Milne Bay.



Weevil Population

The mean number of weevil progeny emerging from individual sampled spikelets for the 12 months at Hagita and Waigani is shown (Figure 3). The mean emergence figure was 76 and 93 weevils per spikelet respectively at Hagita and Waigani. Relatively low weevil densities were observed throughout Milne Bay Estates during the period. At Hagita, a low of about 33,500 weevils/ha and a high of 170,100 weevils/ha occurring at any one day was recorded in July 1994 and December 1993 respectively, while Waigani recorded a low of 42,200 weevil/ha and a high of 167,200 weevils/ha respectively in February 1994 and December 1993. An average of over 95,500 weevils/ha and 82,600 weevils/ha occurring at any one day was recorded at Hagita and Waigani respectively for the period. Such weevil numbers is considerably lower than the minimum required per hectare (200,000 weevils/ha) to efficiently transfer pollen hence pollination can be expected to be seriously affected. Limited breeding sites due to low number of male inflorescences per hectare may have attributed to the very low weevil populations observed at Milne Bay Estates.

Figure 3: Weevil emergence at Milne Bay

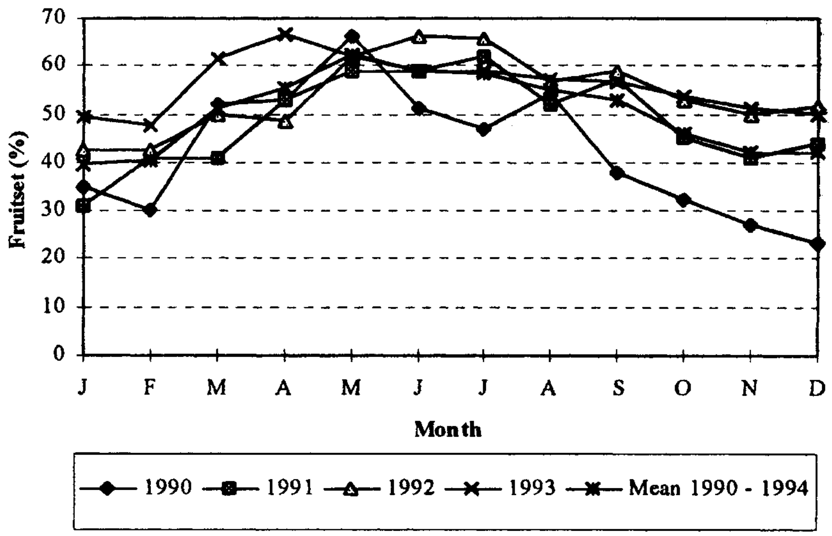


Fruitset (%)

The seasonal trend in fruitset fluctuations at Milne Bay Estates monitored from 1990-1994 is shown (Figure 4). It shows the combined mean fruitset levels obtained at Hagita and Waigani for each year and cumulative average for the area (heavy line). With the exception of 1990 (palms at early stage of production), the succeeding years seem to follow a similar pattern in their fruitset fluctuations hence its seasonal occurrence. A drop in fruitset levels is seen from June to December while an increase begins in January to and reaching its peak in May. Low fruitset below 50% level occurs for a five months period (October to February of following year) while remaining seven months gives good fruitset levels over 50%.

Figure 4 gives the frequency distribution of fruitset at Milne Bay Estates from 1990-1994 for data collected at Hagita and Waigani. It shows a normal distribution of fruitset levels. Of the total of 2,096 bunches analyzed, 56% of the bunches yielded fruitset values of over 50% level with most occurring in the range 51-60%. However, more than 71% of the bunches occurred between 41-100% range thus indicating good levels of fruitsets due to the pollinating weevil, *Eleaidobius*since it was first released in the province back in April 1990.

Figure 4: Seasonal percentage fruitset at Milne Bay, 1990 - May 1994

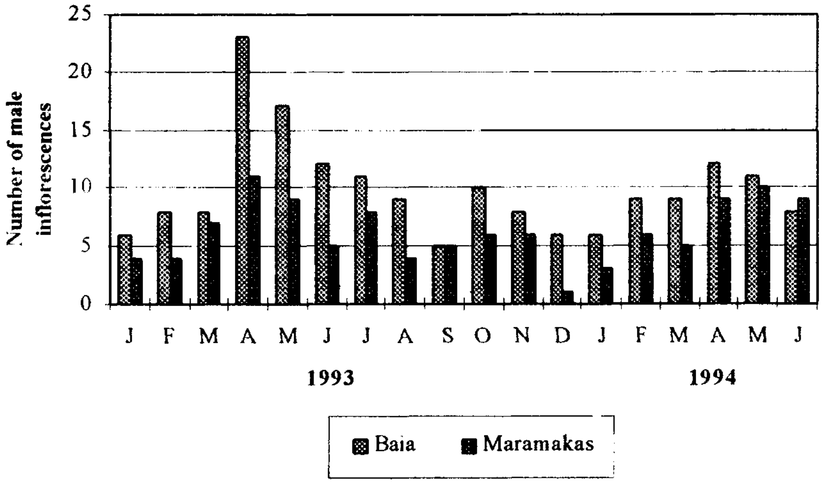


<u>*Poliamba (New Ireland)*</u>

Flower Census

The number of anthesing male inflorescences (AMI) recorded weekly from 100 individual study palms at Baia and Maramakas estates is shown (Figure 5). Generally, there appears to be a low number of male inflorecscences (< 10/ha) for most months in the period from May 1993 to June 1994.This situation is more marked at Maramakas than at Baia. A low of one and three AMI per hectare were recorded in December 1993 and January 1994 respectively at Maramakas. There was generally an unproportionality in the sex ratios, with females inflorescences being higher in numbers than compared to males, averaging at 9.5♂♂ :13.7♀♀ at Baia and 6.1♂♂:14.3♀♀ at Maramakas.

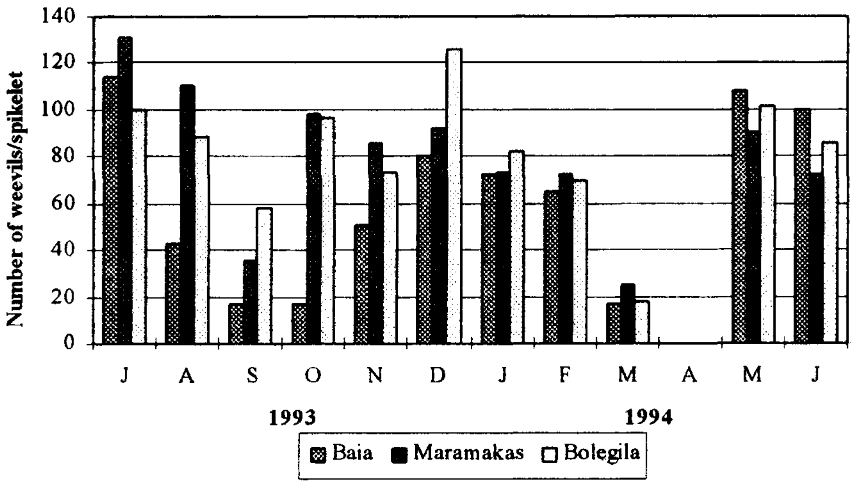
Figure 5: Number of anthesing male inflorescences (average per day in 100 palms) at Poliamba.



