ANNUAL RESEARCH REPORT

OF THE

PAPUA NEW GUINEA

OIL PALM RESEARCH ASSOCIATION

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I. AGRONOMY TRIALS

ISLANDS PROVINCES

(G. Gowae)

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 response to other fertilisers.

RESULTS

The average FFB yield in Trial 107 in 1993 was 27.0 tonnes/ha.

The FFB yield in 1993 was increased by application of ammonium sulphate (Table 2). The increase in yield was largely due to an increase in the number of bunches produced, there was also an increase in the single bunch weight.

This yield response to ammonium sulphate application is more pronounced than in earlier years (Table 3)and may signify the development of the major nitrogen response at about the tenth year after planting

In the cumulative data for 1991 to 1993 reflects the development of the nitrogen response in 1992 and 1993 (Table 4).

Table 2. Main effects of N, P, K and Mg on yield and yield components in 1993 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	24.5	27.4	29.0	***	1.023	13.1
Bunches/ha	1071	1175	1239	**	45.7	13.6
Bunch weight (kg)	22.9	23.3	23.6		0.441	6.6
	P0	P1	P2			
Yield (t/ha/yr)	26.4	27.7	26.9		1.023	13.1
Bunches/ha	1144	1194	1147		45.7	13.6
Bunch weight (kg)	23.1	23.2	23.5		0.441	6.6
	K0	K1				
Yield (t/ha/yr)	26.9	27.1			0.836	13.1
Bunches/ha	1167	1157			37.3	13.6
Bunch weight (kg)	23.0	23.5			0.360	6.6
	Mg0	Mg1				
Yield (t/ha/yr)	27.4	27.0			0.836	13.1
Bunches/ha	1162	1162			37.3	13.6
Bunch weight (kg)	23.3	23.3			0.360	6.6
	Cl0	Cl1				
Yield (t/ha/yr)	27.0	27.0			0.836	13.1
Bunches/ha	1172	1152			37.3	13.6
Bunch weight (kg)	23.1	23.4			0.360	6.6

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

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

Table 4. Main effects of N, P, K, Mg and Cl on yield and yield components from 1991 to 1993 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	24.2	26.1	26.5	***	0.558	7.5
Bunches/ha	1137	1212	1216	*	31.4	9.2
Bunch weight (kg)	21.3	21.6	21.9		0.299	4.8
	P0	P1	P2			
Yield (t/ha/yr)	25.3	26.0	25.6		0.558	7.5
Bunches/ha	1177	1211	1176		31.4	9.2
Bunch weight (kg)	21.5	21.5	21.8		0.299	4.8
	K0	K1				
Yield (t/ha/yr)	25.7	25.5			0.456	7.5
Bunches/ha	1195	1181			25.6	9.2
Bunch weight (kg)	21.6	21.6			0.245	4.8
	Mg0	Mg0				
Yield (t/ha/yr)	25.6	25.7			0.456	7.5
Bunches/ha	1200	1176			25.6	9.2
Bunch weight (kg)	21.4	21.9			0.245	4.8
	Cl0	Cl1				
Yield (t/ha/yr)	25.4	25.9			0.456	7.5
Bunches/ha	1193	1183			25.6	9.2
Bunch weight (kg)	21.3	21.9			0.245	4.8

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 5). 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 5. 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

The yields in this trial were relatively low, with an average plot yield of 23.8 t/ha/yr in 1993.

The yield increase in response to ammonium chloride and urea application are highly significant in 1993 (Table 6) and in the cumulative data from 1991 to 1993 (Table 7). The yield increase following ammonium chloride and urea application is largely due to an increase in the numbers of bunches produced. The effect of ammonium chloride and urea on the number of bunches produced is very similar (Figure 2).

The form of the yield response surfaces for ammonium chloride and urea are very similar (Figure 1), however the ammonium chloride yields are about 1.5 t/ha/year higher than with urea. This is due to the higher single bunch weights that occurred with ammonium chloride treatments. The higher single bunch weights created by the ammonium chloride applications may be due to the effect of chlorine increasing the bunch moisture content.

Table 6. The effects of fertiliser treatments on yield and yield components in 1993 (Trial 117).

	Yield (t/ha/yr)		Bunches/ha		Bunch weight (kg)	
N Level	AC	urea	AC	urea	AC	urea
0	22.1	19.4	794	744	27.9	26.32
1	24.4	23.2	823	824	29.6	28.28
2	25.5	21.8	845	789	30.3	27.64
3	26.0	25.0	872	923	30.0	27.34
4	24.4	22.1	839	825	29.4	26.76
linear response	0.003	<0.001	ns	ns	ns	ns
quadratic resp	0.017	0.002	ns	0.026	ns	ns
cv%	8.1	7.2	10.1	11.8	9.4	8.6

Table 7. The effects of fertiliser treatments on yield and yield components for 1991 to 1993 (Trial 117).

	Yield (t/ha/yr)		Bunches/ha		Bunch weight (kg)	
N Level	AC	urea	AC	urea	AC	urea
0	21.4	19.5	818	782	26.2	25.3
1	21.7	21.6	762	829	28.4	26.2
2	23.9	21.9	869	878	27.6	24.9
3	25.4	23.0	939	922	27.2	25.0
4	24.0	22.9	870	915	27.6	25.0
linear response	<0.001	<0.001	0.020	0.010	ns	ns
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	6.1	8.7	7.9	12.6	7.8	8.5

Figure 1: The effects of fertiliser treatments on yield for 1991 to 1993 (Trial 117)

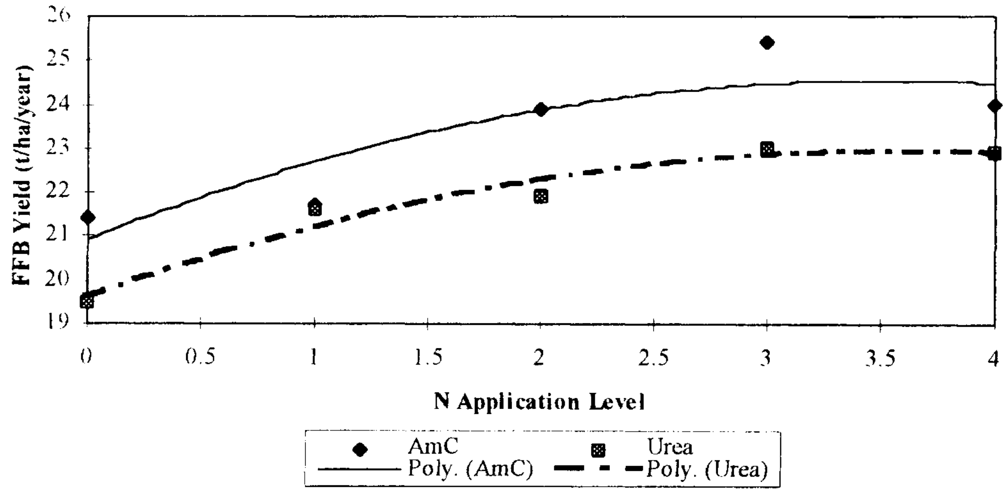
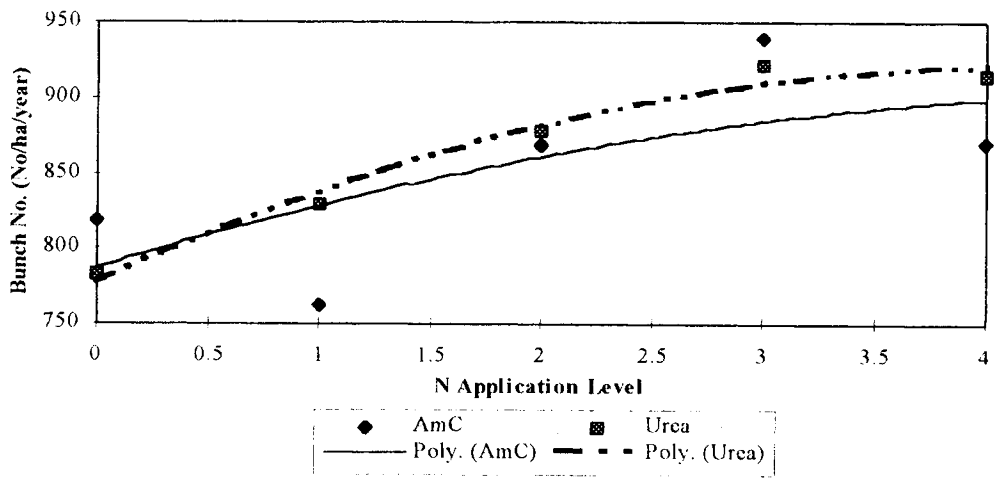


Figure 2: The effects of fertiliser treatments on bunch numbers for 1991 to 1993 (Trial 117).



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 8). 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 8. 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 yields in this trial are high, the average plot yield was 27.93 t/ha/year in 1993 which was 44% higher than 1992.

Ammonium chloride increased the FFB yield in 1993 (Table 9). Although not statistically significant the data shows a marked trend. The increase in FFB yield was due to an increase in the number of bunches produced and the single bunch weight, although neither was statistically significant.

The cumulative data for 1991 to 1993 shows a significant increase in FFB yield due to application of ammonium chloride. This increase is due to increases in both the number of bunches produced and the single bunch weight, although again neither were statistically significant.

Table 9. The effects of fertiliser treatments on yield and yield components for 1991 and 1991 to 1993 (Trial 118).

	1993			1991 to 1993		
Ammonium chloride level	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
0	27.3	974	28.0	22.6	871	25.9
1	27.9	979	28.5	23.5	873	26.9
2	28.8	974	29.6	23.7	881	26.9
3	27.9	964	28.9	24.7	920	26.8
4	29.1	1007	28.9	24.0	898	26.7
linear response	ns	ns	ns	0.016	ns	ns
quadratic resp.	ns	ns	ns	ns	ns	ns
cv%	10.3	8.6	4.3	6.0	5.5	5.0

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 10), 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 10. 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

The average yield in 1993 was high at 32.55 t/ha/year.

The overall treatment effects on yield and yield components in 1993 were significant (Table 11). In the cumulative data for 1992 and 1993 only the overall treatment effects on single bunch weight was significant.

In 1993, nitrogen application in the absence of K or Mg fertiliser significantly increased yield by increasing the number of bunches produced (Table 12). In comparing ammonium chloride with the other nitrogen fertiliser in the absence of K or Mg fertilisers, the ammonium chloride reduced the number of bunches produced and increased the single bunch weight. Muriate of potash increased the single bunch weight. Kieserite applied in the absence of nitrogen fertiliser increased the single bunch weight.

None of the treatment contrasts were significant in the cumulative yield data for 1991 to 1993. In comparing ammonium chloride with the other nitrogen fertiliser in the absence of K or Mg fertilisers, the ammonium chloride reduced the number of bunches produced and increased the single bunch weight. Muriate of potash increased the single bunch weight. Kieserite applied in the absence of nitrogen fertiliser increased the single bunch weight.

Although general conclusions are difficult, it would appear that I) chlorine containing fertilisers increased the single bunch weight, possibly by increasing moisture content, ii) chlorine containing fertilisers especially ammonium chloride reduced the numbers of bunches produced, iii) on balance the application of muriate of potash increases the FFB yield, it is not clear if this is due to the addition of potassium or chlorine.

Table 11. Effect of fertiliser treatments on yield and yield components in 1993 and 1991 to 1993 (Trial 119).

		1993			1991 to 1993		
	Treatment	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)
1	Nil	29.4	1622	18.1	31.2	2271	13.7
2	DAP	34.0	1919	17.7	33.4	2495	13.4
3	SoA	32.7	1896	17.4	32.8	2477	13.3
4	AC	31.2	1637	19.2	32.4	2237	14.5
5	MoP	32.5	1618	20.1	34.6	2264	15.3
6	MoP + DAP	36.4	1861	19.5	35.1	2362	14.9
7	MoP + SoA	34.8	1780	19.5	35.6	2452	14.6
8	MoP + AC	29.8	1440	20.8	32.4	2138	15.2
9	Kies	31.6	1682	18.5	32.2	2269	14.2
10	Kies + DAP	35.3	1828	19.4	34.8	2387	14.6
11	Kies + SoA	32.8	1757	18.7	33.0	2328	14.2
12	Kies + AC	31.0	1493	20.7	33.1	2206	15.0
	significance	*	**	**	ns	ns	**
	sed	2.1	125	0.881	1.689	146.9	0.492
	cv%	8.9	10.1	6.4	7	8.7	4.7

Table 12. Treatment contrasts for yield and yield components (Trial 119)

	CONTRAST	1993 Yield (t/ha/yr)		1993 Bunch Number		1993 SBW (kg)		1991 to 1993 Yield (t/ha/yr)		1991 to 1993 Bunch Number		1991 to 1993 SBW (kg)	
1	- N (- K & Mg)	29.4	*	1622	*	18.1		31.2		2271		13.7	
	+ N (- K & Mg)	32.6		1817		18.1		32.9		2403		13.7	
2	DAP + SoA (- K & Mg)	33.4		1908	*	17.6	*	33.1		2486	*	13.4	**
	AmC (- K & Mg)	31.2		1637		19.2		32.4		2237		14.5	
3	DAP (- K & Mg)	34.0		1919		17.7		33.4		2495		13.4	
	SoA (- K & Mg)	32.7		1896		17.4		32.8		2477		13.3	
4	- Mg (- N)	29.4		1622		18.1		31.2		2271		13.7	
	+ Mg (- N)	31.0		1682		18.5		32.2		2269		14.2	
5	- Mg (+ N)	32.6		1817		18.1	**	32.9		2403		13.7	**
	+ Mg (+ N)	33.0		1693		19.6		33.6		2307		14.6	
6	- K (- N)	29.4		1622		18.1		31.2		2271		13.7	**
	+ K (- N)	32.5		1618		20.1		34.6		2264		15.3	
7	- K (+ N)	32.6		1817		18.1	*	32.9		2403		13.7	*
	+ K (+ N)	33.7		1694		19.9		34.4		2317		14.9	

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 13), 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 13. 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

The average plot yield in 1993 was high at 30.7 t/ha/year.

The overall treatment effects for 1993 and the 1991 to 1993 cumulative data were not significant (Table 14).

Kieserite application in the presence of nitrogen fertiliser increased the FFB yield through an increase in the number of bunches produced (Table 15).

Table 14. Effect of fertiliser treatments on yield and yield components in 1993 and 1991 to 1993 (Trial 120).

	Treatment	1993			1991 to 1993		
		Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
1	Nil	28.8	1391	20.7	28.1	1534	18.3
2	DAP	26.9	1302	20.7	26.6	1483	18.0
3	SoA	28.5	1304	21.9	26.7	1403	19.1
4	AC	31.2	1374	22.8	28.6	1458	19.7
5	MoP	30.3	1457	20.7	28.5	1506	19.0
6	MoP + DAP	30.3	1381	21.9	28.7	1473	19.5
7	MoP + SoA	32.3	1463	22.1	28.6	1556	18.4
8	MoP + AC	31.3	1460	21.5	30.1	1604	18.8
9	Kies	28.8	1317	22.1	29.5	1582	18.7
10	Kies + DAP	32.1	1509	21.3	29.9	1634	18.4
11	Kies + SoA	34.1	1509	22.6	29.2	1556	18.8
12	Kies + AC	33.4	1462	22.9	29.6	1574	18.9
	significance	ns	ns	ns	ns	ns	ns
	sed	2.636	121.9	1.104	1.611	102.4	0.909
	cv%	12	12.1	7.1	7.9	9.3	6.8

Table 15. Treatment contrasts for yield and yield components (Trial 120)

	Contrast	1993 Yield (t/ha/yr)		1993 Bunch Number	1993 SBW (kg)	1991 to 1993 Yield (t/ha/yr)		1991 to 1993 Bunch Number	1991 to 1993 SBW (kg)
1	- N (- K & Mg)	28.8		1391	20.7	28.1		1534	18.3
	+ N (- K & Mg)	28.9		1327	21.8	27.3		1448	18.9
2	DAP + SoA (- K & Mg)	27.7		1303	21.3	26.7		1443	18.6
	AmC (- K & Mg)	31.2		1374	22.8	28.6		1458	19.7
3	DAP (- K & Mg)	26.9		1302	20.7	26.6		1483	18.0
	SoA (- K & Mg)	28.5		1304	21.9	26.7		1403	19.1
4	- Mg (- N)	28.8		1391	20.7	28.1		1534	18.3
	+ Mg (- N)	28.8		1317	22.1	29.5		1582	18.7
5	- Mg (+ N)	28.9	**	1327	21.8	27.3	*	1448	18.9
	+ Mg (+ N)	33.2		1493	22.3	29.6		1588	18.7
6	- K (- N)	28.8		1391	20.7	28.1		1534	18.3
	+ K (- N)	30.3		1457	20.7	28.5		1506	19.0
7	- K (+ N)	28.9		1327	21.8	27.3		1448	18.9
	+ K (+ N)	31.3		1435	21.8	29.1		1544	18.9

Trial 122 NITROGEN AND CROP RESIDUE TRIAL AT KUMBANGO PLANTATION.

PURPOSE

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

DESCRIPTION

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

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

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

DESIGN

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

Table 16. Treatments used in Trial 122.

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

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

RESULTS

There was no significant response of yield or yield components to treatments in 1993 (Table 17). The first treatment applications were started in July 1992 and continued for about two months, the expression of a significant treatment effect on yield would not be expected in 1993.

Table 17. Effects of treatments on yield and yield components in 1993 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	Number of Bunches/ha	Bunch weight (kg)
1	Nil	N + Mg	Weeded Circle	23.2	858	27.3
2	fronds	N + Mg	Weeded Circle	25.8	894	28.9
3	fronds	N + Mg	Frond Pile	22.4	797	28.2
4	fronds & EFB	N + Mg	Weeded Circle	27.2	878	31.0
5	fronds & EFB	N + Mg	Frond Pile	26.7	888	30.1
6	fronds & EFB	N + Mg	EFB	27.8	946	29.4
7	fronds & PKC	N + Mg	Weeded Circle	28.4	1018	28.1
8	fronds & PKC	N + Mg	Frond Pile	25.7	860	30.0
9	fronds & PKC	N + Mg	PKC	27.2	911	30.1
10	Nil	Nil	Nil	26.5	943	28.1
11	fronds	Nil	Nil	25.0	874	28.6
12	fronds & EFB	Nil	Nil	26.2	879	29.8
13	fronds & PKC	Nil	Nil	27.8	979	28.6
			significance	ns	ns	ns
			sed	2.102	82.6	1.225
			cv%	11.4	13.0	6.0

The experimental treatments have had an effect on the rachis and leaflet tissue concentrations of nitrogen, phosphorus, potassium and chlorine. The most noticeable aspect of the treatment effects on nutrient concentrations in rachis and leaflet tissue, is the affect of treatments containing EFB applications (Tables 18 and 19).

The application of EFB has increased the nitrogen concentration in the leaflet and rachis tissue (Tables 20 and 21). In this first sampling, the application of inorganic fertiliser (SoA and Kieserite) and placement of this fertilisers appears not to have affected the concentrations of nitrogen in the rachis and leaflet tissue. Comparing the treatments involving EFB application with those that do not, the EFB has increased the leaflet nitrogen concentration from 2.18% to 2.32%. Using 1992 data from the other fertiliser trials in Kumbango and Bebere plantations, this increase in leaflet nitrogen concentration is equivalent to the effects of applying 1.17kg/palm of nitrogen (as N) in an inorganic form (4.2kg/palm AmC or 5.6kg/palm SoA). Assuming EFB has a nitrogen content of 0.22% (Trial 109a, PNGOPRA Annual Report, 1986), the applied EFB adds an equivalent of 0.82kg nitrogen/palm. EFB appears to be a more efficiently utilised source of nitrogen than inorganic nitrogen fertiliser. EFB could be used as a direct substitute for inorganic fertiliser where fields are an acceptable cartage distance from the oil mill.

EFB has very effectively increased the phosphorus concentration in leaflet and rachis tissue (Tables 22 and 23). EFB has had a particularly marked effect on the concentration of phosphorus in the rachis tissue.

The EFB treatments have increased the concentration of potassium in the rachis tissue (Table 25). This effect is not so clear in the leaflet tissue (Table 24). However the analysis of leaflet tissue for potassium is not a reliable indicator of potassium uptake or status.

Table 18. Effects of treatments on leaflet nutrient concentrations in 1993 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Element as % of leaflet dry matter					
				Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	N + Mg	Weeded Circle	2.17	0.125	0.69	0.08	0.67	0.27
2	fronds	N + Mg	Weeded Circle	2.18	0.124	0.68	0.07	0.65	0.30
3	fronds	N + Mg	Frond Pile	2.20	0.129	0.79	0.09	0.68	0.31
4	fronds & EFB	N + Mg	Weeded Circle	2.32	0.138	0.81	0.07	0.63	0.39
5	fronds & EFB	N + Mg	Frond Pile	2.37	0.138	0.77	0.08	0.66	0.39
6	fronds & EFB	N + Mg	EFB	2.31	0.133	0.78	0.09	0.64	0.36
7	fronds & PKC	N + Mg	Weeded Circle	2.21	0.130	0.76	0.08	0.65	0.27
8	fronds & PKC	N + Mg	Frond Pile	2.15	0.126	0.74	0.08	0.69	0.30
9	fronds & PKC	N + Mg	PKC	2.17	0.125	0.75	0.09	0.69	0.28
10	Nil	Nil	Nil	2.17	0.131	0.70	0.08	0.68	0.29
11	fronds	Nil	Nil	2.17	0.128	0.75	0.10	0.64	0.30
12	fronds & EFB	Nil	Nil	2.27	0.137	0.75	0.09	0.67	0.40
13	fronds & PKC	Nil	Nil	2.19	0.126	0.68	0.09	0.71	0.30
			significance	***	***	*	ns	ns	***
			sed	0.044	0.0032	0.039	0.010	0.034	0.024
			cv%	2.8	3.5	7.5	16.7	7.1	10.5

Table 19 Effects of treatments on rachis nutrient concentrations in 1993 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Element as % of rachis dry matter					
				Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	N + Mg	Weeded Circle	0.25	0.042	1.41	0.04	0.38	0.40
2	fronds	N + Mg	Weeded Circle	0.26	0.047	1.41	0.03	0.36	0.44
3	fronds	N + Mg	Frond Pile	0.28	0.049	1.48	0.03	0.35	0.46
4	fronds & EFB	N + Mg	Weeded Circle	0.28	0.077	1.62	0.03	0.37	0.56
5	fronds & EFB	N + Mg	Frond Pile	0.30	0.077	1.65	0.03	0.36	0.70
6	fronds & EFB	N + Mg	EFB	0.30	0.083	1.71	0.03	0.38	0.79
7	fronds & PKC	N + Mg	Weeded Circle	0.25	0.048	1.43	0.03	0.36	0.36
8	fronds & PKC	N + Mg	Frond Pile	0.26	0.048	1.33	0.03	0.38	0.41
9	fronds & PKC	N + Mg	PKC	0.27	0.045	1.34	0.04	0.37	0.42
10	Nil	Nil	Nil	0.27	0.055	1.35	0.03	0.37	0.39
11	fronds	Nil	Nil	0.25	0.050	1.50	0.04	0.39	0.43
12	fronds & EFB	Nil	Nil	0.29	0.092	1.81	0.03	0.39	0.83
13	fronds & PKC	Nil	Nil	0.25	0.045	1.57	0.03	0.40	0.45
			significance	**	***	**	ns	ns	***
			sed	0.015	0.0090	0.121	0.003	0.029	0.099
			cv%	7.9	21.9	11.3	11.4	10.8	27.5

The EFB treatments had increased the concentration of chlorine in leaflet and rachis tissue (Tables 26 and 27). The EFB used in this trial had come from plantations that have regularly been receiving application of ammonium chloride. At the moment we have no information on the chlorine content of EFB.

