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CONTENTS

I. Islands Region Agronomy Trials

		Page
Trial 107	Factorial Fertiliser Trial, Bebere Plantation.	1
Trial 108	Systematic Nitrogen Fertiliser Trial Kumbango Plantation.	7
Trial 117	Systematic Nitrogen Fertiliser Trial, Kumbango Plantation.	14
Trial 118	Systematic Nitrogen Fertiliser Trial, Kumbango Plantation.	17
Trial 119	Nitrogen/Anion Trial, Malilimi Plantation.	20
Trial 120	Nitrogen/Anion Trial, Dami Plantation.	24
Trial 201	Factorial Fertiliser Trial, Hargy Plantation.	27
Trial 204	Factorial Fertiliser Trial, Navo Plantation	31
Trial 251& 252	Factorial Fertiliser Trials, Maramakas and Luburua Plantations.	35
Trial 401	Factorial Fertiliser Trial, Kautu Plantation.	40
Trial 402	Factorial Fertiliser Trial, Bilomi Plantation.	45

II. Islands Region Smallholder Trials and Demonstrations

Trial 112	Nitrogen and Phosphate Demonstration Trials, Buvusi.	51
Trial 121	Smallholder Fertiliser Trials, Hoskins	54
Trial 124	School Trials, Hoskins	64
Trial 207	Smallholder Fertiliser Trials, Bialla	66

III. Mainland Region Agronomy Trials and Smallholder Trials and Demonstrations

Trial 305	Factorial Fertiliser Trial, Arehe Estate.	72
Trial 306	Factorial Fertiliser Trial, Ambogo Estate.	78
Trial 309	K, Cl and S Fertiliser Trial, Ambogo Estate.	83
Trial 310	K, Cl and S Fertiliser Trial, Ambogo Estate.	87
Trial 311	N, K and EFB Trial, Isavene Estate.	90
Trial 312	N, K and EFB Trial, Ambogo Estate.	96
Trial 317	Factorial Fertiliser Trial on Lower Terrace, Komo Estate, Mamba.	102
Trial 318	Factorial Fertiliser Trial on River Terrace, Komo Estate, Mamba.	107

IV. Entomology

Investigation 603	The Pollinating Weevil, *Elaeidobius kamerunicus*.	112
Investigation 601	Control of Sexava Using Chemicals.	122
Investigation 607	Biological Control of Sexava.	123
Investigation 606	Control of Bagworm.	125
Investigation 605	Observations of Other Pests.	126
Investigation 608	Control of *Scapanes* and *Oryctes*.	127
Pathology		128

Appendices

Appendix I	Meteorological Data	129
Appendix II	Soil Analysis Data	131

I. AGRONOMY TRIALS

ISLANDS PROVINCES

(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 Level			From Jan 89 Level		
	0	1	2	0	1	2
	(kg/palm/yr)			(kg/palm/yr)		
Sulphate of Ammonia (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.
Sulphate of ammonia is 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 reponse to other fertilisers.

RESULTS

FFB yield in 1992 was increased by application of sulphate of ammonia (Table 2). 1992 was the first year in which the yield response to sulphate of ammonia was statistically significant. The increase in yield was due to increases in the numbers of bunches produced and the single bunch weight.

The yield response to kieserite application seen in earlier years was no longer significant in 1992, but a trend was still present. Kieserite application increased single bunch weight in 1992 and in the cumulative data for the period 1990 to 1992 (Table 3).

Sodium chloride application increased single bunch weight in 1992 and in the cumulative data for the period 1990 to 1992.

The concentration of nitrogen in leaflet tissue was increased by application of sulphate of ammonia (Table 4). The fitted value for the concentration of nitrogen in leaflet tissue in the control (N0,P0,K0,Mg0 & Cl0) was 2.28%. The yield in 1992 was increased markedly by application of sulphate of ammonia up to an application rate of 2kg SoA/palm/yr, at which point the concentration of nitrogen in the leaflet tissue was increased to 2.45%. Above a rate of 2kg SoA/palm/yr the increase in yield and concentration of nitrogen in leaflet tissue was small.

The concentration of magnesium in leaflet tissue was decreased by application of sulphate of ammonia, as was the concentration of calcium.

Table 2. Main effects of N, P, K and Mg on yield and yield components in 1992 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	24.9	27.0	27.0	*	0.977	12.9
Bunches/ha	1084	1175	1157		42.4	12.9
Bunch weight (kg)	22.9	23.0	23.4		0.303	4.5
	P0	P1	P2			
Yield (t/ha/yr)	25.7	26.5	26.6		0.977	12.9
Bunches/ha	1126	1150	1141		42.4	12.9
Bunch weight (kg)	22.8	23.0	23.4		0.303	4.5
	K0	K1				
Yield (t/ha/yr)	26.5	26.1			0.797	12.9
Bunches/ha	1144	1134			34.6	12.9
Bunch weight (kg)	23.2	23.0			0.247	4.5
	Mg0	Mg1				
Yield (t/ha/yr)	25.7	26.9			0.797	12.9
Bunches/ha	1133	1144			34.6	12.9
Bunch weight (kg)	22.7	23.5		**	0.247	4.5
	Cl0	Cl1				
Yield (t/ha/yr)	25.7	26.9			0.797	12.9
Bunches/ha	1127	1150			34.6	12.9
Bunch weight (kg)	22.8	23.4		*	0.247	4.5

Kieserite application increased the concentration of magnesium in leaflet tissue. Even with the application of kieserite, the concentration of magnesium in the leaflets was still low.

Application of sodium chloride had increased the concentrations of calcium and chlorine in the leaflet tissue.

Sulphate of ammonia application increased the bunch and vegetative dry matter production, and therefore the total dry matter production (Table 5). There was no change in bunch index.

Sodium chloride application increased total dry matter production through non-significant increases in bunch and vegetative dry matter production.

Table 3. Main effects of N, P, K and Mg on yield and yield components from 1990 to 1992 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	25.4	26.5	26.2		0.539	7.2
Bunches/ha	1351	1402	1372		35.3	8.9
Bunch weight (kg)	18.8	19.0	19.2		0.234	4.3
	P0	P1	P2			
Yield (t/ha/yr)	25.9	26.0	26.1		0.539	7.2
Bunches/ha	1375	1382	1368		35.3	8.9
Bunch weight (kg)	18.9	18.9	19.2		0.234	4.3
	K0	K1				
Yield (t/ha/yr)	26.1	25.9			0.440	7.2
Bunches/ha	1382	1368			28.8	8.9
Bunch weight (kg)	19.0	19.0			0.191	4.3
	Mg0	Mg1				
Yield (t/ha/yr)	26.0	26.1			0.440	7.2
Bunches/ha	1397	1353			28.8	8.9
Bunch weight (kg)	18.6	19.3		**	0.191	4.3
	Cl0	Cl1				
Yield (t/ha/yr)	25.8	26.3			0.440	7.2
Bunches/ha	1384	1366			28.8	8.9
Bunch weight (kg)	18.7	19.3		**	0.191	4.3

Table 4. Treatment main effects on leaflet nutrient concentrations in 1992 (Trial 107).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.35	2.45	2.47	***	0.029	4.1
Phosphorus	0.145	0.147	0.148		0.002	3.9
Potassium	0.83	0.81	0.80		0.023	9.8
Calcium	0.77	0.74	0.74	*	0.013	6.0
Magnesium	0.15	0.13	0.13	***	0.003	9.6
Chlorine	0.38	0.36	0.35		0.024	23.1
	P0	P1	P2			
Nitrogen	2.41	2.45	2.41		0.029	4.1
Phosphorus	0.146	0.147	0.148		0.002	3.9
Potassium	0.82	0.80	0.83		0.023	9.8
Calcium	0.74	0.74	0.76		0.013	6.0
Magnesium	0.14	0.13	0.14		0.003	9.6
Chlorine	0.35	0.36	0.37		0.024	23.1
	K0	K1				
Nitrogen	2.44	2.40			0.029	4.1
Phosphorus	0.147	0.147			0.002	3.9
Potassium	0.81	0.82			0.023	9.8
Calcium	0.74	0.75			0.013	6.0
Magnesium	0.13	0.14			0.004	9.6
Chlorine	0.35	0.37			0.024	23.1
	Mg0	Mg1				
Nitrogen	2.41	2.43			0.029	4.1
Phosphorus	0.148	0.146			0.002	3.9
Potassium	0.82	0.81			0.023	9.8
Calcium	0.76	0.74		*	0.013	6.0
Magnesium	0.126	0.142		***	0.004	9.6
Chlorine	0.34	0.38			0.024	23.1
	Cl0	Cl1				
Nitrogen	2.42	2.42			0.029	4.1
Phosphorus	0.147	0.147			0.002	3.9
Potassium	0.83	0.80			0.023	9.8
Calcium	0.73	0.76		**	0.013	6.0
Magnesium	0.13	0.14			0.004	9.6
Chlorine	0.33	0.39		**	0.024	23.1

Table 5. Main effects of N, P, K and Mg on biomass production in 1992 (Trial 107).

Estimated biomass production components (t/ha/yr)	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Frond dry matter production	15.28	15.70	16.50	**	0.412	9.0
Bunch dry matter production	20.39	22.12	22.16	*	0.777	12.5
Vegetative dry matter production	19.25	19.90	20.80	**	0.458	7.9
Total dry matter production	39.64	42.02	42.96	**	0.945	7.9
Bunch index (BDM/TDM)	0.513	0.525	0.514		0.010	6.8
	P0	P1	P2			
Frond dry matter production	15.34	16.08	16.06		0.412	9.0
Bunch dry matter production	21.10	21.74	21.83		0.777	12.5
Vegetative dry matter production	19.40	20.29	20.27		0.458	7.9
Total dry matter production	40.50	42.03	42.09		0.945	7.9
Bunch index (BDM/TDM)	0.520	0.515	0.518		0.010	6.8
	K0	K1				
Frond dry matter production	16.01	15.64			0.336	9.0
Bunch dry matter production	21.78	21.34			0.635	12.5
Vegetative dry matter production	20.12	19.76			0.374	7.9
Total dry matter production	41.99	41.09			0.772	7.9
Bunch index (BDM/TDM)	0.518	0.518			0.008	6.8
	Mg0	Mg1				
Frond dry matter production	15.77	15.88			0.336	9.0
Bunch dry matter production	21.07	22.04			0.635	12.5
Vegetative dry matter production	19.87	20.10			0.374	7.9
Total dry matter production	40.94	42.14			0.772	7.9
Bunch index (BDM/TDM)	0.514	0.521			0.008	6.8
	Cl0	Cl1				
Frond dry matter production	15.57	16.08			0.336	9.0
Bunch dry matter production	21.07	22.04			0.635	12.5
Vegetative dry matter production	19.65	20.32			0.374	7.9
Total dry matter production	40.71	42.36		*	0.772	7.9
Bunch index (BDM/TDM)	0.517	0.519			0.008	6.8

Trial 108 SYSTEMATIC NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.

PURPOSE

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

DESCRIPTION

Site Kumbango Plantation, Fields E7 and F8.

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

Palms Dami commercial DxP crosses.
Planted in 1972 at 120 palms/ha.
Treatment started in 1984.

DESIGN

Two sources of nitrogen are compared in systematically increasing levels of eight equal steps (the "ladder" design) (Table 6). A set of levels of each source abuts a second set but with the direction of increase of dose in one set being opposite to the other. There are 64 plots made up from two sources of nitrogen, each at eight levels, replicated four times. A single plot consists of the two rows on each side of a harvesting path (twin row) and on average consisting of 33 palms. Two of the replicates are in a field that was mulched with 30 tonnes/ha of EFB in March 1985, the other two replicates are in a field that was not mulched.

There are no guard rows between levels but the two sources are guarded from each other and the end rows are guarded.

Table 6. Rates of fertiliser used in Trial 108.

	Level							
	0	1	2	3	4	5	6	7
	(kg/palm/yr)							
Ammonium chloride	0.0	0.9	1.8	2.7	3.6	4.5	5.4	6.3
Diammonium phosphate	0.0	1.2	2.4	3.6	4.8	6.0	7.2	8.4

Note: At each level of fertiliser application, both nitrogen sources supply the same quantity of nitrogen.

Because of evidence indicating the development of magnesium deficiency in this trial, application of kieserite at 4 kg/palm/yr began in November 1989.

This trial was felled for replanting in early 1993, all recording in this trial was therefore stopped at the end of 1992.

RESULTS

Yields in this trial are low. The average plot yield in 1992 was 20.7 t FFB/ha/yr. The yield response to fertiliser treatments seen in earlier years had largely disapeared in 1992 (Table 7).

In 1992 there were no significant responses to applications of ammonium chloride or diammonium phosphate, both in the presence and absence of kieserite. However, the cumulative yield data for 1990 to 1992 showed diammonium phosphate in the presence of kieserite increased FFB yield (Table 8). The same trend can be seen in the 1992 data even though it was not statistically significant. The application of diammonium phosphate in the absence of kieserite appeared to increase yield but this effect was not statistically significant and was less than when kieseritie was present. The increase in yield was due to an increase in the number of bunches produced.

Both ammonium chloride and diammonium phosphate increased the concentration of nitrogen in leaflet and rachis tissue (Table 9 & 10 and Table 11 & 12). The increase was more pronounced in the rachis. Despite the increase in nitrogen concentration in the leaflet and rachis tissue, nitrogen concentrations in the leaflet tissue were still sub-optimal (according to published threshold values e.g. ???), even at the highest application rates of nitrogen fertiliser.

Diammonium phosphate appeared to increase the phosphorus concentration in leaflet tissue, though this effect was not statistcally significant. Diammonium phosphate decreased the phosphorus conentration in rachis tissue, especially at higher application rates.

The application of ammonium chloride in the absence of kieserite decreased the concentration of potassium in the rachis tissue. A similar effect was seen in the leaflet tissue, but was not statistically significant. The application of kieserite appeared to prevent the reduction in the concentration of potassium in frond tissue.

The concentration of calcium in leaflet and rachis tissue was decreased by the application of diammonium phosphate.

Application of ammonium chloride decreased the concentration of magnesium in the rachis tissue and appeared to do the same in the leaflet tissue. This effect was suppressed by the application of kieserite.

Ammonium chloride increased the concentration of chlorine in both the leaflet and rachis tissue. The increase in leaflet chlorine brought about by ammonium chloride application was much reduced compared to previous years data. The concentration of chlorine in rachis tissue at the zero rate of ammonium chloride was much higher than in the zero rate of diammonium phosphate. This could indicate that significant interplot poaching of fertiliser material was occuring, this poaching could be a one of the major causes of the reduction in treatment response seen since the earlier years of this trial.

Ammonium chloride and diammonium phosphate application increased frond and vegetative dry matter production (Table 13 and Table 14). They also increased total dry matter production but did not affect bunch index.

Table 7. The effects of fertiliser treatments on yield and yield components in 1992 (Trial 108).

	Yield (t/ha/yr)				Bunches/ha				Bunch weight (kg)			
	Ammonium chloride		Diammonium phosphate		Ammonium chloride		Diammonium phosphate		Ammonium chloride		Diammonium phosphate	
N Level	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	17.5	22.8	18.4	15.5	653	788	712	580	26.8	28.8	25.8	26.7
1	21.3	18.3	16.8	17.2	776	648	624	664	27.5	28.0	27.0	26.0
2	22.7	20.5	18.4	17.5	854	742	694	669	26.6	27.6	26.4	26.2
3	20.5	20.8	19.6	18.2	745	715	747	649	27.5	29.3	26.2	28.1
4	19.9	18.0	19.5	20.7	669	620	686	757	29.9	29.0	28.3	27.3
5	20.7	18.7	18.9	19.0	725	644	668	697	29.0	29.0	28.3	27.4
6	21.8	20.7	17.5	21.9	769	702	566	809	28.4	29.5	31.5	27.3
7	21.3	21.4	22.3	19.6	729	727	828	663	29.2	29.4	26.8	29.6
linear response	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
quadratic resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
cv%	9.0	16.4	13.6	17.4	11.2	11.3	11.6	16.8	5.6	8.1	10.1	9.2

Table 8. The effects of fertiliser treatments on yield and yield components for 1990 to 1992 (Trial 108).

	Yield (t/ha/yr)				Bunches/ha				Bunch weight (kg)			
	Ammonium chloride		Diammonium phosphate		Ammonium chloride		Diammonium phosphate		Ammonium chloride		Diammonium phosphate	
N Level	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	15.7	18.6	16.7	15.5	650	710	701	626	24.2	26.2	23.8	24.8
1	18.9	16.3	16.8	16.6	755	641	696	690	25.0	25.4	24.1	24.1
2	19.8	18.3	18.4	16.7	792	711	751	676	25.1	25.8	24.5	24.8
3	18.6	19.8	18.9	17.6	720	730	778	699	25.8	27.3	24.3	25.2
4	19.3	15.6	19.0	20.3	723	597	725	817	26.7	26.1	26.2	24.7
5	19.2	16.5	19.7	20.0	732	619	795	805	26.3	26.6	24.7	25.0
6	18.3	18.3	18.3	21.4	718	706	723	856	25.4	25.9	25.5	25.0
7	18.4	19.5	19.2	17.9	705	736	779	676	26.1	26.5	24.7	26.6
linear response	ns	ns	ns	0.016	ns	ns	ns	0.024	ns	ns	ns	ns
quadratic resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
cv%	8.0	12.9	9.0	10.4	7.5	11.3	10.1	9.1	5.9	6.9	4.7	6.7

Table 9. Effects of ammonium chloride treatments on leaflet nutrient concentrations in 1992 (Trial 108).

Ammonium chloride level	%N		%P		%K		%Ca		%Mg		%Cl	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	2.06	2.16	0.140	0.135	0.73	0.68	0.94	0.83	0.15	0.15	0.46	0.38
1	2.12	2.14	0.137	0.131	0.73	0.62	1.01	0.86	0.16	0.15	0.52	0.55
2	2.11	2.17	0.138	0.140	0.72	0.66	0.99	0.98	0.17	0.16	0.56	0.56
3	2.10	2.16	0.137	0.136	0.70	0.70	0.93	0.92	0.13	0.16	0.52	0.55
4	2.19	2.24	0.138	0.139	0.69	0.74	1.02	0.84	0.13	0.15	0.54	0.57
5	2.26	2.27	0.139	0.139	0.65	0.71	0.97	0.78	0.14	0.15	0.51	0.63
6	2.18	2.23	0.145	0.137	0.71	0.72	0.89	0.77	0.12	0.14	0.54	0.61
7	2.22	2.28	0.141	0.139	0.68	0.74	0.92	0.91	0.15	0.14	0.54	0.55
linear Response	0.040	0.057	ns	ns	ns	ns	ns	ns	ns	ns	0.019	0.006
Quadratic Resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.061	0.011

Table 10. Effects of diammonium phosphate treatments on leaflet nutrient concentrations in 1992 (Trial 108).

Diammonium phosphate level	%N		%P		%K		%Ca		%Mg		%Cl	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	2.08	2.04	0.136	0.134	0.70	0.76	0.80	0.79	0.16	0.14	0.40	0.43
1	2.06	2.13	0.140	0.138	0.70	0.79	0.80	0.89	0.15	0.18	0.37	0.44
2	2.11	2.15	0.141	0.141	0.73	0.77	0.75	0.82	0.15	0.16	0.33	0.44
3	2.01	2.25	0.145	0.144	0.89	0.76	0.61	0.83	0.16	0.18	0.36	0.39
4	2.11	2.26	0.140	0.145	0.86	0.81	0.72	0.74	0.14	0.17	0.31	0.38
5	2.28	2.28	0.145	0.145	0.73	0.74	0.75	0.79	0.14	0.17	0.30	0.37
6	2.17	2.29	0.144	0.146	0.83	0.80	0.77	0.77	0.15	0.15	0.30	0.36
7	2.26	2.28	0.146	0.142	0.79	0.80	0.80	0.69	0.15	0.15	0.32	0.31
linear Response	ns	0.005	0.064	ns	ns	ns	ns	0.031	ns	ns	ns	ns
Quadratic Resp.	ns	ns	ns	ns	ns	ns	0.004	ns	ns	0.009	ns	ns

Table 11. Effect of ammonium chloride treatments on rachis nutrient concentrations in 1992 (Trial 108).

Ammonium chloride level	%N		%P		%K		%Ca		%Mg		%Cl	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	0.18	0.19	0.068	0.065	1.98	2.02	0.50	0.43	0.06	0.05	0.71	0.91
1	0.19	0.20	0.061	0.064	2.03	1.99	0.53	0.49	0.05	0.05	0.93	0.92
2	0.19	0.21	0.060	0.058	1.80	1.96	0.55	0.43	0.05	0.05	1.06	0.96
3	0.21	0.20	0.047	0.050	1.83	1.88	0.49	0.44	0.05	0.05	0.96	0.89
4	0.27	0.20	0.059	0.061	1.75	1.88	0.56	0.48	0.05	0.05	1.05	0.93
5	0.25	0.23	0.056	0.058	1.65	1.88	0.50	0.47	0.04	0.05	1.05	1.09
6	0.32	0.23	0.060	0.049	1.78	1.86	0.53	0.50	0.05	0.05	1.15	1.15
7	0.26	0.21	0.059	0.050	1.70	1.97	0.49	0.44	0.05	0.05	1.07	1.08
linear Response	<001	0.031	ns	ns	0.032	ns	ns	ns	0.041	ns	0.046	0.068
Quadratic Resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 12. Effect of diammonium phosphate treatments on rachis nutrient concentrations in 1992 (Trial 108).

Diammonium phosphate level	%N		%P		%K		%Ca		%Mg		%Cl	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	0.18	0.17	0.094	0.084	1.75	1.75	0.34	0.41	0.04	0.05	0.28	0.45
1	0.17	0.18	0.126	0.103	1.84	1.55	0.38	0.36	0.04	0.05	0.28	0.36
2	0.22	0.17	0.120	0.104	1.83	1.50	0.36	0.33	0.04	0.04	0.24	0.32
3	0.20	0.18	0.095	0.107	1.53	1.80	0.36	0.33	0.04	0.04	0.24	0.33
4	0.18	0.20	0.111	0.097	1.58	1.57	0.37	0.31	0.04	0.05	0.22	0.29
5	0.19	0.22	0.089	0.084	1.43	1.62	0.31	0.35	0.04	0.05	0.19	0.29
6	0.20	0.23	0.090	0.082	1.60	1.70	0.28	0.30	0.04	0.04	0.21	0.29
7	0.23	0.21	0.093	0.073	1.68	1.55	0.33	0.30	0.04	0.04	0.31	0.26
linear Response	0.010	<.001	ns	0.036	ns	ns	0.007	0.009	ns	ns	ns	ns
Quadratic Resp.	ns	ns	ns	0.018	ns	ns	ns	ns	ns	ns	ns	ns

Table 13. Effect of ammonium chloride treatments on estimated biomass production in 1992 (Trial 108).

Ammonium chloride level	FDM (t/ha/yr)		BDM (t/ha/yr)		VDM (t/ha/yr)		TDM (t/ha/yr)		Bunch index	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	13.4	14.4	14.4	18.7	16.5	18.0	30.9	36.7	0.46	0.51
1	13.3	13.3	17.5	15.0	16.7	16.5	34.2	31.5	0.51	0.47
2	13.0	13.7	18.6	16.8	16.5	17.1	35.1	33.9	0.53	0.50
3	13.6	15.3	16.8	17.1	17.0	18.9	33.7	35.9	0.50	0.47
4	15.0	16.2	16.3	14.8	18.5	19.6	34.8	34.4	0.47	0.43
5	14.9	14.7	17.0	15.3	18.5	18.0	35.4	33.4	0.48	0.46
6	14.5	15.5	17.9	17.0	18.1	19.1	36.0	36.1	0.50	0.47
7	15.6	14.7	17.4	17.5	19.2	18.3	36.6	35.8	0.48	0.49
linear Response	0.003	ns	ns	ns	0.002	ns	0.019	ns	ns	ns
Quadratic Resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 14. Effect of diammonium phosphate treatments on estimated biomass production in 1992 (Trial 108).

Diammonium phosphate level	FDM (t/ha/yr)		BDM (t/ha/yr)		VDM (t/ha/yr)		TDM (t/ha/yr)		Bunch index	
	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies	-Kies	+Kies
0	12.7	13.7	15.1	12.7	15.8	16.7	30.8	29.4	0.49	0.43
1	12.3	13.7	13.8	14.1	15.2	16.8	29.0	30.9	0.48	0.46
2	13.3	14.1	15.1	14.4	16.5	17.2	31.6	31.6	0.48	0.46
3	13.3	15.1	16.0	15.0	15.6	18.4	32.6	33.3	0.49	0.45
4	14.9	14.6	16.0	17.0	18.3	18.1	34.3	35.1	0.46	0.48
5	14.0	15.2	15.5	15.6	17.3	18.7	32.8	34.2	0.47	0.46
6	14.9	15.9	14.4	18.0	18.2	19.6	32.5	37.6	0.44	0.47
7	13.9	16.4	18.3	16.1	17.5	20.0	35.7	36.1	0.51	0.45
linear Response	0.054	0.008	ns	ns	0.042	0.007	0.056	0.022	ns	ns
Quadratic Resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Trial 117 **SYSTEMATIC NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.**

PURPOSE

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

DESCRIPTION

Site Kumbango Plantation, Fields D8 and D9.

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

Palms Dami commercial DxP crosses.
Planted in 1975 at 120 palms/ha.
Treatments started in April 1987.

DESIGN

Two sources of nitrogen are compared in systematically increasing amounts (the "ladder" design) (Table 15). A set of levels of each source abuts a second set but with the direction of increase of dose in one set being opposite to the other. There is a total of 56 plots made up from two sources of nitrogen, each at five levels, replicated four times. The zero level in each replicate occupies three adjacent plots. A single plot consists of the two rows on each side of a harvesting path (twin row) and containing about 35 palms. There are no guard rows between levels but the two sources are guarded from each other and the end rows are guarded.

Table 15. Rates of fertiliser used in Trial 117.