Weevil Population

Counting of weevils emerging from sampled male spikelets was done for the three initial release sites at Baia, Bolegila and Maramakas. The number of weevils per spikelet for each month from May 1993 to June 1994 is shown (Figure 6). The emergence data shows adequate weevil density at Poliamba. Slightly lower weevil density may have occurred in September 1993 and March 1994 but pollination and fruitsetting can be assumed to have occurred unaffected. It is evident from the data that the pollinating weevil has successfully established and stabilised itself since it was first released into the province in April 1991.

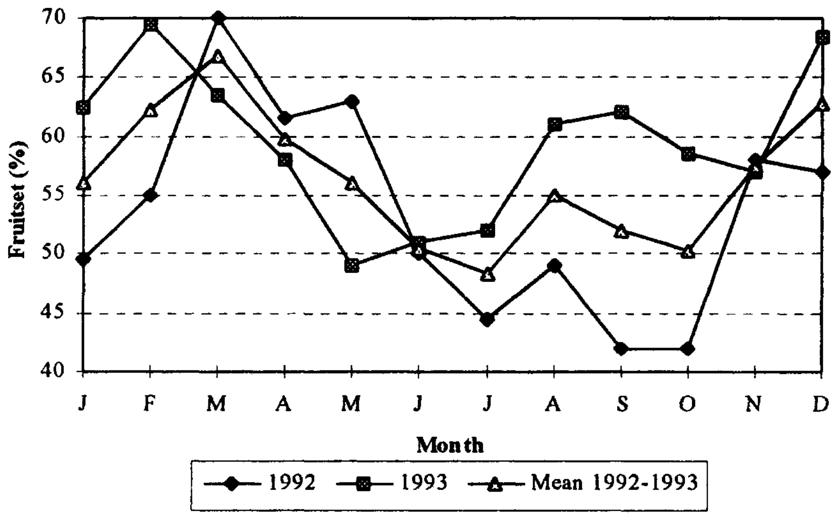
Figure 6: Weevil emergence at Poliamba.



Fruitset (%)

The monthly percentage fruitset (ie. proportion of fertile to infertile per bunch) was determined for Baia and Maramakas up to May 1994. Figure 7 shows mean fruitset for the 2 sites for 1992 and 1993 and the mean for the period from 1992 until May 1994 when recording stopped. Apart from a low of 41% in September and October 1992 and 49% recorded at Maramakas respectively in May 1992, fruitset was consistently high with values over 50% level. The low fruitset levels observed at might have been due to the insufficient male inflorescences that had occurred in preceeding 5-6 months hence possibly resulting in low pollen supply and inadequate breeding sites for *Elaeidobius* thus low weevil populations. Comparatively, the level of fruitset was higher at Baia and Maramakas with values at 53% upwards, reaching highest of 74% and 75% in November and December respectively. These high values can be attributed to the reasonably good number of male inflorescences and a healthy weevil population in preceeding 4-5 months (July-October). At Maramakas a high of 63% was obtained in December.

Figure 7: Seasonal percentage fruitset at Poliamba 1992 - May 1994



<u>*Kapiura Study (West New Britain)*</u>

Purpose

To determine the cause of seasonally poor pollination and subsequent yield trough experienced throughout the development of oil palm at this site.

Background

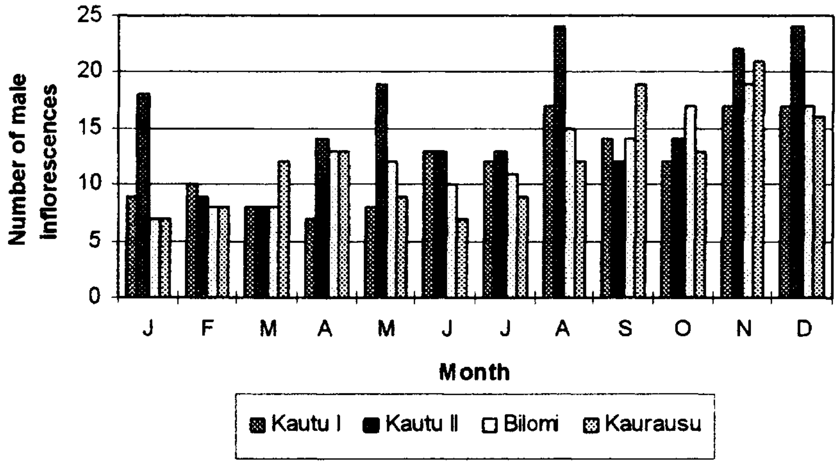
Observations are made in Kautu division I, Kautu division II, Bilomi and Kaurausu. In each division two plots are monitored, one plot contains a group of 20 palms and other consists of 120, 115, 115 and 116 palms respectively at Kautu I, Kautu II, Bilomi and Kaurausu. The following observation are made:

Percentage fruitset and physical analyses on pre-ripe bunches
Number of *Elaeidobius* emerging from five sets of 20 male spikelets
Number of receptive females and male inflorescences at anthesis
Sticky trap enclosing receptive female inflorescences
Pollen Viability tests
Assisted Pollination
Leaf Tissue Analysis (one site at Kautu I)

Flower Census

The number of AMI and receptive females are recorded weekly on selected palms at Kautu I (120 palms), Kautu II (115 palms), Bilomi (115 palms) and at Kaurausu (116 palms). Figure 8 shows the average number of AMI at any one particular day for each site. There was no shortage of male inflorescences throughout Kapiura plantations though low numbers were recorded from January to March. Comparatively, there also appeared to be more male than female inflorescences at the four sites throughout the year indicating good pollination could be expected.

Figure 8: Number of anthesing male inflorescences (average per day in 120, 115, 115 and 116 palms respectively) at Kapiura in 1994.