Table 20. LSD pairwise comparisons of leaflet N treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Leaflet N (% DM)	
5	EFB + fronds	+	frond pile	2.37	a
4	EFB + fronds	+	weeded circle	2.32	a b
6	EFB + fronds	+	EFB	2.31	a b c
12	EFB + fronds	-	---	2.27	a b c d
7	PKC + fronds	+	weeded circle	2.21	b c d
3	fronds	+	frond pile	2.20	b c d
13	PKC + fronds	-	---	2.19	b c d
2	fronds	+	weeded circle	2.18	c d
1	---	+	weeded circle	2.17	c d
9	PKC + fronds	+	PKC	2.17	d
10	---	-	---	2.17	d
11	fronds	-	---	2.17	d
8	PKC + fronds	+	frond pile	2.15	d

Critical value for comparison: 0.1388
Standard error for comparison: 0.0686
Rejection level: 0.05
There are 4 groups (a,b,c & d) in which the means are not significantly different from one another.

Table 21. LSD pairwise comparisons of rachis N treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Rachis N (% DM)	
6	EFB + fronds	+	EFB	0.305	a
5	EFB + fronds	+	frond pile	0.297	a b
12	EFB + fronds	-	---	0.292	a b
4	EFB + fronds	+	weeded circle	0.282	a b c
3	fronds	+	frond pile	0.278	a b c d
9	PKC + fronds	+	PKC	0.268	b c d
10	---	-	---	0.268	b c d
8	PKC + fronds	+	frond pile	0.260	c d
2	fronds	+	weeded circle	0.258	c d
1	---	+	weeded circle	0.255	c d
13	PKC + fronds	-	---	0.255	c d
11	fronds	-	---	0.252	c d
7	PKC + fronds	+	weeded circle	0.250	d

Critical value for comparison: 0.0306
Standard error for comparison: 0.0151
Rejection level: 0.05
There are 4 groups (a,b,c & d) in which the means are not significantly different from one another.

The concentration of magnesium in the leaflet tissue is extremely low, the concentration of magnesium in the rachis tissue is also low. As none of the treatments had an effect on the concentration of magnesium in the leaflet or rachis tissue, the low magnesium status may restrict yield responses to the experimental treatments.

Table 22. LSD pairwise comparisons of leaflet P treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Leaflet P (% DM)	
5	EFB + fronds	+	frond pile	0.138	a
4	EFB + fronds	+	weeded circle	0.138	a
12	EFB + fronds	-	---	0.137	a b
6	EFB + fronds	+	EFB	0.133	a b c
10	---	-	---	0.131	b c d
7	PKC + fronds	+	weeded circle	0.130	c d
3	fronds	+	frond pile	0.129	c d
11	fronds	-	---	0.128	c d
8	PKC + fronds	+	frond pile	0.126	d
13	PKC + fronds	-	---	0.126	d
9	PKC + fronds	+	PKC	0.125	d
1	---	+	weeded circle	0.125	d
2	fronds	+	weeded circle	0.124	d

Critical value for comparison: 0.0067
Standard error for comparison: 0.0033
Rejection level: 0.05
There are 4 groups (a,b,c & d) in which the means are not significantly different from one another.

Table 23. LSD pairwise comparisons of rachis P treatment means (Trial 122)

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Rachis P (% DM)	
12	EFB + fronds	-	---	0.092	a
6	EFB + fronds	+	EFB	0.083	a
5	EFB + fronds	+	frond pile	0.077	a
4	EFB + fronds	+	weeded circle	0.077	a
10	---	-	---	0.055	b
11	fronds	-	---	0.050	b
3	fronds	+	frond pile	0.049	b
7	PKC + fronds	+	weeded circle	0.048	b
8	PKC + fronds	+	frond pile	0.048	b
2	fronds	+	weeded circle	0.047	b
9	PKC + fronds	+	PKC	0.045	b
13	PKC + fronds	-	---	0.045	b
1	---	+	weeded circle	0.042	b

Critical value for comparison: 0.0181
Standard error for comparison: 0.0089
Rejection level: 0.05
There are 2 groups (a & b) in which the means are not significantly different from one another.

Table 24. LSD pairwise comparisons of leaflet K treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Leaflet K (% DM)	
4	EFB + fronds	+	weeded circle	0.805	a
3	fronds	+	frond pile	0.785	a b
6	EFB + fronds	+	EFB	0.775	a b
5	EFB + fronds	+	frond pile	0.765	a b c
7	PKC + fronds	+	weeded circle	0.760	a b c
9	PKC + fronds	+	PKC	0.755	a b c d
12	EFB + fronds	-	---	0.755	a b c d
11	fronds	-	---	0.745	a b c d
8	PKC + fronds	+	frond pile	0.743	a b c d
10	---	-	---	0.705	b c d
1	---	+	weeded circle	0.685	c d
2	fronds	+	weeded circle	0.675	d
13	PKC + fronds	-	---	0.675	d

Critical value for comparison: 0.0805
Standard error for comparison: 0.0398
Rejection level: 0.05
There are 4 groups (a,b,c & d) in which the means are not significantly different from one another.

Table 25. LSD pairwise comparisons of rachis K treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Rachis K (% DM)	
12	EFB + fronds	-	---	1.81	a
6	EFB + fronds	+	EFB	1.71	a b
5	EFB + fronds	+	frond pile	1.65	a b c
4	EFB + fronds	+	weeded circle	1.62	a b c d
13	PKC + fronds	-	---	1.57	a b c d e
11	fronds	-	---	1.50	b c d e
3	fronds	+	frond pile	1.48	b c d e
7	PKC + fronds	+	weeded circle	1.43	c d e
2	fronds	+	weeded circle	1.41	c d e
1	---	+	weeded circle	1.41	c d e
10	---	-	---	1.35	d e
9	PKC + fronds	+	PKC	1.34	e
8	PKC + fronds	+	frond pile	1.33	e

Critical value for comparison: 0.2651
Standard error for comparison: 0.1311
Rejection level: 0.05
There are 5 groups (a,b,c,d & e) in which the means are not significantly different from one another.

Table 26. LSD pairwise comparisons of leaflet Cl treatment means (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Leaflet Cl (% DM)	
12	EFB + fronds	-	---	0.403	a
4	EFB + fronds	+	weeded circle	0.388	a
5	EFB + fronds	+	frond pile	0.388	a
6	EFB + fronds	+	EFB	0.365	a
3	fronds	+	frond pile	0.313	b
8	PKC + fronds	+	frond pile	0.300	b
11	fronds	-	---	0.300	b
13	PKC + fronds	-	---	0.300	b
2	fronds	+	weeded circle	0.297	b
10	---	-	---	0.290	b
9	PKC + fronds	+	PKC	0.282	b
1	---	+	weeded circle	0.273	b
7	PKC + fronds	+	weeded circle	0.270	b

Critical value for comparison: 0.0471
Standard error for comparison: 0.0233
Rejection level: 0.05
There are 2 groups (a & b) in which the means are not significantly different from one another.

Table 27. LSD pairwise comparisons of rachis Cl treatment means (Trial 122)

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	Rachis Cl (% DM)	
12	EFB + fronds	-	---	0.832	a
6	EFB + fronds	+	EFB	0.792	a
5	EFB + fronds	+	frond pile	0.697	a b
4	EFB + fronds	+	weeded circle	0.560	b c
3	fronds	+	frond pile	0.458	c
13	PKC + fronds	-	---	0.455	c
2	fronds	+	weeded circle	0.438	c
11	fronds	-	---	0.435	c
9	PKC + fronds	+	PKC	0.422	c
8	PKC + fronds	+	frond pile	0.413	c
1	---	+	weeded circle	0.395	c
10	---	-	---	0.388	c
7	PKC + fronds	+	weeded circle	0.363	c

Critical value for comparison: 0.2130
Standard error for comparison: 0.1053
Rejection level: 0.05
There are 3 groups (a,b & c) in which the means are not significantly different from one another.

Trial 125 **SOURCES OF NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.**

PURPOSE

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

DESCRIPTION

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

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

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

DESIGN

The trial consists of 8 treatments (Table 28) with 8 replicates in 4 randomised complete blocks. Each block will contain 2 randomly allocated replicates, this allows the later inclusion a further treatment to one of the replicates. The provision to include a further treatment over the nitrogen fertiliser treatments is necessary to be able to extend the trial to accommodate any other nutrient deficiency that may occur. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 28. Fertiliser treatments to be used in Trial 125.

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

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

PROGRESS

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

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

Pre-treatment physiological measurements will be carried out before the end of 1994, and will be repeated in 1995 and 1996.

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

Trial 126 FACTORIAL FERTILISER TRIAL AT MALILIMI PLANTATION.

PURPOSE

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

DESCRIPTION

Site Malilimi Plantation, WNBP.

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

Palms Dami commercial DxP crosses.
Planted in 1985 at 120 palms/ha.
Treatments to be started in May 1995.

DESIGN

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

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

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

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

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

PROGRESS

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

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

Pre-treatment physiological measurements will be carried out before the end of 1994.

Experimental fertiliser treatments will start in May 1995.

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

PURPOSE

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

DESCRIPTION

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

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

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

DESIGN

Trial 129 consists of 8 treatments (Table 30) replicated in 5 randomised complete blocks. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 30. Fertiliser treatments used in Trial 129.

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

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

PROGRESS

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

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

Pre-treatment physiological measurements will be carried out before the end of 1994, and will be repeated in 1995 and 1996.

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

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, Area 2, 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 31). Fertilisers are applied twice yearly.

Table 31. 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.

Trial 201 was discontinued at the end of 1993.

RESULTS

The yields in this trial are low, the average plot yield in 1993 was 18.1 t/ha/year.

Ammonium sulphate and triple superphosphate increased the FFB yield in 1993 (Table 32). These increases were largely due to increases in single bunch weight. The increase in yield due to ammonium chloride application is the first time a nitrogen response has been observed in this trial.

In the cumulative data for 1991 to 1993 (Table 33), the increase in yield due to triple superphosphate application was significant and caused by an increase in the numbers of bunches produced. The largest increase in number of bunches produced and FFB yield was in response to the combined application of ammonium sulphate and triple superphosphate (Table 34), even though the NxP interaction was not statistically significant.

Table 32. Main effects of N, P, K and Mg on yield and yield components in 1993 (Trial 201).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	17.2	17.6	19.6	**	0.596	12.1
Bunches/ha	790	754	834		24.6	11.4
Bunch weight (kg)	21.9	23.4	23.5	**	0.487	7.8
	P0	P1	P2			
Yield (t/ha/yr)	17.2	18.2	18.9	*	0.596	12.1
Bunches/ha	779	803	796		24.6	11.4
Bunch weight (kg)	22.1	22.9	23.8	*	0.487	7.8
	K0	K1	K2			
Yield (t/ha/yr)	18.4	18.3	17.6		0.596	12.1
Bunches/ha	816	792	770		24.6	11.4
Bunch weight (kg)	22.6	23.3	22..96		0.487	7.8
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	18.0	17.7	18.6		0.596	12.1
Bunches/ha	778	777	822		24.6	11.4
Bunch weight (kg)	23.2	22.8	22.7		0.487	7.8

Table 33. Main effects of N, P, K and Mg on yield and yield components for 1991 to 1993 (Trial 201).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	19.6	19.0	20.4		0.579	10.8
Bunches/ha	1089	1023	1109	*	31.0	10.6
Bunch weight (kg)	18.8	18.8	18.4		0.420	8.3
	P0	P1	P2			
Yield (t/ha/yr)	18.5	19.8	20.7	**	0.579	10.8
Bunches/ha	1016	1105	1099	*	31.0	10.6
Bunch weight (kg)	18.4	18.1	18.0		0.420	8.3
	K0	K1	K2			
Yield (t/ha/yr)	19.6	20.0	19.4		0.579	10.8
Bunches/ha	1114	1076	1030	*	31.0	10.6
Bunch weight (kg)	17.7	18.8	18.9		0.420	8.3
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	19.6	19.1	20.3		0.579	10.8
Bunches/ha	1073	1026	1121	*	31.0	10.6
Bunch weight (kg)	18.5	18.7	18.2		0.420	8.3

Table 34. Effects of the N x P interaction on FFB yield for 1991 to 1993 (Trial 201).

	FFB Yield (t/ha/yr)		
	P0	P1	P2
N0	18.6	20.5	19.8
N1	17.5	18.8	20.8
N2	19.6	20.1	21.4
significance		ns	
sed		1.004	
cv%		10.8	

Trial 204 FACTORIAL FERTILISER TRIAL AT NAVO PLANTATION.

PURPOSE

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

DESCRIPTION

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

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 35).

Table 35. Rates of fertiliser used in trial 204.

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

Note: Treatments are factorial combinations of levels of these fertilisers

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

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

RESULTS

The average plot yield in this trial was low at 20.2 t/ha/year.

Ammonium chloride increased yield (Tables 36 and 37). This increase was due to significant increase in single bunch weight. The linear and quadratic regression components of this response are significant.

Muriate of potash increased the FFB yield due to an increase in number of bunches produced.

Although the NxK interaction is statistically non-significant, the NxK two way table (Table 38) indicates that the application of ammonium chloride and muriate of potash together produce that highest yields.

Table 36. Main effects of N, P, K and Mg on yield and yield components in 1993 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	19.1	21.2	20.3	*	0.672	11.5
Bunches/ha	1405	1447	1411		44.5	10.9
Bunch weight (kg)	13.7	14.8	14.5	**	0.314	7.6
	P0	P1	P2			
Yield (t/ha/yr)	20.4	20.3	19.9		0.672	11.5
Bunches/ha	1415	1419	1429		44.5	10.9
Bunch weight (kg)	14.5	14.4	14.1		0.314	7.6
	K0	K1				
Yield (t/ha/yr)	19.7	20.7			0.549	11.5
Bunches/ha	1390	1452			36.3	10.9
Bunch weight (kg)	14.3	14.0			0.256	7.6
	Mg0	Mg1				
Yield (t/ha/yr)	20.1	20.2			0.549	11.5
Bunches/ha	1424	1418			36.3	10.9
Bunch weight (kg)	14.3	14.4			0.256	7.6

Table 37. Main effects of N, P, K and Mg on yield and yield components for 1992 and 1993 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	18.9	21.1	21.3	***	0.610	10.3
Bunches/ha	1481	1532	1582	*	37.6	8.5
Bunch weight (kg)	12.8	13.8	13.5	**	0.275	7.1
	P0	P1	P2			
Yield (t/ha/yr)	20.9	20.5	19.9		0.610	10.3
Bunches/ha	1542	1525	1528		37.6	8.5
Bunch weight (kg)	13.6	13.4	13.1		0.275	7.1
	K0	K1				
Yield (t/ha/yr)	19.8	21.1		*	0.498	10.3
Bunches/ha	1485	1578		**	30.7	8.5
Bunch weight (kg)	13.3	13.4			0.224	7.1
	Mg0	Mg1				
Yield (t/ha/yr)	20.3	20.5			0.498	10.3
Bunches/ha	1529	1534			30.7	8.5
Bunch weight (kg)	13.3	13.4			0.224	7.1

Table 38. Effects of the N x K interaction on yield and bunch numbers for Jan92 to Dec93 (Trial 204).

	Yield (t/ha/year)		Number of Bunches/ha	
	K0	K1	K0	K1
N0	17.7	20.0	1410	1552
N1	20.5	21.7	1505	1559
N2	21.1	21.5	1540	1625
significance	ns		ns	
sed	0.862		53.2	
cv%	10.3		8.5	

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

PURPOSE

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

DESCRIPTION

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

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

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

DESIGN

There are eight treatments comprising all factorial combinations of EFB, triple superphosphate and kieserite each at two levels (Table 39). The treatments are replicated six times, with each replicate comprising one block. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms. The recorded palms comprise 16 different identified Dami DxP progenies which have been arranged in a random spatial configuration in each plot. The 16 progenies are as follows:

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

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

Table 39. Fertiliser and EFB treatments used in Trial 205.

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

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

PROGRESS

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

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

Pre-treatment physiological measurements will be carried out in 1995.

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	Level 1	Level 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 fertiliser applications are split into three applications 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 data recording of these trials commenced in June 1992 and the first annual report of these trials was presented based on data recorded during the one year period from June 1992 to June 1993. This report is based on data recorded from January to December 1993. As this represents only on years recording, caution should be used in interpreting the results.

The yields in these trials are low with the average plot yield being 18.7 t/ha/year.

None of the site (Trial 251 & Trial 252) x fertiliser treatment interactions were statistically significant.

The application of sulphate of ammonia had no effect on FFB yield or yield components (Table 41).

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

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	19.4	18.3	18.3		1.029	18.7
Bunches/ha	2344	2279	2209		115	17.2
Bunch weight (kg)	8.2	8.0	8.3		0.159	6.6
	K0	K1	K2			
Yield (t/ha)	17.9	18.6	19.5		1.012	18.7
Bunches/ha	2216	2275	2341		113	17.2
Bunch weight (kg)	8.1	8.2	8.3		0.156	6.6
	P0	P1				
Yield (t/ha)	18.7	18.7			0.827	18.7
Bunches/ha	2263	2292			93	17.2
Bunch weight (kg)	8.3	8.1			0.128	6.6
	Mg0	Mg1				
Yield (t/ha/yr)	18.8	18.6			0.824	18.7
Bunches/ha	2314	2241			92	17.2
Bunch weight (kg)	8.1	8.3			0.127	6.6
	Trial 251	Trial 252				
Yield (t/ha/yr)	19.7	17.7			1.048	18.7
Bunches/ha	2298	2257			117	17.2
Bunch weight (kg)	8.6	7.8		***	0.162	6.6

The application of muriate of potash increased the FFB yield largely through increasing the number of bunches produced, however these effects are not statistically significant. Although the site x K interaction is not statistically significant the two way table (Table 42) shows that the yield response to muriate of potash was at the Trial 251 site and no response is evident at the Trial 252 site. The reason for this is not entirely clear, however it may be in part due to the difference in potassium status between the sites.

Sulphate of ammonia application has no positive effect on FFB yield. This was not surprising as the concentration of nitrogen in the leaflet tissue was relatively high. The nitrogen concentration of the leaflet tissue in these trials is typical of those seen following the routine tissue sampling and analysis of Poliamba estates. As suggested in the 1992 PNGOPRA Annual Report, the data suggests that there is no need to apply nitrogen fertiliser to much of Poliamba estates for the time being. This conclusion probably applies to the smallholder growers as well.

Muriate of potash increased the concentration of potassium in leaflet and rachis tissue (Tables 43 and 44). This is unlike the response on the volcanic soils of the Islands Region, where application of muriate of potash decreases that leaflet potassium concentration and increases the rachis potassium. The concentration of potassium in rachis tissue for treatment K0 at Trial 251 is lower than that for K0 at Trial 252. A rough rachis deficiency threshold for potassium derived from the 1992 trials data is 0.75% K. Accepting this, the potassium response at the Trial 251 site and lack of response at the Trial 252 site would be expected. However, there is probably another factor limiting yield at the Trial 252 site (soil depth ?).

Muriate of potash decreased the concentration of magnesium in leaflet tissue, and increased the concentrations of calcium and chlorine in leaflet tissue. Muriate of potash in the 1992 analysis also increase the concentrations of chlorine and phosphorus in the rachis tissue, although not statistically significant there is a marked trend suggesting this is also the case in 1993.

The increase in the concentration of nitrogen in leaflet tissue brought about by sulphate of ammonia application in 1992 was not statistically significant in 1993, however the same trends was still evident.

The application of kieserite showed a trend of increasing the concentration of chlorine in rachis tissue. Although not statistically significant, the trend is the same and of a greater magnitude than the statistically significant effect seen in the 1992 analysis.

Table 42. MoP by trial interactions in 1993 (Trials 251 & 252).

	Yield (t/ha/1993)		Rachis K %		Leaflet K %	
	Trial 251	Trial 252	Trial 251	Trial 252	Trial 251	Trial 252
K0	18.1	17.8	0.69	0.90	0.75	0.73
K1	19.5	17.7	0.97	1.10	0.85	0.82
K2	21.4	17.6	1.14	1.17	0.89	0.87
Interaction significance	ns		ns		ns	
sed	1.518		0.155		0.028	
cv%	18.7		38.1		8.3	

Table 43. Treatment main effects on leaflet nutrient concentrations in 1993 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.58	2.61	2.64		0.025	3.3
Phosphorus	0.160	0.158	0.160		0.0015	3.3
Potassium	0.81	0.82	0.83		0.020	8.3
Calcium	1.23	1.21	1.21		0.020	5.6
Magnesium	0.32	0.31	0.30		0.008	8.9
Chlorine	0.69	0.70	0.70		0.014	6.8
	K0	K1	K2			
Nitrogen	2.60	2.61	2.62		0.025	3.3
Phosphorus	0.159	0.150	0.160		0.0015	3.3
Potassium	0.74	0.84	0.88	***	0.020	8.3
Calcium	1.17	1.24	1.24	**	0.020	5.6
Magnesium	0.34	0.30	0.29	***	0.008	8.9
Chlorine	0.58	0.74	0.77	***	0.014	6.8
	P0	P1				
Nitrogen	2.60	2.62			0.021	3.3
Phosphorus	0.159	0.160			0.0012	3.3
Potassium	0.82	0.82			0.016	8.3
Calcium	1.21	1.22			0.016	5.6
Magnesium	0.31	0.31			0.007	8.9
Chlorine	0.70	0.69			0.011	6.8
	Mg0	Mg1				
Nitrogen	2.62	2.60			0.021	3.3
Phosphorus	0.160	0.159			0.0012	3.3
Potassium	0.83	0.81			0.016	8.3
Calcium	1.21	1.22			0.016	5.6
Magnesium	0.30	0.32			0.007	8.9
Chlorine	0.70	0.70			0.011	6.8
	Trial 251	Trial 252				
Nitrogen	2.56	2.66		***	0.021	3.3
Phosphorus	0.157	0.162		*	0.0012	3.3
Potassium	0.83	0.81			0.016	8.3
Calcium	1.19	1.25		***	0.016	5.6
Magnesium	0.30	0.32		*	0.007	8.9
Chlorine	0.68	0.72		**	0.011	6.8

Table 44. Treatment main effects on rachis nutrient concentrations in 1993 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.28	0.28	0.28		0.004	5.8
Phosphorus	0.073	0.069	0.071		0.0050	20.9
Potassium	1.00	1.09	0.89		0.076	38.1
Calcium	0.57	0.56	0.55		0.019	15.9
Magnesium	0.10	0.10	0.11		0.008	28.6
Chlorine	0.76	0.85	0.67		0.044	31.8
	K0	K1	K2			
Nitrogen	0.28	0.28	0.28		0.004	5.8
Phosphorus	0.068	0.068	0.077		0.0050	20.9
Potassium	0.79	1.03	1.16	*	0.076	38.1
Calcium	0.56	0.56	0.55		0.019	15.9
Magnesium	0.11	0.11	0.10		0.008	28.6
Chlorine	0.60	0.82	0.86		0.044	31.8
	P0	P1				
Nitrogen	0.28	0.28			0.004	5.8
Phosphorus	0.069	0.073			0.0035	20.9
Potassium	0.95	1.04			0.089	38.1
Calcium	0.56	0.56			0.021	15.9
Magnesium	0.10	0.10			0.007	28.6
Chlorine	0.71	0.81			0.057	31.8
	Mg0	Mg1				
Nitrogen	0.28	0.28			0.004	5.8
Phosphorus	0.068	0.074			0.0035	20.9
Potassium	0.87	1.12		*	0.089	38.1
Calcium	0.56	0.56			0.021	15.9
Magnesium	0.11	0.10			0.007	28.6
Chlorine	0.67	0.85			0.057	31.8
	Trial 251	Trial 252				
Nitrogen	0.30	0.27		***	0.004	5.8
Phosphorus	0.077	0.065		*	0.0035	20.9
Potassium	0.93	1.06			0.089	38.1
Calcium	0.55	0.56			0.021	15.9
Magnesium	0.11	0.10			0.007	28.6
Chlorine	0.75	0.77			0.057	31.8

Trial 401 FACTORIAL FERTILISER TRIAL AT KAUTU PLANTATION.

PURPOSE

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

DESCRIPTION

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

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

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

DESIGN

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

Table 45. Rates of fertiliser used in trial 401.

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

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

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

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

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

RESULTS

The average FFB yield in 1993 was 28.0 t/ha/year.

There appears to be a yield increase due to ammonium chloride application (Tables 46 and 47). This response was largely due to an increase in the single bunch weight. The yield response is not statistically significant because of the strongly quadratic effect on numbers of bunches produced.

The yield increase due to kieserite application was significant. This response was largely due to an increase in single bunch weight.