	Level						
	0	0	0	1	2	3	4
				(kg /palm/year)			
Ammonium chloride	0.00	0.00	0.00	1.50	3.00	4.50	6.00
Urea	0.00	0.00	0.00	0.85	1.70	2.55	3.40

Note: At each level, both sources supply the same quantity of nitrogen.

There are two applications of fertiliser per year.

Trial fertiliser application commenced in April 1987.

RESULTS

Yields in this trial were relatively low, the average plot yield in 1992 was 23.3 t FFB/ha.

There were significant yield responses to application of ammonium chloride and urea, however the response to ammonium chloride was much greater (Table 16 and Table 17). Both ammonium chloride and urea produced similar increases in the number of bunches produced but the single bunch weight of urea treated palms was lower.

Table 16. The effects of fertiliser treatments on yield and yield components in 1992 (Trial 117).

	Yield (t/ha/yr)		Bunches/ha		Bunch weight (kg)	
N Level	AC	urea	AC	urea	AC	urea
0	21.3	20.4	818	823	26.1	25.0
1	21.9	21.7	774	819	28.3	26.6
2	24.8	23.3	903	920	27.6	25.3
3	27.0	23.9	952	926	28.6	26.0
4	25.6	23.7	892	941	28.8	25.2
linear response	<.001	0.032	0.007	ns	0.013	ns
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	7.5	15.0	8.7	15.3	7.1	7.5

Table 17. The effects of fertiliser treatments on yield and yield components for 1990 to 1992 (Trial 117).

	Yield (t/ha/yr)		Bunches/ha		Bunch weight (kg)	
N Level	AC	urea	AC	urea	AC	urea
0	21.1	19.9	848	831	25.0	24.3
1	20.5	21.0	767	848	26.7	24.8
2	23.8	22.3	911	938	26.2	23.7
3	25.1	22.2	974	937	25.9	23.7
4	24.6	23.2	924	962	26.7	24.1
linear response	<.001	0.010	0.004	0.030	ns	ns
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	6.7	11.0	8.1	13.7	6.9	7.5

Urea and ammonium chloride treatments increased the concentration of nitrogen in leaflet tissue by similar amounts (Table 18).

Urea and ammonium chloride treatments increased the concentration of phosphorus in leaflet tissue by similar amounts, but the increases may not be suficiently large to be of practical significance.

Ammonium chloride decreased the concentration of potassium in leaflet tissue while urea increased leaflet potassium.

Upto a rate of 3kg/palm/yr of ammonium chloride, the concentration of calcium in the leaflet tissue was increased, above this rate the calcium concentration came down. Urea had no effect on the concentration of calcium in leaflet tissue.

Table 18. Effect of ammonium chloride treatments on leaflet nutrient concentrations in 1992 (Trial 117).

Nitrogen application level	%N		%P		%K		%Ca		%Mg		%Cl	
	AC	urea	AC	urea	AC	urea	AC	urea	AC	urea	AC	urea
0	1.98	1.96	0.134	0.134	0.74	0.73	0.92	0.89	0.17	0.16	0.39	0.30
1	2.13	2.04	0.142	0.134	0.71	0.75	0.96	0.83	0.17	0.14	0.48	0.26
2	2.08	2.10	0.141	0.138	0.66	0.77	1.06	0.87	0.17	0.14	0.53	0.22
3	2.09	2.13	0.140	0.140	0.64	0.82	1.01	0.90	0.14	0.14	0.52	0.20
4	2.16	2.16	0.143	0.143	0.70	0.80	0.96	0.93	0.14	0.14	0.52	0.21
linear Response	0.003	<.001	0.001	<.001	0.005	0.017	0.015	ns	0.011	0.002	<.001	<.001
Quadratic Resp.	ns	ns	ns	ns	0.017	ns	0.005	ns	ns	ns	0.035	ns
cv%	4.7	4.7	3.2	2.9	6.8	8.8	6.3	10.6	10.7	11.2	15.0	16.9

Both ammonium chloride and urea treatments decreased the concentration of magnesium in leaflet tissue. Urea decreased the leaflet magnesium at lower application rates.

The concentration of chlorine in leaflet tissue was increased by ammonium chloride application and decreased by urea.

Both ammonium chloride and urea treatments increased bunch dry matter production, but ammonium chloride did so to a much greater degree (Table 19).

Ammonium chloride increased frond and vegetative dry matter production, whereas urea decreased frond and vegetative dry matter production.

Ammonium chloride increased total dry matter production.

Urea because of the reduction in vegetative dry matter production, increased the bunch index.

Table 19. Effect of fertiliser treatments on estimated biomass production in 1992 (Trial 117).

Nitrogen application level	FDM (t/ha/yr)		BDM (t/ha/yr)		VDM (t/ha/yr)		TDM (t/ha/yr		Bunch index	
	AC	urea	AC	urea	AC	urea	AC	urea	AC	urea
0	13.5	13.4	17.7	16.7	16.9	16.7	34.6	33.4	0.51	0.50
1	14.8	13.6	19.3	17.8	18.6	17.0	37.9	34.8	0.51	0.51
2	14.3	13.0	20.0	19.1	18.1	16.6	38.0	35.7	0.53	0.53
3	15.0	12.9	21.1	19.7	19.0	16.5	40.1	36.2	0.52	0.55
4	15.1	11.0	20.6	19.5	19.1	14.4	39.7	33.8	0.52	0.60
linear Response	0.011	ns	0.002	0.023	0.005	ns	<.001	ns	ns	0.044
Quadratic Resp.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
cv%	8.5	22.8	10.3	14.7	8.0	19.5	7.9	10.3	4.6	15.5

Trial 118 **SYSTEMATIC NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.**

PURPOSE

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

DESCRIPTION

Site Kumbango Plantation, Field B9.

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

Palms Dami commercial DxP crosses.
Planted in 1977 at 120 palms/ha.
Treatments started in April 1987.

DESIGN

Five rates of ammonium chloride are compared in systematically increasing equal steps (the ladder design) (Table 20). A set of rates (ie one replicate) abuts a second set, but with the direction of increase opposite in the two sets. There are 28 plots made up from four replicates and seven rates (levels). Within each replicate the zero rate (level 0) occupies three adjacent plots, and the other rates (levels 1,2,3, & 4) occupy one plot each. One plot consists of two rows of palms on each side of a harvesting path (twin-row) and containing about 33 palms. There are no guard rows between levels but the row ends are guarded.

Table 20. Rates of fertiliser used in Trial 118.

	Level						
	0	0	0	1	2	3	4
	(kg /palm/year)						
Ammonium chloride	0.0	0.0	0.0	1.5	3.0	4.5	6.0

Annual fertiliser applications are split into two applications per year.

Trial fertiliser application commenced in April 1987.

RESULTS

The yield in this trial is low, the average plot yield is 19.4 t FFB/ha/yr.

Ammonium chloride significantly increased the yield. In 1992, the yield increase was largely due to an increase in the number of bunches produced (Table 21). In the cumulative data of 1990 to 1992, an increase in single bunch weight was more prominent (Table 21).

Table 21. The effects of fertiliser treatments on yield and yield components for 1990 and 1990 to 1992 (Trial 118).

	1992			1990 to 1992		
Ammonium chloride level	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
0	18.0	678	26.6	22.0	918	23.9
1	20.4	737	27.8	23.2	918	25.3
2	19.0	691	27.5	23.6	947	24.9
3	20.4	768	26.5	23.9	943	25.4
4	21.9	778	28.1	23.3	926	25.2
linear response	0.018	0.045	ns	0.009	ns	0.028
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	13.7	12.6	6.5	5.4	5.5	4.8

Ammonium chloride increased the leaflet concentration of nitrogen from 2.31% to a maximum of 2.39% with an application of 4.5kg AC/palm/yr (Table 22). This increase although significant and equivalent to other trials in West New Britain was smaller than the responses seen on mainland PNG.

Ammonium chloride appeared to decrease the concentration of potassium in leaflet tissue, though this effect was not statistically significant. However, ammonium chloride did significantly decrease the ratio of potassium to total bases (Ca+K+Mg).

The concentrations of calcium and magnesium in leaflet tissue were decreased by ammonium chloride application.

Ammonium chloride application increased the concentration of chlorine in the leaflet tissue.

Ammonium chloride increased bunch dry matter production and total dry matter production, but did not change the bunch index (Table 23).

Table [illegible]. The effects of fertiliser treatments on leaflet nutrient concentrations in 1992 (Trial 118).

Ammonium chloride level	Frond 17 leaflet nutrient concentrations (% of dry matter)					
	N	P	K	Ca	Mg	Cl
0	2.31	0.141	0.79	0.78	0.15	0.29
1	2.36	0.145	0.79	0.82	0.15	0.36
2	2.38	0.144	0.76	0.81	0.13	0.33
3	2.39	0.144	0.74	0.92	0.13	0.36
4	2.37	0.145	0.75	0.89	0.13	0.39
linear response	0.014	ns	ns	0.005	0.015	<.001
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	2.4	2.8	9.3	10.4	10.2	11.1

Table 23. The effects of fertiliser treatments on estimated biomass production in 1992 (Trial 118).

Ammonium chloride level	FDM (t/ha/yr)	BDM (t/ha/yr)	VDM (t/ha/yr)	TDM (t/ha/yr)	Bunch index
0	14.0	14.8	17.2	31.9	0.46
1	14.2	16.8	17.6	34.4	0.49
2	14.5	15.5	17.9	33.4	0.47
3	15.0	16.7	18.5	35.2	0.47
4	14.3	18.0	17.9	35.9	0.50
linear response	ns	0.018	ns	0.009	ns
quadratic resp.	ns	ns	ns	ns	ns
cv%	6.4	13.7	5.9	7.8	7.2

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 24), 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 24. 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+S+Mg (11)
Ammonium chloride	N+Cl (4)	N+Cl+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

Yields in 1992 were high, the average plot yield was 33.9 t FFB/ha/yr.

The overall treatment effect on yield and yield components was not significant. However, partitioning of the treatment variance did show some significant effects.

Muriate of potash in presence or absence of nitrogen fertilisers increased the yield in 1992 (Table 25) and in the cumulative yield for 1990 to 1992. This increase in yield was largely due to an increase in single bunch weight.

Kieserite in the presence of nitrogen fertiliser appeared to increase yield.

Nitrogen fertilisers alone had no effect on yield.

Table 25. Effect of fertiliser treatments on yield and yield components in 1992 and 1990 to 1992 (Trial 119).

		1992			1990 to 1992		
	Treatment	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)
1	Nil	32.1	2303	13.9	29.7	2630	11.3
2	DAP	33.8	2507	13.6	29.7	2700	11.0
3	SoA	32.7	2401	13.7	29.9	2753	10.8
4	AC	32.2	2178	14.8	30.0	2530	11.9
5	MoP	37.2	2367	15.8	32.2	2609	12.4
6	MoP + DAP	34.9	2267	15.4	32.0	2649	12.1
7	MoP + SoA	36.9	2511	14.8	32.6	2739	11.9
8	MoP + AC	32.9	2128	15.5	31.2	2525	12.4
9	Kies	32.9	2266	14.6	28.5	2401	11.8
10	Kies + DAP	35.2	2366	14.9	31.8	2607	11.9
11	Kies + SoA	32.1	2233	14.4	29.6	2572	11.5
12	Kies + AC	34.3	2180	15.8	31.5	2576	12.3
	cv%	8.5	9.4	5.2	7.5	8.5	4.5
	sed	2.079	157	0.560	1.661	161	0.379

The combination of kieserite and nitrogen fertiliser, increased the leaflet concentration of nitrogen more than nitrogen fertilisers alone (Table 26).

In the absence of base fertilisers (muriate of potash or kieserite), the nitrogen fertilisers reduced the concentration of potassium in the leaflet tissue. In the presence of the base fertilisers this effect was not seen, this was because the concentration of potassium in the leaflets of the "nil N fertiliser" treatment were also decreased.

In the absence of base fertilisers, the ammonium chloride treatments increased the concentration of calcium in the leaflet tissue. The treatments containing muriate of potash increased the concentration of calcium in the leaflet tissue. The increase in leaflet calcium is probably a consequence of chloride application in the fertiliser materials.

Table 26. Effect of fertiliser treatments on leaflet nutrient concentrations in 1992 (Trial 119).

		Frond 17 leaflet nutrient concentrations (% of dry matter)					
	Treatment	N	P	K	Ca	Mg	Cl
1	Nil	2.53	0.156	0.97	1.02	0.17	0.15
2	DAP	2.58	0.159	0.92	0.97	0.17	0.16
3	SoA	2.58	0.155	0.89	0.95	0.15	0.26
4	AC	2.58	0.159	0.82	1.05	0.16	0.53
5	MoP	2.58	0.155	0.82	1.07	0.15	0.55
6	MoP + DAP	2.63	0.161	0.87	1.03	0.15	0.50
7	MoP + SoA	2.58	0.154	0.82	1.10	0.15	0.57
8	MoP + AC	2.61	0.154	0.81	1.03	0.15	0.46
9	Kies	2.54	0.155	0.89	1.02	0.19	0.19
10	Kies + DAP	2.65	0.160	0.90	0.98	0.19	0.20
11	Kies + SoA	2.63	0.158	0.91	0.98	0.17	0.30
12	Kies + AC	2.66	0.157	0.88	0.99	0.19	0.47
	cv%	2.3	1.8	8.0	6.3	10.1	32.7
	sed	0.042	0.002	0.049	0.045	0.012	0.084

The concentration of magnesium in leaflet tissue was increased by kieserite application.

The application of muriate of potash decreased the concentration of magnesium in leaflet tissue.

Application of diammonium phosphate increased the concentration of phosphorus in leaflet tissue.

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

Table 27. Effect of fertiliser treatments on estimated biomass production in 1992 (Trial 119).

	Treatment	FDM (t/ha/yr)	BDM (t/ha/yr)	VDM (t/ha/yr)	TDM (t/ha/yr)	Bunch index
1	Nil	14.0	26.3	18.5	44.7	0.59
2	DAP	14.0	27.6	18.6	46.2	0.60
3	SoA	13.8	27.1	18.3	45.3	0.60
4	AC	13.5	26.3	17.9	44.2	0.59
5	MoP	13.5	30.4	18.4	48.8	0.62
6	MoP + DAP	14.2	28.6	18.9	47.5	0.60
7	MoP + SoA	14.3	30.0	19.2	49.2	0.61
8	MoP + AC	14.6	27.2	19.3	46.4	0.59
9	Kies	12.9	27.0	17.3	44.4	0.61
10	Kies + DAP	13.7	28.7	18.4	47.1	0.61
11	Kies + SoA	13.6	26.8	18.1	44.9	0.60
12	Kies + AC	13.9	28.0	18.5	46.5	0.60
	cv%	5.5	8.4	5.0	6.2	3.3
	sed	0.543	1.656	0.658	2.026	0.014

Kieserite application increased the frond dry matter production (Table 27).

Muriate of potash in the presence of nitrogen increased frond and vegetative dry matter production, and in the presence and absence of nitrogen fertilisers increased the total dry matter production. Muriate of potash in the absence of nitrogen fertilisers increased the bunch index.

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 28), 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 28. 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+S+Mg (11)
Ammonium chloride	N+Cl (4)	N+Cl+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

Yields in this trial are high. The average plot yield in 1992 was 29.4 t FFB/ha/yr.

The 1992 yield data showed no significant treatment effects.

The cumulative data for 1990 to 1992 showed that kieserite in the absence of nitrogen fertilisers increased the yield (Table 29). This effect was largely due to an increase in the numbers of bunches produced.

Table 29. Effect of fertiliser treatments on yield and yield components in 1992 and 1990 to 1992 (Trial 120).

	Treatment	1992			1990 to 1992		
		Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
1	Nil	30.0	1484	20.1	29.0	1808	16.0
2	DAP	27.8	1453	19.3	28.9	1836	15.8
3	SoA	28.4	1379	20.7	27.6	1720	16.0
4	AC	30.7	1445	21.3	29.8	1791	16.7
5	MoP	32.1	1531	21.1	29.8	1869	16.1
6	MoP + DAP	30.5	1464	21.0	30.6	1825	16.8
7	MoP + SoA	26.7	1372	19.4	29.7	1936	15.4
8	MoP + AC	31.1	1565	19.9	32.6	2006	16.3
9	Kies	30.0	1531	19.7	32.8	1996	16.5
10	Kies + DAP	29.6	1531	19.4	29.8	1920	15.6
11	Kies + SoA	27.1	1377	19.7	30.4	1930	15.7
12	Kies + AC	28.3	1385	20.6	31.3	1912	16.4
	cv%	13.7	13.9	8.4	7.8	8.3	6.9
	sed	2.868	145	1.212	1.687	112	0.799

The concentration of calcium in leaflet tissue was decreased by the application of kieserite in the presence of nitrogen fertilisers (Table 30).

Application of chlorine containing fertilisers increased the concentration of chlorine in leaflet tissue.

Treatments containing nitrogen fertiliser increased the frond and vegetative dry matter production (Table 31).

In the presence of nitrogen fertiliser, muriate of potash increased the frond and vegetative dry matter production.

Ammonium chloride application increased frond and vegetative dry matter production more than diammonium phosphate or sulphate of ammonia.

Table 30. Effect of fertiliser treatments on leaflet nutrient concentrations in 1992 (Trial 120).

		Frond 17 leaflet nutrient concentrations (% of dry matter)					
	Treatment	N	P	K	Ca	Mg	Cl
1	Nil	2.35	0.146	0.79	0.81	0.13	0.39
2	DAP	2.38	0.149	0.80	0.86	0.15	0.45
3	SoA	2.32	0.144	0.77	0.80	0.11	0.39
4	AC	2.40	0.149	0.79	0.87	0.13	0.47
5	MoP	2.35	0.146	0.73	0.84	0.13	0.47
6	MoP + DAP	2.36	0.147	0.80	0.85	0.13	0.48
7	MoP + SoA	2.38	0.146	0.75	0.83	0.12	0.49
8	MoP + AC	2.35	0.146	0.71	0.83	0.12	0.51
9	Kies	2.35	0.146	0.79	0.82	0.14	0.39
10	Kies + DAP	2.40	0.147	0.76	0.75	0.12	0.34
11	Kies + SoA	2.33	0.145	0.78	0.76	0.13	0.42
12	Kies + AC	2.41	0.145	0.75	0.79	0.13	0.43
	cv%	2.5	2.1	8.3	8.7	14.2	10.6
	sed	0.042	0.002	0.045	0.050	0.013	0.032

Table 31. Effect of fertiliser treatments on estimated biomass production in 1992 (Trial 120).

	Treatment	FDM (t/ha/yr)	BDM (t/ha/yr)	VDM (t/ha/yr)	TDM (t/ha/yr)	Bunch index
1	Nil	14.4	24.6	18.7	43.3	0.56
2	DAP	15.4	22.8	19.6	42.4	0.54
3	SoA	15.2	23.5	19.5	43.0	0.55
4	AC	17.3	25.2	22.0	47.1	0.53
5	MoP	15.7	26.4	20.3	46.7	0.56
6	MoP + DAP	16.6	25.0	21.2	46.2	0.54
7	MoP + SoA	16.8	21.8	21.1	42.9	0.51
8	MoP + AC	16.7	25.5	21.4	46.9	0.55
9	Kies	15.2	24.5	19.6	44.1	0.55
10	Kies + DAP	15.8	24.2	20.2	44.4	0.54
11	Kies + SoA	16.0	22.2	20.2	42.5	0.52
12	Kies + AC	16.5	23.2	20.9	44.0	0.53
	cv%	8.5	13.5	8.0	9.5	5.8
	sed	0.959	2.289	1.150	2.971	0.022

Trial 201 FACTORIAL FERTILISER TRIAL AT HARGY PLANTATION.

PURPOSE

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

DESCRIPTION

Site Hargy Plantation, Blocks 4,6 and 8.

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

Palms I.R.H.O. commercial DxP crosses.
Planted in 1973 at 115 palms/ha.
Treatments started in June 1982.

DESIGN

There are 81 treatments comprising all factorial combinations of N, P, K and Mg each at three levels (Table 32). Fertilisers are applied twice yearly.

Table 32. Rates of fertiliser used in Trial 201.

	June 92 - Dec 90 Level			From Jan 91 Level		
	0	1	2	0	1	2
	(kg/palm/year)			(kg/palm/year)		
Sulphate of ammonia	0.0	1.0	2.0	0.0	3.0	6.0
Triple superphosphate	0.0	0.8	1.6	0.0	2.0	4.0
Muriate of potash	0.0	1.0	2.0	0.0	1.5	3.0
Kieserite	0.0	1.0	2.0	0.0	1.5	3.0

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

There are 81 plots, each consisting of 36 palms (6x6) of which the central 16 are recorded.

The 81 treatments are replicated only once and are divided among three blocks. High order interactions provide the error term in the statistical analysis.

Prior to October 1986, potassium was applied as bunch ash at rates of 0.0, 1.5 and 3.0 kg/palm/year.

In 1991 the fertiliser application rates were increased.

RESULTS

Yields in this trial are low, the average plot yield in 1992 was 20.9 t FFB/ha/yr.

Application of triple superphopshate increased the yield in 1992 (Table 33) and in the cumulative data for 1990 to 1992 (Table 34). This increase in yield was due to increases in the numbers of bunches produced and single bunch weight.

Muriate of potash increased the single bunch weight but reduced the number of bunches produced.

In 1992, the higher rate of kieserite increased the number of bunches produced. The kieserite response had a large quadratic component.

Table 33. Main effects of N, P, K and Mg on yield and yield components in 1992 (Trial 201).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	21.4	20.4	20.9		0.752	13.2
Bunches/ha	1557	1464	1561		66.7	16.1
Bunch weight (kg)	14.2	14.3	13.6		0.548	14.4
	P0	P1	P2			
Yield (t/ha/yr)	19.7	20.7	22.2	**	0.752	13.2
Bunches/ha	1423	1590	1568	*	66.7	16.1
Bunch weight (kg)	14.3	13.2	14.6	*	0.548	14.4
	K0	K1	K2			
Yield (t/ha/yr)	20.6	21.6	20.5		0.752	13.2
Bunches/ha	1613	1540	1429	*	66.7	16.1
Bunch weight (kg)	12.9	14.5	14.7	**	0.548	14.4
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	20.8	20.1	21.7		0.752	13.2
Bunches/ha	1539	1422	1621	*	66.7	16.1
Bunch weight (kg)	13.9	14.6	13.7		0.548	14.4

Table 34. Main effects of N, P, K and Mg on yield and yield components for 1990 to 1992 (Trial 201).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	19.9	19.6	20.8		0.746	13.6
Bunches/ha	1102	1059	1138		41.4	13.8
Bunch weight (kg)	18.3	18.7	18.3		0.446	8.9
	P0	P1	P2			
Yield (t/ha/yr)	18.8	20.3	21.2	**	0.746	13.6
Bunches/ha	1029	1133	1137	*	41.4	13.8
Bunch weight (kg)	18.4	18.1	18.8		0.446	8.9
	K0	K1	K2			
Yield (t/ha/yr)	19.8	20.4	20.2		0.746	13.6
Bunches/ha	1126	1102	1072		41.4	13.8
Bunch weight (kg)	17.6	18.7	19.0	**	0.446	8.9
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	20.1	19.5	20.7		0.746	13.6
Bunches/ha	1096	1056	1147		41.4	13.8
Bunch weight (kg)	18.5	18.6	18.2		0.446	8.9

Application of sulphate of ammonia increased the concentration of nitrogen and phosphorus in the leaflet tissue (Table 35).

Triple superphosphate increased the concentrations of phosphorus, calcium and magnesium in the leaflet tissue.

The concentrations of potassium and chlorine were decreased by application of triple superphosphate.

Muriate of potash increased the concentrations of calcium and chlorine in leaflet tissue.

Kieserite increased the concentration of magnesium in leaflet tissue, but this effect has a significant quadratic component. Even at the highest kieserite application rate, the concentration of magnesium in the leaflet tissue is very low.

Kieserite decreased the concentration of calcium in leaflet tissue.

The reason for the yield response to application of triple superphosphate is not clear. Sulphate of ammonia had a similar effect on the concentration of phosphorus in the leaflets as triple superphosphate but it did not produce the yield response. Triple superphosphate increased the very low concentration of magnesium in leaflets, but so did kieserite without producing the yield response. This result suggests we should question the usefulnes of phosphorus analysis in leaflet tissue as an indicator of crop phosphorus status.

Table 35. **Main effects of N, P, K and Mg on leaflet nutrient concentrations in 1992** (Trial 201).

Element (% of dry matter)	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.24	2.29	2.35	***	0.018	2.9
Phosphorus	0.140	0.143	0.144	**	0.001	3.0
Potassium	0.76	0.76	0.79		0.021	10.2
Calcium	0.85	0.84	0.84		0.017	7.2
Magnesium	0.11	0.10	0.11		0.004	13.8
Chlorine	0.27	0.27	0.28		0.009	11.5
	P0	P1	P2			
Nitrogen	2.28	2.28	2.32		0.018	2.9
Phosphorus	0.139	0.143	0.145	***	0.001	3.0
Potassium	0.80	0.76	0.75	*	0.021	10.2
Calcium	0.84	0.82	0.88	*	0.017	7.2
Magnesium	0.10	0.11	0.11	*	0.004	13.8
Chlorine	0.28	0.27	0.26	*	0.009	11.5
	K0	K1	K2			
Nitrogen	2.31	2.29	2.28		0.018	2.9
Phosphorus	0.144	0.142	0.142		0.001	3.0
Potassium	0.79	0.77	0.76		0.021	10.2
Calcium	0.82	0.85	0.87	**	0.017	7.2
Magnesium	0.11	0.11	0.10		0.004	13.8
Chlorine	0.21	0.29	0.32	***	0.009	11.5
	Mg0	Mg1	Mg2			
Nitrogen	2.30	2.30	2.30		0.018	2.9
Phosphorus	0.143	0.143	0.141		0.001	3.0
Potassium	0.76	0.80	0.75		0.021	10.2
Calcium	0.87	0.86	0.80	***	0.017	7.2
Magnesium	0.10	0.11	0.11	*	0.004	13.8
Chlorine	0.27	0.28	0.27		0.009	11.5

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

Navo Plantation, Area 8, Blocks 10 and 11.