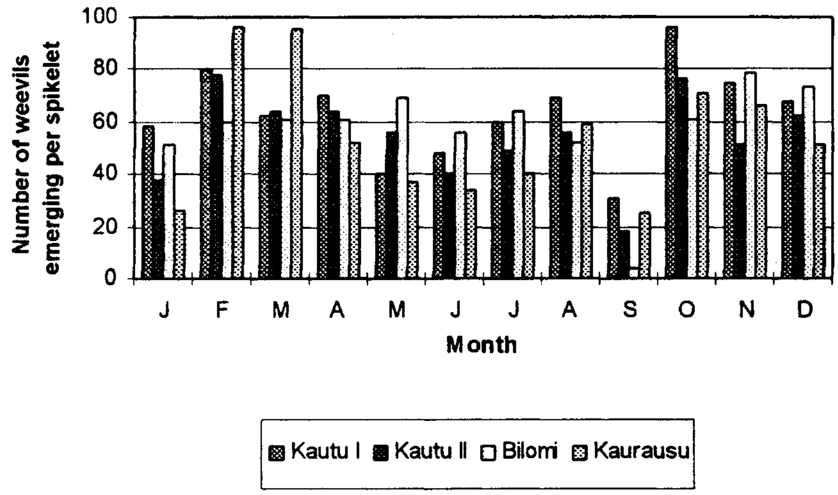


Weevil Population

(a) <u>Weevil Emergence Studies</u>

The number of weevil progeny emerging from each sampled spikelet at Kautu I, Kautu II, Bilomi and Kaurausu plantations is shown (Figure 9).The emergence data indicates a reasonably adequate weevil density throughout Kapiura although it was lower than the minimum required per hectare (ie. <200,000 weevils/ha) in most of the months. A low density of 10,140 weevils/ha was estimated to have occurred in September at Bilomi while a high of over 291,100 weevils/ha occurring in Kautu II in August. The annual average weevil density ranged from 50,900 - 230,800/ha at Kautu I, 41,800 - 291,100/ha at Kautu II, 10,140 - 257,500/ha at Bilomi and 23,400 - 223,800 weevils/ha at Kaurausu. Generally, weevil populations appeared to be low at Kapiura in the year.

Figure 9: Weevil emergence at Kapiura in 1994



(b) Sticky Trap Observation

Sticky traps enclosing receptive female inflorescences was only set at Bilomi in January. Table 163 gives the number of weevils trapped respective to the days set. Despite the heavy and continuous rainfall in January (671ml over 28 days), large numbers of weevils still continued to visit receptive female inflorescences.

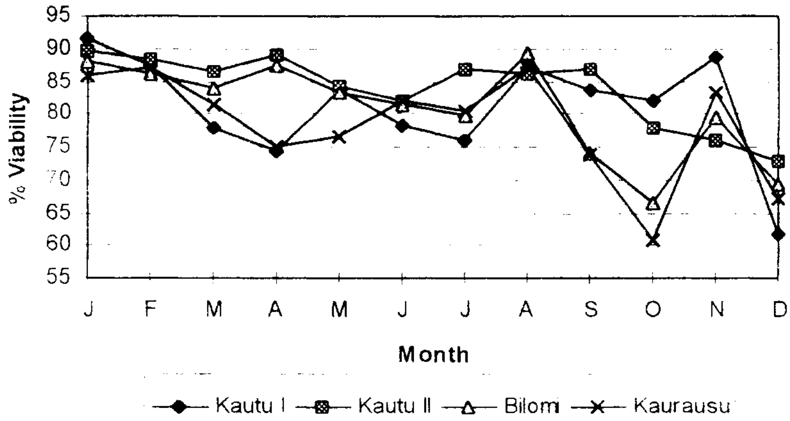
Table 163 Number of weevils trapped.

Location	Trap	Days set for	Weevils Trapped
	I	3	*610* weevils
Bilomi	II	2	*5,182* weevils
	III	1	*17,597* weevils

Pollen Viabilty Tests (%)

Pollen samples are randomly collected from the four locations at Kapiura each month and tested for their viability (ie. percent pollen germination test). Figure 10 shows the mean pollen viability throughout Kapiura for 1994. Pollen was viable throughout the year, ranging from 61-92% and averaging at 81% for the 12 months. A decline in viability was observed from September to October but improved in November then dropping off again in December. The drop may have been associated with relatively dry season,however there was no significant correlation between rainfall and pollen viability (r= 0.384 ns)

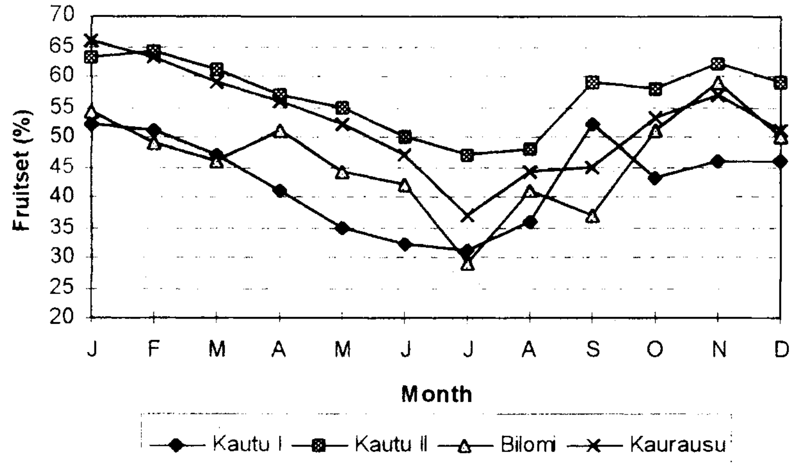
Figure 10: Mean pollen viability (%) results for Kapiura in 1994



Fruitset (%)

The monthly percentage fruitset determination continued for the four monitoring sites. Figure 11 shows the fluctuations in the fruitset levels of the four sites at Kapiura for 1994. The data follows a similar trend in fruitset fluctuations at all four locations hence clearly depicting its seasonal occurrence. Fruitset levels started to decline steadily in February through to and reaching its lowest level in July then increases in August. Periods of low fruitsets below 50% level seem to occur from April to October, while values over 50% occur in the remaining five months (November to March).

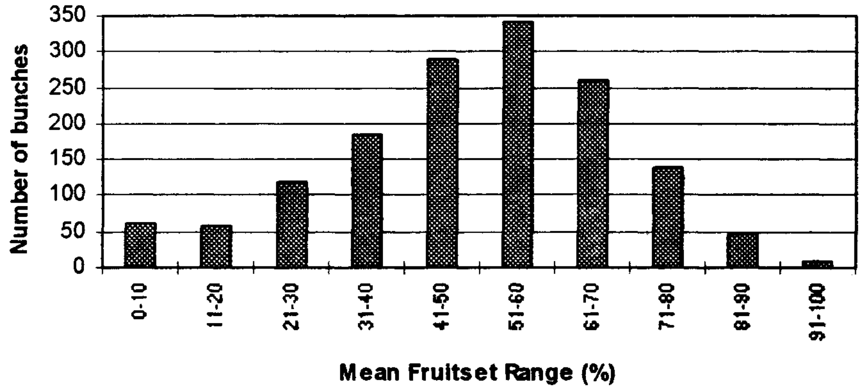
Figure 11: Percentage fruitset at Kapiura in 1994



Kautu I and Bilomi appear to have lower fruitset levels than Kautu II and Kaurausu sites. Kautu II appear to have better fruitset values than the other three sites. Comparative annual fruitset levels were 43%, 46%, 53% and 57% respectively recorded at Kautu I, Bilomi, Kaurausu and Kautu II. An overall annual gain of 3% fruitset was attained at Kapiura as compared to 1993 (47%).