In the cumulative data for 1991 to 1993, muriate of potash application increased the numbers of bunches produced. The yield was increased by just over 4% but this effect was not statistically significant. Despite the indication of a possible K response, the rachis tissue analysis for 1992 suggests the potassium status at this site is adequate.

Table 46. Main effects of N, P, K and Mg on yield and yield components in 1993 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	27.3	27.9	28.8		0.716	8.9
Bunches/ha	1637	1648	1613		55.8	11.8
Bunch weight (kg)	16.8	17.0	17.9	*	0.636	7.4
	P0	P1	P2			
Yield (t/ha/yr)	27.3	28.8	27.9		0.716	8.9
Bunches/ha	1575	1670	1653		55.8	11.8
Bunch weight (kg)	17.4	17.4	17.0		0.636	7.4
	K0	K1				
Yield (t/ha/yr)	27.5	28.5			0.585	8.9
Bunches/ha	1607	1658			45.6	11.8
Bunch weight (kg)	17.2	17.3			0.300	7.4
	Mg0	Mg1				
Yield (t/ha/yr)	27.2	28.8		*	0.585	8.9
Bunches/ha	1636	1629			45.6	11.8
Bunch weight (kg)	16.7	17.8		**	0.300	7.4

Table 47. Main effects of N, P, K and Mg on yield and yield components for 1991 to 1993 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	26.56	27.65	27.78		0.589	7.5
Bunches/ha	2053	2081	2012		47.3	8.0
Bunch weight (kg)	12.98	13.31	13.83	***	0.182	4.7
	P0	P1	P2			
Yield (t/ha/yr)	26.89	27.64	27.45		0.589	7.5
Bunches/ha	2007	2052	2086		47.3	8.0
Bunch weight (kg)	13.43	13.51	13.19		0.182	4.7
	K0	K1				
Yield (t/ha/yr)	26.77	27.88			0.481	7.5
Bunches/ha	2009	2088		*	38.6	8.0
Bunch weight (kg)	13.37	13.39			0.149	4.7
	Mg0	Mg1				
Yield (t/ha/yr)	27.04	27.62			0.481	7.5
Bunches/ha	2080	2017			38.6	8.0
Bunch weight (kg)	13.03	13.72		***	0.149	4.7

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, Mg and EFB each at two levels (Table 48).

Table 48. 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	---
		(t/ha/year)	
EFB	0.0	50	---

Note: Treatments are factorial combinations of levels of these fertilisers

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

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

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

The 36 treatments are replicated twice and are grouped into two blocks. The 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 1993 was 28.2 t/ha/year.

Application of ammonium chloride had significantly increased the single bunch weight. This effect created a significant increase in yield in the cumulative data for 1991 to 1993 (Table 50) and a non-significant trend in the data for 1993 (Table 49).

Muriate of potash increased the single bunch weight.

Table 49. Main effects of N, P, K and Mg on yield and yield components in 1993 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	27.2	28.6	28.9		0.750	9.2
Bunches/ha	1898	1885	1889		52.1	9.5
Bunch weight (kg)	14.4	15.2	15.3	***	0.253	5.9
	P0	P1	P2			
Yield (t/ha/yr)	28.1	28.8	27.8		0.750	9.2
Bunches/ha	1908	1907	1858		52.1	9.5
Bunch weight (kg)	14.7	15.2	15.0		0.253	5.9
	K0	K1				
Yield (t/ha/yr)	27.8	28.7			0.613	9.2
Bunches/ha	1890	1891			42.5	9.5
Bunch weight (kg)	14.8	15.2		*	0.206	5.9
	Mg0	Mg1				
Yield (t/ha/yr)	28.1	28.3			0.613	9.2
Bunches/ha	1897	1885			42.5	9.5
Bunch weight (kg)	14.9	15.0			0.206	5.9

Table 50. Main effects of N, P, K and Mg on yield and yield components from 1991 to 1993 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	26.6	27.8	27.5	*	0.508	6.4
Bunches/ha	2227	2246	2195		48.5	7.6
Bunch weight (kg)	11.9	12.4	12.6	**	0.160	4.5
	P0	P1	P2			
Yield (t/ha/yr)	27.4	27.2	27.3		0.508	6.4
Bunches/ha	2259	2192	2217		48.5	7.6
Bunch weight (kg)	12.2	12.4	12.4		0.160	4.5
	K0	K1				
Yield (t/ha/yr)	27.2	27.4			0.415	6.4
Bunches/ha	2240	2205			39.6	7.6
Bunch weight (kg)	12.2	12.4		*	0.130	4.5
	Mg0	Mg1				
Yield (t/ha/yr)	27.2	27.4			0.415	6.4
Bunches/ha	2236	2209			39.6	7.6
Bunch weight (kg)	12.2	12.4			0.130	4.5

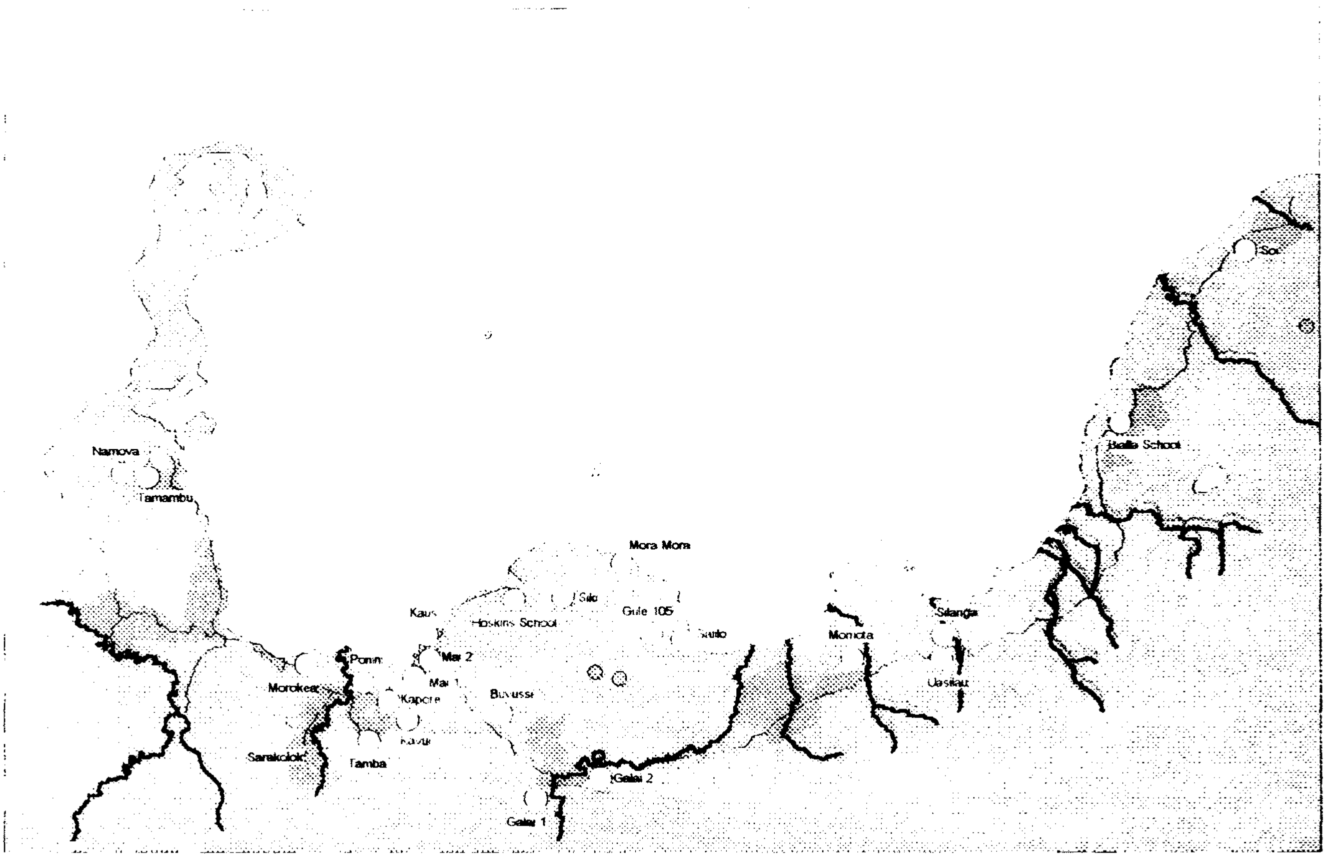
II. SMALLHOLDER DEMONSTRATION TRIALS.

WEST NEW BRITAIN PROVINCE

(P. Navus)

Fertiliser demonstration trials were continued and their number increased on selected smallholder blocks in West New Britain (Figure 3) and New Ireland Provinces.

Figure 3: 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 Buvusi 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 Buvusi subdivision, where the soil conditions were suspected of limiting yield, on eight smallholder blocks (Figure 3, site No. 1).

DESCRIPTION

Site Buvusi subdivision, blocks 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 51). Each plot contains 16 recorded palms, surrounded by a guard row.

Table 51. 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 November 1993.

RESULTS

None of the treatments had any effect on yield (Table 52) in 1993. 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 and 1992. 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 may be is due to fertilizer being washed from one plot to the next and even to the next block during the wet season as was reported (1992). Poaching of fertilizer would have been encouraged. The frequency of harvest was increased from 12 out of possible 36 in a year. The results are from blocks 1152, 1193, 1194, 1396 & 1397 (Table 52 & 53).

The mean cumulative yield of treatments between 1990 and 1992 (Table 53) suggest that the application of phosphorus (TSP), and TSP plus ammonium chloride (AC) increased yield through increased single bunch weights but not significantly.

The concentration of nitrogen were extremely low in the leaflets while chlorine were high in the plots that received ammonium chloride (Table 54A). The recommended minimum concentration of nitrogen is 2.4%. The concentration of potassium were lower while 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 chlorine in the rachis (Table 54B) is also higher in the plots that received ammonium chloride while the concentration of potassium in the rachis is higher in the rachis than the concentration in the leaflet.

It appears there is some advantage in applying fertilizer but it is not possible to make any recommendation for fertiliser use on smallholdings based on these results.

Table 52 Effect of fertiliser treatments on yield, number of bunches and single bunch weight on five smallholder blocks in the Buvussi area, in 1993 (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	6.1	10.2	9.0	282	423	408	21.6	24.1	22.0
1194	6.6	10.3	5.7	333	429	270	19.9	24.0	21.0
1397	16.8	11.6	17.0	729	501	570	23.0	23.2	30.0
1193	19.7	12.0	14.3	888	525	519	22.0	22.9	27.5
1396	13.4	9.4	18.6	519	429	300	23.9	21.9	28.6
Mean	12.5	10.7	12.9	550	461	413	22.2	23.2	25.8
lsd $_{5\%}$		5.1			177			3.6	
cv %		29.0			25.5			10.4	

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

Table 53 Effect of fertiliser treatments on yield on five smallholder blocks in the Buvussi area, in 1990 - 1993 (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	11.4	11.6	13.8	640	659	596	18.0	17.6	23.1
1194	12.4	13.3	14.9	640	697	716	20.7	19.6	20.9
1397	18.9	18.5	20.9	944	839	881	20.1	22.1	23.7
1193	19.4	23.7	23.3	1025	1017	904	18.7	23.0	25.5
1396	14.1	14.8	13.4	683	704	588	21.2	20.7	22.3
Mean	15.2	16.4	17.3	786	783	737	19.7	20.6	23.1
lsd $_{5\%}$		1.8			72.8			2.4	
cv %		7.5			6.5			7.6	

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

Table 54A The mean effect of fertiliser treatments on the leaflets of frond 17 nutrient concentrations on five smallholder blocks in the Buvussi area taken in November 1993 (Trial 112).

Treatment number	Nutrients applied	Rachis nutrient content (% dry matter)					
		N	P	K	Ca	Mg	Cl
1	Nil	1.82	0.12	0.71	1.01	0.17	0.17
2	P	1.85	0.12	0.69	1.03	0.16	0.05
3	N+P	1.87	0.12	0.64	0.95	0.15	0.3
	Mean	1.85	0.12	0.68	1.00	0.16	0.21

Table 54B The mean effect of fertilizer treatments on frond 17 rachis nutrient concentrations on five smallholder blocks in the Buvussi area taken in November 1993 (Trial 112).

Treatment number	Nutrients applied	Rachis nutrient content (% dry matter)					
		N	P	K	Ca	Mg	Cl
1	Nil	0.20	0.051	1.09	0.45	0.04	0.10
2	P	0.20	0.055	0.97	0.45	0.04	0.07
3	N+P	0.20	0.057	1.04	0.51	0.05	0.30
	Mean	0.20	0.054	1.03	0.47	0.04	0.16

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

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, 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 55). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 55. Treatments used in Trial 121.

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

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

RESULTS

The application of ammonium chloride (treatment 2 and 6), ammonium chloride (AC) plus triple superphosphate (treatment 3), AC plus muriate of potash (treatment 4), AC plus kieserite (treatment 5), increased the mean yield, but the increases were not statistically significant because the yields were rather variable (Table 56A). Blocks that responded to the application of AC in 1992 (3, 6, 11, 13, 16) did not in 1993 while other blocks (4, 5, 7, 8, 10, 11, 12, 15) continue to respond including those that did not in 1992. The response from the application of AC plus triple superphosphate (TSP), AC plus muriate of potash (MOP), and AC plus kieserite were very variable. Bunch number production (Table 56B) also was extremely variable. It is possible the increase in the mean yield in the fresh fruit bunch may be was due to increased single bunch weight (56C).

Table 56A. Effect of fertiliser treatments on yield of thirteen blocks in the Hoskins project area in 1993 (Trial 121).

	Yield of FFB (t/ha/yr)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	30.7	25.4	31.9	30.2	35.1	29.2	30.4
3	18.8	16.5	12.7	15.0	14.4	15.6	16.9
4	6.6	21.4	15.9	14.8	21.2	15.3	15.9
5	14.6	17.8	20.0	16.1	11.6	19.0	16.5
6	12.3	11.2	16.8	18.2	15.1	12.1	14.3
7	18.6	26.0	15.3	14.8	20.6	22.7	19.7
8	13.6	25.9	26.6	20.1	17.8	11.5	19.2
10	17.3	17.4	20.4	17.9	22.9	18.4	19.1
11	22.1	24.5	21.6	24.6	23.1	25.4	19.5
12	9.2	15.3	18.1	12.9	15.7	12.8	14.0
13	10.5	10.5	10.9	17.9	12.4	13.1	12.6
15	14.8	14.8	15.4	11.1	10.9	25.1	15.3
16	26.8	25.7	22.5	25.8	25.6	21.4	24.6
Mean	16.6	19.4	19.1	18.4	19.0	18.6	18.5
lsd $_{5\%}$				2.88			
cv %				19.8			

Treatments:

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

Table 56B. Effect of fertiliser treatments on number of bunches on thirteen blocks in the Hoskins project area, in 1993 (Trial 121)

	Bunches (no/palm/year)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	1146	774	1214	1146	1174	1036	1082
3	880	704	636	686	608	720	706
4	675	1260	999	936	1224	900	999
5	7564	816	948	732	556	936	791
6	444	519	765	816	654	564	627
7	1104	1320	792	720	882	1059	980
8	1016	1652	1608	1230	1090	706	1217
10	791	698	833	678	891	744	773
11	1548	1472	1486	1716	1466	1588	1546
12	444	666	816	590	772	654	658
13	618	608	584	896	688	770	694
15	939	861	900	615	639	1392	891
16	1636	1292	1280	1500	1388	1152	1375
Mean	923	1010	989	943	926	940	955
lsd $_{5\%}$				156			
cv %				20.8			

Table 56C. Effect of treatments on single bunch weight on thirteen blocks in the Hoskins project area in 1993 (Trial 121).

	Single bunch weight (kg)						
	Treatment number						
Block	1	2	3	4	5	6	Mean
2	26.8	32.8	26.3	26.3	29.9	28.2	28.4
3	21.4	23.5	20.1	21.8	23.7	21.7	23.0
4	9.8	17.0	15.4	15.8	17.4	17.0	15.4
5	19.3	21.9	21.1	22.0	21.0	20.3	20.9
6	27.8	21.6	21.9	22.3	23.2	21.5	23.1
7	16.8	19.7	19.3	20.6	23.3	21.5	20.2
8	13.4	15.7	16.5	16.3	16.3	16.2	15.7
10	21.9	24.9	24.5	26.4	25.7	24.7	24.7
11	14.3	16.7	14.6	14.3	15.8	16.0	15.3
12	20.7	23.0	22.2	21.9	20.2	19.6	21.3
13	17.0	17.2	18.7	20.0	18.0	17.0	18.0
14	15.7	17.2	17.1	18.1	17.1	18.1	17.2
15	16.4	19.9	17.6	17.2	18.5	18.6	18.0
Mean	18.6	20.8	19.6	20.2	20.8	20.5	20.1
lsd $_{5\%}$				1.3			
cv %				8.3			

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 Secondary School and MoraMora Vocational Centre.

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

DESIGN

Each of the three blocks provides a single replicate, within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 57). Each plot has at least 12 recorded palms, surrounded by a guard row.

Table 57 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 December 1993.

RESULTS

The components of yield (Table 58A, 58B & 58C) were very widely variable because of more than one planting date. It is too early to make any meaningful observations.

Frond 17 leaflet and rachis were sampled and the nutrient concentrations analysed in November 1992 (Table 59A & 59B). 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 above 0.3 % while potassium and magnesium concentrations were low.

The concentration of potassium and magnesium in the rachis (Table 59B) was high in both sites.

Table 58A. Effect of fertiliser treatments on yield of two school blocks in the Hoskins project area in 1993 (Trial 124).

		Yield of FFB (t/ha/yr)						
		Treatment number						
Site No	Site Name[1]	1	2	3	4	5	6	Mean
20	PAS	19.8	19.0	15.2	20.0	20.0	18.3	18.7
23	MVC	5.6	7.4	11.8	7.7	9.3	8.3	6.9
	Mean	12.7	13.2	13.5	13.9	14.7	13.3	13.5
	lsd $_{5\%}$				6.7			
	cv %				19.4			

Treatments:

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

[1] PAS - Poinini Agricultural School, MVC - Mora Mora Vocational Centre

Table 58B. Effect of fertiliser treatments on yield of two school blocks in the Hoskins project area in 1993 (Trial 124).

		Bunches (no/ha/yr)						
		Treatment number						
Site No	Site Name	1	2	3	4	5	6	Mean
20	PAS	1440	1343	1144	1515	1376	1400	1370
23	MVC	549	655	889	566	806	714	697
Mean		995	999	1016	1040	1091	1057	1033
lsd 5%					453			
cv %					17.0			

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

Table 58C Effect of fertiliser treatments on yield of two school blocks in the Hoskins project area in 1993 (Trial 124).

		Single bunch weight (kg)						
		Treatment number						
Site No	Site Name	1	2	3	4	5	6	Mean
20	PAS	13.8	14.2	13.3	13.3	14.5	13.1	13.7
23	MVC	10.8	11.3	13.3	13.7	11.5	11.6	12.0
lsd 5%		12.3	12.8	13.3	13.5	13.0	12.4	12.9
cv %					2.8			
					8.6			

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

Table 59A The 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

Table 59B The 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 60). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 60 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 December 1993.

RESULTS

The response to treatments was greatly vary between the two sites (Table 61A, 61B & 61C). Block number 438 (Silanga) appear to respond to the application of AC (treatment 2 & 6), AC plus TSP, AC plus MOP and AC plus kieserite. Block number 176 (Uasilau) did not respond most treatments.

Frond 17 leaflet and rachis were sampled in December 1993 and the nutrient concentrations were analysed (Table 62). The concentrations of nitrogen and chlorine in leaflets were higher in plots that received ammonium chloride (Table 62A & 62F), and the concentration of potassium and magnesium were lower (Table 62C & 62E). The concentrations of all elements except nitrogen and calcium were low as reported in 1992. In the plots that did not receive any fertiliser the concentrations of nitrogen were at recommended minimum (2.4%).

The concentration of potassium in the rachis in both blocks (438 and 176) were high (Table 63C).

Table 61A. Effect of fertiliser treatments on yield of two blocks in the Bialla project area in 1993 (Trial 207).

	Yield of FFB (t/ha/yr)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
438	15.7	18.5	20.2	19.4	18.8	16.1	18.1
176	13.7	7.9	18.3	9.5	9.8	12.6	12.0
Mean	14.7	13.2	19.3	14.5	14.3	14.4	15.0
lsd 5%				7.5			
cv %				19.3			

Treatments:

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

Table 61B Effect of fertiliser treatments on yield of two blocks in the Bialla project area in 1993 (Trial 207).

	Bunches (no/ha/yr)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
438	1260	1452	1482	1593	1380	1140	1385
176	867	540	1485	678	630	1056	876
Mean	1064	996	1484	1136	1005	1098	1130
lsd 5%				746			
cv %				25.7			

Treatments:

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

Table 61C Effect of fertiliser treatments on yield of two blocks in the Bialla project area in 1993 (Trial 207).

	Single bunch weight (kg)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
438	12.5	12.8	13.6	12.2	13.6	14.1	13.1
176	15.8	14.6	12.3	14.0	15.5	12.0	14.0
Mean	14.2	13.7	13	13.1	14.6	13.1	13.6
lsd				3.8			
cv %				11.0			

Treatments:

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

Table 62A Effect of fertilizer treatments on the mean nitrogen concentrations of frond 17 leaflets at two sites at the Bialla Project from 1992 to 1993 (Trial 207).

	Nitrogen (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	2.46	2.42	2.42	2.39	2.47	2.36	2.42
438	2.55	2.52	2.41	2.46	2.45	2.50	2.48
Mean	2.51	2.47	2.42	2.43	2.46	2.43	2.45
lsd 5%				0.12			
cv %				1.8			

Table 62B Effect of fertilizer treatments on the mean phosphorus concentrations of frond 17 leaflets at two sites at the Bialla Project in December 1993 (Trial 207).

	Phosphorus (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.147	0.146	0.149	0.141	0.142	0.142	0.145
438	0.150	0.150	0.149	0.145	0.145	0.146	0.148
Mean	0.149	0.148	0.149	0.143	0.144	0.144	0.146
lsd 5%				0.003			
cv %				2.4			

Table 62C Effect of fertilizer treatments on the mean potassium concentrations of frond 17 leaflets at two sites at the Bialla Project in December 1993 (Trial 207).

	Potassium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.83	0.77	0.81	0.81	0.83	0.83	0.81
438	1.14	0.81	0.81	0.85	0.85	0.81	0.88
Mean	0.99	0.79	0.81	0.83	0.84	0.82	0.85
lsd 5%				0.22			
cv %				102			

Table 62D Effect of fertilizer treatments on the mean calcium concentrations of frond 17 leaflets at two sites the Bialla Project in December 1993 (Trial 207).

	Calcium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	1.12	0.99	0.98	1.12	0.86	0.94	1.00
438	0.90	0.95	0.99	0.99	0.99	0.95	0.96
Mean	1.00	0.97	0.99	1.06	0.93	0.95	0.98
lsd 5%				0.22			
cv %				8.8			

Table 62E Effect of fertilizer treatments on the mean magnesium concentrations of frond 17 leaflets at two sites at the Bialla Project in December 1993 (Trial 207).

	Magnesium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.16	0.15	0.16	0.15	0.15	0.15	0.15
438	0.20	0.19	0.19	0.16	0.19	0.18	0.19
Mean	0.18	0.17	0.18	0.16	0.17	0.17	0.17
lsd 5%				0.02			
cv %				4.9			

Table 62F Effect of fertilizer treatments on the mean chlorine concentrations of frond 17 leaflets at two sites the Bialla Project in December 1993 (Trial 207).

	Chlorine (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.20	0.49	0.43	0.56	0.42	0.53	0.44
438	0.15	0.45	0.47	0.58	0.52	0.52	0.44
Mean	0.18	0.47	0.45	0.57	0.47	0.53	0.44
lsd 5%				0.02			
cv %				4.9			

Table 63A Effect of fertilizer treatments on the mean nitrogen concentrations of frond 17 rachis in two sites at Bialla Project in December 1993 (Trial 207).

	Nitrogen (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.24	0.23	0.25	0.24	0.25	0.28	0.25
438	0.23	0.26	0.25	0.23	0.23	0.23	0.23
Mean	0.24	0.25	0.25	0.24	0.24	0.26	0.24
lsd $_{5\%}$				0.05			
cv %				7.6			

Table 63B Effect of fertilizer treatments on the mean phosphorus concentrations of frond 17 rachis in two sites at Bialla Project in December 1993 (Trial 207).