Very young coarse textured freely draining soils formed on airfall volcanic scoria.

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 36).

Table 36. 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

Average plot yields in this trial in 1992 were 20.6 t FFB/ha/yr. 1992 was the first year that harvested crop was recorded by OPRA.

In 1992, yield was increased by application of ammonium chloride (Table 37). The increase in yield was due to an increase in single bunch weight and the numbers of bunches produced.

Muriate of potash increased the yield, largely by increasing the number of bunches produced.

Table 37. Main effects of N, P, K and Mg on yield and yield components in 1992 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	18.6	21.0	22.3	***	0.807	13.6
Bunches/ha	1558	1617	1753	**	50.1	10.6
Bunch weight (kg)	11.9	13.0	12.8	**	0.295	8.2
	P0	P1	P2			
Yield (t/ha/yr)	21.3	20.7	19.9		0.807	13.6
Bunches/ha	1670	1630	1627		50.1	10.6
Bunch weight (kg)	12.8	12.6	12.2		0.295	8.2
	K0	K1				
Yield (t/ha/yr)	19.9	21.4		*	0.659	13.6
Bunches/ha	1580	1705		**	40.9	10.6
Bunch weight (kg)	12.5	12.6			0.241	8.2
	Mg0	Mg1				
Yield (t/ha/yr)	20.4	20.8			0.659	13.6
Bunches/ha	1635	1650			40.9	10.6
Bunch weight (kg)	12.5	12. 58			0.241	8.2

Ammonium chloride increased tne concentration of nitrogen in leaflet (Table 38) and rachis tissue (Table 39).

Ammonium chloride increased the concentrations of phosphorus in leaflet tissue, but not in rachis tissue. The concentrations of calcium in the rachis tissue and chlorine in rachis and leaflet tissue were also increased by ammonium chloride.

Table 38. Treatment main effects on leaflet nutrient concentrations in 1992 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.46	2.58	2.60	***	0.022	3.0
Phosphorus	0.146	0.149	0.149	**	0.001	2.5
Potassium	0.85	0.75	0.78	***	0.026	11.5
Calcium	0.87	0.89	0.89		0.005	9.1
Magnesium	0.23	0.20	0.19	***	0.023	11.1
Chlorine	0.31	0.44	0.45	***	0.007	15.6
	P0	P1	P2			
Nitrogen	2.55	2.53	2.56		0.022	3.0
Phosphorus	0.147	0.149	0.149	*	0.001	2.5
Potassium	0.81	0.78	0.80		0.026	11.5
Calcium	0.89	0.88	0.89		0.005	9.1
Magnesium	0.21	0.21	0.20		0.023	11.1
Chlorine	0.42	0.41	0.39		0.007	15.6
	K0	K1				
Nitrogen	2.53	2.56			0.018	3.0
Phosphorus	0.148	0.149			0.001	2.5
Potassium	0.80	0.79			0.021	11.5
Calcium	0.85	0.92		**	0.019	9.1
Magnesium	0.21	0.20			0.005	11.1
Chlorine	0.36	0.45		***	0.015	15.6
	Mg0	Mg1				
Nitrogen	2.56	2.54			0.018	3.0
Phosphorus	0.149	0.148			0.001	2.5
Potassium	0.80	0.79			0.021	11.5
Calcium	0.89	0.88			0.019	9.1
Magnesium	0.20	0.21			0.005	11.1
Chlorine	0.40	0.41			0.015	15.6

Ammonium chloride decreased the concentration of magnesium in leaflet tissue but increased magnesium in the rachis.

Triple superphosphate increased the concentration of phosphorus in the leaflet and rachis tissue. Although this increase was significant, it was very small.

Muriate of potash had no effect on the concentration of potassium in leaflet tissue, however it did increase the potassium in the rachis. As there was a yield reponse to muriate of potash it would appear that the rachis analysis of potassium would be a better predictor of potassium fertiliser response than leaflet analysis. Chlorine, the other element significantly increased in rachis and leaflet tissue by application of muriate of potash appeared to be at an adequate concentration even in the control.

Muriate of potash increased the concentration of calcium in leaflet and rachis tissue, and increased the concentration of phosphorus in the rachis, although this increase was very small.

Kieserite increased the concentration of potassium in the rachis tissue.

Table 39. Treatment main effects on rachis nutrient concentrations in 1992 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.25	0.27	0.27	***	0.005	6.8
Phosphorus	0.074	0.069	0.066		0.004	14.5
Potassium	1.33	1.32	1.29		0.046	12.2
Calcium	0.37	0.46	0.46	***	0.014	11.1
Magnesium	0.052	0.065	0.063	***	0.002	13.2
Chlorine	0.24	0.54	0.55	***	0.028	21.9
	P0	P1	P2			
Nitrogen	0.26	0.26	0.27		0.005	6.8
Phosphorus	0.054	0.074	0.080	***	0.004	14.5
Potassium	1.28	1.33	1.32		0.046	12.2
Calcium	0.43	0.42	0.44		0.014	11.1
Magnesium	0.06	0.06	0.06		0.002	13.2
Chlorine	0.49	0.43	0.46		0.028	21.9
	K0	K1				
Nitrogen	0.26	0.27			0.004	6.8
Phosphorus	0.065	0.074		*	0.003	14.5
Potassium	1.21	1.41		***	0.038	12.2
Calcium	0.42	0.46		*	0.011	11.1
Magnesium	0.06	0.06			0.002	13.2
Chlorine	0.33	0.56		***	0.023	21.9
	Mg0	Mg1				
Nitrogen	0.26	0.26			0.004	6.8
Phosphorus	0.066	0.073			0.003	14.5
Potassium	1.27	1.35		*	0.038	12.2
Calcium	0.43	0.43			0.011	11.1
Magnesium	0.06	0.06			0.002	13.2
Chlorine	0.44	0.45			0.023	21.9

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 40).

Table 40. 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 fertilisers.

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

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 yield data presented (Table 41), represents only one years recording and so caution should be used when interpreting the data.

FFB yield was increased by application of muriate of potash in the twelve months from July 1992 to June 1993. This increase was due to increases in single bunch weight and the number of bunches produced.

Sulphate of ammonia application appeared to decrease the yield, though this effect was not statistically significant. Leaflet nitrogen concentrations are relatively high in these trials and are typical of the nitrogen concentrations seen in the routine estate leaflet analyses. The relatively high concentration of nitrogen in leaflet tissue and lack of yield response to sulphate of ammonia application suggest that nitrogen fertiliser input to the Poliamba Estates could be discontinued for the time being.

Trial 252 produced more but smaller bunches than trial 251. This is probably due to the younger age of palms in trial 252.

Muriate of potash increased the concentration of potassium in leaflet and rachis tissue (Table 42 and Table 43). This effect contrasts markedly with the OPRA trials located on the volcanic soils in the Island Provinces where muriate of potash does not change or may decrease the concentration of potassium in leaflet tissue, even though the concentration of potassium in the rachis tissue increases. The concentration of potassium in leaflet tissue is low but the concentration of potassium in rachis tissue (which seems a better indicator of potassium fertiliser response in the islands region) is extremely low compared to other OPRA trials in this region.

Muriate of potash decreased the concentration of magnesium in both leaflet and rachis tissue, increased the concentration of chlorine in the leaflet and rachis tissue, and increased the concentration of nitrogen and phosphorus in the rachis tissue.

Table 41. Main effects of N, P, K and Mg on yield and yield components for the twelve months from July 1992 to June 1993 (Trials 251 and 252).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	18.2	16.8	16.7		0.917	18.1
Bunches/ha	2769	2616	2557		134.3	17.3
Bunch weight (kg)	6.6	6.4	6.5		0.139	7.3
	K0	K1	K2			
Yield (t/ha)	16.2	17.1	18.4	*	0.902	18.1
Bunches/ha	2577	2596	2768		132.2	17.3
Bunch weight (kg)	6.3	6.6	6.6	*	0.137	7.3
	P0	P1				
Yield (t/ha)	16.8	17.7			0.737	18.1
Bunches/ha	2552	2742			108.0	17.3
Bunch weight (kg)	6.6	6.4			0.112	7.3
	Mg0	Mg1				
Yield (t/ha)	17.2	17.3			0.735	18.1
Bunches/ha	2669	2625			107.7	17.3
Bunch weight (kg)	6.4	6.6			0.111	7.3
	Trial 251	Trial 252				
Yield (t/ha)	16.6	17.8			0.933	18.1
Bunches/ha	2458	2836		*	136.8	17.3
Bunch weight (kg)	6.8	6.3		**	0.142	7.3

Sulphate of ammonia increased the concentration of nitrogen in leaflet tissue but did not change the concentration of nitrogen in the rachis.

Triple superphosphate increased the concentration of nitrogen and phosphorus in leaflet tissue.

Kieserite increased the concentration of chlorine in rachis tissue.

Table 42. **Treatment main effects on leaflet nutrient concentrations** in 1992 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.77	2.82	2.83	*	0.027	3.4
Phosphorus	0.167	0.166	0.166		0.001	3.0
Potassium	0.87	0.86	0.89		0.018	7.3
Calcium	1.33	1.29	1.33		0.028	7.3
Magnesium	0.31	0.31	0.30		0.010	11.4
Chlorine	0.62	0.63	0.64		0.012	6.7
	K0	K1	K2			
Nitrogen	2.78	2.82	2.82		0.027	3.4
Phosphorus	0.167	0.166	0.166		0.001	3.0
Potassium	0.84	0.88	0.91	***	0.018	7.3
Calcium	1.28	1.34	1.34		0.028	7.3
Magnesium	0.33	0.30	0.29	***	0.010	11.4
Chlorine	0.59	0.64	0.66	***	0.012	6.7
	P0	P1				
Nitrogen	2.78	2.83		*	0.022	3.4
Phosphorus	0.165	0.168		*	0.001	3.0
Potassium	0.86	0.89			0.015	7.3
Calcium	1.32	1.32			0.023	7.3
Magnesium	0.31	0.31			0.008	11.4
Chlorine	0.62	0.64			0.010	6.7
	Mg0	Mg1				
Nitrogen	2.83	2.79			0.022	3.4
Phosphorus	0.167	0.166			0.001	3.0
Potassium	0.88	0.87			0.015	7.3
Calcium	1.33	1.31			0.023	7.3
Magnesium	0.30	0.31			0.008	11.4
Chlorine	0.63	0.62			0.010	6.7
	Trial 251	Trial 252				
Nitrogen	2.86	2.75		***	0.022	3.4
Phosphorus	0.173	0.163		***	0.001	3.0
Potassium	0.86	0.89			0.015	7.3
Calcium	1.30	1.34			0.023	7.3
Magnesium	0.31	0.30			0.008	11.4
Chlorine	0.60	0.66		***	0.010	6.7

Table 43. **Treatment main effects on rachis nutrient concentrations in 1992 (Trial 251 and Trial 252).**

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.30	0.30	0.30		0.004	5.1
Phosphorus	0.093	0.081	0.085		0.005	19.9
Potassium	1.21	1.21	1.26		0.076	21.4
Calcium	0.58	0.56	0.58		0.019	11.5
Magnesium	0.13	0.12	0.12		0.008	23.8
Chlorine	0.82	0.81	0.78		0.044	18.9
	K0	K1	K2			
Nitrogen	0.29	0.30	0.31	*	0.004	5.1
Phosphorus	0.076	0.087	0.097	**	0.005	19.9
Potassium	0.97	1.23	1.49	***	0.076	21.4
Calcium	0.59	0.57	0.55		0.019	11.5
Magnesium	0.14	0.12	0.11	**	0.008	23.8
Chlorine	0.66	0.81	0.94	***	0.044	18.9
	P0	P1				
Nitrogen	0.30	0.30			0.004	5.1
Phosphorus	0.084	0.089			0.004	19.9
Potassium	1.17	1.28			0.062	21.4
Calcium	0.57	0.58			0.016	11.5
Magnesium	0.12	0.12			0.007	23.8
Chlorine	0.79	0.82			0.036	18.9
	Mg0	Mg1				
Nitrogen	0.30	0.30			0.004	5.1
Phosphorus	0.087	0.086			0.004	19.9
Potassium	1.20	1.26			0.062	21.4
Calcium	0.57	0.57			0.016	11.5
Magnesium	0.12	0.12			0.007	23.8
Chlorine	0.76	0.84		*	0.036	18.9
	Trial 251	Trial 252				
Nitrogen	0.30	0.30			0.004	5.1
Phosphorus	0.069	0.077		***	0.004	19.9
Potassium	1.23	1.23			0.062	21.4
Calcium	0.56	0.58			0.016	11.5
Magnesium	0.13	0.11		*	0.007	23.8
Chlorine	0.78	0.82			0.036	18.9

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 44).

Table 44. 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 plot yield in 1992 was 26.2 t FFB/ha/yr.

There appears to be a response to the ammonium chloride treatments developing in the trial. In 1992 ammonium chloride increased the yield (Table 45). This effect had a significant quadratic component. The yield response was due to a linear increase in single bunch weight and a statistically non-significant but strongly quadratic effect on numbers of bunches produced.

Kieserite application increased the single bunch weight but decreased the numbers of bunches produced.

Table 45. Main effects of N, P, K and Mg on yield and yield components in 1992 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	25.3	27.1	26.2	*	0.669	8.8
Bunches/ha	1861	1938	1808		57.6	10.7
Bunch weight (kg)	13.6	14.1	15.6	***	0.242	5.9
	P0	P1	P2			
Yield (t/ha/yr)	26.2	26.4	26.0		0.669	8.8
Bunches/ha	1877	1852	1878		57.6	10.7
Bunch weight (kg)	14.1	14.3	13.9		0.242	5.9
	K0	K1				
Yield (t/ha/yr)	25.7	26.7			0.562	8.8
Bunches/ha	1829	1909			48.4	10.7
Bunch weight (kg)	14.1	14.0			0.203	5.9
	Mg0	Mg1				
Yield (t/ha/yr)	26.4	26.0			0.562	8.8
Bunches/ha	1937	1801		**	48.4	10.7
Bunch weight (kg)	13.7	14.5		***	0.203	5.9

Table 46. Main effects of N, P, K and Mg on yield and yield components for 1990 to 1992 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	26.2	27.6	27.2		0.616	7.9
Bunches/ha	2259	2303	2207		50.2	7.7
Bunch weight (kg)	11.6	12.0	12.4	***	0.166	4.8
	P0	P1	P2			
Yield (t/ha/yr)	26.7	27.0	27.2		0.616	7.9
Bunches/ha	2225	2243	2300		50.2	7.7
Bunch weight (kg)	12.0	12.1	11.9		0.166	4.8
	K0	K1				
Yield (t/ha/yr)	26.5	27.5			0.516	7.9
Bunches/ha	2218	2294			42.1	7.7
Bunch weight (kg)	12.0	12.0			0.139	4.8
	Mg0	Mg1				
Yield (t/ha/yr)	27.1	26.9			0.516	7.9
Bunches/ha	2313	2200		*	42.1	7.7
Bunch weight (kg)	11.8	12.2		**	0.139	4.8

Ammonium chloride application decreased the concentration of potassium in leaflet tissue (Table 47) and increased the potassium in the rachis (Table 48). Ammonium chloride also increased the concentration of chlorine in the leaflets and rachis, and the calcium in the rachis.

Triple superphosphate increased the concentration of phosphorus in the rachis tissue but did not affect the phosphorus concentration in the leaflets. Triple superphosphate increased the concentration of calcium in the leaflets.

Muriate of potash increased the concentration of potassium in the rachis tissue but had no effect on the potassium concentration in the leaflets. Muriate of potash increased the chlorine concentration in the rachis and leaflet tissue, and increased the phosphorus and calcium in the rachis.

Table 47. Treatment main effects on leaflet nutrient concentrations in 1992 (Trial 401).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.49	2.51	2.51		0.018	2.5
Phosphorus	0.157	0.157	0.156		0.001	1.9
Potassium	0.85	0.79	0.79	*	0.023	10.0
Calcium	0.97	1.00	0.96		0.017	6.1
Magnesium	0.17	0.16	0.16		0.005	10.4
Chlorine	0.43	0.59	0.59	***	0.023	15.5
	P0	P1	P2			
Nitrogen	2.48	2.50	2.52		0.018	2.5
Phosphorus	0.156	0.157	0.158		0.001	1.9
Potassium	0.83	0.82	0.79		0.023	10.0
Calcium	0.96	0.97	1.01	**	0.017	6.1
Magnesium	0.16	0.16	0.17		0.005	10.4
Chlorine	0.51	0.54	0.56		0.023	15.5
	K0	K1				
Nitrogen	2.49	2.51			0.147	2.5
Phosphorus	0.157	0.156			0.001	1.9
Potassium	0.82	0.80			0.019	10.0
Calcium	0.97	0.99			0.014	6.1
Magnesium	0.16	0.17			0.004	10.4
Chlorine	0.50	0.57		***	0.019	15.5
	Mg0	Mg1				
Nitrogen	2.50	2.50			0.147	2.5
Phosphorus	0.157	0.156			0.001	1.9
Potassium	0.81	0.81			0.019	10.0
Calcium	0.99	0.97			0.014	6.1
Magnesium	0.16	0.17			0.004	10.4
Chlorine	0.54	0.53			0.019	15.5

Table 48. Treatment main effects on rachis nutrient concentrations in 1992 (Trial 401).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.25	0.26	0.26		0.005	7.1
Phosphorus	0.072	0.075	0.074		0.003	12.5
Potassium	1.58	1.74	1.71	*	0.052	10.7
Calcium	0.41	0.47	0.46	***	0.012	9.3
Magnesium	0.05	0.08	0.05		0.018	11.0
Chlorine	0.42	0.67	0.69	***	0.049	28.7
	P0	P1	P2			
Nitrogen	0.26	0.25	0.25		0.005	7.1
Phosphorus	0.068	0.074	0.078	***	0.003	12.5
Potassium	1.64	1.67	1.73		0.052	10.7
Calcium	0.44	0.44	0.46		0.012	9.3
Magnesium	0.05	0.07	0.05		0.018	11.0
Chlorine	0.60	0.57	0.52		0.049	28.7
	K0	K1				
Nitrogen	0.26	0.25			0.004	7.1
Phosphorus	0.068	0.079		***	0.002	12.5
Potassium	1.57	1.79		***	0.042	10.7
Calcium	0.43	0.47		***	0.010	9.3
Magnesium	0.05	0.07			0.015	11.0
Chlorine	0.49	0.70		***	0.040	28.7
	Mg0	Mg1				
Nitrogen	0.26	0.26			0.004	7.1
Phosphorus	0.073	0.074			0.002	12.5
Potassium	1.67	1.69			0.042	10.7
Calcium	0.44	0.45			0.010	9.3
Magnesium	0.05	0.07			0.015	11.0
Chlorine	0.61	0.58			0.040	28.7

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 49).

Table 49. 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	---

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.

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

Yields in this trial are high. The average plot yield in 1992 was 31.0 t FFB/ha/yr.

None of the fertiliser treatments affected the yield.

Application of ammonium chloride increased the single bunch weight in 1992 (Table 50) and in the cumulative data for 1990 to 1992 (Table 51).

In the cumulative data for 1990 to 1992, kieserite increased single bunch weight, but not yield.

Table 50. Main effects of N, P, K and Mg on yield and yield components in 1992 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	30.0	31.6	31.5		0.738	8.0
Bunches/ha	2423	2454	2436		61.9	8.5
Bunch weight (kg)	12.4	12.9	13.0	**	0.194	5.1
	P0	P1	P2			
Yield (t/ha/yr)	30.8	30.8	31.5		0.738	8.0
Bunches/ha	2448	2404	2461		61.9	8.5
Bunch weight (kg)	12.6	12.9	12.8		0.194	5.1
	K0	K1				
Yield (t/ha/yr)	30.6	31.4			0.594	8.0
Bunches/ha	2425	2450			49.9	8.5
Bunch weight (kg)	12.7	12.9			0.156	5.1
	Mg0	Mg1				
Yield (t/ha/yr)	31.1	31.0			0.594	8.0
Bunches/ha	2462	2413			49.9	8.5
Bunch weight (kg)	12.7	12.9			0.156	5.1

Table 51. Main effects of N, P, K and Mg on yield and yield components from 1991 to 1992 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	26.2	27.5	26.8		0.595	7.4
Bunches/ha	2389	2429	2348		58.2	8.2
Bunch weight (kg)	11.0	11.3	11.4	**	0.148	4.4
	P0	P1	P2			
Yield (t/ha/yr)	27.0	26.4	27.1		0.595	7.4
Bunches/ha	2432	2336	2398		58.2	8.2
Bunch weight (kg)	11.1	11.3	11.3		0.148	4.4
	K0	K1				
Yield (t/ha/yr)	26.9	26.8			0.479	7.4
Bunches/ha	2414	2363			46.9	8.2
Bunch weight (kg)	11.1	11.4			0.119	4.4
	Mg0	Mg1				
Yield (t/ha/yr)	26.7	26.9			0.479	7.4
Bunches/ha	2406	2371			46.9	8.2
Bunch weight (kg)	11.1	11.4		*	0.119	4.4

Ammonium chloride application decreased the concentration of potassium in leaflet tissue (Table 52) and increased the potassium in the rachis (Table 53).

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

Ammonium chloride increased the concentrations of phosphorus, calcium and magnesium in the rachis tissue.

Triple superphosphate increased the concentration of phosphorus in the rachis tissue but had little effect on the concentration of phosphorus in the leaflets.

Muriate of potash decreased the concentration of potassium in the leaflet tissue but increased the potassium in the rachis. Muriate of potash decreased the concentration of phosphorus in the leaflet tissue and increased the phosphorus in the rachis. Muriate of potash also increased the concentrations of calcium and magnesium in the rachis tissue.

Kieserite decreased the concentration of phosphorus in the leaflet tissue.

Table 52. **Treatment main effects on leaflet nutrient concentrations in October 1992** (Trial 402).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.56	2.60	2.59		0.020	2.7
Phosphorus	0.155	0.157	0.156		0.001	2.2
Potassium	0.85	0.81	0.79	***	0.014	6.0
Calcium	1.00	1.02	1.04		0.025	8.3
Magnesium	0.16	0.16	0.17		0.005	9.8
Chlorine	0.36	0.50	0.51	***	0.011	8.3
	P0	P1	P2			
Nitrogen	2.59	2.58	2.59		0.020	2.7
Phosphorus	0.155	0.156	0.157		0.001	2.2
Potassium	0.83	0.81	0.82		0.014	6.0
Calcium	1.03	1.00	1.04		0.025	8.3
Magnesium	0.17	0.16	0.16		0.005	9.8
Chlorine	0.45	0.46	0.45		0.011	8.3
	K0	K1				
Nitrogen	2.59	2.58			0.017	2.7
Phosphorus	0.157	0.155		*	0.001	2.2
Potassium	0.84	0.80		**	0.012	6.0
Calcium	1.01	1.03			0.020	8.3
Magnesium	0.17	0.16			0.004	9.8
Chlorine	0.40	0.50		***	0.009	8.3
	Mg0	Mg1				
Nitrogen	2.58	2.59			0.017	2.7
Phosphorus	0.157	0.155		*	0.001	2.2
Potassium	0.81	0.82			0.012	6.0
Calcium	1.03	1.01			0.020	8.3
Magnesium	0.16	0.17			0.004	9.8
Chlorine	0.45	0.46			0.009	8.3

Table 53. Treatment main effects on rachis nutrient concentrations in October 1992 (Trial 402).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.26	0.26	0.27	*	0.005	6.3
Phosphorus	0.062	0.066	0.068	*	0.002	12.1
Potassium	1.5	1.6	1.6	*	0.038	8.5
Calcium	0.46	0.49	0.51	***	0.014	9.9
Magnesium	0.045	0.055	0.052	***	0.001	9.3
Chlorine	0.3	0.52	0.58	***	0.02	14.5
	P0	P1	P2			
Nitrogen	0.26	0.26	0.26		0.005	6.3
Phosphorus	0.058	0.068	0.07	***	0.002	12.1
Potassium	1.59	1.6	1.52		0.038	8.5
Calcium	0.49	0.5	0.48		0.014	9.9
Magnesium	0.05	0.05	0.048		0.001	9.3
Chlorine	0.49	0.47	0.45		0.02	14.5
	K0	K1				
Nitrogen	0.26	0.26			0.004	6.3
Phosphorus	0.06	0.07		***	0.002	12.1
Potassium	1.46	1.68		***	0.031	8.5
Calcium	0.47	0.5		*	0.011	9.9
Magnesium	0.046	0.053		***	0.001	9.3
Chlorine	0.36	0.58		***	0.016	14.5
	Mg0	Mg1				
Nitrogen	0.26	0.26			0.004	6.3
Phosphorus	0.066	0.064			0.002	12.1
Potassium	1.57	1.57			0.031	8.5
Calcium	0.48	0.49			0.011	9.9
Magnesium	0.048	0.05			0.001	9.3
Chlorine	0.47	0.47			0.016	14.5

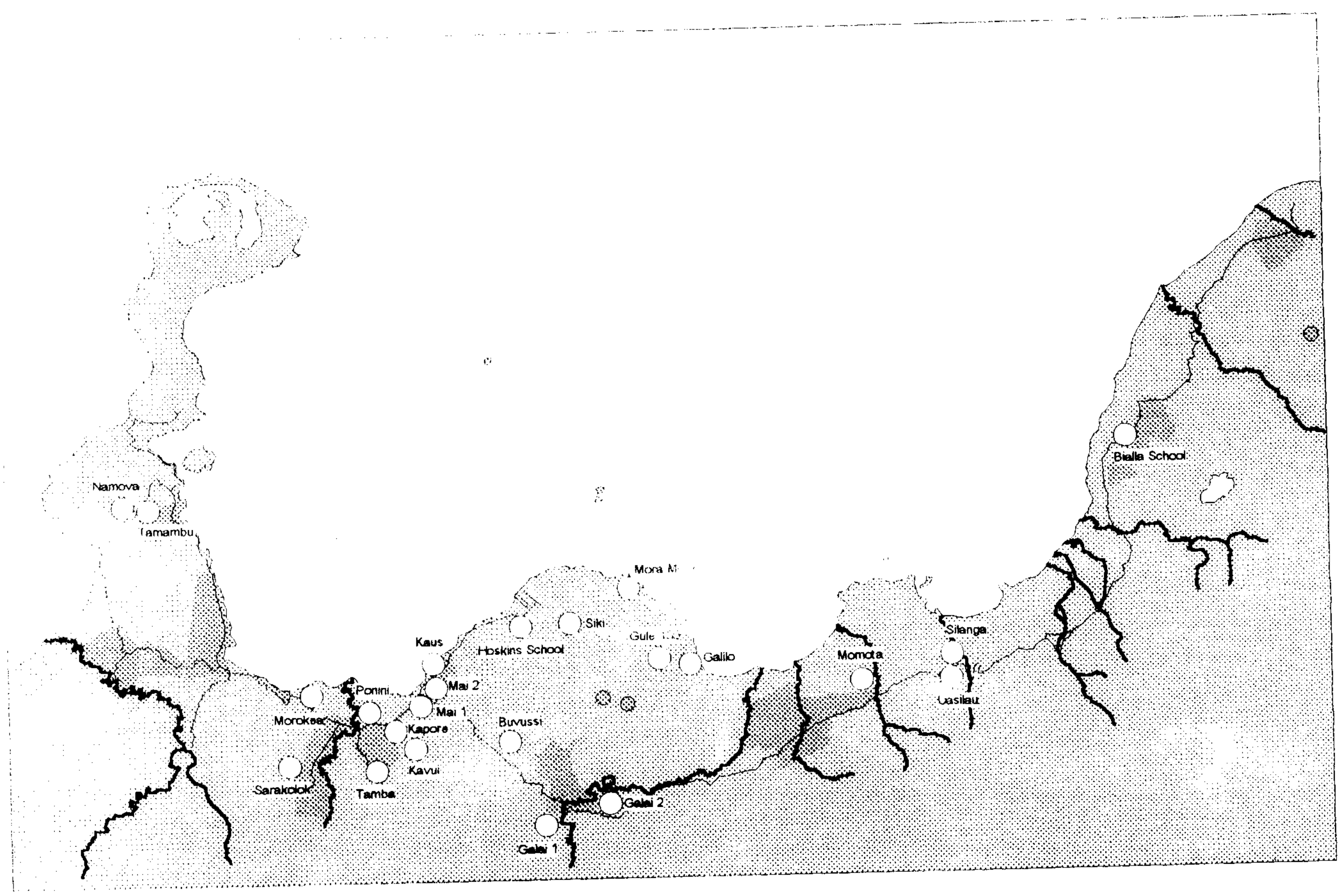
II. SMALLHOLDER DEMONSTRATION TRIALS.