Figure 12 gives the fequency distribution of fruitset for 1,432 bunches analyzed in the year. It shows a normal fruitset distribution pattern with over 71% of the bunches occurring between 41-100% range, most occurring in the 51-60% range.

Figure 12: Frequency distribution of fruitset for 1,432 bunches harvested and analysed from 80 monitored palms (20 palms/site) at Kapiura in 1994.



INVESTIGATION 601 CHEMICAL CONTROL OF SEXAVA (ORTHOPTERA: TETTIGONIIDAE, MECOPODINAE)

Purpose

To assist with surveys of damage, to make treatment recommendations to monitor the chemical control programme, and to test any new chemicals that might be effective against sexava.

Background

Sexava (plural - sexavae) is a common name used to describe several related species of the longhorned coconut or treehoppers found on coconuts and oil palm. Three species of sexavae are recorded to attack oil palm, *Segestidea defoliaria* (Uvarou) in West New Britain, *Segestidea novaeguineae* (Brancsik) in Oro and *Segestes decoratus* (Redtenbacher) in Morobe and West New Britain Provinces.

In Milne Bay, Willemse (1977) recorded *Segestidea acuminata* (Kastner) occurring on the mainland and *Segestidea rufipalpis* (C. Willemse) on the island of Misima on coconuts. No report of these two species is yet known to occur on oil palm.

In New Ireland, Willemse (1977) recorded two species, *Segestidea leefmansi* (C. Willemse) on New Hanover and *Segestidea gracilis* on the mainland and nearby islands on coconuts but not yet reported on oil palm.

Outbreak of sexavae in oil palm can be brought under control by trunk injection of insecticides (Monocrotophos or Acephate).

Progress

In 1994, infestation of economical significance by sexavae continued to occur only in the West New Britain Province. The Bialla and Hoskins oil palm projects reported an increase in sexavae infestations (fresh outbreaks and resurgence) in both smallholdings and plantations during the year. The sexavae species of *Segestidea defoliaria* and *Segestes decoratus*(not yet recorded in Bialla area) being the main defoliators. The oil palm stickinsect, *Eurycantha calcarata* being the other, but usually occurs in association with the two species of sexavae thus effecting serious defoliation of palms.

A total of 267 settler's and village oil palm (VOP) blocks, 194 and 73 blocks (1,165.08 ha) respectively in Bialla and Hoskins and some large unspecified hectarage of plantation areas were recommended for chemical treatment (that is, application of 10ml concentrate of a systemic monocrotophos per palm *via* trunk injection) in both Bialla and Hoskins scheme. This represented a marked increase in the hectarage requiring treatment in the year as compared to 1993 (103ha).

The areas requiring treatment included; 20 blocks (40 ha) at Dami VOP West, Dire VOP 26 blocks (105.56 ha), Galilo VOP 33 blocks (132 ha), Kandori VOP 23 blocks (46 ha), Matanagavae VOP 14 blocks (28 ha), Namova VOP 15 blocks (60.9), Rikau VOP 14 blocks (56.84 ha), Sarakolok Subdivision 21 blocks (133.9 ha) and an unspecified hectarage at Bebere plantation (Portions 12A/13A) and Bilomi Division II (Fields A10/A11 and C1/C2/C3) at Kapiura in Hoskins. In Bialla, areas requiring treatment were; 5 blocks (62.28 ha) at Malasi-Sale LSS, Tiauru Subdivision 55 blocks (333.85 ha), Ubai 1 VOP 13 blocks (52.07 ha), more than 20 plots at Navo Estate and large unspecified hectarage in Hargy Plantation; Areas 1, 2, 4 and 9 in Division I; Areas 6, 8A, 9 and 11 in Division III.

More severe sexavae damages were observed in Bialla than at Hoskins. The oil palm stickinsect, *Eurycantha calcarata* in association with sexavae was responsible for the damages in Bialla. Moderately heavy to severe defoliation (complete stripping of fronds) occurred at Navo Estate and Hargy Plantation. The smallholdings at Bialla also had heavy defoliations, particularly at Tiauru Subdivision. It is evident that in most smallholdings, poor block hygiene attributed to the increase in sexavae numbers and infestations. For instance, the non removal of native host plants of sexavae such as *Helliconia*, wild bananas (*Musa* sp.) and even cultivated *Pandanus* sp. were seen to be harbouring large numbers of sexavae. Very heavy defoliations were observed on blocks having numerous stands of abovementioned plants, which themselves were heavily attacked.

Village oil palm blocks at Bereme/Sepaltapun reported significant sexavae outbreaks but due to poor block hygiene (over grown vegetation) a thorough assessment of damage in the area was not feasible. OPIC extension officers responsible for the area were advised to inform the block owners to clear their blocks prior to OPRA's assessing. Such is a typical case in most smallholdings, hence the persistence of large sexavae numbers and continuous outbreaks annually in West New Britain.

Segestes decoratus Redteneder (a parthenogenesis species, found only in it's female form in West New Britain) was recorded at Kapore Subdivision and Bebere Plantations. This is an extension of its occurrence outside known localities at Dami, Navarai, Pangalu (Talasea), Sarakolok and Tamba.

INVESTIGATION 607 BIOLOGICAL CONTROL OF SEXAVA

Purpose

To find and study biological agents that attack sexava, and rear in *vitro* the most useful parasites for release into infested areas.

Background

Sexava is susceptible to some parasitic insects that can be used to control its population. Two species of wasps that are parasitic on the eggs of sexava are being reared *in vitro* and released into infested areas namely, *Leefmansia bicolor* Waterst. (Hymenoptera:Encyrtidae) and *Doirania leefmansi* Waterst.(Hym.:Trichogrammatidae). Another parasite, *Stichotrema dallatorreanum* Hofender (Strepsiptera:Myrmecolacidae) which lives in the body of sexava is being studied.

Progress

(a) Rearing of the Sexava Egg - parasitoids.

The two species of sexava egg-parasitoids were reared at Dami (West New Britain) and released throughout the year (Table 164), mainly in areas where recent outbreaks had occurred. They were sometimes released concurrently with the chemical control.

Table 164 Number of individuals of the two species of parasitoids that were released during 1994.

	Number of Parasitoids	
Site	*Leefmansia bicolor*	*Doirania leefmansi*
Bebere Plantation	60,800	30,000
Bilomi Plantation	141,720	118,000
Dami Plantation	140,720	113,400
Dobuduru, (Oro Province)	8,800	66,000
Hargy Plantation	8,800	92,000
Kumbango Plantation	8,800	44,000
Lavege VOP	8,800	44,000
Navo/Hargy	15,200	30,000
Rikau VOP	4,400	22,000
Tiauru Settlement, Bialla	4,400	22,000
Ubai VOP	8,800	62,000
Total	411,240	643,400

Just over 1.05 million parasitoids were released into both plantations and smallholdings in West New Britain and Oro provinces in 1994. In West New Britain, releases were made throughout the Bialla and Hoskins schemes. Batches of the two species of the sexava egg parasitoids were airfreighted to and released in Oro in February. This release was made on a smallholder block at Dobuduru, although not necessary it was sent for release to aid build up the already existing endemic biocontrol agents in the province, notably the imago agents the strepsipteran endoparasite, *Stichotrema dallatorreanum* and the tachinid fly, *Exorista notabilis.*

Efforts were made in the year to intensify captive rearing and breeding of wild adult sexavae populations aimed at increasing the number of fresh eggs for parasitoid rearing. This resulted in improved number of parasitoids released in the year of over 1.05 million as compared to under 1.0 million in 1993.