	Phosphorus (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.039	0.033	0.035	0.035	0.043	0.045	0.038
438	0.037	0.037	0.048	0.040	0.036	0.037	0.039
Mean	0.038	0.035	0.042	0.038	0.040	0.041	0.039
lsd $_{5\%}$				0.015			
cv %				14.6			

Table 63C Effect of fertilizer treatments on the mean potassium concentration of frond 17 rachis in two sites at the Bialla Project in December 1993 (Trial 207).

	Potassium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	1.26	1.30	1.14	1.67	1.22	1.47	1.34
438	1.14	1.24	1.37	1.37	1.34	1.10	1.26
Mean	1.20	1.27	1.26	1.52	1.28	1.29	1.30
lsd $_{5\%}$				0.42			
cv %				12.6			

Table 63D Effect of fertilizer treatments on the mean calcium concentration of frond 17 rachis in two sites at Bialla Project in December 1993 (Trial 207).

	Calcium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.44	0.48	0.43	0.51	0.56	0.50	0.49
438	0.35	0.50	0.53	0.51	0.45	0.49	0.47
Mean	0.40	0.49	0.48	0.51	0.51	0.50	0.48
$lsd_{5\%}$				0.14			
cv %				11.3			

Table 63E Effect of fertilizer treatments on the mean magnesium concentration of frond 17 rachis in two sites at the Bialla Project in December 1993 (Trial 207).

	Magnesium (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.04	0.04	0.03	0.04	0.04	0.04	0.04
438	0.03	0.05	0.05	0.04	0.05	0.05	0.05
Mean	0.04	0.05	0.04	0.04	0.05	0.05	0.05
$lsd_{5\%}$				0.02			
cv %				17.5			

Table 63F Effect of fertilizer treatments on the mean chlorine concentration of frond 17 rachis in two sites at the Bialla Project in December 1993 (Trial 207).

	Chlorine (%)						
	Treatment number						
Block No	1	2	3	4	5	6	Mean
176	0.39	0.62	0.09	0.86	0.53	0.62	0.52
438	0.05	0.39	0.33	0.55	0.55	0.41	0.38
Mean	0.22	0.51	0.21	0.71	0.54	0.52	0.45
$lsd_{5\%}$				0.41			
cv %				35.3			

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

PURPOSE

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

DESCRIPTION

Sites: Experiment 208 is on OPIC Bialla Oil Palm Scheme (Figure 1, Site No 23) at Bialla Provincial High School.

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

DESIGN

Each of the three blocks provides a single replicate, within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 64). Each plot has at least 12 recorded palms, surrounded by a guard row.

Table 64 Treatments used in Trial 208.

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

Fertiliser was applied twice a year in May and November.

The yield was recorded with the assistance of the schools. The rachis and leaflets were sampled in October 1993.

RESULTS

Preliminary yield response appear to indicate an increase in the fresh fruit bunches by the application of triple superphosphate (TSP) plus muriate of potash (MOP) probably due to improved single bunch weight.

The leaf tissue analysis done in October 1993 indicated variable element concentrations. However, the concentrations of nitrogen and chlorine in the leaflets and of potassium in the rachis were high. The concentrations of all the other elements were low.

Table 65. Effect of fertiliser treatments on yield of FFB, bunch number and single bunch weight of one block in the Bialla project area in 1993 (Trial 208).

	Yield						
	Treatment number						
	1	2	3	4	5	6	Mean
FFB (t/ha/yr)	10.2	10.8	11.0	29.2	21.3	19.3	17.0
Bunch (no/ha/yr)	1408	1551	1980	1737	1302	1240	1536
Bunch weight (kg)	7.3	7.0	5.6	16.8	16.4	1536	11.5

Treatments:

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

Table 66A. Effect of fertiliser treatments on the nutrient concentrations of leaflets of frond 17 of a block in the Bialla project area in 1993 (Trial 208).

Elements	Frond 17 leaflets analysis						
	Treatment number						
(% DM)	1	2	3	4	5	6	Mean
Nitrogen	2.64	2.57	2.54	2.59	2.46	2.61	2.57
Phosphorus	0.156	0.153	0.167	0.156	0.149	0.151	0.155
Potassium	1.01	0.87	1.07	0.89	0.87	0.95	0.94
Calcium	0.96	0.99	1.00	0.91	0.86	0.87	0.93
Magnesium	0.17	0.18	0.18	0.12	0.15	0.15	0.16
Chlorine	0.21	0.63	0.29	0.44	0.27	0.30	0.36

Table 66B. Effect of fertiliser treatments on the nutrient concentrations of frond 17 rachis of a block in 1993 (Trial 208).

Elements	Frond 17 rachis analysis						
	Treatment number						
(% DM)	1	2	3	4	5	6	Mean
Nitrogen	0.25	0.33	0.29	0.27	0.24	0.22	0.27
Phosphorus	0.064	0.071	0.064	0.073	0.082	0.051	0.068
Potassium	1.26	1.67	1.52	1.37	1.42	1.26	1.42
Calcium	0.43	0.61	0.42	0.46	0.36	0.36	0.44
Magnesium	0.04	0.07	0.04	0.04	0.03	0.03	0.04
Chlorine	0.09	0.82	0.11	0.33	0.16	0.16	0.08

Treatments:

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

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

Purpose

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

Description

Site Experiment 403 is located on OPIC Bialla Oil Palm Scheme (Figure 1, Site No 19) at Mamota near Kapiura Plantations Pty Ltd.

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

DESIGN

Each of the 2 smallholder blocks provide a single replicate within which are six treatments: no fertiliser (control), recommended nitrogen rate (demonstration) and three others with the specific purpose of testing nitrogen application in the presence of phosphorus, potassium and magnesium. One further plot tests a higher rate of nitrogen (Table 67). Each plot has at least 12 recorded palms surrounded by a guard row.

Table 67 Treatments used in Trial 403.

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

Fertiliser was applied twice a year in May and November.

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

RESULTS

It appears that the application of ammonium chloride (AC) may increase yield (Table 68). It is possible that this increase may be was due to increased single bunch weight.

Frond 17 leaflet and rachis were sampled and the nutrient concentrations were analysed (Table 69). The concentrations of nitrogen and chlorine in leaflets were higher in plots that received ammonium chloride (Table 69A). The concentration of potassium and magnesium were relatively high. Ammonium chloride applied at high rate (treatment 6) appear to have increased leaf concentrations of nitrogen and chlorine.

Table 68. Effect of fertiliser treatments on yield of FFB, bunch number and single bunch weight of one block in the Bialla project area in 1993 (Trial 403).

	Yield						
	Treatment number						
	1	2	3	4	5	6	Mean
FFB (t/ha/yr)	9.6	10.0	10.4	10.5	10.4	9.5	10.1
Bunch (no/ha/yr)	1583	1463	1515	1620	1620	1605	1568
Bunch weight (kg)	6.0	6.8	6.8	6.5	6.4	5.9	6.4

Treatments:

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

Table 69A. Effect of fertiliser treatments on the nutrient concentrations of leaflets of frond 17 in a block in the Kapiura project area in 1993 (Trial 403).

Elements (% DM)	Frond 17 leaflets analysis — Treatment number 1	2	3	4	5	6	Mean
Nitrogen	2.55	2.49	2.56	2.67	2.53	2.70	2.59
Phosphorus	0.158	0.153	0.154	0.154	0.147	0.155	0.159
Potassium	1.10	0.93	0.85	0.89	0.87	0.93	1.05
Calcium	0.99	1.01	1.00	0.96	0.96	0.99	0.96
Magnesium	0.21	0.24	0.22	0.19	0.21	0.23	0.24
Chlorine	0.17	0.37	0.44	0.46	0.37	0.73	0.36

Table 69B. Effect of fertiliser treatments on the nutrient concentrations of frond 17 rachis in a block in the Kapiura project area in 1993 (Trial 403).

Elements (% DM)	Frond 17 rachis analysis — Treatment number 1	2	3	4	5	6	Mean
Nitrogen	0.27	0.28	0.27	0.28	0.29	0.29	0.29
Phosphorus	0.077	0.09	0.09	0.084	0.072	0.076	0.072
Potassium	1.52	1.34	1.37	1.28	1.47	1.37	1.42
Calcium	0.40	0.50	0.46	0.49	0.51	0.49	0.45
Magnesium	0.05	0.06	0.06	0.07	0.07	0.07	0.07
Chlorine	0.10	0.31	0.37	0.27	0.32	0.35	0.21

Treatments:

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

BENCHMARK SMALLHOLDER DEMONSTRATION TRIALS.

There are 40 smallholder demonstration blocks covering about 120 hectares being established in West New Britain Province in 1994. Twenty eight blocks (96 hectares) are located in the Hoskins (Trial 128) and twelve(24 hectares) are in the Bialla (Trial 210) Project.

These are whole blocks located in pairs of same local conditions receiving uniform treatments. A trench digger will be used to demarkate the block into two halves. The yields from these blocks will be recorded and used as benchmarks that show how much fruit would be produced if fertiliser were not used at all, and how much would be produced using the recommended amount (pair 1). How much fruit would be produced if again fertiliser were not used at all, and how much is the maximum that could be produced if a generous amounts of all four (N, P, K, Mg) main types of fertilizer was used (pair 2). The results will be used in the calculation of the economic optimum amount of fertiliser, and to demonstrate the smallholders the economic benefits to them of using fertiliser.

The whole block will be harvested in the normal way for a smallholder block and the weight of the fruit will be recorded by the transport company in each project at the time of pickup.

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

PURPOSE

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

DESCRIPTION

Site Experiment 128 is located on OPIC Hoskins Oil Palm Scheme (Figure 3 and Table 72) covering areas between Talasea and Galilo and Galai. The 28 blocks are located at Dire, Sarakolok, Tamba, Kapore, Kavui, Buvussi, Mai, Kwalakesi, Siki, and Kavut selected in pairs. At Kavui and Buvusi there are more than one set of pair selected.

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

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments (Table 70). With the first pair half of the block will receive no fertiliser at all (control) and the remaining half the recommended (demonstration) type and amount of fertiliser to the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control) and the remaining half will receive a generous amounts (generous) of all main types (N, P, K, MG) of fertiliser.

Table 70. Treatments used in Trial 128.

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

Fertiliser will be applied twice a year in May and November.
The whole block will be harvested in the normal way for a smallholder block and the weight of the fruit will be recorded by the transport company in each project at the time of pick up. Leaflets and rachis of frond 17 will be sampled each year. Twenty eight blocks (Table 72) were identified each located in pairs. All the field labelling were completed in August. Pretreatment leaf tissue sampling was completed in June. Signboards are being painted and fertiliser applications for the first half of 1994 was completed in August. Pick up of fruit (FFB) by NBPOD's Mosa Transport Company is being tested in the field with the kind assistance and cooperation from the Smallholder Affairs Department.

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

PURPOSE

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

DESCRIPTION

Site Experiment 210 is located on OPIC Bialla Oil Palm Scheme (Figure 3 and Table 72) covering areas between Mamota and NBPOD's Kapiura Plantations Pty Ltd to Noau and Hargy's Navo Plantation. The twelve are located at Lavege, Bereme, Silanga, Matililiu and Noau, selected in pairs.

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

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments(Table 71). With the first pair half of the block will receive no fertiliser at all (control) and the remaining half the recommended type and amount (demonstration) of fertiliser to the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control), and the remaining half will receive a generous amounts (generous) of all main types (N P K Mg) of fertiliser.

Table 71 Treatments used in Trial 210.

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

Fertiliser will be applied twice a year in May and November. The whole block will be harvested in the normal way for a smallholder block and the weight of the fruit will be recorded by the transport company in each project at the time of pick up. Leaflets and rachis of frond 17 will be sampled each year. Twelve blocks (Table 72) were identified each located in pairs. All the field labelling were completed by July. Pretreatment leaf tissue sampling was completed in July. Signboards are being painted and fertiliser applications for the first half of 1994 was completed in August. Pick up of fruit (FFB) by Hargy's Transport Company and Kapiura Plantations Transport Division have started in September 1994 with assistance from OPIC.

III. AGRONOMY AND SMALLHOLDER TRIALS

MAINLAND PROVINCES

(A.T.Oliver)

Trial 305 FERTILISER TRIAL AT AREHE ESTATE

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on 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 treatment combinations, made up from all combinations of three levels each of N and K, and two levels each of P and Mg (Table 72).

Table 72. Types of fertiliser and amounts used in trial 305.

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

RESULTS

Yield data for 1993, and for the years 1989 - 1993 are summarised in Tables 73 and 75.

There was a large and statistically significant increase caused by SOA, up to level 1 of about 10 tonnes, and then a smaller increase up to level 2 (Table 73). This increase was made up from an increase in number of bunches per hectare, and single bunch weight.

There was also an increase in yield due to MOP, up to level 1, though it was not statistically significant for the period 1987 - 1993 (Table 75). 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 73. Main effects of N, P, K, and Mg on yield and yield components in oil palm in 1993 (Trial 305).

	Nutrient element and level			Statistics		
	N0	N1	N2	sig	cv	lsd
Yield (t/ha/yr)	17.2	27.1	31.1	***	22.4	3.27
Bunch/ha	769	1056	1209	***	19.8	116
Bunch wt (kg)	21.0	25.6	25.8	***	11.5	1.60
	P0	P1				
Yield (t/ha/yr)	24.4	25.9		ns	22.4	-
Bunch/ha	992	1030		ns	19.8	-
Bunch wt (kg)	23.8	24.4		ns	11.5	-
	K0	K1	K2			
Yield (t/ha/yr)	24.5	26.0	24.9	ns	22.4	-
Bunch/ha	1059	1001	974	ns	19.8	-
Bunch wt (kg)	22.6	25.2	24.6	**	11.5	1.60
	Mg0	Mg1				
Yield (t/ha/yr)	25.3	25.0		ns	22.4	-
Bunch/ha	1020	1003		ns	19.8	-
Bunch wt (kg)	24.0	24.2		ns	11.5	-

The interaction between N and K is not significant, but the NxK two-way table (Table 74) suggests that the maximum yield of 32 to 33 t/yr is achieved with 4kg SOA per palm plus between 2 and 4 kg MOP per palm.

There was no response to TSP or Kieserite.

Table 74. Effect of N on yield at different levels of K in 1993 (Trial 305).

Levels of K	Yield (tonnes/ha/year)		
	N0	N1	N2
K0	17.4	27.3	28.7
K1	16.9	28.3	32.8
K2	17.2	25.6	31.7

Table 75. Main effects of N, P, K, and Mg on yield and yield components in 1987 - 1993 (Trial 305).

	Nutrient element and level			Statistics		
	N0	N1	N2	sig	cv	lsd
Yield (t/ha/yr)	21.5	30.8	32.8	***	14.1	2.32
Bunch/ha	1031	1330	1421	***	12.4	91
Bunch wt (kg)	20.5	23.2	23.2	***	8.0	1.04
	P0	P1				
Yield (t/ha/yr)	28.3	28.4		ns	14.1	-
Bunch/ha	1266	1256		ns	12.4	-
Bunch wt (kg)	22.2	22.4		ns	8.0	-
	K0	K1	K2			
Yield (t/ha/yr)	27.2	28.8	29.1	ns	14.1	-
Bunch/ha	1301	1232	1248	ns	12.4	-
Bunch wt (kg)	20.7	23.1	23.0	***	8.0	1.04
	Mg0	Mg1				
Yield (t/ha/yr)	28.7	28.0		ns	14.1	-
Bunch/ha	1281	1241		ns	12.4	-
Bunch wt (kg)	22.2	22.4		ns	8.0	-

Table 76. Effect of N on yield at different levels of K in 1987 - 1993 (Trial 305).

Level of K	Yield (Tonnes/ha/year)		
	N0	N1	N2
K0	20.8	30.0	30.7
K1	21.5	31.1	34.0
K2	22.1	31.2	33.9

Note: NxK interaction not significant.

Trial 306 **FERTILISER TRIAL AT AMBOGO ESTATE**

PURPOSE

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

DESCRIPTION

Site Ambogo Estate block 79B

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

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

DESIGN

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

The 81 plots are a single replicate containing 81 treatments, made up from all combinations of three levels each of N, P, K, and Mg (Table 77). 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 77. Types and amount of fertiliser used in Trial 306.

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

Modifications: Until 1990 SOA rates were half those indicated.

RESULTS

Yield data for 1993, and for the period 1987 - 1993 are summarised in Tables 78 and 80.

There was a statistically significant increase in yield caused by SOA, of 4 tonnes up to level 1, and a further, but smaller increase up to level 2 (Table 78). This increase was made up from 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 78. Main effects of N, P, K, and Mg on yield and yield components in 1993.

	Nutrient element and level			Statistics		
	N0	N1	N2	sig	cv	lsd
Yield (t/ha/yr)	19.1	23.9	26.6	***	17.9	2.27
Bunch/ha	892	949	1040	***	14.6	77
Bunch wt (kg)	21.3	25.1	25.7	***	9.4	1.23
	P0	P1	P2			
Yield (t/ha/yr)	23.5	22.4	23.8	ns	17.9	-
Bunch/ha	979	932	970	ns	14.6	-
Bunch wt (kg)	23.9	23.8	24.2	ns	9.4	-
	K0	K1	K2			
Yield (t/ha/yr)	22.9	23.6	23.2	ns	17.9	-
Bunch/ha	1004	945	932	ns	14.6	-
Bunch wt (kg)	22.7	24.8	24.6	***	9.4	1.23
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	22.6	23.5	23.6	ns	17.9	-
Bunch/ha	960	956	965	ns	14.6	-
Bunch wt (kg)	23.3	24.4	24.4	ns	9.4	-

The interaction between N and K was not significant, but the two-way table (Table 79) shows that the maximum yield of about 28 t/ha/yr is achieved with 6 kg/palm of SOA and 2.5 kg/palm of MOP.

There was no response to TSP or Kieserite.

Table 79. Effects of N on yield at different levels of K in 1993.

Levels of K	Yields (tonnes/ha/year)		
	N0	N1	N2
K0	19.3	23.5	25.8
K1	19.0	24.1	27.8
K2	19.0	24.1	26.4

Table 80. Main effects of N, P, K, Mg on yield and yield components in 1987 - 1993.

	Nutrient element and level			Statistics		
	N0	N1	N2	sig	cv	lsd
Yield (t/ha/yr)	22.6	27.7	29.2	***	9.3	1.34
Bunch/ha	1194	1320	1386	***	7.4	54
Bunch wt (kg)	19.0	21.0	21.1	***	7.3	0.81
	P0	P1	P2			
Yield (t/ha/yr)	26.5	26.1	27.1	ns	9.3	-
Bunch/ha	1307	1285	1309	ns	7.4	-
Bunch wt (kg)	20.2	20.2	20.6	ns	7.3	-
	K0	K1	K2			
Yield (t/ha/yr)	25.4	27.3	26.9	**	9.3	1.34
Bunch/ha	1326	1287	1288	ns	7.4	-
Bunch wt (kg)	19.1	21.2	20.7	***	7.3	0.81
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	25.8	27.0	26.7	ns	9.3	-
Bunch/ha	1293	1315	1293	ns	7.4	-
Bunch wt (kg)	19.9	20.5	20.7	ns	7.3	-

Table 81. Effects of N on yield at different levels of K for 1987 - 1993.

Level of K	Yield (tonnes/ha/year)		
	N0	N1	N2
K0	22.3	26.6	27.4
K1	23.6	27.8	30.4
K2	22.1	28.5	30.0

Note: NxK interaction not significant.

Trial 309 POTASSIUM, CHLORINE AND SULPHUR TRIAL AT AMBOGO ESTATE.

PURPOSE

To test the response to potassium, chlorine and sulphur.

DESCRIPTION

Site Ambogo Estate block 80H

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

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

DESIGN

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

The 25 plot are divided into five replicate blocks each containing five treatments (Table 82). 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 has a latin square design.

The treatments are combinations of fertilisers, one of which is bunch ash (BA). The right hand part of table 82 shows the amount of each element that is applied to each treatment. The effects of an element is found by comparing the yields from two treatments: for example the effect of chlorine is found by comparing the yields from treatment 4 and 5.

The treatments that were used from January 1988 to June 1990 were similar, but there are some important differences. Treatment 3 now receives N and S, but used to receive only K. Treatment 2 now receives N and Cl, but used to receive K and Cl. Thus in 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 82. 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 on the effects of N, S, K, and Cl for 1992 and 1993, are summarised in Table 83 and 84.

Treatment 4, applications of MOP and SOA in combination gave maximum mean yield of about 31 tonnes/ha/year for the period 1991 - 1993. Treatment 3 and 5, gave mean yields of about 27 tonnes/ha and 29 tonnes/ha respectively. The control plots produced an average of 13 tonnes/ha.

In comparison between mean yield for the 3 years (Table 84), with treatment 3 and 1, there was a large statistically significant response to SOA (effect of N and S), a yield difference of almost 14 tonnes/ha/year. The effects of K and S, in comparing treatment 4 and 2, there was a significant yield difference of 8.8 tonnes/ha/year. N and Cl also gave a significant yield response of 8.6 tonnes/ha/year.

SOA (effects of N and S) application, provided the highest yield difference. It would appear that the major elements considered important would be N, S, and K.

Table 83. Effects of N, S, K, and Cl in different combinations, on yield and yield components in 1992 and 1993 (Trial 309).

	1992			1993		
Treatment	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	32.5	1340	24.2	28.4	1192	23.9
5 N S K	30.9	1340	23.1	28.7	1214	23.6
3 N S	27.8	1270	21.8	25.2	1178	21.4
2 N Cl	21.7	1130	19.0	19.4	1023	19.3
1 Nil	13.6	917	14.2	9.8	665	14.2
Sig	***	(ns)	***	***	**	***
cv	20.0	18.7	5.2	19.1	22.1	7.9
lsd	7.0	310	2.3	5.9	322	2.2

Table 84. Mean yield for 1991 - 1993, and difference in yield for selected comparisons (Trial 309).

Mean Yield 1991 - 1993		Selected Comparisons		
Treatment	Yield (t/ha/yr)	Comparisons	Difference (t/ha/yr)	Sig
4 N S K Cl	30.7	4-2 (effect of K and S)	8.8	*
5 N S K	29.4	3-2 (substituting S for Cl	5.3	*
3 N S	27.2	4-3(effect of K and Cl)	3.5	ns
2 N Cl	21.9	4-5 (effect of Cl)	1.3	ns
1 Nil	13.3	5-3 (effect of K)	2.2	ns
		3-1 (effect of N and S)	13.9	**
		2-1(effect of N and Cl)	8.6	*

F sig ***, cv 14.8%, sed 2.30

Nutrient analysis

The analysis on nutrient concentrations from sampling in December 1993 of frond 17. These are presented in Table 85 and 86, comparing the effects of N, S, K, and Cl on concentration of elements in the leaf and rachis.

All the treatment receiving N sources maintained leaf N levels above 2%. The overall effect of SOA was to depress the level of total bases, whereas the overall effect of MOP was to raise the level of total bases. SOA also brought about reductions in leaf Ca and Mg, increases in leaf K and redistribution of P from rachis to the leaf. In treatment 4 and 2 applications of AMC and MOP had increased Cl in the leaflets and rachis. The Cl component in these two fertilisers have significantly change the proportion of individual bases in the leaflets, increasing Ca and decreasing K. BA application appeared to reduce plant Ca levels, while both sources of K raised plant K levels. The nature of the response developing to MOP in this trial is identical to that in other trials.

Table 85. Effects of N, S, K, and Cl in different combinations, on the concentration of elements in the leaf tissue of frond 17 in 1993 (Trial 309).

Treatment	Concentration (% of dry matter)						
	N	P	K	Ca	Mg	Cl	S
4 N S K Cl	2.14	0.129	0.67	0.70	0.15	0.43	0.14
5 N S K	2.06	0.130	0.72	0.64	0.14	0.25	0.14
3 N S	2.00	0.127	0.72	0.63	0.17	0.19	0.14
2 N Cl	2.02	0.130	0.57	0.74	0.17	0.46	0.12
1 Nil	1.65	0.114	0.57	0.71	0.25	0.22	0.11
Sig	**	**	**	**	**	***	**
cv	7.5	4.3	9.1	5.7	20.8	13.5	9.3
lsd	0.20	0.008	0.08	0.05	0.05	0.06	0.02

Table 86. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in rachis of frond 17 in 1993 (Trial 309).