WEST NEW BRITAIN PROVINCE

(P. Navus)

Fertiliser demonstration trials were continued and their number increased on selected smallholder blocks in West New Britain (Figure 1) and New Ireland Provinces.

Figure 1: Distribution of smallholder demonstration trials in West New Britain (Hoskins, Bialla and Kapiura) Oil Palm Scheme.



EXPERIMENT 112 NITROGEN AND PHOSPHATE DEMONSTRATION TRIALS.

PURPOSE

To determine why oil palm growth and yield are poor in the Buvussi Subdivision of the Hoskins Oil Palm Project, and to demonstrate that poor fertility can be alleviated by application of fertiliser. To demonstrate that use of fertiliser combined with good management can maintain or increase yields.

LOCATION AND HISTORY

In 1984 declining yield was reported to OPRA by the Oil Palm Industry Corporation (OPIC) at Hoskins. This trial was set up in Buvussi subdivision, where the soil conditions were suspected of limiting yield, on eight smallholder blocks (Figure 1, site No. 1).

DESCRIPTION

Site Buvusi subdivision, blocks 1142, 1150, 1151, 1152, 1193, 1194, 1396 & 1397.

Palms Dami commercial D X P.
Planted in 1980 at 120 palms/ha.
Treatments started in April 1986.

DESIGN

Each of the eight smallholder blocks provides a single replicate, within which are three treatments: no fertiliser (control), phosphate, and phosphate plus nitrogen (Table 54). Each plot contains 16 recorded palms, surrounded by a guard row.

Table 54. Treatments used in Trial 112.

	Amount of fertiliser (kg/palm/year)	
Treatment number	Ammonium chloride	Triple super phosphate
1	0	0
2	0	1
3	2	1

Treatments were started in April 1986 and revised in November 1988 when ammonium chloride was increased from 1kg/palm/year to 2kg/palm/year. Ammonium chloride is applied twice a year in May and November.

The yield was recorded in four months (January, April, July and October), and leaf and rachis samples (frond 17) were taken for analysis in August 1992.

RESULTS

None of the treatments had any effect on yield (Table 55) in 1992. The application of phosphorus (treatment 2), and phosphorus plus nitrogen (treatment 3), did not increase yield. The number of bunches continued to show wide variation as in 1991. Single bunch weight appears to have been increased by the application of ammonium chloride (AC) but not significantly .

It is possible that the lack of response in this trial is due to fertilizer being washed from one plot to the next and even to the next block during the wet season when surface runoff occurs. It is also possible that poaching of fertilizer would have been encouraged.

The standard of upkeep of most of the blocks in the trial has gradually fallen to less than average. One of the reason is that farmers tend to concentrate most of their management input on the bearing (replanted) palms. In this part of the block (non-trial area) palms are shorter and are easier to maintain because they are nearest to the road (pick up point) and more accessible in terms of cutting bunches and cartage.

The frequency of harvest was increased from 9 out of possible 36 in a year. However, it was not easy to do the recording of yield in the months as planned because of practical and socially related difficulties. For examples the frequency of cutting fruit by farmers following the harvest schedules were low leading to some data not recorded. Blocks 1142, 1150 and 1151 (Table 55 & 56) were screened with others (1152, 1193, 1194, 1396 & 1397) and had to be excluded when results were analysed because the information from the three blocks were not reliable.

The concentration of nitrogen and chlorine in leaflets were high in the plots that received ahmmonium chloride, and the concentrations of potassium were lower (Table 56A). The concentration of all elements except calcium were very low. In the plots that did not receive ammonium chloride the concentration of chlorine were extremely low. The concentration of chlorine that is recommended is 0.3 - 0.4%, while the average for palms on plots not receiving ammonium chloride was 0.15%.

The concentration of nitrogen and clorine in the rachis (Table 56B) is also higher in the plots that received ammonium chloride. The concentration of potassium in the rachis is higher in the rachis than the concentration in the leaflet.

The concentration of elements except calcium were lower than the recommended minimum in the Mosa area of West New Britain Province.

Table 55 Effect of fertiliser treatments on yield, number of bunches and single bunch weight on five smallholder blocks in the Buvussi area, in 1992 (Trial 112).

	Yield (t/ha/yr)			Bunches (no/ha/yr)			Single bunch weight (kg)		
	Treatment			Treatment			Treatment		
Block	1	2	3	1	2	3	1	2	3
1152	13.6	10.0	12.3	796	508	568	17.1	19.7	21.6
1194	18.8	12.8	12.2	824	640	588	22.9	20.0	20.8
1397	20.2	19.0	19.0	948	856	820	21.4	22.2	23.1
1193	13.5	16.9	13.6	788	788	584	17.2	21.5	23.3
1396	12.7	14.6	8.0	552	648	344	23.0	22.5	23.4
Mean	15.8	14.7	13.0	658	688	561	20.2	21.2	22.5
$lsd_{5\%}$		3.5			253			2.4	
cv %		16.5			27.2			7.7	

Treatment: 1 = control (no fertilizer)
2 = 1 kg TSP/palm/yr
3 = 1 kg TSP/palm/yr plus 2 AC kg/palm/yr

Table 56A. The mean effect of fertiliser treatments on the leaflets of frond 17 nutrient concentrations on five smallholder blocks in the Buvussi area in 1992 (Trial 112).

Treatment number	Nutrients applied	Leaflets nutrient content (% dry matter)					
		N	P	K	Ca	Mg	Cl
1	Nil	1.91	0.123	0.70	0.97	0.15	0.15
2	P	1.95	0.125	0.71	0.92	0.14	0.16
3	N+P	2.00	0.129	0.67	0.96	0.13	0.29
	$lsd_{5\%}$	0.104	0.005	0.050	0.061	0.021	0.039
	cv %	0.3	6.0	4.8	4.4	10.1	13.3

Table 56B The mean effect of fertilizer treatments on frond 17 rachis nutrient concentrations on five blocks in the Buvussi area in 1992 (Trial 112).

Treatment number	Nutrients applied	Rachis nutrient content (% dry matter)					
		N	P	K	Ca	Mg	Cl
1	Nil	0.20	0.046	1.18	0.49	0.03	0.07
2	P	0.20	0.052	1.11	0.44	0.04	0.07
3	N+P	0.21	0.052	1.00	0.52	0.04	0.25
	$lsd_{5\%}$	0.024	0.008	0.158	0.093	0.005	0.037
	cv %	8.0	11.0	9.9	13.2	8.8	19.1

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 the (OPIC) Hoskins Oil Palm Scheme (Figure 1, Site Nos 2-16) at Kapore, Tamambu, Tamba, Sarakolok, Buvussi, Galai 1 & 2, Siki, Namova, Morokea, 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 57). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 57. 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 results for the number of blocks in this trial was increased from seven in 1991 to eight in 1992. The results from two blocks (site 9 & 14) had to be excluded from analyses because they are unreliable.

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, but the increases were not statistically significant because the yields were rather variable (Table58A). Some blocks appeared to respond to AC (3, 4, 5, 6, 7, 10, 13, 15 & 16), some to AC plus triple superphosphate (2, 4, 5, 6, 10, 11, 12, 15 & 16), some to AC plus muriate of potash (4, 5, 10, 13, & 16), and some appeared to respond to AC plus kieserite (2, 3, 4, 5, 6, 7, 8, 10, 11, 12 & 16). Blocks 2, 8, 11 & 12 did not appear to respond to AC, blocks 3, 7, 8 & 13 did not appear to respond to triple superphosphate (TSP) and 2, 3, 6, 7, 8, 11 & 15 did not appear to respond to muriate of potash (MOP). Blocks 3, 4, 5, 6, 7, 10, & 16 responded to all treatments, blocks 3, 8, 12, & 13 had poor yields with most treatments while blocks 2, 8, 13 & 15 had good yields even without fertiliser. Blocks 3, 4, 5, 7, 10 & 16 responded to the higher level (3kg/palm/yr) of AC. Kieserite appeare to increase mean yields in most blocks but not significantly. There appears to be some benefit from applying fertiliser, however at this stage the results are not sufficient to make recommendation for fertiliser usage.

The components of yield, number of bunches and single bunch weight, showed wide variation (Table 58B & 58C), but the differences are not statistically significant. It appeared that the increase in the single bunch weight may be caused by the application of ammonium chloride and kieserite..

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 59). The concentrations of all elements, except calcium, are low. The concentration of chlorine that would be regraded as adequate is 0.3 - 0.4%, while the average for palms not receiving ammonium chloride was 0.19%. In plots that did not receive any fertiliser (treatment 1), the concentration of potassium in the leaflets is relatively high, while in plots that received fertiliser treatments, including muriate of potash, the average concentration of potassium in the leaflets was reduced. Application of kieserite had no significant effect on leaflet magnesium concentrations.

The concentrations of nitrogen and chlorine in the rachis of frond 17 (Table 60) was higher in the plots that received ammonium chloride. The concentrations of potassium however is higher in the rachis than the leaflets tissue.

Table 59A. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets on thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Nitrogen (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	2.36	2.52	2.47	2.42	2.50	2.46	2.46
3	2.30	2.35	2.33	2.35	2.42	2.42	2.36
4	2.14	2.21	2.35	2.37	2.55	2.48	2.35
5	2.18	2.30	2.38	2.28	2.40	2.39	2.32
6	2.21	2.28	2.35	2.29	2.40	2.32	2.31
7	2.26	2.35	2.43	2.32	2.38	2.39	2.36
8	2.21	2.35	2.33	2.25	2.36	2.29	2.31
10	2.14	2.26	2.29	2.26	2.33	2.32	2.26
11	2.38	2.63	2.53	2.62	2.55	2.62	2.56
12	2.13	2.23	2.40	2.18	2.36	2.20	2.25
13	2.45	2.47	2.52	2.46	2.52	2.49	2.49
15	2.33	2.38	2.38	2.40	2.26	2.42	2.36
16	2.29	2.39	2.47	2.47	2.43	2.45	2.42
Mean	2.26	2.36	2.40	2.36	2.42	2.40	2.36
$lsd_{5\%}$				0.04			
cv %				2.4			

Table 59B. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Phosphorus (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.144	0.150	0.150	0.147	0.147	0.149	0.148
3	0.140	0.143	0.144	0.139	0.144	0.144	0.142
4	0.134	0.136	0.139	0.139	0.143	0.143	0.139
5	0.136	0.140	0.149	0.141	0.147	0.143	0.143
6	0.138	0.141	0.148	0.145	0.140	0.138	0.142
7	0.138	0.140	0.148	0.140	0.145	0.149	0.143
8	0.134	0.141	0.145	0.136	0.138	0.143	0.140
10	0.131	0.134	0.138	0.136	0.135	0.140	0.136
11	0.145	0.149	0.157	0.159	0.150	0.158	0.152
12	0.124	0.138	0.142	0.134	0.144	0.125	0.135
13	0.156	0.154	0.154	0.152	0.158	0.161	0.156
15	0.144	0.141	0.147	0.144	0.143	0.145	0.144
16	0.148	0.152	0.154	0.152	0.150	0.153	0.152
Mean	0.139	0.143	0.147	0.143	0.145	0.146	0.144
$lsd_{5\%}$				0.003			
cv %				2.4			

Table 59C. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Potassium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.79	0.67	0.75	0.81	0.79	0.83	0.77
3	0.79	0.77	0.75	0.75	0.77	0.77	0.77
4	0.81	0.77	0.78	0.81	0.75	0.75	0.78
5	0.87	0.77	0.81	0.83	0.83	0.79	0.82
6	0.83	0.69	0.75	0.65	0.71	0.69	0.72
7	0.77	0.71	0.73	0.73	0.71	0.67	0.72
8	0.83	0.91	0.67	0.61	0.63	0.69	0.72
10	0.67	0.61	0.65	0.73	0.77	0.79	0.70
11	0.91	0.65	0.73	0.71	0.79	0.77	0.76
12	0.79	0.73	0.73	0.77	0.75	0.73	0.75
13	0.87	0.77	0.67	0.71	0.73	0.81	0.76
15	0.81	0.73	0.75	0.75	0.79	0.75	0.76
16	0.81	0.79	0.87	0.85	0.77	0.83	0.82
Mean	0.81	0.74	0.74	0.75	0.76	0.76	0.76
lsd $_{5\%}$				0.04			
cv %				7.4			

Table 59D. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Calcium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	1.01	1.12	1.02	0.99	0.95	0.98	1.01
3	0.89	0.84	0.82	0.88	0.89	0.92	0.87
4	0.86	1.00	0.90	1.05	0.81	0.79	0.90
5	0.98	1.10	0.97	1.01	1.03	1.05	1.02
6	0.89	0.98	0.90	0.95	0.75	0.89	0.89
7	1.04	1.05	1.12	1.13	1.05	1.08	1.08
8	0.75	0.91	0.92	0.83	0.85	1.00	0.88
10	0.91	0.90	0.89	0.98	0.95	0.96	0.93
11	0.94	0.85	1.07	1.16	0.97	1.05	1.01
12	0.93	1.11	0.98	1.10	0.99	0.96	1.01
13	0.91	1.04	1.04	1.09	1.05	1.05	1.03
15	1.00	1.07	1.01	1.05	1.04	1.02	1.03
16	1.00	0.97	0.95	0.94	0.92	0.94	0.95
Mean	0.93	0.93	1.01	1.01	0.94	1.98	1.96
lsd $_{5\%}$				0.09			
cv %				11.4			

Table 59E. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

Block	Magnesium (%) Treatment number 1	2	3	4	5	6	Mean
2	0.14	0.11	0.12	0.11	0.11	0.12	0.12
3	0.15	0.11	0.12	0.11	0.12	0.11	0.12
4	0.25	0.18	0.19	0.18	0.17	0.12	0.19
5	0.14	0.12	0.14	0.13	0.15	0.13	0.14
6	0.18	0.18	0.15	0.12	0.13	0.14	0.15
7	0.17	0.15	0.15	0.14	0.15	0.14	0.15
8	0.14	0.15	0.13	0.14	0.10	0.12	0.13
10	0.10	0.11	0.11	0.13	0.14	0.14	0.12
11	0.17	0.15	0.19	0.17	0.16	0.17	0.17
12	0.12	0.11	0.12	0.13	0.13	0.14	0.13
13	0.18	0.14	0.15	0.15	0.18	0.18	0.16
15	0.16	0.13	0.18	0.17	0.20	0.16	0.17
16	0.17	0.16	0.16	0.17	0.16	0.15	0.16
Mean	0.16	0.14	0.15	0.14	0.15	0.14	0.15
lsd $_{5\%}$				0.01			
cv %				11.8			

Table 59F. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

Block	Chlorine (%) Treatment number 1	2	3	4	5	6	Mean
2	0.26	0.32	0.33	0.37	0.35	0.36	0.33
3	0.23	0.30	0.32	0.33	0.30	0.33	0.30
4	0.36	0.39	0.33	0.48	0.41	0.41	0.33
5	0.11	0.33	0.32	0.39	0.36	0.37	0.31
6	0.26	0.24	0.33	0.38	0.35	0.35	0.34
7	0.18	0.31	0.33	0.39	0.36	0.43	0.33
8	0.18	0.32	0.33	0.33	0.35	0.37	0.31
10	0.14	0.25	0.27	0.34	0.32	0.43	0.29
11	0.25	0.32	0.32	0.36	0.33	0.37	0.33
12	0.24	0.34	0.42	0.33	0.32	0.36	0.34
13	0.13	0.24	0.29	0.36	0.29	0.29	0.27
15	0.08	0.20	0.26	0.34	0.29	0.29	0.24
16	0.10	0.24	0.22	0.33	0.25	0.28	0.24
Mean	0.19	0.30	0.32	0.36	0.33	0.36	0.31
lsd $_{5\%}$				0.03			
cv %				11.2			

Table 60A. Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Nitrogen (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.25	0.25	0.30	0.27	0.28	0.28	0.27
3	0.26	0.26	0.25	0.25	0.22	0.24	0.25
4	0.18	0.20	0.21	0.21	0.25	0.22	0.21
5	0.25	0.25	0.22	0.21	0.26	0.29	0.25
6	0.25	0.27	0.28	0.29	0.28	0.32	0.28
7	0.24	0.34	0.23	0.24	0.26	0.28	0.27
8	0.27	0.26	0.25	0.27	0.27	0.25	0.26
10	0.24	0.25	0.26	0.26	0.25	0.25	0.25
11	0.24	0.25	0.27	0.25	0.29	0.28	0.26
12	0.24	0.27	0.25	0.20	0.25	0.24	0.24
13	0.25	0.27	0.25	0.26	0.25	0.24	0.25
15	0.22	0.25	0.24	0.23	0.25	0.24	0.24
16	0.22	0.23	0.25	0.25	0.24	0.23	0.24
Mean	0.24	0.26	0.25	0.25	0.26	0.26	0.25
$lsd_{5\%}$				0.02			
cv %				7.9%			

Table 60B. Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Phosphorus (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.079	0.080	0.079	0.058	0.087	0 .087	0.080
3	0.043	0.045	0.061	0.047	0.041	0.040	0.050
4	0.086	0.078	0.070	0.061	0.056	0.052	0.070
5	0.043	0.045	0.069	0.045	0.057	0.045	0.050
6	0.051	0.055	0.092	0.063	0.045	0.040	0.060
7	0.048	0.045	0.057	0.044	0.053	0.068	0.050
8	0.054	0.047	0.089	0.050	0.042	0.047	0.050
10	0.049	0.044	0.064	0.047	0.038	0.038	0.050
11	0.053	0.079	0.053	0.083	0.064	0.092	0.070
12	0.050	0.036	0.078	0.037	0.054	0.034	0.050
13	0.083	0.079	0.096	0.103	0.085	0.086	0.090
15	0.034	0.034	0.043	0.035	0.033	0.040	0.040
16	0.034	0.073	0.082	0.088	0.078	0.080	0.070
Mean	0.054	0.057	0.070	0.062	0.056	0.052	0.060
$lsd_{5\%}$				0.010			
cv %				20.6%			

Table 60C. Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Potassium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	1.24	1.32	1.47	1.52	1.34	1.36	1.38
3	1.18	1.20	1.05	1.47	1.07	1.12	1.18
4	1.36	1.30	1.28	1.36	1.26	1.14	1.28
5	1.16	1.22	1.20	1.30	1.24	1.20	1.22
6	1.12	0.95	1.03	1.52	1.30	1.12	1.17
7	0.99	1.07	1.03	1.34	1.24	1.52	1.20
8	1.42	1.26	1.20	1.32	1.26	1.24	1.28
10	1.22	1.28	1.28	1.47	1.07	1.28	1.27
11	1.38	1.34	1.34	1.52	1.47	1.28	1.39
12	1.13	1.12	1.28	1.32	1.03	1.42	1.23
13	1.20	1.10	1.20	1.36	1.28	1.42	1.26
15	1.03	0.97	1.16	1.20	1.14	1.10	1.10
16	0.91	1.32	1.20	1.30	1.16	1.14	1.17
Mean	1.18	1.19	1.21	1.39	1.22	1.26	1.24
lsd $_{5\%}$				0.09			
cv %				9.1%			

Table 60D. Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Calcium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.48	0.50	0.55	0.53	0.62	0.57	0.54
3	0.39	0.61	0.57	0.66	0.56	0.57	0.56
4	0.28	0.43	0.40	0.51	0.42	0.36	0.40
5	0.47	0.57	0.41	0.58	0.49	0.58	0.52
6	0.45	0.53	0.58	0.58	0.55	0.61	0.45
7	0.38	0.53	0.51	0.55	0.50	0.55	0.50
8	0.42	0.49	0.49	0.55	0.49	0.52	0.49
10	0.52	0.52	0.48	0.50	0.44	0.53	0.50
11	0.40	0.51	0.50	0.52	0.55	0.49	0.50
12	0.58	0.70	0.54	0.55	0.53	0.58	0.58
13	0.41	0.47	0.50	0.54	0.53	0.49	0.49
15	0.35	0.42	0.38	0.47	0.41	0.41	0.41
16	0.38	0.39	0.44	0.40	0.44	0.38	0.41
Mean	0.42	0.51	0.49	0.53	0.50	0.51	0.49
lsd $_{5\%}$				0.04			
cv %				9.1%			

Table 60E. Effect of fertilizer treatments on frond 17 rachis nutrient content of thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Magnesium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.04	0.04	0.05	0.05	0.05	0.06	0.04
3	0.03	0.05	0.04	0.04	0.05	0.04	0.04
4	0.05	0.06	0.05	0.05	0.05	0.05	0.05
5	0.04	0.04	0.04	0.04	0.05	0.04	0.04
6	0.04	0.06	0.05	0.05	0.06	0.06	0.05
7	0.03	0.05	0.04	0.04	0.04	0.05	0.04
8	0.04	0.05	0.05	0.06	0.05	0.06	0.05
10	0.03	0.04	0.04	0.04	0.03	0.04	0.04
11	0.05	0.06	0.06	0.06	0.06	0.06	0.06
12	0.05	0.04	0.05	0.05	0.05	0.05	0.05
13	0.05	0.06	0.06	0.07	0.06	0.06	0.06
15	0.03	0.03	0.03	0.04	0.03	0.03	0.03
16	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Mean	0.04	0.05	0.05	0.05	0.05	0.05	0.05
$lsd_{5\%}$				0.04			
cv %				10.5%			

Table 60F. Effect of fertilizer treatments on frond 17 rachis nutrient content on thirteen blocks in the Hoskins Project area in 1992 (Trial 121).

	Chlorine (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	0.13	0.46	0.46	0.65	0.56	0.66	0.49
3	0.09	0.37	0.31	0.53	0.36	0.37	0.34
4	0.21	0.40	0.37	0.55	0.35	0.32	0.37
5	0.05	0.28	0.23	0.54	0.32	0.35	0.30
6	0.11	0.36	0.49	0.79	0.47	0.60	0.44
7	0.09	0.43	0.20	0.37	0.28	0.38	0.29
8	0.08	0.26	0.30	0.43	0.30	0.43	0.30
10	0.09	0.30	0.33	0.44	0.27	0.37	0.30
11	0.09	0.29	0.29	0.57	0.30	0.36	0.32
12	0.42	0.29	0.56	0.51	0.32	0.43	0.42
13	0.05	0.17	0.23	0.38	0.19	0.35	0.23
15	0.04	0.08	0.09	0.19	0.09	0.10	0.10
16	0.17	0.06	0.23	0.13	0.18	0.14	0.15
Mean	0.13	0.30	0.32	0.47	0.31	0.37	0.31
$lsd_{5\%}$				0.07			
cv %				27.0%			

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 Hoskins Oil Palm Scheme (Figure 1, Site Nos 20, 21& 22) at Ponini Agricultural School, Hoskins Provincial High School and Mora Mora 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 61). Each plot has at least 12 recorded palms, surrounded by a guard row.

Table 61 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 1992.

RESULTS

Frond 17 leaflet and rachis was sampled and the nutrient concentrations were analysed (Table 62A). 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 . The concentrations of chlorine was increased to 0.3 % while potassium and magnesium concentrations were low.

The concentration of potassium in the rachis (Table 62B) was high in both site at Ponini and Mora Mora schools.