In a new development to intensify parasitoid propagation a new large biocontrol facility was established in Bialla by Hargy Oil Palms P/L. The company was very supportive and consented to construct the insectary with the entomology unit of PNGOPRA providing details of the insectary and to be incharge of the actual parasitoid production. This very much shows the need to control the most significant pest of oil palm in the province sexavae, *Segestidea defoliania.* Upon production, it should supply parasitoids for the whole of Bialla area. The rearing of the parasitoids commenced in November with stock materials from Dami.

(b) Observation on the Strepsipteran Endoparasite of Sexava, *Stichotrema dallatorreanum* Hofeneder (Insecta: Strepsiptera)

Observations aimed at determining and possibly identifying the suspected ant-host to the free -living male of *Stichotrema* continued in the year. Colonies of a *Camponotus* sp. continued to be reared and established both in the laboratory and on young palms at Dami Research Station. However, there has not been any success todate.

Following the first endemic record of a female strepsipteran parasitizing a bush katydid, *Phyllophora lanceolota* (Orthoptera: Tettigoniidae) in West New Britain in 1993, attempts were made to confirm and establish its distribution in the province. An awareness campaign was organised in the form of a bounty payment for the surrendering of stylopized tettigoniids by the general public. Such a campaign proved successful that a total of K530.00 were paid for 85 confirmed specimens, all being *Phyllophora lanceolata.* Further payments ceased after just four months of campaign, due to high turnover of specimens delivered and depletion of funds. Most specimens received died before they could be used for further observation. Specimens included both virgin and mated female strepsipteran, emerging triungulins and some specimens having dislodged aedeagi (male penis) on their expanding broad canal. Specimens of the endoparasite were sent to Dr. Jeyaraney Kathirithamby (entomoparasitic specialist, at Oxford University) for determination in May. Currently, it is thought to be the same species (*Stichotrema dallatorreanum*) that stylopizes two other species of sexavae, *Segestidea novaeguineae* and *Sesgestes decoratus* in Oro and Morobe Provinces respectively.

The campaign was a success in that:

(I). It has confirmed that the strepsipteran are indigenous in West New Britain.

(ii) It has provided some useful information of the occurrence of the endoparasite in the province, currently from Kapiura through to Hoskins, including Dami Research Station (in fact the first ever stylopized tettigonid specimen - a lesser katydids was found by the entomologist in 1992 when it was attracted to light). Areas in Hoskins which have records of the stylops included Gaivava, Kapiura, Kasia, Kavutu and Lavege.

(iii) Some information, though not substantiated on the host preference by the strepsipteran, currently being the broad-winged and lesser katydids and *not* sexavae. No stylopized specimens of neither *Segestes decoratus* or *Segestidea defoliaria* were received, though they occur in abundance in these areas. However, it may be possible that it could adapt to develop on these tettigoniids in future. Attempts were made to infect both the nymphs and adults of these two injurious species of sexavae but these have not been successful.

(iv) Research work should not neglect villagers or small farmers but should encourage their involment and participation.

Impregnation of *Camponotus* brood, nymphs and adults of both *Segestes decoratus* and *Segestidea defoliaria* with triungulins of the strepsipteran in laboratory conditions yielded no success.

For the record a parasitic dipteran was obtained for the first time from a *Phyllophora.lanceolata* specimen simultaneously stylopized by the strepsipteran endoparasite in West New Britain. A pre-pupal larva emerging from the body cavity of the katydid specimen was reared to adult in the laboratory. The adult fly, a species of tachinid will be sent to the International Institue of Entomology in United Kingdom for identification.

The importance of the introduction of other biological control agents, particularly those that affect both the nymphal and adult stages of sexavae should be looked into, especially for introduction into West New Britain Province. Egg parasitoids alone would probably not be effective in controlling this most significant pest in West New Britain.This was observed from the increasing fresh sexavae outbreaks and resurgence in the province beginning in late 1993. Therefore, it is neccessary to pursue and enhance research into establishing those biological control agents (BCA) that attack both the nymph and adult stages of this single most significant pest of oil palm at present. Current research should be aimed at introducing the parasitic tachinid fly, *Exorista notabilis* (Diptera: Tachinidae) and the strepsipteran endoparasite, *Stichotrema dallatorreanum* into West New Britain. Both these BCA do occur in Papua New Guinea and appear to be very effective in keeping in check the largest species of sexavae, *Segestidea novaeguineae* in Oro Province. Intensive studies aimed on introducing and establishing *Stichotrema* on *Segestidea defoliaria* in West New Britain commenced in late 1994. The study is part of the entomologists' MSc project (University of Oxford).

INVESTIGATION 606 CONTROL OF BAGWORMS (LEPIDOPTERA:PSYCHIDAE)

Purpose

To monitor the amount and distribution of damage to oil palm caused by bagworms, to identify factors linked with high levels of parasitism of bagworms and to formulate control measures.

Background

Bagworms are caterpillars of various species of moth, that stick to the underside of oil palm leaves, inside bags that are made of pieces of leaf stuck together by silk. The caterpillar eats holes in the leaf. The adult male moth flies and mates with the female (which does not fly) while she is till in the bag. The female dies in the bag and her body becomes the egg-case of the newly fertilised eggs. When the eggs hatch the new caterpillars come out of the bag. There are several species of bagworm that attack oil palm, but all are susceptible to attack by parasites and pathogens which usually keep the population under control.

Progress

West New Britain Province

Significant damage by the 'rough' bagworm, *M.corbetti* was detected in Kaurausu plantation in May at Kapiura. Damage levels was light to heavy on two fields, with infestation being heavy from the road inwards. Initial assessment of the number of its natural enemies were low but these have increased as observed during subsequent monitoring particularly, the number of parasitic chalcids, *Brachmeria* sp. and a species of a tachinid fly. Monthly monitoring and sampling of bagworms indicated an increase in both parasitism and mortality rates, with 11% and 84% respectively. The plantation was advised to encourage the flourishing of beneficial weeds such as *Ageratum conyzoides* or 'Goat weed' (Compositae) and 'Milk weeds' species of *Eurphobia* (Euphorbiaceae) in the affected fields. These soft-bodied weeds provide a source of nectar, resting spots and shelter for various beneficial insects,including the abovementioned. A similar infestation at Bilomi Plantation also at Kapiura in 1992 was effectively controlled naturally following OPRA's advice. By the end of the year full control was achieved naturally.