Treatment	Concentration (% dry matter)						
	N	P	K	Ca	Mg	Cl	S
4 N S K Cl	0.25	0.056	1.69	0.39	0.07	0.16	0.03
5 N S K	0.24	0.058	1.30	0.28	0.05	0.16	0.04
3 N S	0.22	0.054	1.00	0.30	0.06	0.14	0.04
2 N Cl	0.38	0.108	1.15	0.41	0.12	0.22	0.02
1 Nil	0.19	0.116	1.04	0.27	0.12	0.22	0.02
Sig	***	***	***	***	***	***	**
cv	18.4	22.2	11.9	8.9	17.5	16.2	23.1
lsd	0.06	0.024	0.20	0.04	0.02	0.12	0.01

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

PURPOSE

To test the response to potassium chlorine, and sulphur.

DESCRIPTION

Site Ambogo block 80D5.

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

Palms Dami commercial DxP crosses planted in 1980 at 143 palms per hectare. Trial started in 1986, but the 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 87). The treatments are combination of fertilisers. The lower half of Table 88 shows the amount of each element that is applied to each treatment. The effect of an element is found by comparing the yields from two treatments; for example the effect of Cl in the presence of K and S is found by comparing treatments 6 and 4, and the effect of Cl in the absence of K and S is found by comparing treatments 3 and 1.

The treatments that were used before November 1991 were similar, but there are some important differences (Table 88). All treatments used to get their N from urea, but now only treatment 1 does. The others get it from SOA or AMC. Treatment 6 now has Cl but did not before, while treatment 7 now has S but did not before.

Table 87. Amount of each type of fertiliser, and each element, used for each treatment in Trial 310.

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

Table 88. Amount of each element used in each treatment from November 1988 until May 1990.

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

Note: All N is from Urea.

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

RESULTS

Yield data comparisons are given in Table 89 for 1993 and Table 90 for the period 1991 - 1993.

There were no significant differences from treatment 6 compared with the other treatments. The base yield with urea alone was around 28 t/ha in 1993, and 26 t/ha averaged over three years. Treatment 3 which is receiving AMC produced the highest yields of 31.5 t/ha in 1993, and about 30 t/ha over the three year period. Treatment 6 and 2 both produced yields of around 30 t/ha in 1993. The effects of poaching may have flattened the responses. Trenching of the trial has been completed, it is expected that the treatment effects may show more clearly in 1995.

Table 89. The effects of K, Cl, and S on yield in 1993 (Trial 310).

Treatment No	Elements supplied	Elements missing	Yield (t/ha/yr)	Differences from Treatment No 6 t/ha/yr	%
6	N,K,Cl,S	None	29.9	0.0	0.0
4	N,K,S	Cl	26.8	-3.1	-10.4
7	N,Cl,S	K	28.7	-1.2	- 4.0
5	N,K,Cl	S	28.9	-1.0	- 3.3
2	N,S	K,Cl	29.9	0.0	0.0
3	N,Cl	K,S	31.5	+1.6	+5.4
1	N (urea)	K,Cl,S	28.1	-1.8	-6.0
		sig	ns		
		cv	12.0		
		lsd	-		

Table 90. The effect of K, Cl and S on yield for the period 1991 - 1993 (Trial 310).

Treatment No	Elements supplied	Elements missing	Yield (t/ha/yr)	Differences from Treatment No. 6 t/ha/yr	%
6	N,K,Cl,S	None	30.2	0.0	0.0
4	N,K,S	Cl	28.[illegible]	2.2	7.3
7	N,Cl,S	K	28.4	-1.8	-6.0
5	N,K,Cl	S	28.3	1.9	6.3
2	N,S	K,Cl	28.6	1.6	5.3
3	N,Cl	K,S	30.3	+0.1	+0.3
1	N (urea)	K,Cl,S	26.3	3.9	-12.9
		sig	ns		
		cv	8.0		
		lsd	-		

Nutrient analysis

The analysis of nutrient concentrations sampled in October 1993, from frond 17 are presented in Table 91 and 92. These are comparing the effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaf and rachis.

There were significant differences in the concentrations of leaf K, Cl, and Ca. The increases of K in the leaflets from Bunch Ash applications brought about reductions in Cl and other bases. Applications of MOP and AMC reduced leaflet K, but indicated uptake was present in the rachis and increased plant Cl, Ca and Mg. SOA had an effect on the redistribution of rachis P to leaflet P.

Table 91. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in the leaf tissues of frond 17 in 1993 (Trial 310).

	Concentration (% dry matter)						
Treatment	N	P	K	Ca	Mg	Cl	S
6 N S K Cl	2.12	0.131	0.70	0.68	0.13	0.25	0.13
4 N S K	2.17	0.132	0.73	0.60	0.13	0.18	0.14
7 N S Cl	2.16	0.130	0.61	0.69	0.14	0.46	0.13
5 N K Cl	2.19	0.133	0.69	0.73	0.13	0.49	0.12
3 N Cl	2.15	0.132	0.64	0.70	0.14	0.48	0.12
2 N S	2.15	0.130	0.73	0.67	0.14	0.15	0.13
1 N (urea)	2.13	0.132	0.70	0.71	0.16	0.16	0.13
sig	ns	ns	**	*	ns	***	ns
cv	4.3	2.5	7.2	8.5	12.8	27.7	11.9
lsd	-	-	0.06	0.08	-	0.11	-

Table 92. Effects of N, S, K, and Cl, in different combinations, on the concentration of elements in rachis on frond 17 in 1993 (Trial 310).

	Concentration (% dry matter)						
Treatment	N	P	K	Ca	Mg	Cl	S
6 N S K Cl	0.26	0.135	1.21	0.37	0.05	0.51	0.05
4 N S K	0.26	0.111	1.03	0.31	0.04	0.25	0.06
7 N S Cl	0.27	0.118	1.07	0.44	0.07	0.71	0.04
5 N K Cl	0.26	0.145	1.28	0.44	0.06	1.00	0.04
2 N S	0.27	0.094	0.85	0.30	0.04	0.03	0.05
3 N Cl	0.29	0.146	1.11	0.46	0.09	0.94	0.04
1 N (urea)	0.25	0.118	0.83	0.31	0.05	0.03	0.04
sig	ns	**	***	***	***	***	*
cv	9.0	17.4	11.1	8.9	11.1	32.1	18.8
lsd	-	0.03	0.15	0.04	0.008	0.21	0.01

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 of all combinations of four levels each of N and K, and two levels of EFB (Table 93). 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 93, 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 93. Amounts of fertiliser and EFB used in Trial 311.

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

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

EFB has been applied once every two years commencing November 1988, October 1990, missed in 1992 but applied in June 1993.

RESULTS

Yield data for 1993, and for the period years 1989 - 1993 are summarised in Table 94 and 95

In 1993 there was a large statistically significant increase in yield due to N of 8 tonnes up to level 1 (2 kg of SOA), and a smaller and steady increase up to level 3. The trend is similar for the period 1989 - 1993. The form of response to SOA was linear. Bunch numbers were also increased significantly, despite single bunch weights reaching maximum of around 28 kg.

There were no significant effects to MOP. Averaged over the four year period, MOP gave a significant increase in yield at P < 0.05 level. This increase was caused by of increased bunch weights.

EFB had a significant effect on yield, with an increase of about 3 tonnes. EFB also increased single bunch weights.
There were no interaction effects between NxK and NxEFB, but there was a significant interaction between KxEFB at P < 0.05 level. The maximum yield of 40 t/ha was achieved with 6 kg of SOA and 2 kg of MOP.

Although the NxEFB was not significant, it appears that in the presence of EFB there was a yield increase of 8 tonnes up to 2 kg of SOA/palm/year as in Fig. 6. In the absence of EFB increasing N causes a steady increase to 6 kg of SOA/palm/year.
At the K0 and K1 level, the presence of EFB increased the yields. At the higher rates of K, in the presence of EFB yields were lower than at the lower K rates. The observed response to MOP was variable. It appears that EFB is supplying both N and K.

Table 94. Main effects of N, K, and EFB on yield and yield components for 1993.

	Level of nutrient element or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	24.1	31.9	35.9	36.8	***	8.6	3.18
Bunches/ha	889	1120	1214	1324	***	9.0	118
Bunch weight (kg)	26.8	28.5	29.7	27.9	*	5.8	1.89
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.7	31.4	35.9	36.8	ns	8.6	
Bunch/ha	1117	1109	1099	1221	ns	9.0	-
Bunch weight (kg)	27.5	27.9	29.3	28.2	ns	5.8	-
	EFB 0	EFB 1					
Yield (t/ha/yr)	30.6	33.7			*	8.6	2.25
Bunch/ha	1103	1170			ns	9.0	-
Bunch weight (kg)	27.5	28.9			*	5.8	1.33

Table 95. Effect of combinations of N and K, N and EFB, and K and EFB on yield in 1993 (Trial 311).

	Yield (t/ha/yr) Level of N			
Level of K	N0	N1	N2	N3
K0	23.7	28.6	34.8	35.7
K1	22.4	27.7	35.1	40.3
K2	22.7	34.4	35.0	36.7
K3	27.5	37.0	38.6	34.6
Level of EFB				
EFB 0	29.6	26.3	31.9	34.7
EFB 1	26.7	34.7	36.5	36.8

	Level of K			
Level of EFB	K0	K1	K2	K3
EFB 0	29.6	26.3	31.9	34.7
EFB 1	31.8	36.4	32.5	34.1

NxK and NxEFB interactions not significant
KxEFB interaction significant at (*) $P < 0.05$ level.

It is not possible to do a proper economic analysis of the results because of the effects of poaching.Obviously there is some benefits to EFB 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 as shown in Fig.6.

FIG.6 Effect of EFB on Yield at various Levels of N in 1993 (Trial 311)

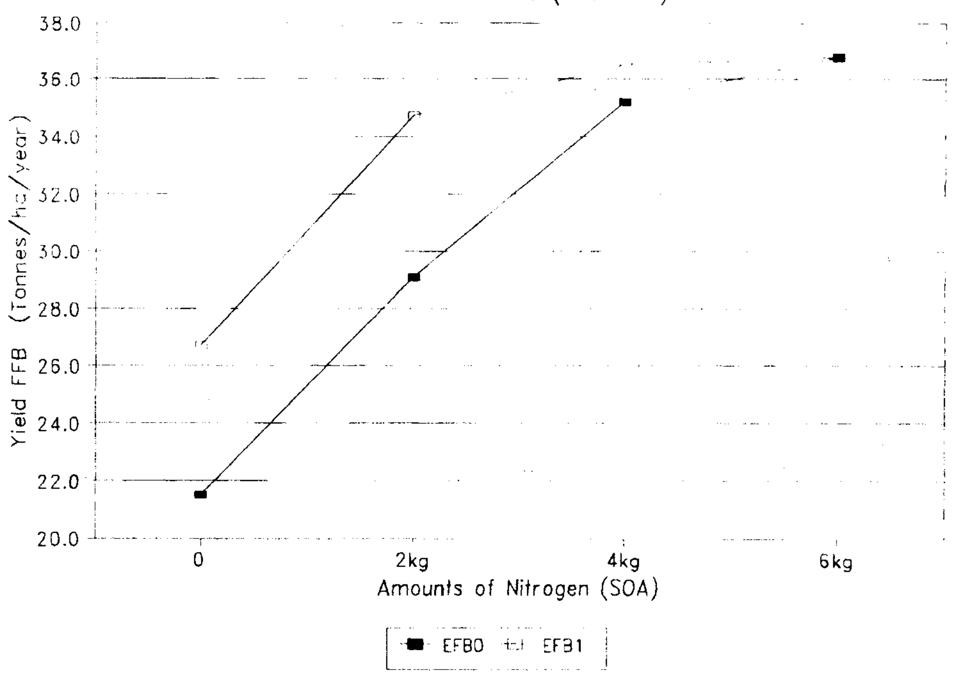


Table 96. Main effects of N, K, and EFB on yield and yield components for 1989 - 1993. (Trial 311).

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	sig	cv	lsd
Yield (t/ha/yr)	27.9	31.5	33.3	35.4	***	5.6	2.07
Bunch/ha	1091	1212	1236	1328	**	7.3	103
Bunch weight (kg)	25.5	25.9	27.0	26.7	(ns)	4.3	1.30
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.5	31.6	32.0	33.9	*	5.6	2.07
Bunch/ha	1216	1192	1188	1271	ns	7.3	-
Bunch weight (kg)	25.1	26.3	27.1	26.7	*	4.3	1.30
	EFB0	EFB1					
Yield (t/ha/yr)	30.8	33.3			**	5.6	2.07
Bunch/ha	1195	1238			ns	7.3	-
Bunch weight (kg)	25.7	26.9			*	4.3	0.92

Table 97. Effect of combination of N and K, N and EFB and K and EFB, on yield for 1989 - 1993 (Trial 311).

	Yield (t/ha/yr) Level of N			
Level of K	N0	N1	N2	N3
K0	26.3	29.9	32.1	33.9
K1	25.5	29.2	33.1	38.6
K2	28.9	32.5	32.8	33.9
K3	30.9	34.4	35.2	35.1
Level of EFB				
EFB 0	27.2	28.8	32.9	34.2
EFB 1	28.6	34.2	33.7	36.5

	Level of K			
Level of EFB	K0	K1	K2	K3
EFB 0	29.6	27.8	31.9	33.8
EFB 1	31.5	35.4	32.2	34.0

NxK and NxEFB interactions not significant
KxEFB interactions significant (*) at $P < 0.05$.

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 98). Sulphate of ammonia (SOA) is the source of N, and Muriate of potash (MOP) is the source of K. The EFB is applied by hand as a mulch between palm circles. The weights of EFB given in Table 98 are fresh weights ex-mill. When EFB was given for the first time in November 1988 the amount was 333 kg/palm. In September 1990 it was increased to 500 kg/palm, and it is intended to give this amount every two years.

Table 98. Amounts of fertiliser and EFB used in Trial 312.

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

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

EFB has been applied once every two years (November 1988, September 1990 and November 1992).

RESULTS

Yield data for 1993, and for the four years 1989 - 1993 are summarised in Tables 99 and 101.

There was a significant increases in yield, caused by SOA, of 6 tonnes up to level 1 in 1993 and, an increase of 4 tonnes averaged over the period (1989 - 1993).

Application of MOP did not have any significant effect on yield.

In 1992 EFB1 increased yields averaged 3 t/ha/yr from EFB0, the variation was reversed in 1993 to give an increase of only 0.3 t/ha/yr. There were no interaction effects between NxK, NxEFB and KxEFB. Table 100 indicates an increase in the presence of EFB with N up to level 1, of 6 tonnes. In the absence of EFB increasing N causes a steady increase in yield up to 6kg SOA/palm/yr.

The very high yields of the zero plots are the results of a combination of high residual soil fertility, and the poaching effects of fertiliser from neighbouring plots.

Table 99. Main effects of N, K, and EFB on yield and yield components in 1993 (Trial 312).

	Level of nutrients elements or EFB				Statistics		
	N0	N1	N2	N3	sig	cv	lsd
Yield (t/ha/yr)	**22.9**	**29.3**	**32.2**	**31.8**	**	**14.5**	**4.85**
Bunches/ha	1113	1228	1366	1347	**(ns)**	**14.0**	**(204)**
Bunch wt (kg)	**20.5**	**24.0**	**23.6**	**23.7**	*	**8.0**	**2.11**
	K0	K1	K2	K3			
Yield (t/ha/yr)	28.7	27.7	30.4	29.3	ns	14.5	-
Bunches/ha	1263	1238	1314	1239	ns	14.0	-
Bunch wt (kg)	22.6	22.4	23.1	23.8	ns	8.0	-
	EFB0	EFB1					
Yield (t/ha/yr)	28.9	29.2			ns	14.5	-
Bunches/ha	1267	1260			ns	14.0	-
Bunch wt (kg)	22.7	23.2			ns	8.0	-

Table 100. Effect of combinations of N and K, N and EFB, and K and EFB on Yield in 1993 (Trial 312).

	Yield (t/ha/yr) Level of N			
Level of K	N0	N1	N2	N3
K0	19.2	31.0	32.7	32.1
K1	23.4	29.4	32.2	25.8
K2	23.2	32.1	31.6	34.8
K3	25.8	24.8	32.3	34.3
Level of EFB				
EFB0	21.9	29.1	31.4	33.0
EFB1	23.9	29.5	33.0	30.5
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB0	27.7	27.0	30.6	30.1
EFB1	29.8	28.4	30.3	28.5

Table 101. Main effects of N, K, and EFB on yield and yield components from 1989 - 1993 (Trial 312).

	Level of nutrients elements or EFB				Statistics sig	cv	lsd
	N0	N1	N2	N3			
Yield (t/ha/yr)	**28.5**	**32.8**	**35.0**	**34.9**	***	**6.7**	**2.5**
Bunch/ha	**1543**	**1575**	**1687**	**1690**	**(ns)**	**7.4**	**(139)**
Bunch wt (kg)	**18.5**	**20.9**	**20.8**	**20.7**	**	**5.6**	**1.3**
	K0	K1	K2	K3			
Yield (t/ha/yr)	32.7	32.2	33.2	33.3	ns	6.7	-
Bunch/ha	1621	1612	1641	1621	ns	7.4	-
Bunch wt (kg)	20.1	19.9	20.2	20.6	ns	5.6	-
	EFB0	EFB1					
Yield (t/ha/yr)	32.5	33.1			ns	6.7	-
Bunch/ha	1628	1619			ns	7.4	-
Bunch wt (kg)	19.9	20.5			ns	5.6	

Table 102. Effects of combinations of N and K, N and EFB and K and EFB on yield for 1989 - 1993 (Trial 312).

	Yield (t/ha/yr) Level of N			
Level of K	N0	N1	N2	N3
K0	27.2	33.8	35.6	34.0
K1	28.2	33.1	34.7	32.7
K2	27.2	34.0	34.9	36.2
K3	31.0	30.4	34.9	36.7
Level of EFB				
EFB 0	27.4	32.8	34.2	35.6
EFB 1	29.6	32.8	35.8	34.2
	Level of K			
Level of EFB	K0	K1	K2	K3
EFB 0	32.8	30.5	32.7	34.1
EFB 1	32.5	33.8	33.7	32.5

NxK, NxEFB, and KxEFB interactions not significant.

Nutrient analysis

The analysis on nutrient concentrations from sampling in October 1993 of frond 17 are presented in Table 103 and 104.

SOA applications significantly increased rachis N, and were almost significant in leaf N. Redistribution of rachis P to the leaflets were also observed. There was also a significant increase in rachis Cl and a depressing effect on rachis K.

MOP increased rachis K significantly indicating uptake was taking place. Levels of Cl in the plant were increased as indicated in other trials. EFB gave a significant increase in rachis K and Cl levels. All other elements showed slight increases but were not significant.

Table 103. Main effects of N, K, and EFB on concentrations of elements in leaf tissue in 1993 (% of dry matter) (Trial 312).

	Level of nutrient element or EFB				Statistics		
					sig	cv	lsd
	N0	N1	N2	N3			
N%	**2.02**	**2.13**	**2.22**	**2.23**	**(ns)**	**6.9**	**(0.17)**
P%	**0.131**	**0.132**	**0.136**	**0.138**	*	**2.8**	**0.004**
K%	0.74	0.71	0.71	0.72	ns	5.0	-
Ca%	0.72	0.72	0.71	0.70	ns	4.2	-
Mg%	**0.19**	**0.18**	**0.16**	**0.18**	*	**10.9**	**0.02**
Cl%	0.45	0.43	0.47	0.44	ns	13.7	-
S%	**0.12**	**0.12**	**0.13**	**0.14**	**(ns)**	**11.8**	**(0.02)**
	K0	K1	K2	K3			
N%	2.10	2.13	2.22	2.23	ns	6.9	-
P%	0.134	0.137	0.133	0.135	ns	2.8	-
K%	0.72	0.72	0.71	0.74	ns	5.0	-
Ca%	**0.67**	**0.73**	**0.74**	**0.71**	**	**4.2**	**0.03**
Mg%	0.18	0.18	0.18	0.17	ns	10.9	-
Cl%	**0.35**	**0.46**	**0.51**	**0.48**	**	**13.7**	**0.07**
S%	0.13	0.13	0.12	0.12	ns	11.8	-
	EFB 0	EFB 1					
N%	2.16	2.14			ns	6.9	-
P%	0.134	0.136			ns	2.8	-
K%	0.71	0.73			ns	5.0	-
Ca%	0.72	0.71			ns	4.2	-
Mg%	0.18	0.18			ns	10.9	-
Cl%	0.45	0.44			ns	13.7	-
S%	0.13	0.13			ns	11.8	-

Table 104. Main effects of N, K, and EFB on concentrations of elements in the rachis in 1993. (% of dry matter) (Trial 312).

	Level of nutrient element or EFB				Statistics		
	N0	N1	N2	N3	Sig	cv	lsd
N%	**0.22**	**0.24**	**0.25**	**0.28**	**	**7.5**	**0.02**
P%	**0.159**	**0.106**	**0.083**	**0.076**	***	**21.1**	**0.03**
K%	**1.73**	**1.58**	**1.62**	**1.58**	*	**5.1**	**0.10**
Ca%	0.36	0.40	0.38	0.39	ns	10.4	-
Mg%	0.07	0.07	0.06	0.06	ns	17.1	-
Cl%	**0.88**	**0.91**	**0.98**	**1.04**	***	**5.3**	**0.06**
S%	0.04	0.05	0.05	0.05	ns	36.0	-
	K0	K1	K2	K3			
N%	0.24	0.26	0.25	0.28	ns	7.5	-
P%	0.10	0.11	0.10	0.11	ns	21.1	-
K%	**1.33**	**1.66**	**1.72**	**1.81**	***	**5.1**	**0.10**
Ca%	**0.36**	**0.40**	**0.38**	**0.39**	**(ns)**	**10.4**	**(0.04)**
Mg%	0.06	0.06	0.06	0.06	ns	17.1	-
Cl%	**0.47**	**1.00**	**1.13**	**1.22**	***	**5.3**	**0.06**
S%	0.05	0.05	0.04	0.05	ns	36.0	-
	EFB 0	EFB 1					
N%	**0.24**	**0.26**			**(ns)**	**7.5**	**(0.02)**
P%	0.105	0.106			ns	21.1	-
K%	**1.52**	**1.74**			***	**5.1**	**0.07**
Ca%	0.38	0.38			ns	10.4	-
Mg%	0.06	0.06			ns	17.1	-
Cl%	**0.91**	**1.00**			***	**5.3**	**0.04**
S%	0.05	0.05			ns	36.0	-

Trial 314 SMALLHOLDER DEMONSTRATION SITES, ORO PROVINCE

PURPOSE

1. To demonstrate the value of fertiliser applications, for the benefit of all smallholders.

2. To monitor the selected sites so as to obtain agronomic data (e.g. soil, leaf and yield) in order to improve the understanding of the basic agronomy for all smallholder areas.

3. To provide an assessment of fertiliser response and requirement for smallholder requirement for smallholder locations.

DESCRIPTION

Site Currently 19 sites up to 60 km apart and throughout the major smallholder oil palm areas of Northern Province.

Soil Soils have been categorised into 3 major groupings. The `SANDY' group of soils approximate to the Ambogo and Penderetta families as outlined for estate trial 306.The `VOLCANIC' group are characterised by high organic matter levels and high phosphate retention levels. The top soil which is often deep, is a black loam.The remainder of the soils are less easily characterised as a group, and generally possess clay loam topsoils and deep subsoils also with a clay component. Some have an alluvially re-worked origin, whilst others have been formed in situ with weathered pyrolistic material. They have been named `CLAY LOAM' group.

Palms Dami commercial DxP crosses. Planted at various dates at 120 palms/ha. Trial started in 1988.

DESIGN

The trial comprises; 18 of 4 ha and 1 of 2 ha - total 74 ha. Each smallholder block provides a single replicate. On the 4 ha holdings there are normally 6 experimental plots and on the 2 ha holding there are only 4 plots, each with a core of 25 palms. The numbers and weights of bunches from each individual core palm are recorded at intervals of 14 days. Of the 19 blocks 4 are recorded quarterly during the year. In each plot the core palms are surrounded by at least one guard row making a total of 49 palms per plot.