Table 62A. Preliminary means of nutrient concentrations in the leaflets of frond 17 in two schools in the Hoskins project in November 1992 (Trial 124)

Site	Site	N	P	K	Mg	Ca	Cl	S
Number	Name	% dry matter of leaflets						
20	PAS	2.49	0.146	0.77	0.15	0.82	0.32	0.14
21	MVC	2.18	0.140	0.77	0.16	0.73	0.35	0.15

PAS Ponini Agricultural School
MVC MoraMora Vocational Centre

Table 62B. The preliminary means of nutrient concentrations in the rachis of frond 17 in two schools in the Hoskins Project in November 1992 (Trial 124)

Site	Site	N	P	K	Mg	Ca	Cl	S
Number	Name	% dry matter of rachis						
20	PAS	0.26	0.063	1.34	0.42	0.04	0.26	0.05
21	MVC	0.24	0.560	1.34	0.37	0.05	0.25	0.05

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 Bialla Oil Palm Scheme (Figure 1, Site Nos 17 & 18) at Silanga and Uasilau areas near 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 63). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 63. 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. Leaflets and rachis of frond 17 were sampled in August 1992.

RESULTS

Frond 17 leaflet and rachis were sampled and the nutrient concentrations were analysed (Table 64 and 65). The concentrations of chlorine in leaflets were higher in plots that received ammonium chloride (Table 64A), and the concentration of potassium and magnesium were lower (Table 64C & E). The concentrations of all elements except nitrogen and calcium were low. In the plots that did not receive ammonium chloride the concentration of chlorine were low. The concentration of chlorine in the leaflet that is recommended is 0.3 - 0.4%.

The concentration of potassium in the rachis in both blocks (438 and 176) were high (Table 64B). The mean concentration of chlorine is high in the plots that receive ammonium chloride (Table 65F).

Table 64A. Effect of fertilizer treatments on the nutrient concentrations of frond 17 leaflets at two sites*[1] in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Nitrogen (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	2.65	2.64	2.61	2.57	2.61	2.59	2.61
18	2.50	2.60	2.64	2.57	2.45	2.56	2.55
Mean	2.58	2.62	2.62	2.57	2.53	2.58	2.58
lsd $_{5\%}$				0.14			
cv %				2.2			

Table 64B. Effect of fertilizer treatments on the phosphorus concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Phosphorus (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.153	0.157	0.154	0.153	0.153	0.153	0.154
18	0.153	0.153	0.155	0.146	0.143	0.144	0.149
Mean	0.153	0.155	0.155	0.150	0.148	0.149	0.152
lsd $_{5\%}$				0.008			
cv %				2.0			

[1]*Portion numbers are 438and176 at site 17 and 18 respectively (Figure 1)*

Table 64C. Effect of fertilizer treatments on the potassium concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Potassium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.95	0.81	0.85	0.83	0.85	0.73	0.84
18	0.93	0.67	0.77	0.77	0.79	0.83	0.79
Mean	0.94	0.74	0.81	0.80	0.82	0.78	0.82
lsd				0.15			
cv %				6.9			

Table 64D. Effective of fertilizer treatments on the calcium concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Calcium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.92	0.98	0.96	1.04	0.96	0.99	0.98
18	0.99	0.99	1.00	0.97	0.84	0.88	0.95
Mean	0.96	0.99	0.98	1.00	0.90	0.94	0.96
$lsd_{5\%}$				0.15			
cv %				5.9			

Table 64E. Effect of fertilizer treatments on the magnesium concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Magnesium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.21	0.19	0.17	0.20	0.21	0.20	0.20
18	0.22	0.15	0.19	0.16	0.17	0.16	0.18
Mean	0.22	0.17	0.18	0.18	0.19	0.18	0.19
$lsd_{5\%}$				0.05			
cv %				2.3			

Table 64F. Effect of fertilizer treatments on the chlorine concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Chlorine (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.14	0.32	0.33	0.41	0.32	0.37	0.32
18	0.23	0.33	0.38	0.37	0.32	0.34	0.33
Mean	0.19	0.33	0.36	0.39	0.32	0.36	0.33
lsd 5%				0.09			
cv %				10.8			

Table 64G. Table of fertilizer treatments on the sulphur concentrations of frond 17 leaflets at two sites* in the Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Sulphur (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.14	0.14	0.14	0.14	0.15	0.15	0.14
18	0.13	0.12	0.11	0.11	0.10	0.11	0.11
Mean	0.14	0.13	0.13	0.13	0.13	0.13	0.13
lsd 5%				0.03			
cv %				7.8			

Table 65A. Effect of fertilizer treatments on frond 17 rachis in two sites*[2] at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Nitrogen (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.39	0.26	0.25	0.25	0.22	0.22	0.27
18	0.24	0.22	0.22	0.20	0.24	0.22	0.22
Mean	0.32	0.24	0.24	0.23	0.23	0.22	0.24
lsd 5%				0.11			
cv %				16.4			

[2]**Portion numbers are 438 and 176 at site number 17 and 18 respectively (Figure 1)*

Table 65B. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Phosphorus (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.048	0.047	0.055	0.047	0.041	0.044	0.047
18	0.035	0.038	0.036	0.036	0.036	0.038	0.037
Mean	0.042	0.043	0.046	0.042	0.039	0.041	0.042
lsd $_{5\%}$				0.009			
cv %				8.6			

Table 65C. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Potassium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.99	1.16	1.26	1.14	1.14	1.10	1.13
18	1.16	1.22	1.10	1.37	1.24	1.14	1.21
Mean	1.08	1.19	1.18	1.26	1.19	1.12	1.17
lsd $_{5\%}$				0.24			
cv %				8.1			

Table 65D. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Calcium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.36	0.49	0.52	0.48	0.42	0.45	0.45
18	0.42	0.49	0.53	0.50	0.47	0.49	0.48
Mean	0.39	0.49	0.53	0.49	0.45	0.47	0.47
lsd $_{5\%}$				0.043			
cv %				1.4			

Table 65E. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Magnesium (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.05	0.05	0.06	0.05	0.05	0.05	0.05
18	0.03	0.05	0.05	0.05	0.05	0.05	0.05
Mean	0.04	0.05	0.06	0.05	0.05	0.05	0.05
$lsd_{5\%}$				0.02			
cv %				12.0			

Table 65F. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Chlorine (%)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.12	0.21	0.24	0.33	0.20	0.25	0.23
18	0.10	0.27	0.29	0.43	0.22	0.31	0.27
Mean	0.11	0.24	0.27	0.38	0.21	0.28	0.25
$lsd_{5\%}$				0.07			
cv %				11.7			

Table 65G. Effect of fertilizer treatments on frond 17 rachis in two sites* at Central Nakanai area of the Bialla Project in 1992 (Trial 207).

	Sulphur						
	Treatment number						
Block	1	2	3	4	5	6	Mean
17	0.04	0.05	0.06	0.05	0.05	0.04	0.05
18	0.06	0.06	0.07	0.05	0.05	0.05	0.06
Mean	0.05	0.06	0.07	0.05	0.05	0.05	0.06
$lsd_{5\%}$				0.01			
cv %				10.1			

III. AGRONOMY AND SMALLHOLDER TRIALS

MAINLAND PROVINCES

(A.T.Oliver)

Trial 305 FERTILIZER TRIAL AT AREHE ESTATE

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 66).

Table 66. Types of fertiliser and amounts used in trial 305.

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

RESULTS

Yield data for 1992, and for the 5 years 1987 - 1992 are summarised in Tables 67 and 69.

There was a large and statistically significant increase in yield caused by SoA, of 13 tonnes up to level 1 of SoA (2kg/palm/year), and then a smaller increase up to level 2 (Table 67). This increase was due to an increase in bunch numbers and single bunch weight.

There was also an increase in yield due to MoP up to application level 1, though this was not statistically significant for the period 1987-92. MoP increased single bunch weight, but as the increase was accompanied by a reduction in bunch numbers the overall effect on yield was marginal.

Table 67. Main effects of N, P, K, and Mg on yield and yield components in 1992 (Trial 305).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	19.8	32.9	35.7	***	21.7	3.6
Bunches/ha	870	1310	1400	***	20.9	144
Bunch weight	21.3	25.3	25.5	***	12.1	1.6
	P0	P1				
Yield (t/ha/yr)	30.0	29.0		ns	21.7	-
Bunches/ha	1230	1170		ns	20.9	-
Bunch weight	23.9	24.2		ns	12.1	-
	K0	K1	K2			
Yield (t/ha/yr)	27.9	30.2	30.2	ns	21.7	-
Bunches/ha	1220	1180	1180	ns	20.9	-
Bunch weight	22.3	25.0	24.9	**	12.1	1.6
	Mg0	Mg1				
Yield (t/ha/yr)	29.8	29.0		ns	21.7	-
Bunches/ha	1220	1180		ns	20.9	-
Bunch weight	23.9	24.2		ns	12.1	-

The interaction between N and K was not significant, but the NxK two-way table (Table 68) shows that a maximum yield of 38t/ha/yr is achieved with 4 kg SoA per palm, plus between 2 and 4 kg MoP per palm in 1992, this corresponded to 34 t/ha/year for the period 87-92.

There was no response to TSP and Kieserite.

A formal economic analysis of the results would be unreliable, because the effects of poaching would have flattened the response curves. A rough estimate suggests that the optimum amount of fertiliser would be equivalent to 2 kg SoA per palm per year.

Table 68. Effect of N on yield at different levels of K in 1992 (Trial 305).

	Yield (t/ha/yr)		
	N0	N1	N2
K0	18.9	32.3	32.0
K1	19.3	33.5	37.9
K2	21.1	32.4	37.1

Note: NxK interaction not significant.

Table 69. Main effects of N, P, K, and Mg on yield and yield components, 1987 to 1992 (Trial 305).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	22.2	31.4	33.2	***	13.3	2.2
Bunches/ha	1070	1380	1460	***	11.8	89
Bunch wt (kg)	20.4	22.9	22.8	***	7.8	1.0
	P0	P1				
Yield (t/ha/yr)	28.9	28.9		ns	13.3	-
Bunches/ha	1310	1290		ns	11.8	-
Bunch wt (kg)	22.0	22.1		ns	7.8	-
	K0	K1	K2			
Yield (t/ha/yr)	27.6	29.3	29.8	ns	13.3	-
Bunches/ha	1340	1270	1290	ns	11.8	-
Bunch wt (kg)	20.5	22.9	22.8	***	7.8	-
	Mg0	Mg1				
Yield (t/ha/yr)	29.3	28.5		ns	13.3	-
Bunches/ha	1320	1280		ns	11.8	-
Bunch wt (kg)	22.0	22.1		ns	7.8	-

Table 70. Effect of N on yield at different levels of K, 1987 to 1992 (Trial 305)

	Yield (t/ha/yr)		
	N0	N1	N2
K0	21.4	30.5	31.0
K1	22.2	31.6	34.2
K2	21.9	32.1	34.3

Note: NxK interaction not significant.

The analysis of frond 17 nutrient concentrations from sampling in March 1992 are presented in Tables 71 and 72.

SoA application had significantly increased rachis N levels as well as leaflet levels. P levels in the leaflet tissue was also significantly increased, but significantly depressed levels in the rachis.

TSP caused an increase in leaflet P levels which was not quite significant at the 5% level. TSP also significantly increased N, P and Mg levels in the rachis.

MoP caused a significant reduction of leaflet K, although rachis K increased indicating an uptake of K was occuring. Leaflet Ca and Cl and rachis P, K, Mg, Ca and Cl were all increased by MoP applications.

Table 71. Main effects of N, P, K, and Mg on the concentration of elements in leaflet tissue in 1992 (Trial 305).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	1.94	2.12	2.27	***	9.2	0.11
P%	0.133	0.140	0.144	***	4.6	0.004
K%	0.70	0.70	0.71	ns	6.5	-
Mg%	0.17	0.15	0.15	*	21.1	0.02
Ca%	0.76	0.75	0.71	**	8.0	0.03
Cl%	0.25	0.24	0.23	ns	11.0	-
	P0	P1				
N%	2.11	2.11		ns	9.2	-
P%	0.138	0.140		(ns)	4.6	(0.003)
K%	0.71	0.69		ns	6.5	-
Mg%	0.16	0.15		ns	21.1	-
Ca%	0.74	0.74		ns	8.0	-
Cl%	0.24	0.24		ns	11.0	-
	K0	K1	K2			
N%	2.11	2.15	2.08	ns	9.2	-
P%	0.138	0.141	0.138	(ns)	4.6	(0.004)
K%	0.73	0.71	0.67	***	6.5	0.03
Mg%	0.16	0.15	0.15	ns	21.1	-
Ca%	0.70	0.75	0.76	**	8.0	0.03
Cl%	0.08	0.30	0.34	***	11.0	0.02
	Mg0	Mg1				
N%	2.11	2.11		ns	9.2	-
P%	0.140	0.138		ns	4.6	-
K%	0.69	0.72		ns	6.5	-
Mg%	0.15	0.16		ns	21.1	-
Ca%	0.75	0.73		ns	8.0	-
Cl%	0.23	0.25		(ns)	11.0	0.01

Table 72. Main effects of N, P, K, and Mg on concentrations of elements in rachis of frond 17, 1992 (Trial 305).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	0.17	0.20	0.21	***	10.7	0.01
P%	0.169	0.112	0.094	***	25.3	0.02
K%	1.27	1.23	1.21	ns	11.7	-
Mg%	0.07	0.06	0.05	***	24.6	0.008
Ca%	0.37	0.38	0.37	ns	11.1	-
Cl%	0.51	0.45	0.42	***	15.3	0.04
	P0	P1				
N%	0.19	0.20		*	10.7	0.01
P%	0.088	0.161		***	25.3	0.02
K%	1.25	1.23		ns	11.7	-
Mg%	0.05	0.06		**	24.6	0.006
Ca%	0.37	0.38		ns	11.1	-
Cl%	0.47	0.45		ns	15.3	-
	K0	K1	K2			
N%	0.20	0.19	0.19	ns	10.7	-
P%	0.101	0.139	0.134	***	25.3	0.02
K%	0.92	1.32	1.48	***	11.7	0.08
Mg%	0.05	0.06	0.07	**	24.6	0.008
Ca%	0.31	0.39	0.42	***	11.1	0.02
Cl%	0.06	0.55	0.77	***	15.3	0.04
	Mg0	Mg1				
N%	0.20	0.19		ns	10.7	-
P%	0.126	0.124		ns	25.3	-
K%	1.24	1.24		ns	11.7	-
Mg%	0.06	0.06		ns	24.6	-
Ca%	0.38	0.36		*	11.1	0.02
Cl%	0.46	0.46		ns	15.3	-

Table 73 shows data of plots not recieving MoP which indicates very high yields in spite of low Cl levels.

Table 73. Yields from all plots that were not given MoP, listed in descending order, with the concentration of chlorine in the leaflet tissue in 1992 (Trial 305).

Plot No.	Yield (t/ha/yr)	Treatment N	P	K	Mg	Cl (% dry matter)
26	37.4	1	0	0	0	0.08
4	36.9	1	1	0	0	0.08
22	35.7	1	1	0	1	0.06
12	35.2	2	1	0	0	0.13
42	33.9	2	0	0	0	0.05
35	33.3	1	1	0	1	0.05
19	32.6	2	0	0	1	0.11
63	32.4	1	0	0	1	0.07
46	32.0	2	1	0	1	0.05
62	31.9	2	0	0	0	0.09
36	30.7	1	0	0	0	0.05
37	30.7	2	1	0	0	0.03
8	30.0	2	1	0	1	0.10
69	29.7	2	0	0	1	0.03
16	28.8	0	1	0	1	0.12
47	28.1	1	0	0	1	0.06
54	27.6	1	1	0	0	0.06
28	26.3	0	1	0	0	0.08
18	26.0	0	0	0	1	0.12
44	24.6	0	1	0	0	0.07
45	21.2	0	0	0	1	0.06
68	16.0	0	0	0	1	0.06
61	5.2	0	0	0	0	0.07
60	2.9	0	1	0	1	0.12

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 Penderatta 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 numbers and weights of bunches for 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 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 74). 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 74. Types and amounts of fertiliser used in Trial 306.

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

RESULTS

Yield data for 1992, and for the 5 years 1987 - 1992 are summarised in Tables 75, 76 and 77.

There was a large and statistically significant increase in yield caused by SoA, this amounted to 6 t FFB/ha/yr up to level 1, and a further, but smaller increase up to level 2 (Table 74). This increase was due to the increase in bunch numbers and single bunch weight.

Application of MoP did not significantly increase yield. MoP increased single bunch weight, but as the increase was accompanied by a reduction in bunch numbers, the overall effect on yield was marginal.

Table 75. **Main effects of N, P, K, and Mg an yield and yield components in 1992 (Trial 306).**

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	24.6	31.5	32.1	***	15.2	4.2
Bunches/ha	1110	1260	1280	***	13.2	88
Bunch weight	22.0	25.2	25.2	***	7.5	1.0
	P0	P1	P3			
Yield (t/ha/yr)	29.1	29.4	29.6	ns	15.2	-
Bunches/ha	1210	1230	1210	ns	13.2	-
Bunch weight	24.1	23.9	24.4	ns	7.5	-
	K0	K1	K2			
Yield (t/ha/yr)	29.4	30.3	28.5	ns	15.2	-
Bunch/ha	1280	1210	1160	*	13.2	88
Bunch weight	22.9	25.1	24.4	***	7.5	1.0
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	28.8	29.8	29.5	ns	15.2	-
Bunch/ha	1220	1220	1210	ns	13.2	-
Bunch weight	23.4	24.4	24.5	ns	7.5	-

The interaction between N and K is not significant, but the two-way table (Table 76) shows that the maximum yield of about 33 t/ha/yr was achieved with 6kg SoA /palm and 2.5kg MoP /palm.

There was no response to TSP or Kieserite.

A formal economic analysis of the results would be unreliable because the effects of poaching would have flattened the response curve. A rough estimate suggests that the optimum amount of fertiliser would be equivalent to about 3kg SoA per palm per year.

Table 76. Effect of N on yield at different levels of K in 1992 (Trial 306)

	Yield (t/ha/yr)		
	N0	N1	N2
K0	25.0	31.6	31.5
K1	26.5	31.5	32.9
K2	22.4	31.3	31.8

Note: NxK interaction not significant.

Table 77. Main effects of N, P, K, and Mg on yield and yield components for 1987 - 1992 (Trial 306)

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	23.2	28.3	29.7	***	8.6	1.3
Bunches/ha	1250	1380	1440	***	7.3	54
Bunch weight	18.7	20.5	20.6	***	7.2	0.8
	P0	P1	P2			
Yield (t/ha/yr)	27.0	26.7	27.6	ns	8.6	-
Bunches/ha	1360	1340	1370	ns	7.3	-
Bunch weight	19.7	19.8	20.2	ns	7.2	-
	K0	K1	K2			
Yield (t/ha/yr)	25.9	27.9	27.5	**	8.6	1.3
Bunches/ha	1380	1340	1350	ns	7.3	-
Bunch weight	18.7	20.8	20.3	***	7.2	0.8
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	26.3	27.6	27.3	ns	8.6	-
Bunches/ha	1350	1380	1350	ns	7.3	-
Bunch weight	19.5	20.1	20.2	ns	7.2	-

Table 78. Effects of N on yield at different levels of K for 1987-1992 (Trial 306).

	Yield (t/ha/yr)		
	N0	N1	N2
K0	22.8	27.2	27.6
K1	24.4	28.5	30.8
K2	22.6	29.2	30.6

Note: NxK interaction not significant.

The analysis of frond 17 nutrient concentrations from sampling in January and February 1992 are presented in Tables 79 and 80.

SoA application increased the leaflet and rachis N, as well as bringing about reductions in leaflet K and rachis K, Mg, Cl, and a reduction in rachis P with a corresponding increase in leaflet P.

TSP application significant increased the rachis P, and did not affect any other nutrient concentrations.

MoP applications caused a significant reduction of leaflet K, but the Cl component of MoP may be responsible for the increased Ca and Cl leaflet concentrations. Rachis P, K, Mg, Ca and Cl were increased by MoP applications.

Table 79. Main effects of N, P, K, and Mg on concentrations of nutrient elements in leaflet tissue in 1992 (Trial 306).

	Nutrient element and level			Statistics		
				sig	cv	lsd
	N0	N1	N2			
N%	2.06	2.20	2.27	***	6.0	0.07
P%	0.140	0.145	0.146	***	3.4	0.003
K%	0.89	0.86	0.83	***	5.6	0.03
Mg%	0.21	0.19	0.19	ns	14.2	-
Ca%	0.69	0.70	0.72	ns	7.2	-
Cl%	0.27	0.30	0.29	ns	26.0	-
	P0	P1	P2			
N%	2.17	2.17	2.20	ns	6.0	0.07
P%	0.143	0.144	0.145	ns	3.4	0.003
K%	0.86	0.86	0.86	ns	5.6	0.03
Mg%	0.20	0.20	0.20	ns	14.2	-
Ca%	0.69	0.70	0.71	ns	7.2	-
Cl%	0.29	0.29	0.28	ns	26.0	-
	K0	K1	K2			
N%	2.17	2.19	2.18	ns	6.0	0.07
P%	0.144	0.143	0.144	ns	3.4	0.003
K%	0.89	0.84	0.86	**	5.6	0.03
Mg%	0.21	0.19	0.19	ns	14.2	-
Ca%	0.67	0.71	0.72	***	7.2	-
Cl%	0.16	0.34	0.35	***	26.0	-
	Mg0	Mg1	Mg2			
N%	2.15	2.20	2.19	ns	6.0	-
P%	0.142	0.145	0.145	ns	3.4	-
K%	0.87	0.85	0.86	ns	5.6	-
Mg%	0.19	0.20	0.20	ns	14.2	-
Ca%	0.70	0.71	0.69	ns	7.2	-
Cl%	0.27	0.31	0.29	ns	26.2	-

Table 80. Main effects of N, P, K, Mg on concentrations of elements in rachis of frond 17 in 1992 (Trial 306)

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	0.19	0.20	0.22	***	8.1	0.009
P%	0.22	0.15	0.12	***	19.2	0.02
K%	1.62	1.46	1.36	***	11.2	0.09
Mg%	0.07	0.06	0.06	***	17.6	0.006
Ca%	0.30	0.31	0.32	ns	14.8	-
Cl%	0.57	0.48	0.47	**	24.3	0.07
	P0	P1	P2			
N%	0.21	0.20	0.20	ns	8.1	-
P%	0.146	0.165	0.177	**	19.2	0.17
K%	1.49	1.46	1.49	ns	11.2	-
Mg%	0.07	0.06	0.07	ns	17.6	-
Ca%	0.31	0.31	0.32	ns	14.8	-
Cl%	0.50	0.51	0.52	ns	24.3	-
	K0	K1	K2			
N%	0.20	0.20	0.20	ns	8.1	-
P%	0.137	0.175	0.177	***	19.2	0.02
K%	1.18	1.56	1.70	***	11.2	0.09
Mg%	0.06	0.07	0.07	(ns)	17.6	0.006
Ca%	0.28	0.33	0.33	***	14.8	0.03
Cl%	0.14	0.61	0.78	***	24.3	0.07
	Mg0	Mg1	Mg2			
N%	0.21	0.20	0.21	ns	8.1	-
P%	0.163	0.165	0.162	ns	19.2	-
K%	1.49	1.46	1.48	ns	11.2	-
Mg%	0.06	0.07	0.07	ns	17.6	-
Ca%	0.30	0.31	0.31	ns	14.8	-
Cl%	0.51	0.49	0.53	ns	24.3	-

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

PURPOSE

To test the response to potassium, chlorine and sulphur at Ambogo Estate.

DESCRIPTION

Site Ambogo Estate block 80H.

Soil Penderetta family. Thin dark sandy clay 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 81). 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 the Table 81shows 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 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 81. Types and amounts of fertiliser given in each treatment, and the corresponding amounts of nutrient element in Trial 309

Treatment No	Amount of fertiliser (kg/palm/year)				Amount of element (kg/palm/year)			
	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

RESULTS

Yield data comparisons of the effects of N, S, K, and Cl for 1991 and 1992, are summarised in Table 81 and 82.

Treatment 4, application of MoP and SoA in combination, gave a maximum mean yield of about 32t/ha. Treatment 3 and 5, gave mean yields of about 28t/ha and 30t/ha respectively. Ammonium Chloride alone produced a mean yield of 23t/ha. The control plots produced an average of 15t/ha.

The FFB yield increases were largely due to increased single bunch weight.

In a comparison between treatment 3 and 1 yield for 1991-1992 (Table 83), there was a significant response to N and S, with a yield increase of 13.2 t/ha/yr. Comparing the effects of K and S, treatments 4 and 2, there was a significant yield increase of 8.8 t/ha/yr. N and Cl also gave a significant yield increase of 8.1 t/ha/yr.

SoA (effects of N and S) application, gave the highest yield difference.

Table 82. Effects of N, S, K, and Cl, in different combinations, on yield and yield components in 1991 and 1992 (Trial 309)

Treatment	1991			1992		
	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	31.3	1440	21.7	32.5	1340	24.3
5 N S K	28.6	1470	19.5	30.9	1340	23.1
3 N S	28.5	1480	19.1	27.8	1270	21.8
2 N Cl	24.5	1460	16.8	21.7	1130	19.0
1 Nil	16.4	1110	14.6	13.6	917	14.3
sig	**	*	***	***	(ns)	***
cv	17.1	13.9	8.7	20.0	18.7	5.2
lsd	6.1	270	2.2	7.0	310	2.3

Table 83. Mean yield for 1991 - 1992, and difference in yield for selected comparisons (Trial 309)

Mean yield 91 - 92		Selected comparisons		
Treatment	Yield (t/ha/yr)	comparison	Difference (t/ha/yr)	sig
4 N S K Cl	31.9	4-2 (effect of K and S)	8.8	*
5 N S K	29.7	3-2 (substituting S for Cl)	5.1	ns
3 N S	28.2	4-3 (effect of K and Cl)	3.7	ns
2 N Cl	23.1	4-5 (effect of Cl)	2.2	ns
1 Nil	15.0	5-3 (effect of K)	1.5	ns
		3-1 (effect of N and S)	13.2	**
		2-1 (effect of N and Cl)	8.1	*

F sig ***, cv 16.8%, sed 2.72

The analysis of frond 17 nutrient concentrations from sampling in December 1992 are presented in Tables 84 and 85. This compares the effects of N, S, K, and Cl on the concentration of elements in the leaflet and rachis. All the treatments receiving fertiliser N maintained leaflet N levels around 2%. The major response, corresponding to yield response, was an increase in N levels for the palms receiving SoA. SoA also brought about reductions in leaflet Ca and Mg, increases in leaflet K, and a reduction in the rachis P and a corresponding increase in leaflet P. In Treatment 4 and 2, applications of MoP and AmC increased Cl levels in both the leaflet and rachis.