Oro Province

Light infestations by *Mahasena corbetti* and the 'ice-cream cone' bagworms continued to be reported from Embi Estate, New Warisota development. Naturally controlling factors appeared to be effective in the area resulting in a high mortality rate of 86% in the year. Predominant of the natural enemies included mostly tachinids and chalcid wasps; and a few entomopathogens often found infecting larvae, pupae and even adults of the moths. Periodic monitoring is continuing.

Milne Bay and New Ireland Provinces

There were no bagworm infestations reported from developments in Milne Bay and New Ireland Provinces. Where this lepidopterous pest occurs in these two provinces, it can be assumed to be successfully kept in check by its natural controlling factors, both biotic and abiotic factors (especially weather). Biotic factors would mostly involve parasites, predators and entomopathogens.

INVESTIGATION 608 CONTROL OF *SCAPANES* AND *ORYCTES* (COLEOPTERA: SCARABAEIDAE- DYNASTINAE)

Purpose

To determine if underplanting or leaving poisoned palms or felled trunks in the field causes an increase in attack by rhinoceros beetles, and to decide whether any changes in plantation practice should be recommended.

Background

The adult rhinoceros beetles (*Oryctes rhinoceros* and *Scapanes australis*) attack palms, including oil palms, by tunnelling in through the frond rachis and the unemerged developing fronds. The larvae live in decaying vegetable matter such as the trunks of dead or felled palms and bunch refuse.When oil palms are replanted from earlier oil palm or from coconuts the old trunks should be covered by a fast growing legume to hide them so that the beetles do not lay their eggs there Rhinoceros beetles from neighbouring jungle can attack palms on the edges of plantations. *Scapanes* is widely distributed in PNG, but *Oryctes* is only in East New Britain and New Ireland.

Progress

Incidence of the two rhinoceros beetles continue to remain low throughout the oil palm developments in the country. Both beetles have potential pest status in the country at present.

In West New Britain, slight infestation by *Scapanes australis* Boisd. continue to occur at Bebere plantation and throughout Kapiura plantations, particularly on young palms and replantings. There is still no record of the occurrence of *Oryctes rhinoceros* in West New Britain.

No reports of infestation by the two beetles were reported from Milne Bay, New Ireland and Oro Provinces during the year.

INVESTIGATION 605 OBSERVATION ON OTHER PESTS

Purpose

To determine for minor pests of oil palm, level of damage, life cycles, wild or natural host plants, distribution in Papua New Guinea and records of its pest status overseas, and to formulate control measures.

Progress

West New Britain Province

(i) The Oil Palm Skipper Butterfly, *Cephrenes* sp. (Lepidoptera: Hesperiidae).

There was a slight increase in the number of skipper butterflies at Kapiura especially at Kaurausu division early in the year. The larvae conceals itself inside a rolled up leaf blade and feeds from inside by chewing away the edges of the leaflet. However its incidence subsequently declined towards the end of the year, due to the presence of a large number of natural enemies. Both the larvae and pupae were found to be parasitized by parasitic Diptera and Hymenoptera respectively.

(ii) A Noctuid Moth, *Spodoptera* sp. (Lepidotera: Noctuidae).

Gregarious larvae of the moth were confirmed stripping the epidermis of the undivided leaves of juvenile seedlings at the nursery at Kapiura. The caterpillars are dark green with yellow stripes along their back and sides and various black markings. Significant damage was observed on a few seedlings that were attacked however, it incidence was low. No treatment action was necessary but manual picking and destroying of larvae was recommended.

(iii) The "Webworm" of Oil Palm, *Acria sp.* (Lepidoptera: Xyloryctidae).

Since its initial sighting in 1991 at Bebere, this moth has spread to Kumbango and surrounding smallholdings. It has also been observed throughout the Kapiura plantations. The larvae does inflict considerable damage to the surface area of the palm foliage, especially when in large numbers. The moth is observed to be most abundant at the beginning and during the dry seasons (April-July) hence suggesting its seasonality. A high mortality due to natural factors, especially by parasities and entomopathogens is also observed. Larvae are predominately parasitized by a braconid wasps while pupae are attacked by a chalcid wasp, *Brachymeria* sp. and entomopathogens. This seasonal lepidopteran does appear to be a potentially significant pest of oil palm foliage. Hence, any practices that may be detrimental to the population of abovementioned beneficial insects should be minimized, particularly the use of herbicides to control weeds. Observations and recording is continuing on the biology of the moth.

(iv) The Oil Palm Stickinsect, *Eurycantha calcarata* (Phasmatodea: Phasmidae)

The presence and damage to oil palm foliage by this pest was confirmed in July at Kaurausu division, Kapura. Damage was moderate on 2-3 palms, hence no treatment action was necessary. Peroidic monitoring continued in the year by OPRA.

(v) The Coconut Leafhopper, *Zophiuma lobulata* Ghauri (Homoptera: Lophopidae).

Zophiuma lobulata Ghauri is thought to be associated with a disorder known as 'Finshhafen Disease' on coconuts. Early accounts of this insect and the associated disorder was recorded along the north coast of Finschhafen, Morobe Province in 1950s. It was the most predominant disorder on coconuts during that time in the area hence its common name. The symptoms of the disease in marked by severe yellowing of fronds, retarded growth, loss of crop and occasionally death to young palms.

In West New Britain, a widespread occurrence this homopteran was first observed on coconuts at Mai, Buluma, and Banaule villages in March 1994. Further spread and outbreak was confirmed at Dami, Mosa and Kapiura plantations again on coconuts from August onwards. The high incidence of the leaf hopper at this locations and its proximity to large oil palm stands necessitated an immediate action, though no obvious symptoms were expressed by the oil palm. Therefore, recommendation was issued for treatment at these locations-on coconuts in November. The chemical and method of treatment recommended were similar to those engaged for the control of sexava. That is, application of 10cc concentration of monocrotophos via trunk infection. For the record, a total of 228 oil palm at Dami in close proximity to a severely infested coconut block was treated in November as a precautionary measure.

(vi) The Bunch Moth, *Tirathaba rufivena* (Lepidoptera: Pyralidae)

Infestation by the bunch moth was reported from Malilimi in March. Its occurrence was reported to have caused the poor pollination of bunches observed at that time however, this was disproved further our investigation. Moderately heavy infestation caused by larvae of the moth was observed on developing black bunches (3-4 months old) but its occurrence was not extensive. Kernel development was not affected as observed on some damaged bunches sampled thus suggesting that normal pollination had occurred prior to infestation by *Tirathaba*. The large number of rotten bunches (2-3 months old) observed on the young palms at Malilimi may have been due abortion resulting from overbearing. For instance, a range of 3-14 well pollinated black bunches per palm was observed on the young palms hence suggesting a possible normal physiological reaction by the palm to abort some bunches to conserve resoures and energy for bunch production later.

Other Oil Palm Developments Throughout Papua New Guinea.