The 6 plots, comprises of a control plot which receives no fertiliser, a demonstration plot receiving overall treatment, and 4 systematic applications of N and K fertilisers, each applied in a gradient at right angles to the other. Two of these 4 plots also receive TSP, and two do not. There is a zero fertiliser guard row on both sides of the nil treatments and the guard row beyond the highest treatment receives an incrementally higher rate. In 1992 four of the systematic blocks were converted into factorials with the modification of the treatments.

In 1993 two more blocks were converted as demonstration blocks, comprising only two plots. The block is halved into two, to consist of a control and demonstration plot. The demonstration plot receives the current recommendations and the control plots receives nothing.

Treatments:

1. The "control" receives no fertiliser.

2. The "Demonstration" plot (and all perimeter palms) are fertilised according to the current

recommendations.

3. The conversion phase of the four blocks receives N1/N2 as SOA, with or without PotassiumChloride. Because of the belief that when the yields in trials increased in response to muriate of potash, it was the chlorine that was effective rather then the potassium. It was intended to separate out the effects of Cl from those of K. Plots receiving no P were given TSP to achieve standard P status throughout the trial.

Application frequency for N and K fertilisers is twice a year, but TSP is applied in a single annual application of 1 kg per palm.

Table 105. Fertiliser rates for demonstration plots;kg/palm 1990

	Soil Classification		
Fertiliser	Clay loam	Sandy	Volcanic organic
N SOA	1.25	1.25	2.0
N AMC	1.0	1.0	0.0
K MOP	0.0	0.0	1.0

Table 106. Fertiliser rates for demonstration plots;kg/palm 1991, 1992 and 1993.

Fertiliser	All Areas
N SOA	1.25
N AMC	1.0

Table 107. Systematic component rates in kg/palm/year

Fertiliser		Level			
		0	1	2	3
N	SOA	0.0	1.25	2.5	3.75
K	MOP	0.0	1.25	2.5	3.75

RESULTS

Yields from the control and fertilised plots from trials on smallholder blocks 1991 - 1993 are summarised in Table 108, 109, 110 and Fig.8.

On the `sandy' soils, averaged yields on the control plots was 8 t/ha/yr, and demonstration plots was 14 t/ha/yr in 1993. Application of 2.5kg/palm/year of SOA provided an average response of 43%.

On the `volcanic' soils, averaged yields on control plots was 13 t/ha/yr, and on the demonstration plot was 22 t/ha/yr in 1993. Application of 2.5 kg/palm/year of SOA provided an average response of 41%.

On the `clay loam' soils, averaged yields on control plots was 14t/ha/yr, and on the demonstration plot was 18t/ha/yr in 1993. Applications of 2.5 kg/palm/year of SOA provided an average response of 25%.

Table 108. Yields from control and fertilised plots for 1991 - 1993 (Tonnes/ha/year).

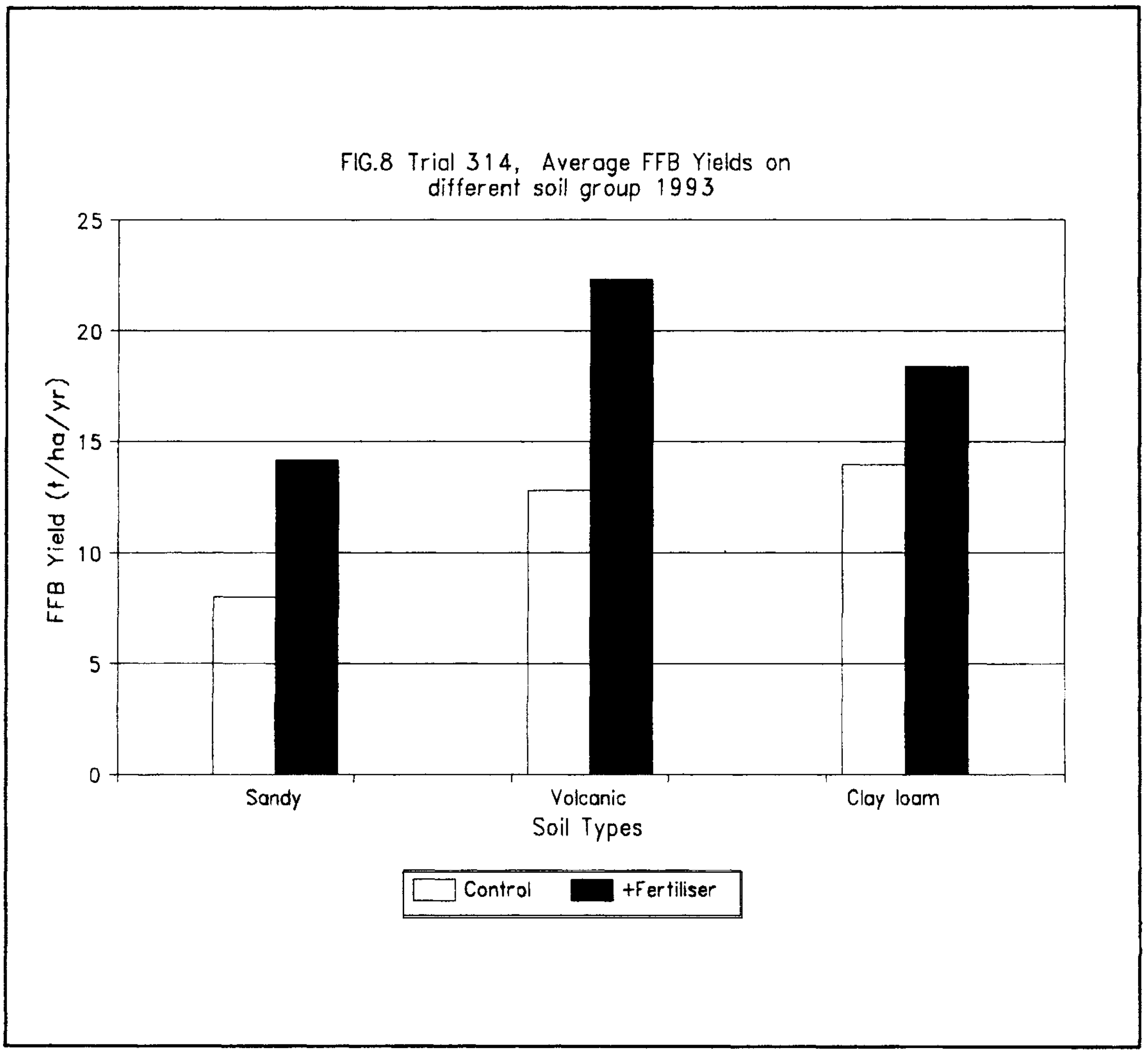
Block	Trial	Treatment	1991	1992	1993
SANDY SOILS					
030309	314	Control	11.3	10.0	9.3
		Fertilised	16.0	18.0	15.3
260002	314	Control	8.5	8.2	8.1
		Fertilised	15.6	5.1	12.9
881111	314	Control	5.5	5.6	4.5
		Fertilised	10.6	8.6	9.6
040266	314	Control	17.9	16.9	10.2
		Fertilised	24.9	25.2	18.9
Mean		Control	10.8	10.2	8.0
		Fertiliser	16.8	14.2	14.2

Table 109. Yields from control and fertilised plots 1991 - 1993 (Tonnes/ha/year).

Block	Trial	Treatment	1991	1992	1993
VOLCANIC ORGANIC					
300029	314	Control	15.9	17.6	16.0
		fertilised	24.8	24.5	22.6
520003	314	control	11.0	12.4	8.2
		fertilised	11.6	18.1	18.2
111578	314	control	13.0	11.8	9.5
		fertilised	19.5	13.5	21.1
101179	314	control	13.5	8.9	8.6
		fertilised	16.5	13.4	14.0
320012	314	control	21.5	16.4	12.3
		fertilised	28.5	20.8	23.2
390001	314	control	27.0	24.4	15.9
		fertilised	31.0	26.1	26.0
520011	314	control fertilised	314	25.4	18.9
				33.0	30.8
Mean		control	18.5	16.7	12.8
		fertilised	23.5	21.3	22.3

Table 110. Yields from control and fertilised plots for 1991 - 1993 (Tonnes/ha/year).

Block	Trial	Treatment	1991	1992	1993
CLAY LOAM					
050157	314	Control	8.5	5.5	9.2
		fertilised	23.9	19.5	12.8
111611	314	control	7.1	8.5	7.9
		fertilised	15.3	15.2	11.2
230003	314	control	17.6	18.3	17.8
		fertilise	16.9	22.7	23.4
080079	314	control	26.5	20.8	21.2
		fertilised	28.5	24.5	26.3
Mean		Control	14.9	13.3	14.0
		fertilised	21.1	20.5	18.4



Discussion

The data highlights the essential requirements for N fertiliser to ensure reasonable yields in all trial areas. In the control plots yields have plummeted to around 10 t/ha/yr, as expected. These are typical of the smallholder situations. Indications from the demonstration blocks have also declined over the three years. The question is are the current rates too low to maintain economic yields, or should there be different rates for the three different soil categories.

Successful operation of a trial of this nature is more complex than work on the estates, and the goodwill and co-operation of the block owners must always be maintained.

An important objective of the trial is for the demonstration blocks to provide the basis for extension work to encourage correct fertiliser use by other block owners.

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

PURPOSE

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

DESCRIPTION

Site Komo estate block 27

Soil Dark sandy loam, derived from airfall ash.

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

DESIGN

There are 36 plots, each with a core of 10 palms. The numbers and the weights of bunches from each individual core palms are recorded at intervals of 14 days. The core palms are surrounded by trenches (one metre 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 111).

Table 111. Types of fertiliser and amounts used in Trial 317

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

RESULTS

Yield data for 1993 and for the period from 1991 - 1993 are summarised in Table 112 and 114

SOA increased yield up to level N1 (2.5 kg SOA/palm/year), but that effect was lost at the level N2 (5 kg SOA/palm/year) in 1993. The trend was the same averaged over the three year period. The form of response was quadratic which was significant at $P < 0.05$ level.

There was a small but significant increase observed caused by MOP and Kieserite on single bunch weight in 1993. Baseline yields were heavy at about 27 t/ha/yr.

There was no response to TSP.

Table 112. Main effects of N, P, K, and Mg on yield and yield components in 1993 (Trial 317).

	Nutrient element and level			Statistics		
				sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	**28.7**	**31.7**	**25.9**	**(ns)**	**19.7**	**4.9**
Bunch/ha	1274	1243	1318	ns	14.6	-
Bunch wt (kg)	**22.4**	**23.3**	**21.2**	**(ns)**	**9.2**	**(1.8)**
	K0	K1	K2			
Yield (t/ha/yr)	27.0	28.8	30.5	ns	19.7	-
Bunch/ha	1295	1243	1318	ns	14.6	-
Bunch wt (kg)	**20.8**	**23.2**	**23.0**	*	**9.2**	**1.8**
	P0	P1				
Yield (t/ha/yr)	28.7	28.9		ns	19.7	-
Bunch/ha	1289	1281		ns	14.6	-
Bunch wt (kg)	22.2	23.1		ns	9.2	-
	Mg0	Mg1				
Yield (t/ha/yr)	28.4	29.2		ns	19.7	-
Bunch /ha	1308	1262		ns	14.6	-
Bunch wt (kg)	**21.5**	**23.1**		*	**9.2**	**1.45**

Table 113. Effect of K on yield at different levels of N in 1993 (Trial 317).

	Yield (t/ha/yr) Level of K		
Level of N	K0	K1	K2
N0	27.0	29.7	29.4
N1	28.5	31.2	35.5
N2	25.5	25.6	26.6

The interactions between N and K were not significant, but the NxK two-way table (Table 113) indicates that maximum yield of 35 t/ha/yr is achieved with 2.5 kg of SOA/palm/year and 5 kg MOP/palm/year in 1993.

There was a steady increase in yield due to K in the presence of N up to 2.5 kg SOA/palm/year. The yields appear to be depressed at N2 level (5 kg SOA/palm/year).

Table 114. Main effects of N, P, K, and Mg on yield and yield components from 1991 - 1993 (Trial 317)

	Nutrient element			Statistics		
	N0	N1	N2	sig	cv	lsd
Yield (t/ha/yr)	29.1	29.3	27.4	ns	9.9	-
Bunch/ha	1542	1518	1531	ns	11.0	-
Bunch wt (kg)	18.9	19.4	17.8	ns	9.0	-
	K0	K1	K2			
Yield (t/ha/yr)	**27.2**	**27.8**	**30.8**	*	**9.9**	**2.4**
Bunch/ha	1522	1471	1598	ns	11.0	-
Bunch wt (kg)	17.9	18.9	19.3	ns	9.0	-
	P0	P1				
Yield (t/ha/yr)	28.1	29.1		ns	9.9	-
Bunch/ha	1510	1551		ns	11.0	-
Bunch wt (kg)	18.7	18.7		ns	9.0	-
	Mg0	Mg1				
Yield (t/ha/yr)	28.0	29.1		ns	9.9	-
Bunch/ha	1538	1523		ns	11.0	-
Bunch wt (kg)	**18.2**	**19.2**		**(ns)**	**9.0**	**(1.18)**

Table 115 Effect of K on yield at different levels of N in 1991 - 1993 (Trial 317)

	Yield (Tonnes/ha/yr)		
	N0	N1	N2
K0	22.3	26.6	27.4
K1	23.6	27.8	30.4
K2	22.1	28.5	30.0

Note: NxK interaction not significant

Nutrient analysis

The analysis of nutrient concentrations, from sampling in March 1993 are presented in Table 116 and 117.

There were no significant effect of SOA on leaf and rachis N, and all other nutrients had remained unaffected. Leaf N levels were about the critical levels.TSP applications have improved rachis P status, which was significant at $P < 0.05$ level. No other responses were observed.

MOP applications have improved K and Cl status in the palms and a depressing effect on Mg status.

Applications of Kieserite significantly increased plant Mg, but a depressing effect on leaf K and rachis Ca levels were also observed. Magnesium deficiency symptoms have been observed visually in the trials, so it will be interesting to see if yield responses to Kieserite.

Table 116. Main effects of N, K, P, and Mg on concentrations of elements in leaf tissues of frond 17 in 1993 (Trial 317).

	Nutrient element and level			Statistics		
				sig	cv	lsd
	N0	N1	N2			
N%	2.49	2.57	2.54	ns	7.8	-
P%	0.161	0.160	0.160	ns	4.6	-
K%	0.71	0.74	0.72	ns	9.0	-
Ca%	1.08	1.05	1.08	ns	15.5	-
Mg%	0.16	0.17	0.14	ns	23.7	-
Cl%	0.43	0.44	0.46	ns	11.2	-
	P0	P1				
N%	2.55	2.52		ns	7.8	-
P%	0.159	0.162		ns	4.6	-
K%	0.72	0.73		ns	9.0	-
Ca%	1.05	1.09		ns	15.5	-
Mg%	0.13	0.19		ns	23.7	-
Cl%	0.45	0.43		ns	11.2	-
	K0	K1	K2			
N%	2.59	2.47	2.54	ns	7.8	-
P%	0.162	0.159	0.161	ns	4.6	-
K%	**0.67**	**0.73**	**0.77**	**	**9.0**	**0.06**
Ca%	1.09	1.05	1.08	ns	15.5	-
Mg%	**0.19**	**0.14**	**0.15**	**	**23.7**	**0.03**
Cl%	**0.29**	**0.48**	**0.56**	***	**11.2**	**0.04**
	Mg0	Mg1				
N%	2.53	2.54		ns	7.8	-
P%	0.160	0.161		ns	4.6	-
K%	**0.75**	**0.69**		**	**9.0**	**0.05**
Ca%	1.11	1.03		ns	15.5	-
Mg%	**0.13**	**0.19**		***	**23.7**	**0.03**
Cl	0.45	0.44		ns	11.2	-

Table 117. Main effects of N, P, K, and Mg on concentrations of elements in the rachis of frond 17 in 1993 (Trial 317).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
	0.24	0.25	0.25	ns	7.0	-
N%	0.066	0.066	0.058	ns	24.7	-
P%	0.69	0.65	0.63	ns	21.3	-
K%	0.47	0.48	0.51	ns	17.8	-
Ca%	**0.06**	**0.06**	**0.05**	*	**17.1**	**0.01**
Mg%	0.40	0.41	0.43	ns	19.8	-
Cl%						
	P0	P1				
N%	0.24	0.25		ns	7.0	-
P%	**0.058**	**0.062**		*	**24.7**	**0.01**
K%	0.67	0.65		ns	21.3	-
Ca%	0.48	0.50		ns	17.8	-
Mg%	0.05	0.06		ns	17.1	-
Cl%	0.42	0.41		ns	19.8	-
	K0	K1	K2			
N%	0.25	0.24	0.25	ns	7.0	-
P%	**0.054**	**0.067**	**0.069**	**(ns)**	**24.7**	**(0.01)**
K%	**0.29**	**0.63**	**1.05**	***	**21.3**	**0.12**
Ca%	0.48	0.52	0.47	ns	17.8	-
Mg%	**0.06**	**0.05**	**0.06**	*	**17.1**	**0.01**
Cl%	**0.10**	**0.45**	**0.70**	***	**19.8**	**0.07**
	Mg0	Mg1				
N%	0.25	0.24		ns	7.0	-
P%	0.064	0.062		ns	24.7	-
K%	0.69	0.63		ns	21.3	-
Ca%	**0.53**	**0.45**		*	**17.8**	**0.06**
Mg%	**0.04**	**0.07**		***	**17.1**	**0.01**
Cl%	0.43	0.40		ns	19.8	-

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 mamba soil.

DESCRIPTION

Site Komo Estate block 39

Soil Dark sandy loam

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

DESIGN

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

The 36 plots are in 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 118).

Table 118. 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	6.0
P	TSP	0	2.5	-
K	MOP	0	2.5	6.0
Mg	Kies	0	2.5	-

RESULTS

None of the treatments had any significant effect on yield (Table 119 and 120), though there was a significant effect of N on single bunch weights. As in trial 317, the development of response is quadratic.

There were also no significant responses on yield due to TSP, MOP and Kieserite. It is likely that the lack of response in this trial is due to residual fertility of the soil.

Table 119. Main effects of N, P, K, and Mg on yield and yield components in 1993 (Trial 318)

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	21.2	26.1	26.0	ns	26.9	-
Bunch/ha	1159	1278	1260	ns	20.0	-
Bunch wt (kg)	18.0	20.4	20.6	ns	17.0	-
	P0	P1				
Yield (t/ha/yr)	25.8	23.1		ns	26.9	-
Bunch/ha	1296	1169		ns	20.0	-
Bunch wt (kg)	19.9	19.5		ns	17.0	-
	K0	K1	K2			
Yield (t/ha/yr)	22.8	24.9	25.6	ns	26.9	-
Bunch/ha	1197	1212	1289	ns	20.0	-
Bunch wt (kg)	18.7	20.4	19.8	ns	17.0	-
	Mg0	Mg1				
Yield (t/ha/yr)	23.3	25.6		ns	26.9	-
Bunch/ha	1217	1249		ns	20.0	-
Bunch wt (kg)	18.8	20.5		ns	17.0	-

Table 120. Effect of K on yield at different levels of N

	Level of K Yield (t/ha/yr)		
Level of N	K0	K1	K2
N0	15.8	20.6	27.4
N1	27.7	26.2	24.5
N2	24.9	28.0	25.2

Note: NxK interaction not significant.

The NxK interaction was not significant, although a maximum yield of 27 - 29 t/ha/yr was obtained with 5 kg MOP/palm/year. The trend is the same as in Trial 317.

Table 121. Main effects of N, P, K, and Mg on yield and yield components from 1991 - 1993 (Trial 318)

	Nutrient element and level			Statistics sig	cv	ls
	N0	N1	N2			
Yield (t/ha/yr)	25.7	28.1	28.0	ns	16.5	-
Bunch/ha	1626	1552	1631	ns	9.9	-
Bunch wt (kg)	15.7	18.1	17.2	*	11.6	1.
	P0	P1				
Yield (t/ha/yr)	27.7	26.8		ns	16.5	-
Bunch/ha	1609	1598		ns	9.9	-
Bunch wt (kg)	17.3	16.7		ns	11.6	-
	K0	K1	K2			
Yield (t/ha/yr)	25.4	27.7	28.7	ns	16.5	-
Bunch/ha	1554	1610	1645	ns	9.9	-
Bunch wt (kg)	16.4	17.2	17.4	ns	11.6	-
	Mg0	Mg1				
Yield (t/ha/yr)	26.4	28.2		ns	16.5	-
Bunch/ha	1579	1628		ns	9.9	-
Bunch wt (kg)	16.6	17.4		ns	11.6	-

Table 122. Effects of K on yield at different levels of N

	Level of K Yield (t/ha/year)		
Level of N	K0	K1	K2
N0	22.0	26.0	29.1
N1	26.6	28.6	29.0
N2	27.6	28.5	27.9

Note: NxK interaction not significant.

Nutrient analysis

The analysis of nutrient concentrations, sampled in March 1993 are summarised in table 123 and 124.

SOA applications had an almost significant effect on leaf N levels, and maintained levels above 2.5%. There were also small increases in leaf K those were not significant. A redistribution of plant P from the rachis to the leaflets was observed.

There were no responses to TSP.

MOP applications significantly improved both K and Cl levels, accompanied with a depressing effect on the other bases, which were not significant.

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 123. Main effects of N, P, K, and Mg on concentrations of elements in leaf tissue of frond 17 in 1993 (% of dry matter) (Trial 318).

	Nutrient element and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	2.42	2.53	2.57	ns	6.6	(0.14)
P%	0.156	0.157	0.158	ns	3.5	-
K%	0.82	0.84	0.87	ns	19.7	-
Ca%	0.91	0.90	0.86	ns	15.1	-
Mg%	0.17	0.17	0.17	ns	33.2	-
Cl%	0.47	0.57	0.52	ns	26.1	-
	P0	P1				
N%	2.52	2.49		ns	6.6	-
P%	0.157	0.157		ns	3.5	-
K%	0.89	0.81		ns	19.7	-
Ca%	0.89	0.89		ns	15.1	-
Mg%	0.18	0.16		ns	33.2	-
Cl%	0.52	0.52		ns	26.1	-
	K0	K1	K2			
N%	2.49	2.55	2.48	ns	6.6	-
P%	0.158	0.159	0.154	ns	3.5	-
K%	0.69	0.89	0.96	**	19.7	0.14
Ca%	0.90	0.92	0.85	ns	15.1	-
Mg%	0.20	0.15	0.16	ns	33.2	-
Cl%	0.43	0.55	0.59	*	26.1	0.12
	Mg0	Mg1				
N%	2.46	2.56		ns	6.6	(0.12)
P%	0.159	0.155		ns	3.5	(0.004)
K%	0.90	0.79		ns	19.7	(0.12)
Ca%	0.91	0.87		ns	15.1	-
Mg%	0.11	0.23		***	33.2	0.04
Cl%	0.51	0.53		ns	26.1	-

Table 124. Main effects of N, P, K, and Mg on concentrations of elements in the rachis of frond 17 in 1993 (% of dry matter) (Trial 318)

	Nutrient elements and level			Statistics sig	cv	lsd
	N0	N1	N2			
N%	0.21	0.25	0.26	***	8.7	0.02
P%	0.078	0.071	0.067	ns	15.4	(0.01)
K%	0.77	0.86	0.82	ns	30.5	-
Ca%	0.38	0.41	0.38	ns	23.5	-
Mg%	0.07	0.07	0.06	ns	41.0	-
Cl%	0.50	0.62	0.58	ns	55.0	-
	P0	P1				
N%	0.24	0.24		ns	8.7	-
P%	0.067	0.077		*	15.4	0.01
K%	0.86	0.77		ns	30.5	-
Ca%	0.39	0.39		ns	23.5	-
Mg%	0.07	0.07		ns	41.0	-
Cl%	0.58	0.55		ns	55.0	-
	K0	K1	K2			
N%	0.24	0.24	0.24	ns	8.7	-
P%	0.062	0.075	0.079	ns	15.4	-
K%	0.37	0.85	1.24	***	30.5	0.22
Ca%	0.42	0.40	0.35	ns	23.5	-
Mg%	0.08	0.06	0.06	ns	41.0	(0.02)
Cl%	0.35	0.57	0.78	*	55.0	0.27
	Mg0	Mg1				
N%	0.25	0.23		*	8.7	0.02
P%	0.07	0.07		ns	15.4	-
K%	0.84	0.79		ns	30.5	-
Ca%	0.41	0.37		ns	23.5	-
Mg%	0.05	0.09		***	41.0	0.02
Cl%	0.59	0.54		ns	55.0	-

Trial 501 **FERTILISER TRIAL AT HAGITA ESTATE.**

PURPOSE

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

DESCRIPTION

Site Hagita Estate

Soil Plantation family. Alluvial clay loam with seasonally high water table.