Table 84. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaflet tissue in 1992 (Trial 309)

	Concentration (% dry matter)					
Treatment	N	P	K	Mg	Ca	Cl
4 N S K Cl	2.15	0.132	0.77	0.16	0.75	0.38
5 N S K	2.10	0.132	0.81	0.16	0.70	0.24
3 N S	2.03	0.134	0.86	0.19	0.71	0.20
2 N Cl	2.01	0.134	0.67	0.20	0.78	0.42
1 Nil	1.76	0.120	0.67	0.23	0.69	0.20
sig	*	*	**	*	**	***
cv	8.5	5.2	9.1	19.8	4.8	9.0
lsd	0.24	0.009	0.09	0.05	0.05	0.03

Table 85. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in rachis of frond 17 in 1992 (Trial 309)

	Concentration		(% dry matter)			
Treatment	N	P	K	Mg	Ca	Cl
4 N S K Cl	0.24	0.057	1.64	0.06	0.37	0.86
5 N S K	0.22	0.054	1.31	0.04	0.29	0.20
3 N S	0.21	0.052	0.98	0.05	0.34	0.23
2 N Cl	0.31	0.120	1.17	0.11	0.37	0.82
1 Nil	0.17	0.108	0.94	0.10	0.24	0.22
sig	***	***	***	***	**	***
cv	13.8	18.7	11.2	16.4	14.4	21.4
lsd	0.04	0.02	0.18	0.02	0.06	0.13

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

PURPOSE

To test the response to potassium, chlorine, and sulphur at Ambogo Estate.

DESCRIPTION

Site Ambogo Estate 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 at least one guard row, sometimes two.

The 35 plots are divided into five replicate blocks, each containing seven treatments that are randomised (Table 84). The treatments are combinations of fertilisers. The lower half of Table 84 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 treatment: 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 86). 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 7 now has S but did not before.

Table 86. Amount of each type of fertiliser, and each element, used for each treatment in Trial 310.

	Treatment number						
	1	2	3	4	5	6	7
	(kg fertiliser/palm/year)						
Urea	1.8	-	-	-	-	-	-
SoA	-	4	-	4	-	4	2
AmC	-	-	3.2	-	3.2	-	1.6
BA	-	-	-	4.4	4.4	-	-
MoP	-	-	-	-	-	2.2	-
	(kg element/palm/yr)						
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 87 Amount of each element used in each treatment from November 1988 until May 1990 (Trial 310).

	Treatment number						
	1	2	3	4	5	6	7
	(kg element/palm/yr)						
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 is from urea.

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

RESULTS

Comparisons yield data are presented in Tables 88 and 89.

Treatment 6 which receives SoA and MoP produced the highest yields at 34 t FFB/ha/yr. Treatment 4 receiving SoA and BA which contains no Cl gave the next high yield of 31t/ha and AmC (missing elements K and Cl) produced the third highest yield of 30t/ha. Although there is a significant difference between the treatments, the current treatments have not been running long enough to give a definitive treatment effect for K, Cl, and S.

Table 89 compares the differences in yield for treatment 6 (full fertiliser), and the effect caused by withholding K, Cl, and S in successive six month periods between 1991 - 1993. The effects are shown as a percentage of the 6 monthly mean.

Table 88. The effects of K, Cl, and S on yield in 1992 (Trial 310)

Treatment No	Elements supplied	Elements missing	Yield (t/ha/yr)	Difference from treatment No 6 t/ha/yr	Difference from treatment No 6 %
6	N,K,Cl,S	None	34.0	0	0
4	N,K,S	Cl	31.0	-3.0	-8.8
7	N,Cl,S	K	28.9	-5.1	-15.0
5	N,K,Cl	S	28.6	-5.4	-15.9
2	N,S	K,Cl	29.6	-4.4	-12.9
3	N,Cl	K,S	30.3	-3.7	-10.9
1	N (urea)	K,Cl,S	25.6	-8.4	-24.7
		sig	**		
		cv	8.8		
		lsd	3.4		

The analysis of frond 17 nutrient concentrations sampled in October 1992 are presented in Tables 90 and 91. These compare the effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaflet and rachis. There were significant differences between the concentrations of leaflet K and Cl. The increased K in the leaflets due to BA application was associated with reductions in Cl and other bases. The applications of MoP and AmC reduced leaflet K but increased rachis K and increased leaflet and rachis Cl, Ca, and Mg.

Table 89. The yield of treatment 6 (full fertiliser) in successive six month periods, and the difference in yield caused by withholding K, Cl, and S (Trial 310)

Treatment	1991 Jan-Jun	1991 Jul-Dec	1992 Jan-Jun	1992 Jul-Dec	1993 Jan-Jun
	Yield of treatment 6 (t/ha/six months)				
6	18.7	8.0	22.6	11.4	16.8
	Difference in yield from treatment 6 (%)				
4 (-Cl)	+4.3	-15.0	-5.0	-11.4	+0.6
7 (-K)	+2.1	+6.3	-19.9	-5.2	+3.0
5 (-S)	+8.6	-11.3	-19.5	-8.8	+15.5
2 (-K,Cl)	+4.3	-12.5	-17.7	-2.6	+4.8
3 (-K,S)	+8.6	+10.0	-13.0	-0.9	+16.7
1 (-K,Cl,S)	-5.3	-5.0	-32.3	-9.6	0

Table 90. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaflet tissue in 1992 (Trial 310).

Treatment	N	P	K	Mg	Ca	Cl
	Concentration (% dry matter)					
6 N S K Cl	2.17	0.132	0.79	0.12	0.68	0.31
4 N S K	2.23	0.135	0.81	0.13	0.65	0.19
7 N S Cl	2.22	0.135	0.79	0.14	0.69	0.37
5 N K Cl	2.24	0.139	0.73	0.12	0.74	0.42
2 N S	2.21	0.136	0.84	0.14	0.67	0.14
3 N Cl	2.25	0.140	0.78	0.15	0.73	0.41
1 N (urea)	2.14	0.136	0.84	0.15	0.64	0.14
sig	ns	ns	*	ns	ns	***
cv	3.4	3.1	6.5	12.5	9.6	9.1
lsd	-	-	0.07	-	-	0.03

Table 91. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in rachis in 1992 (Trial 310).

Treatment	N	P	K	Mg	Ca	Cl
	Concentration (% dry matter)					
6 N S K Cl	0.25	0.140	1.25	0.05	0.38	0.31
4 N S K	0.25	0.117	1.13	0.04	0.31	0.14
7 N S Cl	0.24	0.124	1.07	0.05	0.38	0.44
5 N K Cl	0.26	0.154	1.24	0.06	0.41	0.76
2 N S	0.24	0.096	0.88	0.05	0.29	0.10
3 N Cl	0.26	0.152	1.09	0.07	0.39	0.65
1 N (urea)	0.25	0.134	0.99	0.05	0.32	0.19
sig	ns	**	*	***	**	***
cv	6.1	17.9	13.9	11.9	12.3	32.0
lsd	-	0.03	0.20	0.008	0.06	0.15

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 92). 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 the palm circles. The weights of EFB given in Table 92 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 92. Amounts of fertiliser and EFB used in trial 311.

Type of fertiliser or EFB	Amount Level 0	Level 1	Level 2	Level 3
		(kg/palm/ha)		
SoA	0	2	4	6
MoP	0	2	4	6
	(kg/palm/two years)			
EFB	0	500	-	-

Notes: SoA and MoP have been applied twice a year since April 1988.
EFB has been applied once every two years(November 1988 and September 1990 missed).

RESULTS

Yield data for 1992 and for the three years 1989 - 1992 are summarised in Tables 93 and 94.

The results are rather variable, which makes it difficult to say with certainty whether EFB can be used economically as a mulch to replace or supplement chemical fertilisers. The EFB would be beneficial as a mulch in that it would help to protect the soil against erosion, and the cost of transporting it to the field and spreading it could be offset by a decrease in the amount of fertiliser used.

In 1992 there was a significant increase in yield due to N application. This effect was similar for the 3 year period 1989-1992. The form of response to SoA was mainly linear. There were no significant effects of MoP in 1992. Averaged over 3 years MoP gave a significant increase in yield at the 5% level. This increase was mainly due to increased single bunch weights. The affect of EFB on yield was almost significant in 1992, and this was due to a significant increase in single bunch weight. Over the 3 year period from 1989-1992, a significant yield increase of about 3 tonnes was obtained. There were no significant interactions between the three factors in 1992, however a KxEFB interaction was significant at the 5% level over the three year period.

Table 93. Main effects of N, K, and EFB on yield and yield components in 1992 (Trial 311)

	Level of nutrient element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	28.7	31.5	32.4	35.9	*	10.8	4.0
Bunches/ha	1030	1150	1140	1240	ns	11.9	-
Bunch wt (kg)	27.8	27.4	28.6	29.0	ns	5.2	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.0	32.6	32.4	33.6	ns	10.8	-
Bunches/ha	1130	1160	1120	1160	ns	11.9	-
Bunch wt (kg)	26.6	27.9	29.2	29.1	*	5.2	1.7
	EFB0	EFB1					
Yield (t/ha/yr)	30.8	33.5			(ns)	10.8	-
Bunches/ha	1130	1160			ns	11.9	-
Bunch wt (kg)	27.4	29.1			*	5.2	1.2

It is not possible to do a proper economic analysis of the results because of the effects of poaching. We have no proper baseline from which to measure the economic benefits of either fertiliser or EFB. The very high yields of the zero plots (29-30t/ha/yr) are probably the result of a combination of high residual soil fertility and the poaching of fertiliser from neighbouring plots.

Table 94. Effect of combinations of N and K, N and EFB, and K and EFB in 1992 (Trial 311)

	Yield (t/ha/yr)			
	Level of N			
Level of K	N0	N1	N2	N3
K0	25.4	29.9	30.2	34.7
K1	27.6	30.1	32.8	39.9
K2	30.9	32.1	32.5	33.9
K3	30.9	33.9	34.3	35.3
Level of EFB				
EFB0	29.3	28.4	32.6	32.9
EFB1	28.1	34.7	32.3	39.0
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	29.3	28.4	32.0	33.4
EFB1	30.8	36.8	32.7	33.8

NxK, NxEFB, and KxEFB interactions not significant.

Table 95. Main effects of N, K, and EFB on yield and yield components for 1989-1992 (Trial 311)

	Level of nutrient Element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	28.9	31.4	32.7	35.0	***	5.7	2.1
Bunches/ha	1140	1240	1240	1330	***	5.8	107
Bunch wt (kg)	25.2	25.4	26.4	26.4	ns	4.5	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.5	31.7	32.0	33.8	*	5.7	2.1
Bunches/ha	1240	1210	1210	1280	ns	5.8	-
Bunch wt (kg)	24.6	25.9	26.5	26.3	*	4.5	1.3
	EFB0	EFB1					
Yield (t/ha/yr)	30.8	33.1			**	5.7	1.5
Bunches/ha	1220	1260			ns	5.8	-
Bunch wt (kg)	25.3	26.4			*	4.5	1.0

Table 96. Effect of combinations of N and K, N and EFB, and K and EFB, on yield from 1989 to 1992 (Trial 311).

	Yield (t/ha/yr)			
	Level of N			
Level of K	N0	N1	N2	N3
K0	26.9	30.2	31.5	33.5
K1	26.3	29.6	32.6	38.1
K2	30.5	32.0	32.3	33.2
K3	31.7	33.8	34.3	35.2
Level of EFB				
EFB0	28.6	28.7	32.4	33.5
EFB1	29.1	34.1	33.0	36.4
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	29.6	28.2	31.9	33.6
EFB1	31.5	35.1	32.1	33.9

NxK and NxEFB interactions not significant
KxEFB interaction significant at $P < 0.05$

The analysis of frond 17 nutrient concentrations from sampling in March 1992 are presented in Tables 97 and 98.

SoA has significantly increased both the N levels in the leaflet and rachis. Levels of leaflet P and Cl were also increased. SoA had significantly reduced the levels of rachis Mg and Ca.

MoP application caused a significantly reduction of leaflet K, despite significantly increased levels in the rachis, this probably indicates that uptake of K is occuring. Rachis P, Mg, Ca and Cl were increased by MoP applications.

EFB applications had no effect on leaflet K and caused a small reduction of leaflet Ca and Mg. An effect on leaflet N was indicated, though not significant at the 5% level.

Table 97. Main effects of N, K, and EFB on concentrations of elements in leaflet tissue in 1992 (Trial 311)

	Level of nutrient element or EFB				Statistics		
					sig	cv	lsd
	N0	N1	N2	N3			
N%	2.06	2.13	2.17	2.34	***	4.2	0.11
P%	0.138	0.141	0.141	0.147	***	2.0	0.003
K%	0.71	0.70	0.70	0.70	ns	4.7	-
Mg%	0.15	0.15	0.14	0.13	(ns)	10.4	(0.02)
Ca%	0.78	0.78	0.76	0.76	ns	5.0	-
Cl%	0.26	0.29	0.27	0.30	*	7.5	0.02
	K0	K1	K2	K3			
N%	2.18	2.15	2.18	2.19	(ns)	4.2	0.11
P%	0.143	0.139	0.142	0.142	(ns)	2.0	0.003
K%	0.75	0.69	0.67	0.69	**	4.7	0.04
Mg%	0.15	0.13	0.14	0.14	ns	10.4	-
Ca%	0.75	0.74	0.78	0.80	*	5.0	0.04
Cl%	0.18	0.28	0.33	0.33	***	7.5	0.02
	EFB0	EFB1					
N%	2.14	2.21			(ns)	4.2	(0.07)
P%	0.141	0.143			ns	2.0	-
K%	0.70	0.70			ns	4.7	-
Mg%	0.15	0.13			**	10.4	0.01
Ca%	0.79	0.74			**	5.0	0.03
Cl%	0.27	0.29			**	7.5	0.02

Table 98. Main effects of N, K, and EFB on concentrations of elements in rachis in 1992 (Trial 311)

	Level of nutrient element or EFB				Statistics		
					sig	cv	lsd
	N0	N1	N2	N3			
N%	0.21	0.21	0.22	0.24	***	5.9	0.01
P%	0.080	0.084	0.068	0.080	***	11.8	0.008
K%	1.27	1.46	1.20	1.32	***	8.9	0.09
Mg%	0.06	0.06	0.05	0.05	***	7.5	0.003
Ca%	0.43	0.45	0.43	0.43	***	3.4	0.01
Cl%	0.49	0.65	0.54	0.57	***	14.5	0.07
	K0	K1	K2	K3			
N%	0.22	0.21	0.22	0.22	ns	5.9	-
P%	0.076	0.070	0.080	0.087	***	11.8	0.008
K%	1.13	1.20	1.40	1.52	***	8.9	0.09
Mg%	0.05	0.05	0.06	0.06	***	7.5	0.003
Ca%	0.41	0.42	0.46	0.46	***	3.4	0.01
Cl%	0.27	0.53	0.66	0.79	***	14.5	0.07
	EFB0	EFB1					
N%	0.22	0.22			ns	5.9	-
P%	0.076	0.080			ns	11.8	-
K%	1.30	1.33			ns	8.9	-
Mg%	0.05	0.05			ns	7.5	-
Ca%	0.44	0.43			*	3.4	0.009
Cl%	0.55	0.57			ns	14.5	-

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, 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 99). 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 the palm circles. The weights of EFB given in Table 99 are the fresh weights ex-mill. When EFB was given for the first time in November 1988 the amount was 333kg/palm. In September 1990 it was increased to 500kg/palm, and it is intended to give this amount every two years.

Table 99. Amounts of fertiliser and EFB used in trial 312.

Type of fertiliser or EFB	Amount			
	Level 0	Level 1	Level 2	Level 3
		(kg/palm/yr)		
SoA	0	2	4	6
MoP	0	2	4	6
		(kg/palm/two/years)		
EFB	0	500	-	-

Notes: SoA and MoP have been applied twice a year since April 1988.

EFB has been applied once every two years (November 1988 and September 1990).

RESULTS

Yield data for 1992, and for the three years 1989 - 1992 are summarised in Tables 100 and 102.

SoA application caused a significant increase in yield of 4 t FFB/ha up to level 1 (2 kg SoA/palm) in 1992 and over the 3 year period (1989-1992). A further increase of about 2 t FFB/ha up to level 2. The increase in yield was the result of increased single bunch weight.

Application of MoP had no effect on yield. The K0 treatment produced a high yield of around 34t/ha/yr.

A response to EFB of around 3 tonnes was observed in 1992.

In the absence of EFB, the N treatment caused a steady increase in yield up to a rate of about 6kg SoA/palm/yr (Table 103). In the presence of EFB there is an increase in yield up to 4kg SoA/palm/yr.

The very high yields of the zero plots (around 28 - 30t/ha/yr) are probably the result of a combination of high residual soil fertility and the poaching effect of fertiliser 1 om neighbouring plots.

Table 100. Main effects of N, K, and I FB on yield and yield components in 1992 (Trial 312).

	Level of nutrients element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	30.0	34.3	37.6	38.3	**	10.2	4.1
Bunches/ha	1430	1450	1620	1680	*	10.2	182
Bunch wt (kg)	20.3	23.7	23.3	22.8	***	5.2	1.4
	K0	K1	K2	K3			
Yield (t/ha/yr)	34.5	34.6	35.0	35.0	ns	10.2	-
Bunches/ha	1550	1560	1550	1520	ns	10.2	-
Bunch wt (kg)	22.3	22.1	22.6	23.0	ns	5.2	-
	EFB0	EFB1					
Yield (t/ha/yr)	33.5	36.1			(ns)	10.2	(3.0)
Bunches/ha	1510	1580			ns	10.2	-
Bunch wt (kg)	22.1	22.9			ns	5.2	-

Table 101. Effect of combinations of N and K, N and EFB, and K and EFB on yield in 1992 (Trial 312).

	Yield (t/ha/yr)			
	Level of N			
Level of K	N0	N1	N2	N3
K0	29.4	36.0	37.1	35.7
K1	28.0	33.7	38.3	38.5
K2	28.0	34.8	37.0	39.9
K3	30.4	32.6	37.8	39.1
Level of EFB				
EFB0	26.0	33.0	36.0	38.9
EFB1	31.9	35.7	39.1	37.7
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	33.9	31.6	33.5	34.9
EFB1	35.2	37.7	36.4	35.1

NxK, NxEFB, and KxEFB interactions not significant.

Table 102. Main effects of N, K, and EFB on yield and yield components from 1989 to 1992 (Trial 312).

	Level of nutrient element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	30.0	33.7	35.7	35.7	***	5.5	2.2
Bunches/ha	1650	1660	1770	1780	ns	6.9	-
Bunch wt (kg)	18.2	20.3	20.2	20.1	**	5.2	1.2
	K0	K1	K2	K3			
Yield (t/ha/yr)	33.6	33.3	33.9	34.2	ns	5.5	-
Bunches/ha	1710	1710	1720	1720	ns	6.9	-
Bunch wt (kg)	19.6	19.5	19.7	20.0	ns	5.2	-
	EFB0	EFB1					
Yield (t/ha/yr)	33.4	34.1			ns	5.5	-
Bunches/ha	1720	1710			ns	6.9	-
Bunch wt (kg)	19.4	20.0			ns	5.2	-

Table 103. Effect of combinations of N and K, N and EFB on yield from 1989 to 1992 (Trial 312).

	Yield (t/ha/yr)			
	Level of N			
Level of K	N0	N1	N2	N3
K0	29.3	34.5	36.4	34.4
K1	29.4	34.0	35.3	34.4
K2	28.8	34.5	35.7	36.6
K3	32.3	31.8	35.5	37.4
Level of EFB				
EFB0	28.8	33.7	34.9	36.2
EFB1	31.1	33.7	36.6	35.2
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	34.0	31.4	33.2	35.0
EFB1	33.2	35.2	34.6	33.5

NxK, NxEFB, and KxEFB interactions not significant.

The analysis of frond 17 nutrient concentrations from sampling in October 1992 are presented in Tables 104 and 105.

SoA application significantly increased leaflet and rachis N and reduced the rachis P with a corresponding increase in leaflet P. All other elements remained unaffected.

MoP increased the level of Cl in the leaflets and increased all base elements in the rachis.

EFB produced a small but significant increase in rachis K. All other elements tested appeared to be increased slightly, but these effects were not statistically significant.

Table 104. Main effects of N, K, and EFB on concentrations of elements in leaflet tissue in 1992 (as % of dry matter) (Trial 312).

	Level of nutrient element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
N%	2.02	2.16	2.25	2.28	***	3.2	0.08
P%	0.134	0.137	0.140	0.140	**	2.0	0.003
K%	0.81	0.78	0.79	0.79	ns	11.1	-
Mg%	0.17	0.16	0.15	0.16	ns	10.9	-
Ca%	0.75	0.71	0.72	0.73	ns	6.9	-
Cl%	0.40	0.41	0.41	0.42	ns	8.2	-
	K0	K1	K2	K3			
N%	2.21	2.23	2.13	2.13	*	3.2	0.08
P%	0.139	0.140	0.136	0.137	ns	2.0	-
K%	0.83	0.80	0.75	0.78	ns	11.1	-
Mg%	0.16	0.16	0.17	0.16	ns	10.9	-
Ca%	0.71	0.73	0.72	0.75	ns	6.9	-
Cl%	0.32	0.41	0.46	0.45	***	8.2	0.04
	EFB0	EFB1					
N%	2.16	2.20			ns	3.2	-
P%	0.137	0.139			ns	2.0	-
K%	0.78	0.81			ns	11.1	-
Mg%	0.16	0.16			ns	10.9	-
Ca%	0.71	0.74			ns	6.9	-
Cl%	0.40	0.42			ns	8.2	-

Table 105. Main effects of N, K, and EFB on concentration of elements in the rachis in 1992 (% of drymatter) (Trial 312)

	Level of nutrient element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
N%	0.21	0.23	0.25	0.24	**	6.6	0.02
P%	0.124	0.103	0.081	0.096	ns	33.8	-
K%	1.52	1.40	1.35	1.41	ns	12.4	-
Mg%	0.05	0.05	0.05	0.05	ns	14.5	-
Ca%	0.33	0.35	0.35	0.34	ns	9.2	-
Cl%	0.67	0.65	0.67	0.74	ns	14.6	-
	K0	K1	K2	K3			
N%	0.22	0.24	0.24	0.23	ns	6.6	-
P%	0.103	0.084	0.112	0.104	ns	33.8	-
K%	1.19	1.38	1.50	1.61	**	12.4	0.20
Mg%	0.04	0.05	0.06	0.05	*	14.5	0.00
Ca%	0.30	0.33	0.37	0.38	**	9.2	0.04
Cl%	0.36	0.69	0.82	0.86	***	14.6	0.12
	EFB0	EFB1					
N%	0.23	0.24			ns	6.6	-
P%	0.104	0.098			ns	33.8	-
K%	1.35	1.50			*	12.4	0.14
Mg%	0.05	0.05			ns	14.5	-
Ca%	0.34	0.35			ns	9.2	-

Trial 317 FERTILISER TRIAL ON LOWER TERRACE AT 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 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 106).

Table 106. Types of fertiliser and amounts used in trial 317.

Element	Type of fertiliser	Amount of fertiliser Level 0	Level 1	Level 2
			(kg/palm/year)	
N	SOA	0	2.5	5
P	TSP	0	2.5	-
K	MOP	0	2.5	5
Mg	Kies	0	2.5	-

RESULTS

Year data for 1992 and for period from 1991 - 1992 are summarised in Table 107, 108 and 109.

There was a significant but small effect of K on yield, but no effect of N, P, or Mg (Table 108). All of the yields were heavy, with a baseline yield of about 27t/ha/yr.

As previously reported, the lack of response in this trial is due to the residual fertility of the soil, from the fertiliser that was given before the trial started.

Table 107. **Main effects of N, P, K, and Mg on yield and yield components in 1992 (Trial 317).**

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	28.9	28.6	27.0	ns	15.9	-
Bunches/ha	1450	1400	1420	ns	17.5	-
Bunch wt (kg)	20.1	20.6	19.0	ns	12.0	-
	P0	P1				
Yield (t/ha/yr)	27.7	28.7		ns	15.9	-
Bunches/ha	1400	1440		ns	17.5	-
Bunch wt (kg)	19.8	20.0		ns	12.0	-
	K0	K1	K2			
Yield (t/ha/yr)	26.8	27.1	30.7	ns	15.9	-
Bunches/ha	1420	1370	1470	ns	17.5	-
Bunch wt (kg)	19.0	20.0	20.8	ns	12.0	-
	Mg0	Mg1				
Yield (t/ha/yr)	27.6	28.8		ns	15.9	-
Bunches/ha	1440	1410		ns	17.5	-
Bunch wt (kg)	19.3	20.6		ns	12.0	-

Table 108. **Effect of K on yield at different levels of N in 1992 (Trial 317).**

	Yield (t/ha/yr) Level of K		
Level of N	0	1	2
0	27.7	26.4	32.7
1	25.9	29.0	30.9
2	26.9	25.9	28.3

Note: NxK interaction not significant.