There were no reports of the occurrence or outbreaks of any new insect pests from oil palm developments in Milne Bay, New Ireland and Oro Provincce.

PATHOLOGY

West New Britain Province

A widespread incidence of Fan Blight, a condition caused by mycelial growth (fungi) on the upper and lower surfaces of oil palm leaves (pinnae) was observed on NBPOD Ltd's properties at Bebere, Kumbango and Malilimi plantations. This condition predominantly occurs on the lower most fronds which are otherwise insignificant in photosynthetic related activities of the palm. Its occurrence is thought to be of no economic significance.

New Ireland Province

First report of a palm attacked by *Ganoderma* at Poliamba was from Kapsu estate. The fungi was reported to have caused both root and basal stem rots of a palm, subsequently resulting in its death in March.

Oro Province

No diseases were reported from Oro Province.

APPENDICES

Appendix I	Meteorological Data
Appendix II	Soil Analysis Data

APPENDIX I

METEOROLOGICAL DATA

Table 165 Meteorological Data from Dami, 1970 -1994

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1970-1994	1994	1970-1994	1994	1970-1994	1994
January	616	737	24	29	112	79
February	641	611	24	25	105	101
March	528	187	24	18	120	153
April	339	220	21	16	148	163
May	216	217	17	19	165	135
June	160	73	15	11	156	127
July	196	428	16	18	143	61
August	173	390	14	17	173	99
September	160	134	13	9	177	182
October	169	53	15	8	177	183
November	229	46	17	7	177	230
December	419	343	22	20	127	118
Total	3846	3439	222	97	1777	1631

Table 166 Meteorological Data from Higaturu, 1981-1994

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1981-1994	1994	1981-1994	1994	1981-1994	1994
January	316	208	20	14	170	139
February	302	195	20	17	142	112
March	260	146	21	16	185	215
April	304	239	21	14	172	176
May	176	190	16	19	184	123
June	139	50	14	7	152	74
July	105	123	13	15	171	150
August	118	255	14	16	182	157
September	153	30	13	8	185	134
October	249	156	18	10	188	139
November	242	121	16	10	217	213
December	334	373	21	19	163	157
Total	2698	2086	207	165	2111	1789

Table 167 Rainfall (mm) at all Sites in 1994

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
West New Britain Province													
Dami	737	611	187	220	217	73	428	390	134	53	46	343	3439
Bebere	580	630	219	210	239	96	318	305	126	67	57	314	3161
Kumbango	511	639	334	214	310	111	337	317	166	93	84	292	3408
Malilimi	521	608	279	353	300	72	537	235	97	113	90	462	3667
Togulo	668	854	360	240	334	66	369	269	81	79	140	302	3760
Kautu	671	617	255	224	194	163	531	333	130	111	89	312	3630
Hargy	1490	993	386	420	430	280	517	715	158	93	33	358	5873
Navo	872	739	440	330	442	283	420	448	192	128	60	205	4559
Oro Province													
Sangara	224	469	473	902	485	98	446	87	98	132	145	450	4009
Ambogo	765	598	208	226	155	18	120	144	-	175	71	417	2897
OPRA Higaturu	208	195	146	239	190	50	123	255	30	156	121	373	2086
Milne Bay Province													
Hagita	319	117	143	122	443	104	92	279	39	374	52	5	2089
Waigani	358	127	160	113	488	105	87	321	43	412	36	31	2281
GiliGili	234	106	131	127	647	99	100	295	60	397	56	0	2252
New Ireland Province													
Lakuramau		400	297	380	259	118	250	151	105	144	65	397	2566

APPENDIX II

SOIL ANALYSIS DATA

National Agricultural Chemistry Laboratory
Department of Agriculture and Livestock
Kila Kila, Port Moresby

Table 168 Soil Analysis Summary, Islands Provinces, 1994 - Smallholder

Trial	Depth (cm)	pH	Extractable Bases (me%)				CEC (me%)	Olsen P (mg/kg)	P Retention (%)	pH in NaF	Organic C (%)	Total N (%)	C/N ratio	PSDA (%)		
			Ca	Mg	K	Na								Sand	Silt	Clay
HOSKINS																
061682	0-20	6.1	13.7	1.10	0.13	0.08	13.2	6.2	46	9.1	3.72	0.33	11	55	32	13
061681	0-20	6.2	15.1	1.19	0.15	0.06	13.0	6.7	44	9.2	3.42	0.30	11	56	31	13
330012	0-20	6.2	14.4	1.86	1.05	0.08	16.0	22.7	30	8.9	2.39	0.22	10	47	32	21
330037	0-20	6.2	19.2	2.27	1.33	0.09	20.5	20.5	35	8.8	2.76	0.32	9	37	32	30
020556	0-20	6.2	9.5	0.69	0.13	0.10	10.7	1.7	63	9.4	3.06	0.30	10	49	38	13
020555	0-20	6.1	6.4	0.48	0.15	0.10	9.3	1.6	65	9.3	2.83	0.30	9	50	37	13
030922	0-20	5.9	7.9	0.71	0.14	0.10	11.1	1.9	72	9.4	3.72	0.38	10	49	38	13
030923	0-20	5.9	8.7	0.60	0.16	0.10	10.7	1.4	65	9.4	3.21	0.31	10	49	39	13
340001	0-20	5.9	18.3	2.20	0.39	0.13	19.5	4.2	68	9.3	5.28	0.55	10	49	35	16
340005	0-20	5.9	16.8	2.14	0.48	0.10	19.9	3.5	72	9.2	4.71	0.54	9	46	36	18
041399	0-20	6.0	8.1	0.53	0.10	0.05	10.8	1.9	67	9.4	4.28	0.39	11	54	35	12
041418	0-20	5.9	5.3	0.34	0.11	0.06	8.9	1.5	71	9.7	4.21	0.33	13	51	33	16
010306	0-20	6.1	6.8	0.52	0.12	0.13	8.7	2.2	57	9.4	3.43	0.28	12	53	28	18
010307	0-20	6.1	11.2	0.66	0.21	0.05	12.3	2.7	55	9.4	4.00	0.36	11	50	34	16
01705	0-20	6.2	16.9	1.26	0.13	0.06	17.7	1.8	84	9.7	4.91	0.49	10	52	29	19
01704	0-20	6.2	17.5	1.27	0.15	0.05	17.6	1.6	84	9.5	4.99	0.48	10	47	32	21
550514	0-20	6.1	8.3	1.30	0.17	0.06	12.7	1.6	83	9.7	3.74	0.39	10	53	26	21
550514	0-20	6.0	9.1	1.53	0.15	0.06	15.7	1.4	80	9.7	4.21	0.42	10	54	25	21
130001	0-20	6.0	6.7	0.85	0.32	0.05	9.0	2.8	49	9.4	3.40	0.30	11	56	29	15
130002	0-20	6.1	7.0	1.14	0.19	0.05	9.3	3.0	46	9.4	3.35	0.30	11	52	33	15