Palms Dami commercial DxP crosses. Planted in April 1986 at 127 palms/ha.Trial started in July 1986.

DESIGN

There are 54 plots, each with a core of 8 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 54 plots are divided into three replicates blocks each containing 18 treatments, made up from all combinations of three levels of N and K, and two levels of P (Table 125).

There are four additional plots that are given no potassium at all, because in the main part of the trial the level 0 amount of potassium is 0.5 kg MOP/palm/year. This is because in some parts of the estate such severe deficiency symptoms were seen that it was thought the palms might die.

Table 125. Types of fertiliser and amounts used in trial 501.

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)		
		Level 0	Level 1	Level 2
N	SOA	0	1.8	3.6
P	TSP	0	1.0	2.0
K	MOP	0.5	2.5	4.5

RESULTS

Yield data for 1993, and for the 3 years 1991 - 1993 are summarised in Tables 126 and 128.

In 1993 there was no response in yield to N or P. There was a significant increase in single bunch weight due to MOP, but as the increase was accompanied by a reduction in bunch numbers, there was no effect on yield in 1993 (Table 126).

Over the three year period (1991 - 1993), there was no response to N or P, but there was a significant increase in yield due to MOP (Table 128). This was because of the increase in bunch weight.

There was no interaction between the effects of N and K. Considering the combined effects of MOP and

SOA shown in Table 127, the maximum K rate of 4.5 kg reduced the yield in the absence of SOA. Whilst a response was obtained with the N1K2 combination, the most economic treatment would be K1 (2.5kg/palm/year) alone.

Table 126. Main effects of N, P, and K on yield and yield components in 1993 (Trial 501)

	Nutrient element and level			Statistics		
				sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	21.6	22.0	21.4	ns	12.9	-
Bunch/ha	1275	1284	1235	ns	12.5	-
Bunch wt (kg)	17.1	17.2	17.3	ns	8.0	-
	P0	P1				
Yield (t/ha/yr)	21.4	21.9		ns	12.9	-
Bunch/ha	1258	1271		ns	12.5	-
Bunch wt (kg)	17.1	17.4		ns	8.0	-
	K0	K1	K2			
Yield (t/ha/yr)	20.9	22.2	21.9	ns	12.9	-
Bunch/ha	1336	1226	1231	ns	12.5	(25.4)
Bunch wt (kg)	15.7	18.1	17.8	ns	8.0	16.2

Table 127. Effect of N on yield at different levels of K in 1993 (Trial 501).

Levels of K	Yield (t/ha/yr)		
	N0	N1	N2
K0	20.6	22.0	20.0
K1	23.2	21.2	22.1
K2	21.0	22.8	22.0

Table 128. Main effects of N, P, and K on yield and yield components 1991 - 1993 (Trial 501)

	Nutrient element and level			Statistics		
				sig	cv	lsd
	N0	N1	N2			
Yield (t/ha/yr)	26.0	26.3	25.3	ns	7.9	-
Bunch/ha	2189	2155	2085	ns	8.8	-
Bunch wt (kg)	11.9	12.6	12.2	ns	13.9	-
	P0	P1				
Yield (t/ha/yr)	26.0	25.8		ns	7.9	-
Bunch/ha	2175	2112		ns	8.8	-
Bunch wt (kg)	12.0	12.5		ns	13.9	-
	K0	**K1**	**K2**			
Yield (t/ha/yr)	**24.6**	**26.3**	**26.8**	**	**7.9**	**16.0**
Bunch/ha	**2245**	**2108**	**2077**	*	**8.8**	**17.9**
Bunch wt (kg)	**11.0**	**12.5**	**13.2**	***	**13.9**	**28.2**

Table 129. Effect of N on yield at different levels of K in 1991 - 1993 (Trial 501).

Levels of N	Yield (tonnes/ha/year)		
	K0	K1	K2
N0	24.6	26.8	26.6
N1	25.8	26.3	27.0
N2	23.4	25.7	26.8

Trial 502A FERTILISER TRIAL AT WAIGANI ESTATE.

PURPOSE

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

DESCRIPTION

Site Waigani Estate

Soil Plantation family. Alluvial clay loam with seasonally high water table.

Palms Dami commercial DxP crosses. Planted in 1986 at 127 palms/ha. Trial started in March 1990.

DESIGN

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

The 48 plots were divided into two replicate blocks each containing 24 treatments made up from all combinations of three levels of N, two levels of P, and four levels of K. An additional treatment of EFB was imposed to convert the trial to a single replicate, each comprising factorial combinations of three levels of N, two levels of P, four levels of K and two levels of EFB (Table 130).

Table 130. Types of fertiliser and amounts used in trial 502A

Element	Type of fertiliser	Amount of fertiliser (kg/palm/year)			
		Level 0	Level 1	Level 2	Level 3
N	SOA	0.0	2.5	5.0	-
P	TSP	0.0	2.0	-	-
K	MOP	0.0	2.5	5.0	7.5
		(kg/palm/2 years)			
	EFB	0.0	500		

RESULTS

Yield data for 1993, and for the period 1991 - 1993 are summarised in Table 131 and 133. There were no significant increases in yield in response to N, P, and EFB, but there was a small response to K in 1993. There was no interaction between N and K.

All of the yields were high. The yield was about 26t/ha/yr without fertiliser, and between 28-31t/ha/yr with both N and K.

The small responses to fertiliser in this trial is possibly because of poaching, and also the area was subjected to occassional flooding. There may also be some residual effects of fertiliser that was given before the treatments started in March 1990.

Table 131. Main effects of N, P, K, and EFB on yield and yield components in 1993.

	Nutrient element and level				Statistics		
	N0	N1	N2		sig	cv	lsd
Yield(t/ha/yr)	26.4	26.3	28.4		ns	10.9	-
Bunches/ha	1584	1618	1718		ns	12.6	-
Bunch wt (kg)	16.7	16.3	16.5		ns	5.9	-
	P0	P1					
Yield(t/ha/yr)	26.7	27.4			ns	10.9	-
Bunches/ha	1633	1646			ns	12.6	-
Bunch wt (kg)	16.4	16.6			ns	5.9	-
	K0	K1	K2	K3			
Yield(t/ha/yr)	24.9	27.2	27.8	28.2	*	10.9	2.48
Bunches/ha	1584	1675	1668	1633	ns	12.6	-
Bunch wt (kg)	15.7	16.4	16.7	17.3	**	5.9	0.83
	EFB 0	EFB 1					
Yield(t/ha/yr)	26.9	27.2			ns	10.9	-
Bunches/ha	1656	1624			ns	12.6	-
Bunch wt (kg)	16.3	16.7			ns	5.9	-

Table 132. Effects of N at different levels of K in 1993

Levels of N	Yield (tonnes/ha/year)			
	K0	K1	K2	K3
N0	25.6	26.1	25.9	27.8
N1	24.1	28.0	26.[illegible]	27.1
N2	24.9	27.7	31.5	29.5

Note: NxK interaction not significant.

Table 133. Main effects of N, P, K, and EFB on yield and yield components in 1991 - 1993.

	Nutrient element and level				Statistics		
	N0	N1	N2		sig	cv	lsd
Yield (t/ha/yr)	27.9	27.8	29.4		*	6.4	1.33
Bunches/ha	2201	2206	2364		(ns)	9.0	(148)
Bunch wt (kg)	12.7	12.6	12.5		ns	4.9	-
	P0	P1					
Yield (t/ha/yr)	28.4	28.4			ns	6.4	-
Bunches/ha	2255	2259			ns	9.0	-
Bunch wt (kg)	12.6	12.6			ns	4.9	-
	K0	K1	K2	K3			
Yield (t/ha/yr)	26.9	28.8	28.8	29.0	*	6.4	1.54
Bunches/ha	2178	2340	2276	2234	ns	9.0	-
Bunch wt (kg)	12.4	12.4	12.7	13.0	(ns)	4.9	(0.52)
	EFB0	EFB1					
Yield (t/ha/yr)	28.5	28.2			ns	6.4	-
Bunches/ha	2274	2239			ns	9.0	-
Bunch wt (kg)	12.6	12.6			ns	4.9	-

Table 134. Effects of N on yield at different levels of K for 1991 - 1993.

Levels of N	Yield (tonnes/ha/year)			
	K0	K1	K2	K3
N0	27.2	28.4	27.8	28.3
N1	26.9	28.7	27.3	28.5
N2	26.8	29.4	31.2	30.3

Trial 502B FERTILISER TRIAL AT WAIGANI ESTATE.

PURPOSE

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

DESCRIPTION

Site Waigani Estate, Field 6503 and 6504.

Soil Plantation family, which is of recent alluvial origin.

Site Dami commercial DxP crosses. Planted 1986 at 127 palms/ha Trial started 1994

DESIGN

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

The 64 treatments are made up from all combinations of four levels of N and K, and two levels of P and EFB (Table 135). EFB will be applied by hand as a mulch between the palm circles.

Table 135. Amounts of fertiliser and EFB used in Trial 502B.

Type of fertiliser or EFB	Amount (kg palm year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	[illegible]	4.0	[illegible]
MOP	0.0	2.5	5.0	7.5
TSP	0.0	2.0		
	(kg/palm year)			
EFB	0.0	600		

Trial Progress. Trial marking, numbering, Tissue sampling have been completed. Yield recording has commenced, and trenching has started. First dose of fertiliser application is due this quarter.

Trial 504 MATURE PHASE FERTILISER TRIAL AT SAGARAI.

PURPOSE

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

DESCRIPTION

Site Sagarai Estate, blocks 0610, 0611 and 0612.

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

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

DESIGN

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

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

The 64 plots will be divided into replicates of 32 plots. In each replicate there will be 32 treatments, made up from all combinations of four levels each of N and K, and two levels of an additional treatment (Table 136).

Table 136. Types of fertiliser and amounts to be used in Trial 504.

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

Progress: Trial mapping. Trial marking and numbering. Pre-treatment measurements all completed

Trial 506 SMALLHOLDER DEMONSTRATION SITES, MILNE BAY PROVINCE

PURPOSE

1. To demonstrate the value of fertiliser applications, for the benefit of all smallholders.

2. To monitor the selected sites so as to obtain agronomic data (e.g. soil, leaf and yield) in order to improve understanding of the basic agronomy for all smallholder areas.

3. To provide an assessment of fertiliser response and requirement response and requirement for smallholder locations.

DESCRIPTIONS

Site Details: The initial sites selected were at Kerakera (adjacent to South Maiwara block Hagita estate) and at Baraga (to the south west of Waigani estates, at Giligili estate, block 87F4 and Waigani estate, block 88D2.

Soil Both smallholder blocks lie on the Plantation series soils. which are predominant in the area, and are described under Trial 501.

Palms Dami commercial DxP crosses. Planting dates 1987 - 1989 at 127 palms/ha.

DESIGN

Each smallholder block provides a single replicate. Within this there are up to 6 plots, comprising 2 with overall treatments, and up to 4 with systematic applications of N and K fertilisers, each applied in a gradient at right angles to the other. 2 of these 4 plots also receive TSP, and 2 do not.

The plots consist of a core of 25 recorded palms, surrounded by a guard row, making a total of 49 palms per plot. The systematic gradients have a zero fertiliser quard row around the plot and on both sides of the zero treatment the guard row beyond the highest treatment receives an incrementally higher rate. There no guard rows between the remaining treatments which are in equal increments. On each plot there are 5 recorded palms receiving each of the four rates for individual fertilisers, and 1 palm for each of the 16 combinations of the two fertilisers. These are replicated 4 times at each site.

Treatments:

1. The "control" plot receives no fertiliser whatsoever.
2. The "demonstration" plot (and all perimeter palms) are fertilised according to the current recommendation for smallholders.

Application frequency for N and K fertilisers is twice a year, but TSP is applied in a single annual application of 1 kg per palm.

Table 137. Fertiliser rates in kg/palm

PLOT	Types of fertiliser and amounts (kg/palm)		
	MOP	SOA	TSP
Demonstration	2.5	1.25	0.0
Control	0.0	0.0	0.0
S-0	0.0	0.0	0.0
S-1	1.25	1.25	1.0
S-2	2.5	2.5	-
S-3	3.75	3.75	-

Trial 511 FERTILISER TRIAL ON INTERFLUVE TERRACES SOILS AT WAIGANI ESTATE.

PURPOSE

To investigate the response of oil palm to on interfluve/terraces soils.

DESCRIPTIONS

Site Waigani Estate,field 8501 and 8502

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

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

DESIGN

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

The 64 plots is in a single replicate split into four blocks,comprising factorial applications of 4x4x2x2 of NPK and EFB treatments.The treatments are made up from all combinations of four levels of each of N and K and two of each P and EFB (Table 137).EFB will be applied by hand as a mulch between palm circles.

Table 138. Amounts of fertiliser and EFB used in Trial 511

Fertiliser or EFB	Amount of fertiliser (kg/palm/year)			
	Level 0	Level 1	Level 2	Level 3
SOA	0.0	2.0	4.0	6.0
MOP	0.0	2.5	5.0	7.5
TSP	0.0	2.0	-	-
	(KG/PALM/2 YEARS)			
EFB	0.0	600	-	-

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

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

MILNE BAY PROVINCE

Flower Census

The number of anthesing male inflorescences (AMI) and receptive females were recorded weekly from the 100 palms at Hagita and Waigani estates. The average number of AMI recorded for the two sites is shown (Figure 11). A low number of male inflorescences (ie. below the required minimum of 10 per hectare) was observed throughout the year. This was more marked at Waigani than at Hagita from February to June. Though there was a low number of male inflorescences, the number of female inflorescences was also low. As a result of the reasonably balanced sex ratio, adequate pollination can be expected at Milne Bay.

Weevil Population

The monitoring of *Elaeidobius* emerging from sampled male spikelets continued in 1993 at Hagita and Waigani estates (Figure 12). The emergence figures indicated an adequate weevil population for most of the year at both sites, though there was a slight reduction in July, August and September. An annual average emergence of 90 and 102 weevils per spikelet was observed at Hagita and Waigani respectively. Thus, an average pollination force of 464,000 and 451,000 weevils per 100 palms would have been expected at Hagita and Waigani estates at any one time. The pollination force ranged from a low of 161,000 to a high of 817,000 weevils per 100 palms in 1993 at Milne Bay.

(*Pollination force* or weevil density is expressed as the number of weevils per hectare. This is calculated from the number of male inflorescences, weevils emergence and the number of palms per hectare where recording is done. This gives an estimated guide of the number of weevils available for pollination at any one time. Generally a pollination force of around 200,000 weevils per hectare would be required to achieve fruitsets of about 60%).

Figure 11: Number of male inflorescences at anthesis (average per day in 100 palms) at Milne Bay in 1993

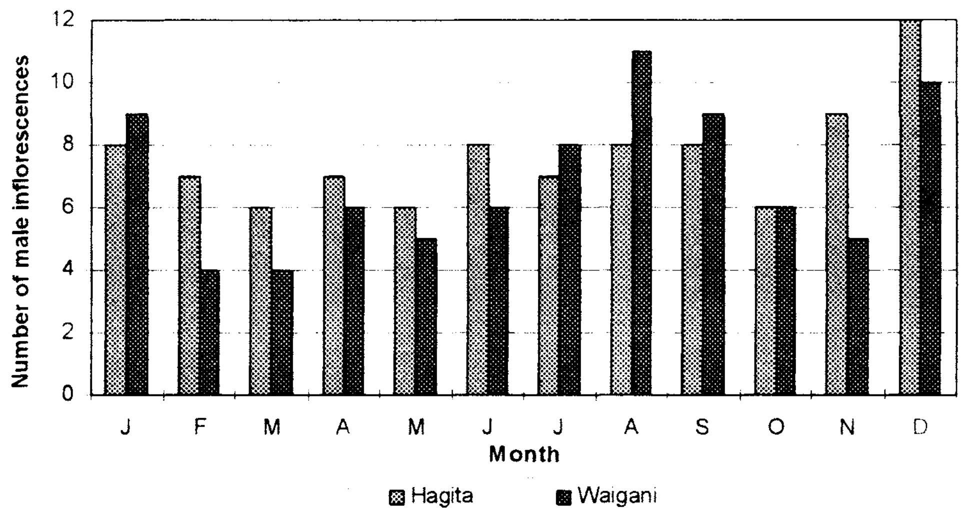
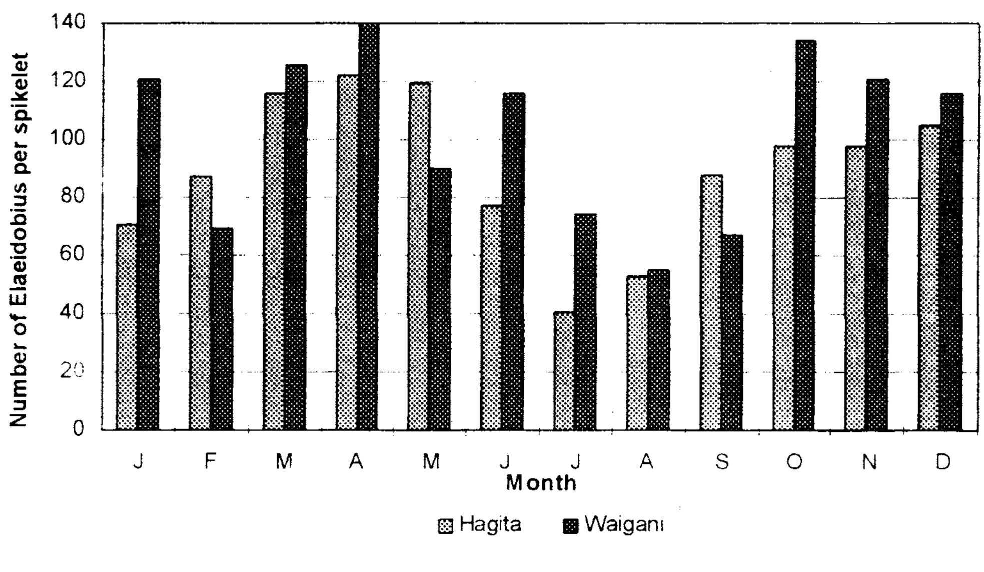


Figure 12: Weevil emergence at Milne Bay in 1993

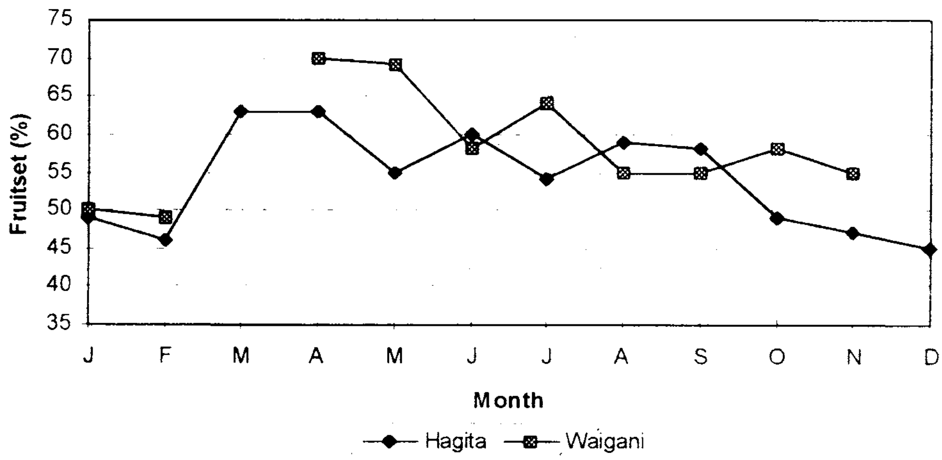


Percentage Fruitset

The percent fruitset at Hagita and Waigani for 1993 (Figure 13) shows the seasonal trend in the fruitset fluctuations for the area. Low fruitset values are usually seen in January to March and then later from October to December. In 1993 low values of 46% and 45% were recorded in February and December at Hagita while Waigani recorded a low of 49% in February. High values of 63% and 71% were observed at Hagita and Waigani in March and April, which probably coincides with the peak crop period (April to August). The fruitset ranged was from 45% to 71% with an annual average of 57%. This value suggests an acceptable level of fruitset in Milne Bay Province. While the seasonal trend in fruitset fluctuation is observed there has also been a significant improvement in the overall fruitset levels each year, from 42% recorded in 1990, 49% in 1991, 54% in 1992 and to 57% in 1993.

The drop in fruitsets observed from September to December, particularly at Hagita might have resulted from the low number of male inflorescences and consequently the low weevil population observed in the preceding 4 - 5 months (May to September).

Figure 13: Percentage fruitset at Milne Bay in 1993



NEW IRELAND PROVINCE

Flower Census

The number of AMI is recorded weekly from the 100 palms at Baia and Maramakas (Figure 14). A low number of male inflorescences was observed in January, February and March, then later from August to December. This effect was more marked at Maramakas than at Baia. The lowest value of one male inflorescence to nine females was observed in December at Maramakas, this indicates there may have been a pollen shortage at this time. Although there were less than 10/ha for eight months at Baia there was probably sufficient pollen supplied and sufficient breeding sites for *Elaeidobius* to maintain acceptable fruitset values. When there are low male inflorescence numbers at Baia this tends to correspond to low female inflorescence numbers.

Weevil Population

The number of weevils emerging from sampled male spikelets was monitored at Baia, Bolegila and Maramakas at Poliamba (Figure 15). A drop in weevil population may have occurred in February, March and later in September at Poliamba as indicated by the low emergence data. However, an adequate weevil population of over 260,000 per hectare would have been present throughout Poliamba at any one time.