Table 109. **Main effects of N, P, K, and Mg on yield and yield components from 1991 - 1992 (Trial 317).**

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	29.2	28.2	28.1	ns	10.3	-
Bunches/ha	1680	1600	1690	ns	12.8	-
Bunch wt (kg)	17.5	17.8	16.6	ns	8.9	-
	P0	P1				
Yield (t/ha/yr)	27.8	29.1		ns	10.3	-
Bunches/ha	1620	1690		ns	12.8	-
Bunch wt (kg)	17.2	17.3		ns	8.9	-
	K0	K1	K2			
Yield (t/ha/yr)	27.3	27.2	31.0	**	10.3	2.5
Bunches/ha	1640	1590	1740	ns	12.8	-
Bunch wt (kg)	16.7	17.3	17.8	ns	8.9	-
	Mg0	Mg1				
Yield (t/ha/yr)	27.9	29.1		ns	10.3	-
Bunches/ha	1650	1650		ns	12.8	-
Bunch wt (kg)	16.8	17.7		ns	8.9	-

Table 110. **Effect of K on yield at different levels of N in 1991 - 1992 (Trial 317).**

	Yield (t/ha/yr) Level of K		
Level of N	0	1	2
0	27.8	27.6	32.4
1	26.1	27.8	30.5
2	27.9	26.3	30.0

Note NxK **interaction not significant.**

The analysis from nutrient sampling in January 1992 are presented in Tables 111 and 112.

SoA applications had no effect on leaflet N, but has significantly reduced rachis P and K.

TSP applications has improved the P status in both leaf and rachis, and a significant increase in leaf K.

MOP applications had improved K, P, and Cl status in the palms and depressed leaf Ca.

Applications of Kieserite significantly raised levels in the leaf and rachis. Magnesium deficiency symptoms have been observed in the trial, though it will be interesting to note any significant increases in yield due to magnesium applications.

Table 111. Main effects of N, P, K, and Mg on concentrations of elements in leaf tissue in 1992 (% of dry matter) (Trial 317).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	2.50	2.57	2.54	ns	3.8	-
P%	0.166	0.167	0.167	ns	2.1	-
K%	0.80	0.86	0.79	ns	9.3	-
Mg%	0.16	0.16	0.15	ns	22.8	-
Ca%	1.00	0.98	1.01	ns	11.8	-
Cl%	0.33	0.36	0.37	ns	23.4	-
	P0	P1				
N%	2.51	2.56		ns	3.8	-
P%	0.164	0.169		***	2.1	0.003
K%	0.79	0.85		*	9.3	0.05
Mg%	0.16	0.16		ns	22.8	-
Ca%	0.97	1.02		ns	11.8	-
Cl%	0.34	0.37		ns	23.4	-
	K0	K1	K2			
N%	2.51	2.53	2.57	ns	3.8	-
P%	0.165	0.166	0.169	(ns)	2.1	(0.003)
K%	0.78	0.80	0.88	**	9.3	0.07
Mg%	0.16	0.15	0.16	ns	22.8	-
Ca%	1.01	1.01	0.98	ns	11.8	-
Cl%	0.27	0.38	0.42	***	23.4	0.07
	Mg0	Mg1				
N%	2.53	2.54		ns	3.8	-
P%	0.168	0.166		ns	2.1	-
K%	0.84	0.79		(ns)	9.3	(0.05)
Mg%	0.14	0.18		**	22.8	0.03
Ca%	1.02	0.98		ns	11.8	-
Cl%	0.35	0.36		ns	23.4	-

Table 112. Main effects of N, P, K, and Mg on concentrations of elements in the rachis in 1992 (% of dry matter) (Trial 317).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	0.19	0.19	0.20	ns	9.3	-
P%	0.069	0.066	0.055	*	17.2	0.009
K%	0.74	0.68	0.56	**	18.0	0.1
Mg%	0.07	0.07	0.06	ns	16.7	-
Ca%	0.46	0.46	0.51	ns	21.5	-
Cl%	0.37	0.34	0.35	ns	23.2	-
	P0	P1				
N%	0.20	0.19		ns	9.3	-
P%	0.055	0.072		***	17.2	0.008
K%	0.67	0.65		ns	18.0	-
Mg%	0.07	0.06		ns	16.7	-
Ca%	0.47	0.49		ns	21.5	-
Cl%	0.35	0.37		ns	23.2	-
	K0	K1	K2			
N%	0.19	0.19	0.20	ns	9.3	-
P%	0.05	0.07	0.07	***	17.2	0.009
K%	0.36	0.65	0.96	***	18.0	0.1
Mg%	0.06	0.07	0.07	ns	16.7	-
Ca%	0.46	0.51	0.46	ns	21.5	-
Cl%	0.10	0.40	0.57	***	23.2	0.07
	Mg0	Mg1				
N%	0.19	0.19		ns	9.3	-
P%	0.065	0.061		ns	17.2	-
K%	0.67	0.65		ns	18.0	-
Mg%	0.05	0.08		***	16.7	0.008
Ca%	0.48	0.48		ns	21.5	-
Cl%	0.33	0.38		ns	23.2	-

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.
Treatyments 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 113).

Table 113. Types of fertiliser and amounts used in trial 318.

Element	Type of fertiliser	Amount of fertiliser Level 0	Level 1	Level 2
		(kg/palm/year)		
N	SOA	0	2.5	5
P	TSP	0	2.5	-
K	MOP	0	2.5	5
Mg	Kies	0	2.5	-

RESULTS

None of the treatments had a significant effect on yield (Table 114, 115 and 116), though there was a significant effect of N on single bunch weights. All of the yields were heavy with a baseline yield of about 27t/ha/yr, as in trial 317.

It is possible that the lack of response in this trial is due to residual fertility of the soil, from the fertiliser that was given before the trial started. The experimental treatments started in March 1990.

Table 114. Main effects of N, P, K, and Mg on yield and yield components in 1992 (Trial 318).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	24.9	30.3	28.3	ns	23.4	-
Bunches/ha	1500	1530	1520	ns	15.7	-
Bunch wt (kg)	16.5	19.8	18.6	*	15.1	2.4
	P0	P1				
Yield (t/ha/yr)	28.6	27.0		ns	23.4	-
Bunches/ha	1530	1500		ns	15.7	-
Bunch wt (kg)	18.8	17.8		ns	15.1	-
	K0	K1	K2			
Yield (t/ha/yr)	25.5	28.3	29.7	ns	23.4	-
Bunches/ha	1470	1520	1570	ns	15.7	-
Bunch wt (kg)	17.3	18.6	18.9	ns	15.1	-
	Mg0	Mg1				
Yield (t/ha/yr)	26.1	29.6		ns	23.4	-
Bunches/ha	1440	1590		ns	15.7	-
Bunch wt (kg)	17.9	18.7		ns	15.1	-

Table 115. Effect of K on yield at different levels of N (Trial 318)

	Yield of K		
	Level of K		
Level of N	0	1	2
0	20.9	26.1	27.6
1	27.4	31.3	32.2
2	28.1	27.4	29.4

Note: NxK interaction not significant.

Table 116. Main effects of N, P, K, and Mg on yield and yield components from 1991 to 1992 (Trial 318).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	28.0	29.1	29.0	ns	14.3	-
Bunches/ha	1860	1690	1820	ns	9.5	-
Bunch wt (kg)	15.0	17.2	16.0	*	10.5	1.5
	P0	P1				
Yield (t/ha/yr)	28.7	28.6		ns	14.3	-
Bunches/ha	1770	1810		ns	9.5	-
Bunch wt (kg)	16.4	15.8		ns	10.5	-
	K0	K1	K2			
Yield (t/ha/yr)	26.7	29.1	30.2	ns	14.3	-
Bunches/ha	1730	1810	1820	ns	9.5	-
Bunch wt (kg)	15.5	16.1	16.6	ns	10.5	-
	Mg0	Mg1				
Yield (t/ha/yr)	27.9	29.4		ns	14.3	-
Bunches/ha	1760	1820		ns	9.5	-
Bunch wt (kg)	15.9	16.3		ns	10.5	-

Table 117. Effect of K on yield at different levels of N (Trial 318).

	Yield (t/ha/yr)		
	Level of K		
Level of N	0	1	2
0	25.1	28.8	30.0
1	26.1	29.8	31.3
2	29.0	28.7	29.3

Note: NxK interaction not significant.

The analysis of nutrients from sampling in January 1992 are presented in Tables 118 and 119.

SOA applications had no significant effect on leaf N, although there was a significant depressing effect on rachis P. There were a small increase in leaf K and Cl observed, but were not significant.

TSP responses were not significant.

As observed in trial 317, MOP did improve leaf and rachis K, but the leaf levels were not significant. Cl was increased in both the leaf and rachis significantly. Otherwise MOP had a depressing effect on plant Ca and rachis Mg. Also observed in the trial are symptoms of Potassium deficiency.

Applications of Kieserite improved the Mg status in both leaf and rachis. As seen in trial 317, Magnesium deficiency symptoms appear very clearly in plots not treated with Kieserite.

Table 118. Main effects of N, P, K and Mg on concentrations of elements in leaf tissue in 1992 (% of dry matter) (Trial 318).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	2.45	2.51	2.52	ns	5.2	-
P%	0.168	0.166	0.168	ns	3.1	-
K%	0.87	0.91	0.93	ns	22.0	-
Mg%	0.16	0.16	0.15	ns	29.5	-
Ca%	0.86	0.86	0.85	ns	14.2	-
Cl%	0.41	0.44	0.43	ns	9.8	-
	P0	P1				
N%	2.51	2.48		ns	5.2	-
P%	0.166	0.170		ns	3.1	-
K%	0.88	0.89		ns	22.0	-
Mg%	0.19	0.17		ns	29.5	-
Ca%	0.87	0.84		ns	14.2	-
Cl%	0.42	0.43		ns	9.8	-
	K0	K1	K2			
N%	2.51	2.48	2.51	ns	5.2	-
P%	0.170	0.167	0.165	ns	3.1	-
K%	0.80	0.91	0.93	ns	22.0	-
Mg%	0.19	0.17	0.19	ns	29.5	-
Ca%	0.87	0.85	0.84	ns	14.2	-
Cl%	0.36	0.45	0.46	***	9.8	0.04
	Mg0	Mg1				
N%	2.47	2.53		ns	5.2	-
P%	0.166	0.168		ns	3.1	-
K%	0.93	0.84		ns	22.0	-
Mg%	0.15	0.22		**	29.5	0.04
Ca%	0.84	0.87		ns	14.2	-
Cl%	0.42	0.43		ns	9.8	-

Table 119. Main effects of N, P, K, and Mg on concentrations of elements in the rachis in 1992 (% of dry matter) (Trial 318).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	0.20	0.22	0.21	ns	8.8	-
P%	0.075	0.068	0.063	*	15.0	0.009
K%	0.75	0.85	0.79	ns	28.0	-
Mg%	0.08	0.07	0.07	ns	36.6	-
Ca%	0.37	0.36	0.36	ns	22.1	-
Cl%	0.43	0.47	0.45	ns	45.0	-
	P0	P1				
N%	0.21	0.21		ns	8.8	-
P%	0.066	0.072		(ns)	15.0	0.007
K%	0.84	0.76		ns	28.0	-
Mg%	0.07	0.08		ns	36.0	-
Ca%	0.35	0.37		ns	22.1	-
Cl%	0.45	0.45		ns	45.0	-
	K0	K1	K2			
N%	0.20	0.22	0.21	ns	8.8	-
P%	0.061	0.071	0.075	**	15.0	0.009
K%	0.40	0.80	1.19	***	28.0	0.19
Mg%	0.09	0.07	0.06	(ns)	36.0	0.02
Ca%	0.40	0.37	0.32	ns	22.1	-
Cl%	0.26	0.43	0.65	***	45.0	0.18
	Mg0	Mg1				
N%	0.21	0.21		ns	8.8	-
P%	0.070	0.068		ns	15.0	-
K%	0.80	0.79		ns	28.0	-
Mg%	0.06	0.09		***	36.0	0.02
Ca%	0.38	0.35		ns	22.1	-
Cl%	0.45	0.45		ns	45.0	-

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.

INTRODUCTION

The weevil was first released in Papua New Guinea in 1981, in West New Britain and Oro Province. In April, 1989 it was released in Milne Bay 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 Province) and Baia, Bolegeia and Maramakas Estates (New Ireland Province). In each estate a group of 100 palms are used and the following parameters are observed:

- Number of *Elaeidobius* emerging from 20 individual male spikelets.
- Number of anthesing male and receptive female inflorescences at anthesis. (As a rule of thumb, ten anthesing males are required per hectare to achieve good pollination)
- Percentage fruitset was determined on 20 bunches each month. (Less than 50% is considered poor).

MILNE BAY PROVINCE

Weevil Population

The number of weevils emerging from male spikelets at Hagita and Waigani Estates in 1992 is shown (Figure 2). The data showed high emergence numbers throughout the year at both locations, although they was a small drop in March. An average of 114 and 124 weevils/spikelet was recorded at Hagita and Waigani respectively. This indicates an adequate weevil population throughout the period, adequate pollination would be expected.

Flower Census

The numbers of anthesing male inflorescences appeared low in January - July then slightly improving in August - December at both Hagita and Waigani (Figure 3).

Percentage Fruitset

The percentage fruitset was low in January, February, March and April at both estates, and was low at Waigani in October, November and December (Figure 4). Shortage of male inflorescences along with the low weevil population in the preceding six months (July - October 1991) may have probably caused the low fruitset values obtained in the earlier part of 1992.

Hagita estate produced high fruitset for eight months, the highest value of 68% occurring in June. Waigani estate produced high fruitset for six months, the highest value of 67% occurring in July. The average annual fruitset continued to improve with the palm age in Milne Bay, from 42% in 1990, 49% in 1991 to 54% in 1992 at Hagita and from 42% in 1990, 48% in 1991 to 54% at Waigani.

Figure 2: Weevil Emergence at Milne Bay in 1992

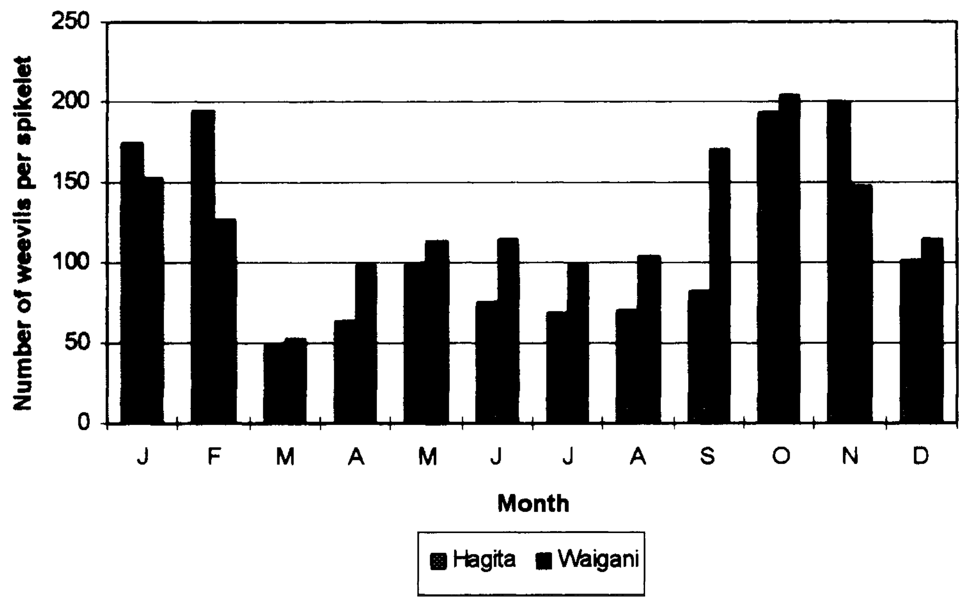


Figure 3: Number of male inflorescences at anthesis (average per day in 100 palms) at Milne bay in 1992

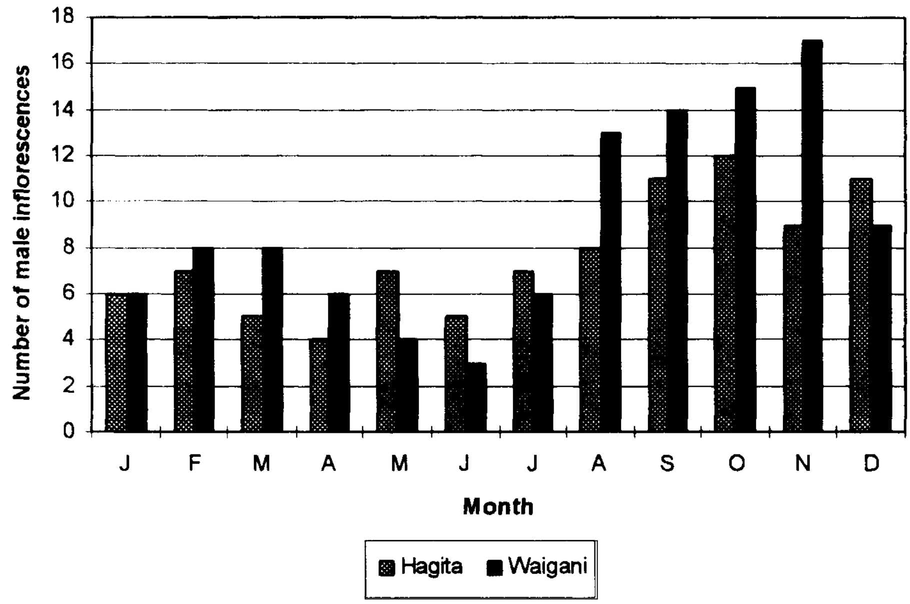
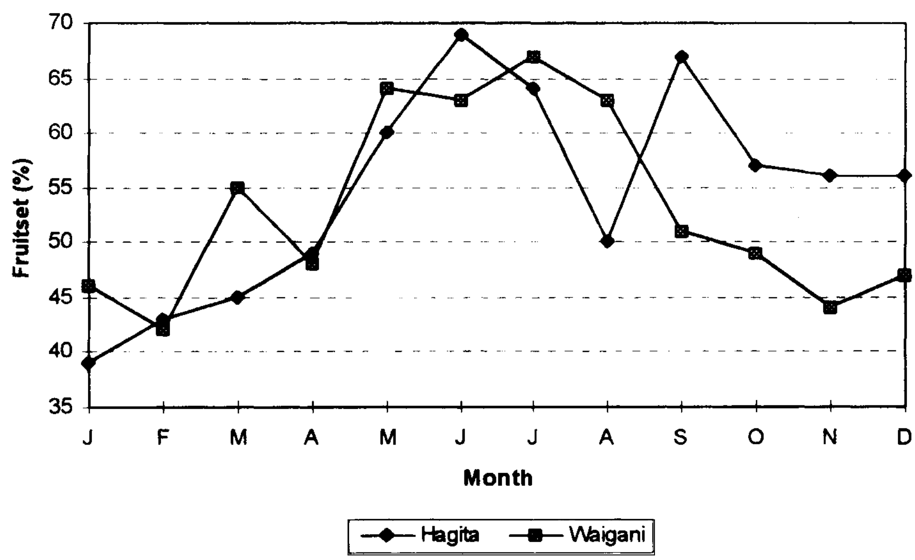


Figure 4: Percentage fruitset at Milne Bay in 1992.



Weevil Population

Counting of the number of weevils emerging from male spikelets commenced in June for Baia, Bolegila and Maramakas estates (Figures 5). It indicates a reasonable establishment of the pollinating weevil following the release in April 1991.

Flower Census

The numbers of anthesing male inflorescences were low during most of the year (Figure 6). This was more marked at Maramakas than Baia where the lowest values of 0.4, 0.5 and 2 males per 100 palms were recorded in March, April and May respectively. As a consequence, inadequate pollination would be anticipated in the subsequent 5-6 months (July - October) due to a pollen deficit.

Percentage Fruitset

The percentage fruitset at Baia and Maramakas for 1992 (including November and December 1991) is shown (Figure 7). High fruitset values of 73% and 67% were recorded in March at Maramakas and Baia respectively. The low fruitset values in June, July and later in September and October may have resulted from the shortage of pollen experienced in the earlier part of the year. However, overall the first complete years fruitset data from Poliamba showed an acceptable annual mean of 54% at both Baia and Maramakas.

Figure 5: Weevil Emergence at Poliamba Jun - Dec 1992

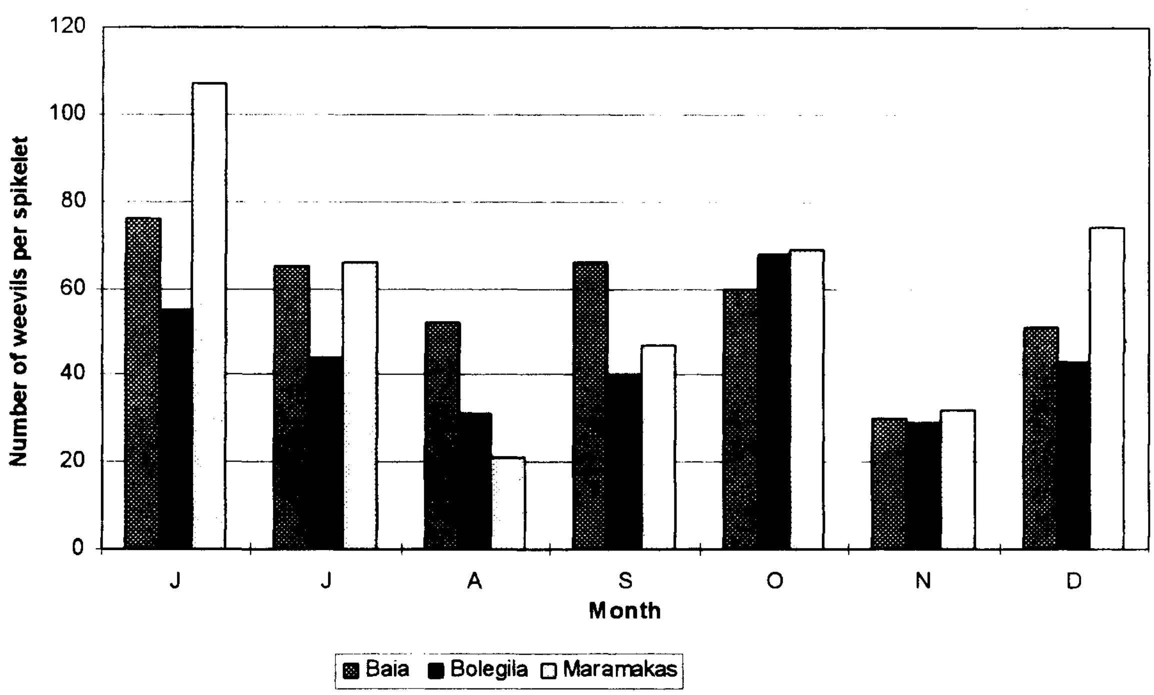


Figure 6: Number of male inflorescences at anthesis (average per day in 100 palms) at Poliamba in 1992.

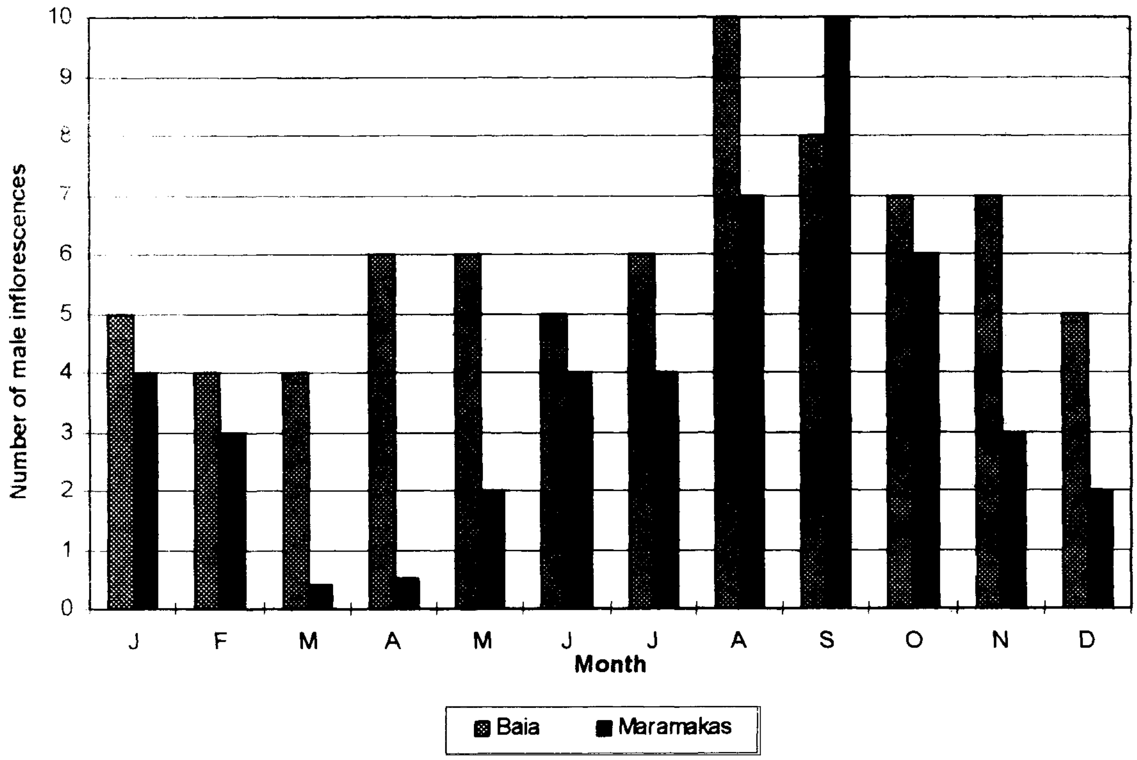
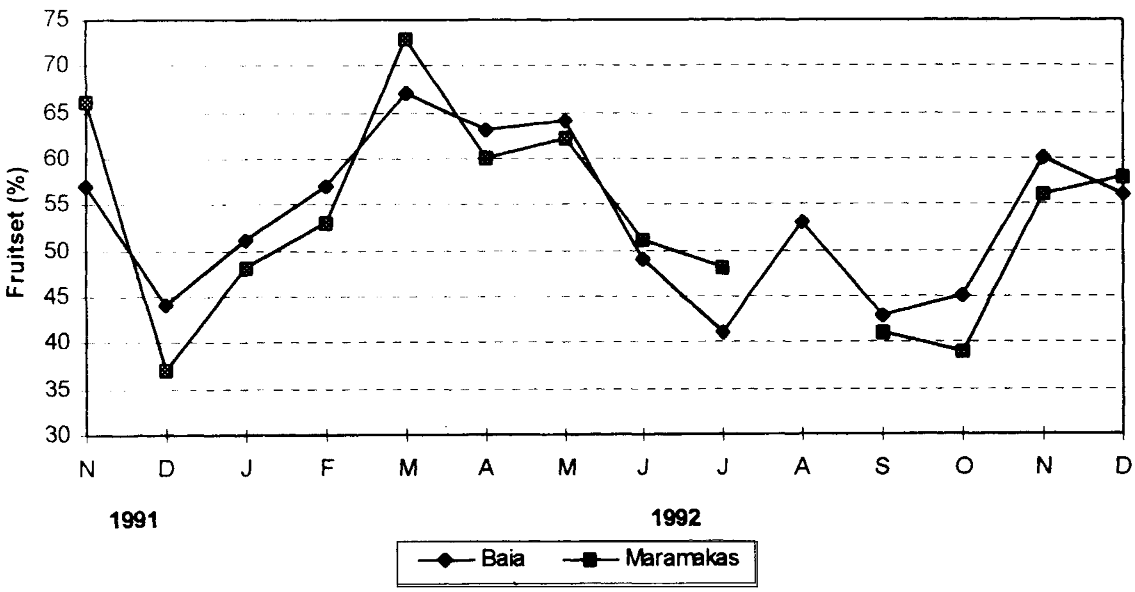


Figure 7: Percentage fruitset at Poliamba in 1992



PURPOSE

To determine the cause of seasonally poor pollination and subsequent yield trough experienced throughout the development.