Table 169 Soil Analysis Summary, Islands Provinces

Trial	Depth (cm)	pH	Extractable Bases (me%)				CEC (me%)	Olsen P (mg/kg)	P Retention (%)	pH in NaF	Organic C (%)	Total N (%)	C/N ratio	PSDA (%)		
			Ca	Mg	K	Na								Sand	Silt	Clay
HOSKINS																
107	0-20	6.3	4.70	0.46	0.19	0.13	8.0	4.7	53	9.7	1.73	0.18	10	52	35	13
	40-60	6.6	7.90	0.92	1.88	0.40	13.2	4.7	40	8.8	0.65	0.07	9	54	20	27
108	0-20	6.4	5.00	0.27	0.58	0.28	9.3	2.7	67	9.8	1.34	0.15	9	52	35	14
	40-60	6.4	5.10	0.24	0.61	0.38	9.9	2.8	65	9.9	1.27	0.13	10	52	33	15
110	0-20	6.3	3.50	0.27	0.22	0.11	6.3	2.5	51	9.8	1.30	0.13	10	54	35	11
	40-60	6.5	5.90	0.53	1.44	0.34	10.4	2.7	49	9.4	0.80	0.13	10	62	23	17
117	0-20	6.1	3.50	0.17	0.38	0.07	6.2	2.9	53	10.0	1.31	0.15	9	53	38	9
	40-60	6.3	5.80	0.35	0.78	0.58	10.9	4.4	62	9.8	1.09	0.12	10	55	36	10
119	0-20	6.1	3.90	0.39	0.18	0.09	6.3	3.6	56	9.7	1.35	0.13	10	46	38	16
	40-60	6.0	3.40	0.26	0.15	0.08	5.1	3.5	49	9.8	0.84	0.10	8	49	17	14
120	0-20	6.0	7.90	0.60	0.77	0.22	10.7	9.7	26	8.7	1.87	0.17	12	69	17	14
	40-60	6.5	3.10	0.36	0.84	0.14	5.4	6.0	17	8.8	0.24	0.02	12	82	10	9

Trial	Depth (cm)	pH	Extractable Bases (me%)				CEC (me%)	Olsen P (mg/kg)	P Retention (%)	pH in NaF	Organic C (%)	Total N (%)	C/N ratio	PSDA (%)		
			Ca	Mg	K	Na								Sand	Silt	Clay
BIALLA																
201	0-20	5.9	10.50	0.74	0.10	0.06	18.2	3.0	92	10.5	4.95	0.53	9	43	37	20
	40-60	6.3	4.30	0.28	0.07	0.06	10.1	1.4	92	10.4	1.41	0.17	8	44	39	17
KAPIURA																
401	0-20	6.2	18.50	3.17	0.63	0.08	24.3	2.4	52	9.3	2.16	0.22	10	40	35	25
	40-60	6.1	16.40	3.20	0.52	0.12	36.4	4.1	42	8.7				47	27	27
POLIAMBA																
251	0-20	6.1	11.1	1.69	0.12	0.04	17.3	7.6	68	7.4	2.48	0.23	10	9	15	77
252	0-20	5.8	13.5	1.25	0.23	0.06	19.1	8.5	75	9.3	3.37	0.33	10	11	14	75

NACL Methods Used: S1, S3, S5, S8, S9, S10, S11, S12, S13, S15, S16, S22, S25. Detection limits as follows: - available P(olsen) 0.1 mg/Kg: extractable Mg, K, Na, 0.01 me%; extractable Ca 0.1 me%: CEC 0.1 me%; Organic carbon 0.01 %; micronutrients (Cu, Zn, Mn & Fe) 1mg/Kg; available boron 0.01 mg/Kg.

Results are quoted on an air dry basis (2mm soil) except PSDA (oven dry basis).

Table 170 Soil Analysis Summary. Mainland Provinces

Trial	Depth (cm)	pH	Extractable Bases (me%) Ca	Mg	K	Na	CEC (me%)	Olsen P (mg/kg)	P Retention (%)	pH in NaF	Organic C (%)	Total N (%)	C/N ratio	PSDA (%) Sand	Silt	Clay
HIGATURU																
305	0-20	6.2	9.3	0.94	0.13	0.02	11.0	7.0	22	8.2	2.02	0.21	10	58	22	20
	40-60	6.4	8.8	2.13	0.24	0.11	11.8	6.3	47	8.9	0.54	0.06	10	44	14	42
306	0-20	6.2	10.1	2.63	0.11	0.03	12.9	10.1	17	7.8	1.97	0.19	10	57	28	15
	40-60	6.3	2.9	[illegible].70	0.16	0.12	4.2	4.3	6	7.5	0.14	0.02	7	83	10	7
309	0-20	6.0	4.6	[illegible].24	0.37	0.04	14.5	8.6	50	na	3.10	0.26	12	65	24	11
	40-60	6.2	0.9	0.21	0.10	0.03	3.1	4.3	12	na	0.22	0.03	8	82	12	6
310	0-20	6.3	9.5	[illegible].72	0.16	0.04	13.0	12.6	28	na	2.10	0.21	10	62	23	16
	40-60	6.5	1.8	0.95	0.08	0.02	3.2	5.4	9	na	0.15	0.02	7	81	13	6
311	0-20	6.0	7.2	1.20	0.43	0.03	11.4	6.5	27	na	1.98	0.22	9	63	20	17
	40-60	6.2	7.6	1.83	0.28	0.09	11.2	5.9	41	na	0.42	0.05	8	49	10	41
312	0-20	6.1	8.0	2.23	0.62	0.03	13.1	10.0	40	9.1	2.82	0.26	11	58	36	6
	40-60	6.3	2.2	0.75	0.24	0.03	3.6	4.4	12	8.0	0.22	0.03	9	72	25	3
MAMBA																
317	0-20	5.3	1.8	0.17	0.09	0.03	14.9	11	83	na	5.04	0.52	10	65	22	14
	40-60	5.5	0.65	0.05	0.03	0.02	6.9	11	74	na	1.64	0.19	9	67	23	10
318	0-20	4.8	0.7	0.13	0.08	0.01	8.5	12.9	42	8.8	2.41	0.25	10	52	29	19
	40-60	5.6	0.2	0.03	0.03	0.01	3.1	7.7	26	8.9	0.45	0.07	7	69	19	13
MILNE BAY																
502b	0-20	6.2	34.2	14.5	0.15	0.63	47.1	5.2	47	na	3.36	0.31	11	16	40	44
	40-60	6.8	33.8	13.8	0.07	0.66	46.4	1.5	40	na	0.74	0.09	9	21	36	43

Methods Used :pH(1:5 soil:distill water); Phosphorus (Olsen Extraction); CEC and cations (ammonium acetate pH 7 method); Organic C (Walkley-Black); Total N (Kjeldahl); P retention (Saunders method); pH in NaF (1:50 soil:sat.NaF soln); PSDA (hydrometer).