INTRODUCTION

Observations were made at 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 parameters were assessed;

- 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).

RESULTS

Weevil Population

The numbers of *Elaeidobius* emerging from male spikelets at the four sites were very low in January, February and March (Figure 8). Low number of weevils were later seen in May, November and December, particularly at Kautu I and Kautu II. The annual mean number of weevil emerging per spikelet was 56 at Kautu I, 57 at Kautu II, 76 at Bilomi and 75 at Kaurausu. Generally the weevil population was acceptable for most months of the year.

Figure 8: Weevil emergence at Kapiura in 1992

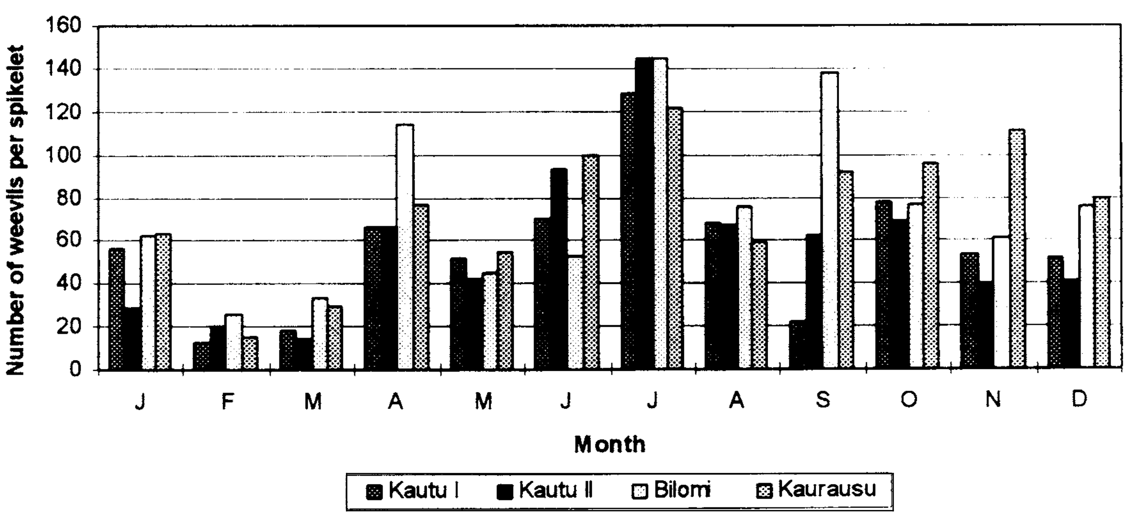


Figure 9: Number of male inflorescences at anthesis (average per day in 120, 115, 115 and 116 palms) at Kapiura in 1992

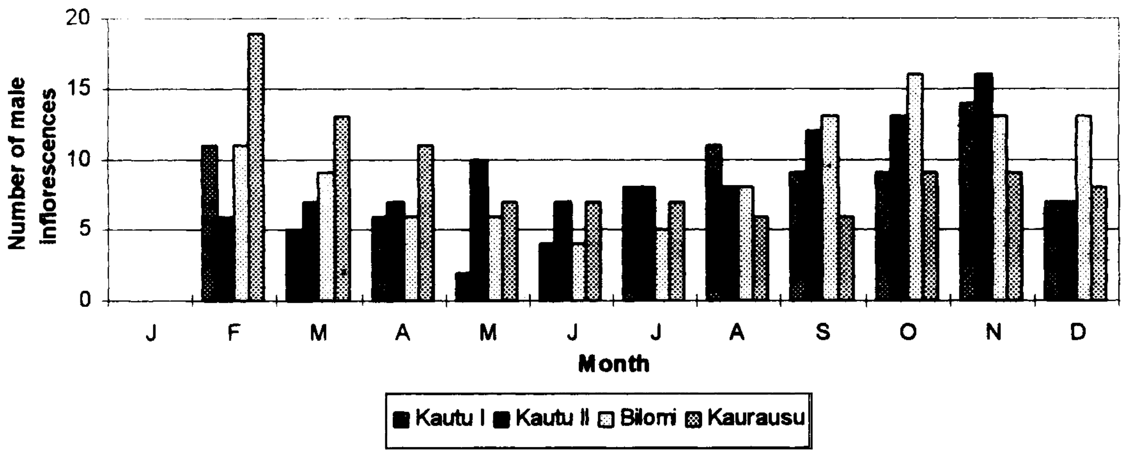
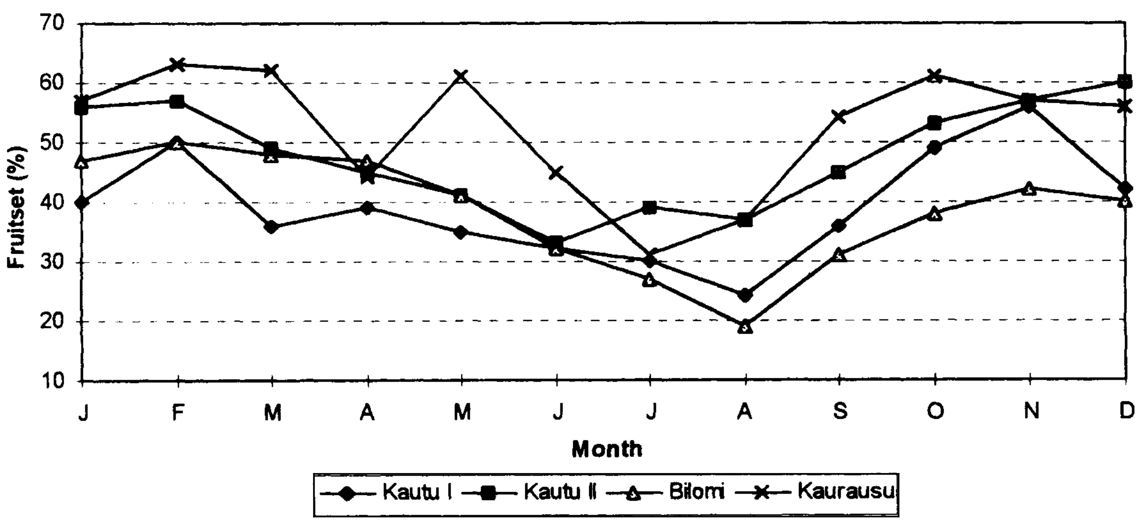


Figure 10: Percentage fruitset at Kapiura in 1992



Flower Census

The number of anthesing male inflorescences appeared low in April, May, June, July and August at all four sites (Figure 9).

Fruitset (%)

The percentage fruitset was relatively low from March - September at all locations (Figure 10). With the exception of Kaurausu, the Kautu I & II and Bilomi sites showed a similar trend in their fruitset fluctuations. Poor fruitset (40% or less) was seen to occur from May - August the timing of which reflects the serious situation observed in 1991 where poor pollination had resulted in very low fruitset and yield. The exact cause of the seasonally poor fruitset during the May to August period is difficult to ascertain at this stage, however it is possible that a number of factors or combinations of factors may have contributed to this phenomenon. Some possible factors suggested by the initial data are:

- Heavy rainfall during January, February, March and April.
- Low weevil density and restricted activity during the prolonged rains.
- Insufficient male inflorescences and possible shortage of pollen in April - August.
- Compaction of the basal portion of young bunches

The effect of continous heavy rainfall in February, March and April (Figure 11) on the population density and the mobility of Elaeidobius to effectively transfer pollen is manifested later in June, July and August (Figure 10) as very low fruitsets (below 40%). In young palms this effect is confounded by a lack of pollen source due to low male inflorescence numbers.

An aspect to be considering as contributing to poor fruitset in this age of palm (1986 - 1989 plantings) is the compaction of developing bunches between the frond base and trunk. This does limit the access of the weevil.

Fruitset data from the basal part of the bunch is usually very low (< 15%) which contributes to the low average fruitset for the whole bunch.

Sticky Trap Observation

Sticky traps (flywire mesh covered in an adhesive substance) enclosing receptive female inflorescences were set in June, July, August, October and November. This observation was to monitor the visiting of *Elaeidobius* to receptive females and to give some indication of the strength of scent released from the female inflorescence and its attractiveness to the weevil.

Table 119. Mean number of *Elaeidobius* trapped while attempting to visit the receptive female inflorescences and which became stuck to the flywire over a three day period.

Location	Month traps set	Rainfall mm	Mean number of E.k trapped per female inflorescence	Range
Kautu I	June 1992	113	7,081 weevils /♀ inflo	(6,900-7,790 *E.k*)
	October 1992	203	8,150 weevils/♀ inflo	(4,120-16,336 *E.k.*)
Kautu II	June 1992	113	5,256 weevils/♀ inflo	(4,120-9,669 *E.k.*)
	November 1992	166	8,350 weevils/♀ inflo	(3,600-13,563 *E.k.*)
Bilomi	July 1992	217	5,688 weevils/♀ inflo	(2,340-9,735 *E.k.*)
	January 1993	503	2,988 weevils/♀ inflo	(1,980-4,713 *E.k.*)
Kaurausu	August 1992	148	8,313 weevils/♀ inflo	(5,225-10,365 *E.k.*)
	February 1993	578	5,062 weevils/♀ inflo	(7,350-7,734 *E.k.*)

The numbers of weevil trapped whilst visiting receptive females indicated a relatively high weevil density throughout the sites being assessed (Table 319). It could therefore be anticipated that fruitset values in the subsequent 5-6 months (October - December, January - March 1993) would be adequate, giving values over 60% (Syed considers 1,500 weevil is required to give fruitset over 50% and about 3,000-6,000 weevils per female inflorescence to achieve even higher fruitset of over 60%). Traps set in January and February 1993 at Bilomi and Kaurausu indicated high weevil density and activity even during the heavy rains, therefore fruitset would be expected to be adequate in the subsequent 5 to 6 months (May - July 1993).

Pollen Viability

Pollen germination tests were carried out between February and July (Table 320). Assessments were not carried out between August and December due to equipment failure. The data from first half of the year indicated that the pollen was sufficiently viable with an average value of 85%.

Table 120. Gives the mean pollen viability results for the four locations at Kapiura in 1992.

	Mean Pollen Viability (%)			
	Kautu 1	Kautu II	Bilomi	Kaurausu
Jan				
Feb	82.5	88.0	82.3	81.7
Mar	85.2	86.2	86.8	82.2
Apr	81.6	83.4	84.7	84.3
May	90.7	89.9	87.7	88.4
Jun	86.0	88.1	88.1	90.0
Jul	80.3	81.4	81.4	79.9

No further tests were done from August - December. The above results indicate that pollen was viable throughout the earlier part of 1992.

Assisted Pollination

No progress was made this year.

INVESTIGATION 601 CONTROL OF SEXAVA (ORTHOPTERA: TETTIGONIIDAE, MECOPODINAE) USING CHEMICALS.

PURPOSE

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

INTRODUCTION

Sexava (plural - sexavae) is a common name used to describe several related species of the longhorned coconut or treehoppers found on coconut and oil palm, particularly of the Melanesian subregion. 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* (Krastner) occurring on the mainland and *Segestidea rufipalpis* (C. Willemse) on the island of Misima on coconuts. Todate, there have been no recorded cases of these two species feeding 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 coconut but these are not yet recorded on oil palm.

Outbreaks of sexavae in oil palm can be controlled by trunk injection of insecticides (commonly monocrotophos or acephate).

PROGRESS

In West New Britain, the area requiring chemical treatment continued to decrease markedly from 1991. The total area treated in 1992 was under 500 ha compared with 1823 ha in 1991. The area treated comprised of 400 ha of smallholding (on 100 blocks) and less than 100 ha of plantations at Dami and Navo Plantations.

At Navo Plantation near Bialla, the stickinsect *Eurycantha calcarata* (Phasmatodea:Phasmatidae) in association with sexava, *Segestidea defoliaria* caused severe defoliation of palms to produce the characteristic skeletonised 'broomstick' appearance.

Smallholder blocks at Bialla continued to experience more sexava infestation problems than other areas, mostly due to lack of block hygiene. Delay by the OPIC sexava injection team to treat some blocks also contributed to the increasing infestation and dispersal of the pest.

In West New Britain, *Segestes decoratus* (a species of sexava thought to reproduce parthenogenetically) was located on both coconut and oil palm at Dami. No chemical treatment was recommended, but egg-parasitoids had being continuously released.

In Oro Province no damage of economic significance was reported for *Segestidea novaeguineae*. Presence of natural control agents in the province such as the tachinid fly (*Exorista notabilis*) and the internal parasite, *Stichotrema dallatorreanum*, plus their predators have probably kept the pest population in check.

No reports of sexavae damage on oil palm was recorded for Milne Bay and New Ireland Provinces.

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.

INTRODUCTION

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

PROGRESS

Parasitoids of the sexava eggs were reared and released throughout the year (Table 121), mainly in areas where recently outbreaks had occurred. They were sometimes released concurrently with the chemical treatment.

Table 121 Number of individuals of two species of parasitoid of sexava that were released during 1992 at various sites

	Number of Parasites	
SITE	*Leefmansia bicolor*	*Doirania leefmansi*
Bebere Plantation	-	44,000
Bialla Subdivisions/VOP	24,520	154,000
Buvussi Subdivision	8,000	-
Cape Glouscester (coconuts)*	11,200	44,000
Dami Plantation	74,000	303,800
Kumbango Plantation	17,600	98,000
Navarai Plantation	16,400	22,000
Navo Plantation, Bialla	23,800	126,800
Rikau VOP	2,000	20.000
Tamba Subdivision	-	44,000
TOTAL	177,520	856,600

*Note: * This release was made on the request of the Economic Services of WNB Provincial Goverment*

Just over 1.0 million parasitoids were released in 1992, compared to more than 2.5 million released in 1991. The marked decline in the quantity of the parasitoids released was primarily due to shortage of the parasitoid rearing media, ie. sexava eggs. Due to a scarcity of wild sexava, it was not possible to maintain a sufficiently high sexeva population in the laboratory, this resulted in low egg production. Therefore, in order to continuously maintain, rear and release sufficient quantity of the two egg-parasitoids year, an alternate method of culturing the parasitoids is would appear necessary, particularly when adult sexava numbers become low. The idea of rearing parasitoids on semi-synthetic media should be given reconsidered. It is essential that parasitoids are continously reared and released in large numbers even when pest population are low in the fields. This would ensure good control of the sexava.

Sexava eggs were collected from fields where the two egg-parasitoids had been released earlier. The aim being to obtain evidence of parasitoid establishment. Of the 122 eggs collected, 8 exhibited obvious parasitoid emergence holes, indicating about 7% parasitism. This method gives a reasonable indication of the establishment and survival of the parasites in the fields after release.

The endoparasite of sexava, *Stichotrema dallatorreamum* (Strepsiptera: Myrmecolacidae) studies continued duriong the year. A laboratory reared colony of ants, (*Camponotus sp.*) was impregnated with emerging triungulins (ie; first instar larvae) from parasitized sexava specimens from Popondetta. No evidence of stylops development was observed. This work will continue.

INVESTIGATION 606 CONTROL OF BAGWORMS (LEPIDOPTERA:PSYCHIDAE)

PURPOSE

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

INTRODUCTION

Bagworms are caterpillars of various species of moth, that attach to the underside of oil palm leaves, in 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 still 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 emerge from 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

In West New Britain, light to moderate infestation by the 'rough' bagworm, *Mahasena corbetti* Tams was recorded at Bilomi Plantation at Kapiura. Samples taken fortnighlty and monthly show high mortality rates of 22-89% with 6-58%, being due to parasitism by their natural enemies, mainly tachinid flies and a species of chalcid wasp. No chemical control was recommended.

Monthly monitoring continued which later revealed a decline in the pest numbers and infestation levels and an increase in the number of its natural enemies.

Light bagworm infestation was present at Kumbango and Togulo Plantations.

In Oro Province, *Mahasena corbetti, Clania* sp. and the 'ice cream' cone bagworms were reported from Embi and smallholder blocks. Damage remained light and of no economic significance. Monthly monitoring and sampling at Embi continue to show high mortality and parasitism, ranging from 24-27% and 6-19% respectively. Parasitic Diptera and Hymenoptera are the most commonly occuring natural enemies. Fungal pathogens have also been reported. An increasing occurrence of the 'ice cream' cone bagworm was reported in October. However, damage was light and good control by it's natural enemies was reported.

In New Ireland, light bagworm damage was reported from Poliamba. A high parasitism rate of 61% was recorded.

No report of bagworm damage was recorded from Milne Bay Province.

INVESTIGATION 605 OBSERVATIONS 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

In West New Britain, the following insect pests were reported; the Sugarcane weevil, *Rhabdocelis obscurus* Boidsducal (Coleoptera:Curculionidae), the bunch or coconut spike-moth, *Tirathaba rufivena* Wlk. (Lepidoptera:Pyralidae) and an unknown species of moth.

The Sugarcane weevil was reported as causing damage to mature frond bases at Bebere Plantation. Further investigation confirmed that the pest was being attracted to the smell of the fractured or rotting tissue which was associated with the high incidence of leaf base wilt that was experienced in March/April period. No economically significant damage was observed and no treatment was recommended.

Tirathaba rufivena was reported at Bebere and Kapiura Plantations. Light damage by the larvae of the moth was observed on post-anthesing male inflorescences and young developing fruits. The pest is commonly seen occuring on young plantings and at the same time various parasitic wasps are known to attack it. Therefore, it's numbers can be expected to decline as the palms grow older and with the expected increase in the number of its natural enemies.

At Togulo Plantation (WNBP), light damage by the unidentified lepidopteran (a moth) was reported (the first appearance of this pest was reported in PNGOPRA Annual Report 1991). Most larvae and pupae were found parasitised by braconid and chalcid wasps therefore good natural control can be expected.

Another unidentified species of moth was reported to be causing extensive defoliation on a fern, *Diplazium sp.* at Bebere. The fern is a weed in most plantations, growing profusely in swampy areas or beside creeks and streams running through plantations. Larvae were reared to adults in laboratory and sent to DAL Konedobu for identification. There may be a possibility of using the moth as a biocontrol agent for the fern.

In Oro Province, a species of a longicorn beetle (Coleoptera) was reported inflicting slight damage to oil palm foliage.

In Milne Bay, light rat damage has been continuously reported on male inflorescences.

In New Ireland, varying degree of rat damage has been reported on male inflorescences and black bunches. An aggressive species of ant was reported as predating on the pollination weevil larvae. No control measure was recommended but monthly monitoring continues.

INVESTIGATION 608 CONTROL OF *SCAPANES* AND *ORYCTES*

PURPOSE

To determine whether 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.

INTRODUCTION

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 stand trunks should be covered by a fast growing legume to hide them so that the beetles do not lay eggs there. Rhinoceros beetles from neighbouring jungle will 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

In West New Britain, light *Scapanes* damage occurred at Kapiura Plantations. The beetle attack is confined to young and underplanted palms and is scattered throughout the development. At Bilomi Plantation, one underplanted palm was severely damaged by Scapanes and had its damaged spear cut and removed. The palm was cleared and ten adult beetles were collected, consisting of four males and six females. The palm was fully recovered.

No reports of rhinoceros beetle damage was reported for New Ireland, Milne Bay or Oro Provinces.

PATHOLOGY

In West New Britain, the first reports of palms affected by diseases were reported from Sarakolok Subdivision and Malilimi Plantation. At Sarakolok, two palms showed symptoms of the upper stem rot and stem wet rot diseases. Though the pathogens responsible for these conditions are not known, it is possible that a species of *Ganoderma* may have caused the rotting and the subsequent collapse of one of the palms. Bracket shaped sporophores having a chocolate brown colour on the upper surface and with white colouring on the under side were collected (similar to Turner's (1980) description of *Ganoderma* sporophores). The bracket specimens were sent to the International Mycological Institute (IMI), UK for identification in May.

The recommendation was to fell, dig and burn up *in situ* the two diseased palms.

At Malilimi, one palm was reported suffering from stem wet rot while another suffering from a bud and spear rot. The palm suffering from stem wet rot was recommended for felling and burning *in situ.*

In Oro Province, several palms were reported suffering from basal stem rot and upper stem rot diseases on both smallholdings and estates. At an Iseveni smallholding; five palms were reported suffering from basal stem rot with one reported as yielding spores of *Armillariella mellea*. Two palms were reported suffering from upper stem rot and yielding sporophores of *Phellinus noxius*. *Ganoderma* was also reported occurring in conjunction with *Armillariella mellea*. The recommendation was to fell and burn the affected palms in situ.

No incidence of disease was reported for the Milne Bay and New Ireland developments.

APPENDICES

Appendix I	Meteorological Data
Appendix II	Soil Analysis Data

APPENDIX 1

METEOROLOGICAL DATA

Table 122 Rainfall (mm) at all sites in 1992

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
West New Britain Province													
Dami	401	558	684	433	179	43	84	229	94	71	106	317	3200
Bebere	558	827	759	344	221	62	75	201	75	54	129	439	3844
Kumbango	433	811	995	395	210	15	51	180	69	143	127	532	3997
Malilimi	276	319	626	415	346	50	208	201	116	16	25	534	3232
Togulo	749	868	957	672	252	53	119	189	157	152	87	578	4533
Kautu	473	540	689	605	268	113	217	147	118	206	166	507	4046
Hargy	1287	898	1071	574	319	209	500	208	76	196	195	665	6198
Navo	1044	753	1045	455	257	202	-	-	-	-	-	-	3756
Oro Province													
Sangara	307	284	361	296	175	62	58	45	43	133	118	170	2286
Ambogo	432	246	310	250	139	34	42	65	12	63	109	200	2118
OPRA Higaturu	355	325	346	305	137	85	59	59	56	139	112	170	2368
Milne Bay Province													
Hagita	59	269	160	143	340	91	196	63	00	47	17	227	1612
Waigani	104	259	256	220	328	124	197	64	2	68	24	29	1675
GiliGili	141	255	164	161	360	124	187	58	10	43	66	294	1863
New Ireland Province													
Lakuramau	344	317	354	151	215	150	107	201	126	338	178	-	2481

TABLE 123 Meteorological Data from Dami, 1970 -1992

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1970-1992	1992	1970-1992	1992	1970-1992	1992
January	616	401	25	25	114	94
February	629	558	24	25	109	88
March	546	684	25	27	120	85
April	352	433	21	18	148	135
May	221	179	17	15	167	178
June	153	43	15	7	161	151
July	185	84	16	14	148	107
August	164	229	15	10	174	136
September	165	95	13	11	178	191
October	176	71	15	8	175	174
November	235	106	17	10	175	192
December	427	317	22	23	124	86
Total	3869	3200	213	193	1793	1617

Table 124 Meteorological Data from Higaturu, 1981-1992

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1981-1992	1992	1981-1992	1992	1981-1992	1992
January	403	355	25	17	211	174
February	344	325	26	21	172	151
March	381	346	26	27	200	173
April	409	305	25	18	176	140
May	221	137	19	12	191	186
June	188	85	18	14	162	150
July	132	39	14	10	177	168
August	135	39	15	9	184	200
September	206	56	16	4	191	211
October	330	139	23	13	197	152
November	306	111	20	10	201	173
December	390	170	25	18	163	90
Total	3445	2147	252	173	2225	1968

Table 125 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
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

APPENDIX II

SOIL ANALYSIS DATA

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

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	5.8	10.7	1.95	0.11	0.04	18.2	5.7	65	9.2	2.63	0.28	9	9	15	76
	40-60	5.7	8.0	1.11	0.05	0.04	13.2	8.5	67	9.3	1.33	0.21	7	9	7	84
252	0-20	5.3	8.2	1.15	0.13	0.04	17.6	9.1	75	9.3	2.63	0.23	11	9	15	76
	40-60	5.6	9.5	0.89	0.08	0.06	14.7	12.4	76	9.4	1.83	0.25	7	8	8	84

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).

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 126 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	1.70	0.16	0.12	4.2	4.3	6	7.5	0.14	0.02	7	83	10	7
309	0-20	5.0	4.6	1.24	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	1.72	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	5.1	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	0.6	0.05	0.03	0.02	6.9	11	47	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).