Figure 14: Number of male inflorescences at anthesis (average per day in 100 palms) at Poliamba in 1993

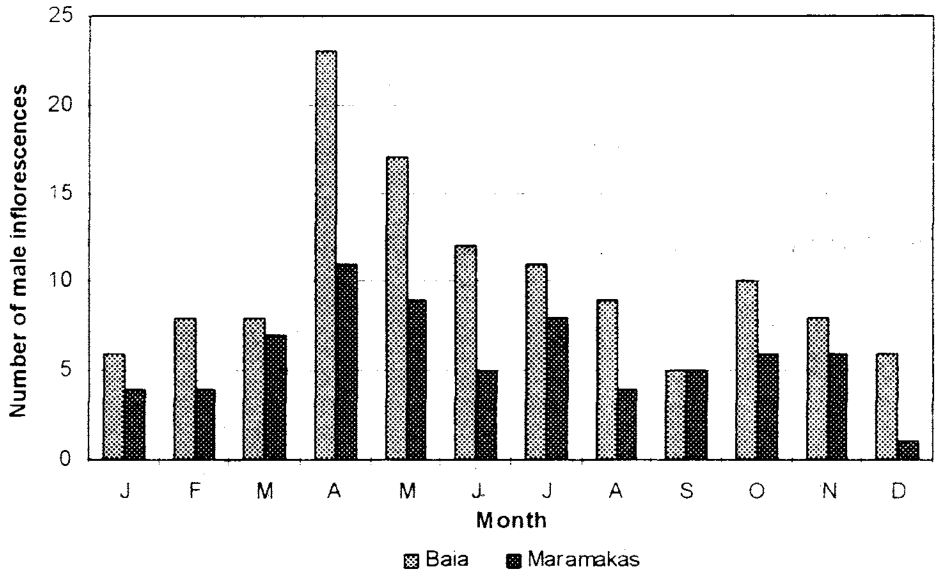
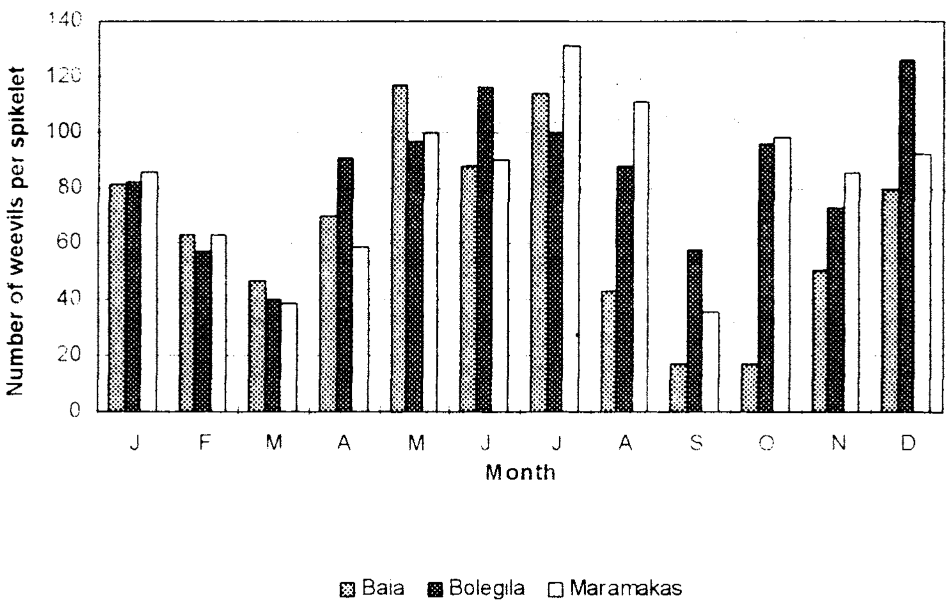


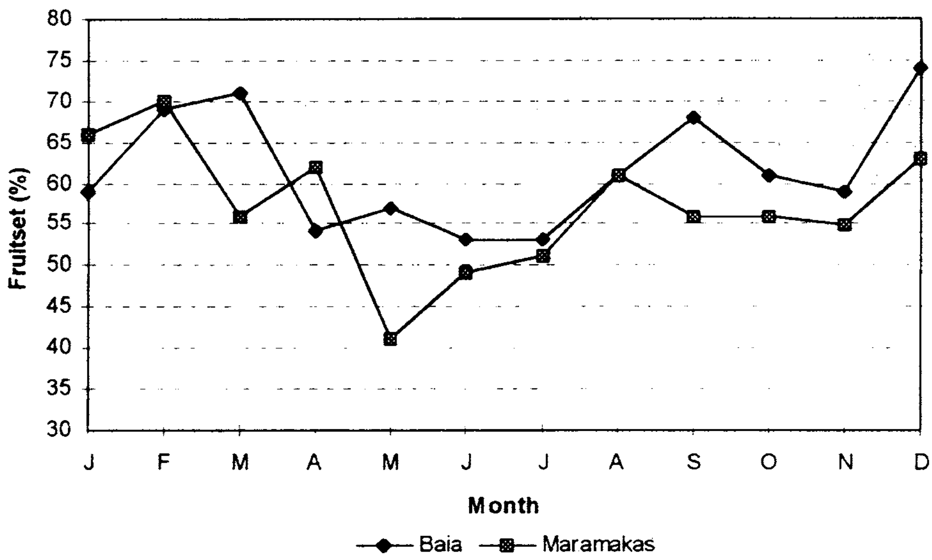
Figure 15: Weevil emergence at Poliamba in 1993



Percentage Fruitset

The percent fruitset monitored at Baia and Maramakas is shown (Figure 16). Consistently high fruitset values (50% or more) were observed at Poliamba throughout the year, except for the low values of 41% and 49% observed in May and June respectively at Maramakas. The highest fruitset value of 71% was recorded in March at Baia. The average for the twelve months was 62% and 57% recorded at Baia and Maramakas respectively. Such levels of fruitset are not usually obtained in West New Britain, Milne Bay or in Oro Provinces for the palms of similar age (1988/89 plantings). Therefore, it is possible that favourable environmental factors might have enhanced the efficiency of *Elaeidobius* and other entomophilies in the area to cause such high fruitset levels. The low fruitset values observed in May and June at Maramakas may have been due to the low number of male inflorescences in preceding 4-5 months (January to March), resulting in low pollen availability and low *Elaeidobius* population.

Figure 16: Percentage fruitset at Poliamba in 1993



KAPIURA STUDY (West New Britain)

PURPOSE

To determine the cause of seasonally poor pollination and the subsequent yield trough experienced in this and other developments.

INTRODUCTION

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

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

RESULTS

Flower Census

The recording of AMI and receptive females was carried out weekly at Kautu *I* (120 palms), Kautu *II* (115 palms), Bilomi (115 palms) and Kaurausu (116 palms). The average number of male inflorescences for each sites is shown (Figure 17). Generally, there was a low number of male inflorescences (below the required minimum of *10* per hectare) at Kapiura from January to April and then later from September to December. The low number of male inflorescences was more marked at Kautu *I* and Kaurausu than at the Kautu *II* and Bilomi sites. A possible shortage of pollen and low weevil population would be expected as a result of this between January to April.

Weevil Population

(a) Weevil Emergence Studies

The number of *Elaeidobius* emerging from individual spikelets at Kautu *I*, Kautu *II*, Bilomi and Kaurausu is shown (Figure 18). Low emergence values were observed in January, February and March and later in June and July at the four sites. The lowest value of *1* weevil/spikelet, *6*/spikelet, *8*/spikelet and *12*/spikelet was recorded at Kaurausu, Kautu *II*, Kautu *I* and Bilomi respectively in January. Consequently, a low weevil population might have occurred in January, February and March. Fruitset determination in the subsequent 4 - 5 months (April, May, June, July) should indicate this deficiency. The low number of male inflorescences and the continuous heavy rains at Kapiura in January (599 mm), February (604 mm) and March (407 mm) might have caused the low emergence figures observed.

Figure 19 shows the approximate weevil density (or 'Pollination force') that would have been expected throughout Kapiura in 1993. The trend very much corresponds to Figure 18. Weevil population was below 200,000 per hectare (the minimum weevil density required per hectare to achieve fruitsets of 50%

Figure 17: Number of male inflorescences at anthesis (average per day in 120, 115, 115, and 116 palms respectively) at Kapiura in 1993.

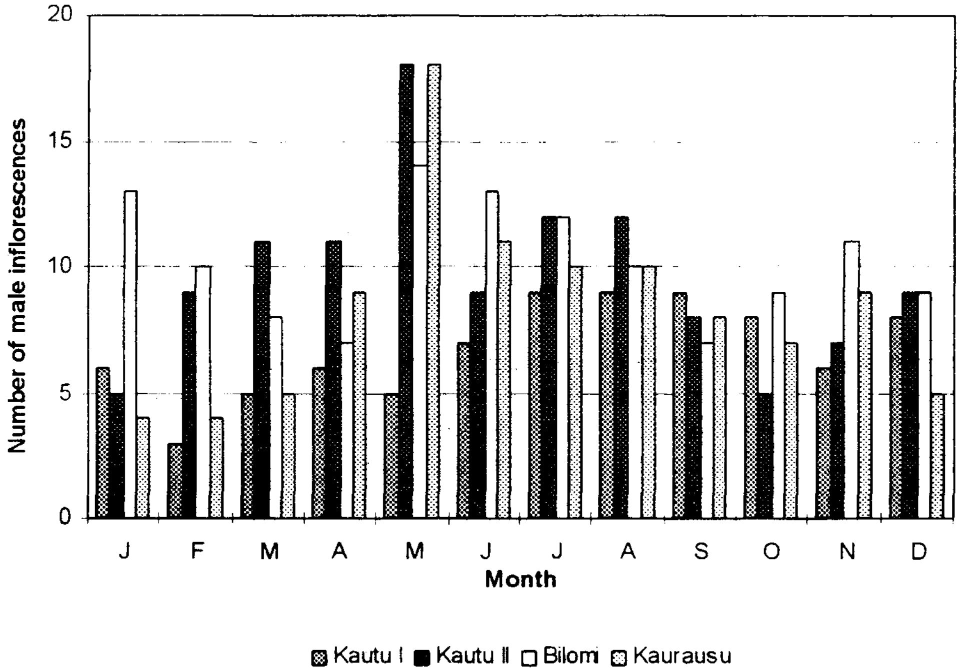


Figure 18: Weevil emergence at Kapiura in 1993

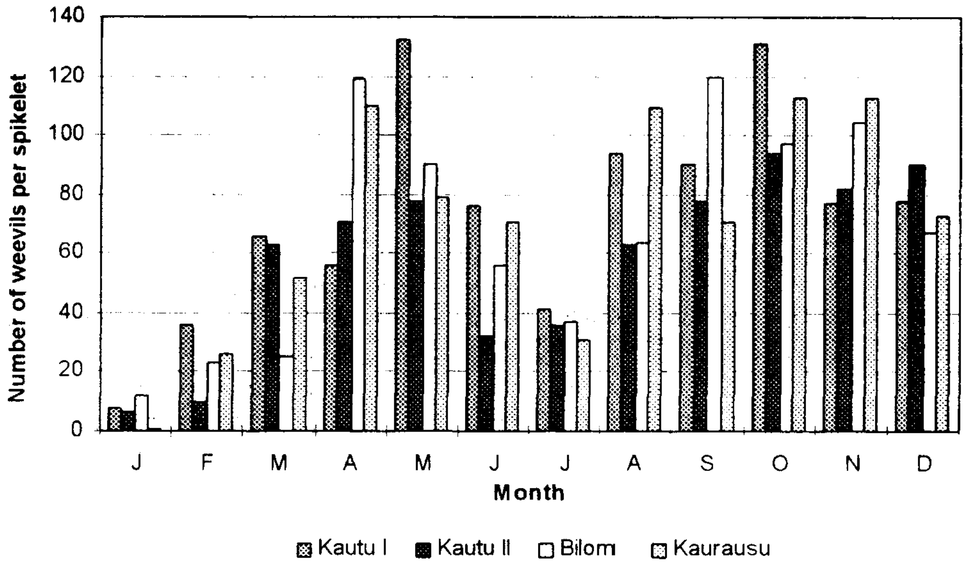
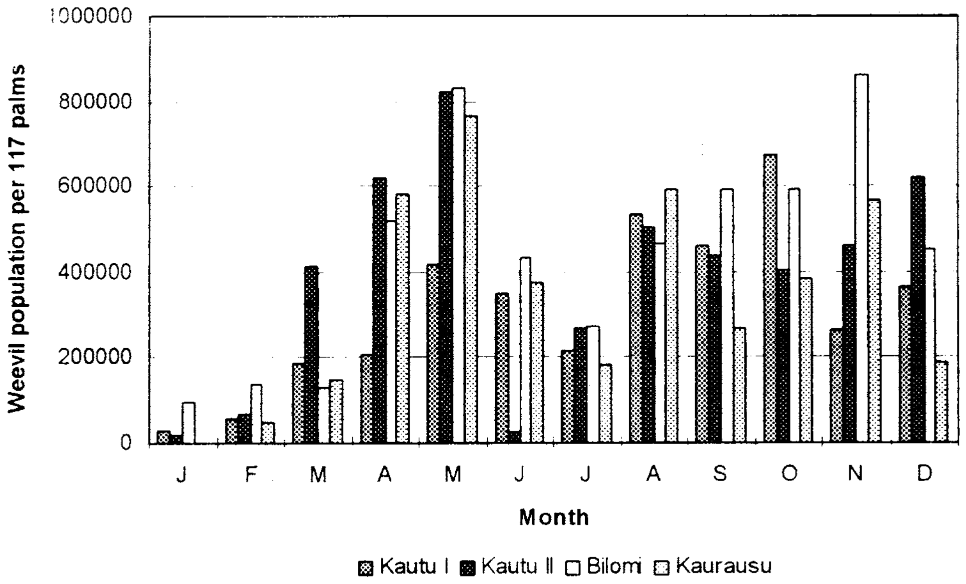


Figure 19: Weevil population at Kapiura in 1993



or more) in January to April. Therefore, pollination would be adversely affected in these months. The weevil population was lowest at Kapiura in January, which had the lowest population of 896 weevils/ha at Kaurausu, 19,680/ha at Kautu *II*, 28,032/ha at Kautu *I* and 97,344/ha at Bilomi. Other months had sufficiently high weevil populations over 200,000 weevils/ha at any one time.

(b) Sticky Trap Observation

Sticky traps (ie. flywire mesh covered in sticky substance) enclosing receptive female inflorescences were set at Kapiura during the year.

Table 139. Number of *Elaeidobius* trapped per month at Kapiura in 1993.

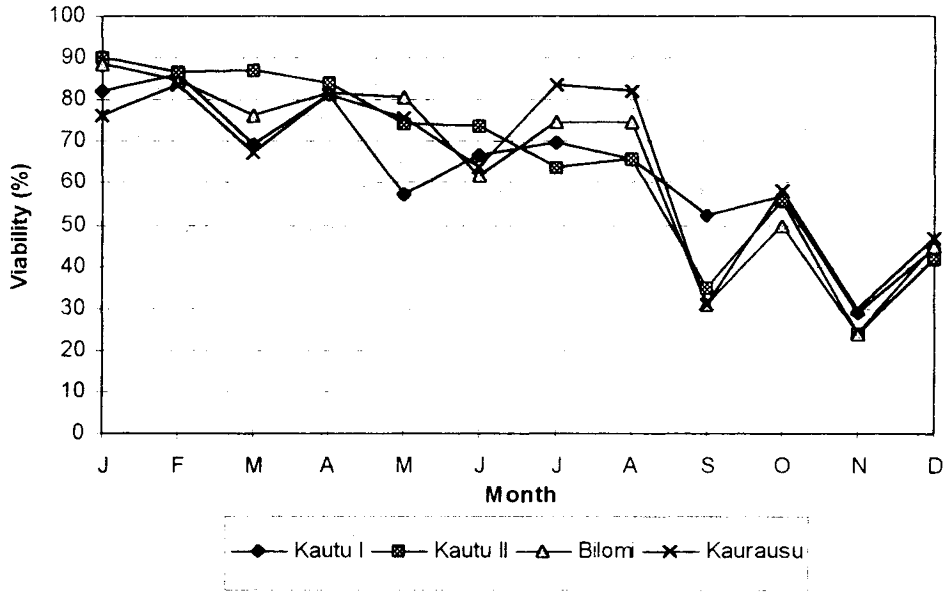
Location	Month	Rainfall (mm)	E.k Trapped per female inflorescence	Range
Bilomi	January	599	2,988	1,900 - 4,700
"	October	97	11,533	8,000 - 16,500
Kaurausu	February	604	5,062	700 - 7,700
"	October	97	7,206	6,000 - 8,300
Kautu I	July	281	1,876	3,000 - 4,900
Kautu II	August	222	8,308	4,000 - 14,400

The trapping data indicate that there were sufficient number of weevil visiting receptive female inflorescences even during the wettest months (Table 138).

Pollen Viability Tests

Figure 20 gives the first results of the pollen viability tests for Kapiura in 1993. The percent pollen germination test is carried out each month. This preliminary data shows a sharp decline in pollen viability between September and December. The seasonal drop in fruitset that is observed from March to August could be due in part to the low pollen viability in the preceding 4-5 months (September to December).

Figure 20: Mean pollen viability results at Kapiura in 1993



Percentage Fruitset

The percentage fruitset for the four sites at Kapiura in 1993 is shown (Figure 21). The data indicates a similar trend in the fruitset as observed in 1992.

A drop in fruitset level was seen between April and September, followed by an improvement in October. The lowest value of 28% fruitset was observed at Bilomi in August while the highest 68% fruitset was observed at Kautu *II* and Kaurausu in March and April. An annual average of 39%, 53%, 43% and 53% fruitset was recorded at Kautu *I*, Kautu *II*, Bilomi and Kaurausu respectively. Kautu *II* and Kaurausu appear to give good fruitset levels compared to the Kautu *I* and Bilomi sites. Kautu *I* did not show any improvement in overall fruitset. Kautu *II*, Bilomi and Kaurausu did indicate gains of + 5%, +4%, and +1% for the twelve month period as compared to 1992. The overall average fruitset for the area in the 12 months period was 47%.

The precise cause of the seasonally low fruitset observed from April to September at Kapiura is difficult to

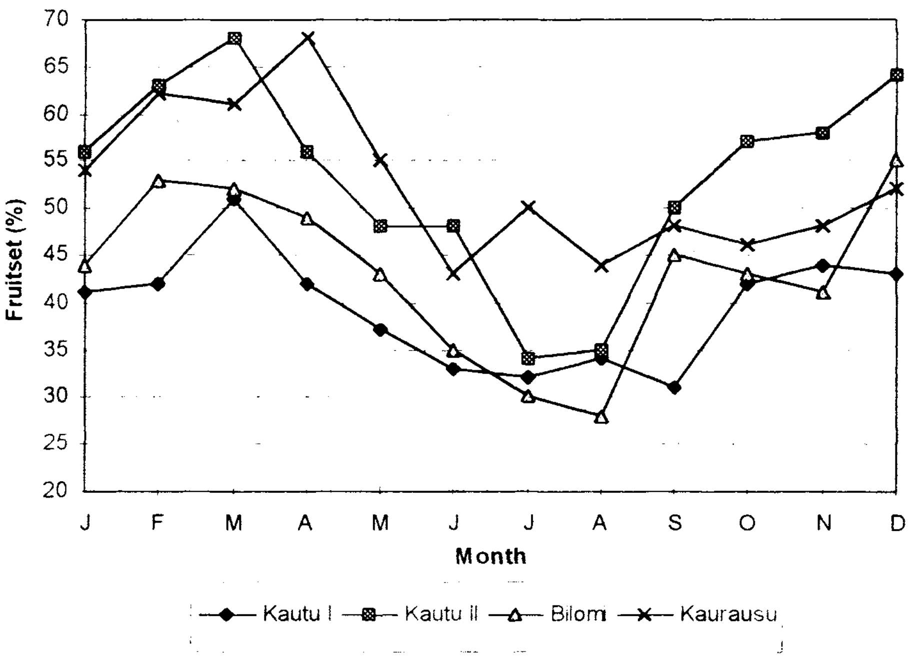
ascertain at this stage. However, the following factors or a combination of these factors are likely to have resulted in the drop in fruitset.

- Shortage of male inflorescences. This is due to the high sex or bunch ratio in the early stage of production.
- Reduction in female inflorescence scent production resulting from stress induced by low solar

radiation interception during prolonged periods of dense cloud cover.

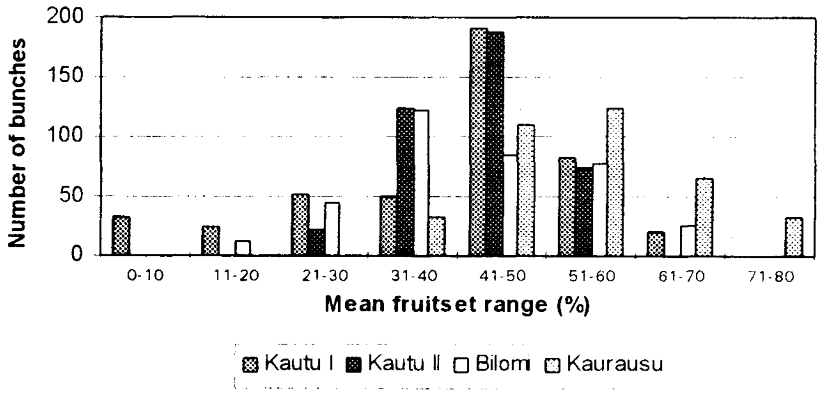
- Inadequate weevil population.
- Immobility of *Elaeidobius* during the continous rainfall.
- Possible rapid deterioration of pollen. Preliminary data obtained from the area shows a sharp decline in pollen fertility from September to December which does correspond to the seasonally low fruitsets in subsequent 4 to 5 months (January to June of the following year).

Figure 21: Percentage fruitset at Kapiura in 1993



The frequency distribution of fruitset for *1,593* bunches harvested from *80* palms (ie. 20 palms each from the four monitoring sites) at Kapiura is shown (Figure 22). The data shows a normal distribution of fruitset in the area, with most bunches in the 41-50% range (573 bunches) and 32% of the bunches gave values of over 50%. From the *80* monitored palms, only 32% (28/80 palms) consistently produced bunches with fruitset of 50% or more over the 12 months while the other palms (52 palms) produced bunches with less than 50% fruitset. Eight palms had consistently yielded bunches of 30% fruitset or less for two years ,1992 and 1993. The data collected to date indicates that the fruitset levels at Kapiura are low

Figure 22: Frequency distribution of fruitset for 1,593 bunches harvested from 80 monitored palms (20 palms/site) at Kapiura in 1993



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

PURPOSE

To assist with surveys of damage, to make treatment recommendations to monitor the chemical control program, and to test 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 1993, reports of economically significant outbreaks of sexavae were from the Bialla and the Hoskins Oil Palm Projects in West New Britain. However, the area requiring chemical treatment in 1993 was the lowest in the past seven years

A total of 103 hectares (comprising of 44 smallholder blocks and 15 ha area of plantation) required treatment for sexava this year. The areas requiring treatment were: 13 VOP blocks at Gule, 18 blocks at Lavege and 11 blocks at Waisisi VOP in the Hoskins area, 2 blocks at Noau VOP in the Bialla area and 15 ha in Bilomi Plantation at Kapiura.

The new development in Kapiura experienced it's first outbreak of sexava (*Segestidea defoliaria*) and was treated in June. The infestation source was the numerous stands of *Helliconia* sp. growing around the periphery of the plantation. Along with the chemical treatment, recommendation was issued for the removal of this native host plant of sexava seen in the vicinity of the fields, particularly the boundary areas.

It is usual that after a lapse of 3-4 years, new and often serious sexavae outbreaks can be expected in West New Britain.

In Oro Province, damage by *Segestidea novaeguineae* remained at a low level.

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* Waterst. (Hymenoptera:Encyrtidae) and *Doirania leefmansi* Waterst. (Hymenoptera:Trichogrammatidae). Another parasite, *Stichotrema dallatorreanum* Hofender (Strepsiptera:Myrecolacidae) which lives in the body of sexava is being studied.

PROGRESS

Rearing of the Sexava Egg Parasitoids.

The two species of sexava egg-parasitoids were reared at Dami (West New Britain) and released throughout the year (Table 139), mainly in areas where recent outbreaks had occurred. They were sometimes released concurrently with the chemical control.

Table 140. Number of individuals of the two species of parasitoids that were released during 1993.

SITE	Number of Parasitoids	
	Leefmansia bicolor	*Doirania leefmansi*
Bilomi, Kapiura Plantations	33,600	142,000
Dami	49,960	80,000
Gule VOP	16,000	62,000
Kavugara	20,000	40,000
Kumbango Plantations	20,000	44,000
Lavege VOP	91,400	258,000
Noau VOP (Bialla)	8,400	62,000
Ubai VOP (Bialla)	4,400	44,000
Waisisi VOP	22,800	---
TOTAL	266,560	732,000

Just under 1.0 million parasitoids were released on both plantations and smallholdings in 1993, mainly in West New Britain. The number of parasitoids released was comparatively lower than those released over the past three years.

Due to a scarcity of wild sexava, it was not possible to maintain a sufficiently high sexava 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 continuously reared and released in large numbers even when pest population are low in the fields. This would ensure good control of the sexava.

Attempts were made in 1993 to infect other orthopteran eggs with the two parasitoids. Successful infection. rearing and emergence of *Leefmansia bicolor* was observed from the fresh eggs of a broadwing bush katydid. *Phyllophora* species (Orthopterea: Tettigonidae - Phyllophorinae). An average of 33 parasitoids of *L. bicolor* emerged per egg. Emergence was observed 32 days after infection. this is similar to the time taken for *L.bicolor* to develop from sexava eggs. This indicates a possible alternate media for rearing the parasitoids. at the same time confirming that the parasitoids are not host-specific and can parasitise other orthopteran eggs and still continue to establish and survive in the field when released even during periods of low sexava population. Attempt to infect the fresh eggs of the katydid with *Doirania leefmansi* has not been successful todate and this work is continuing.

Observation on the Endoparasite of sexava, *Stichotrema dallatorreanum* Hof.

Attempts to identify the host of the male strepsipteran continued in the year with specimens being received from Oro Province. Parasite specimens (mated females with emerging triungulins) were impregnated into a candidature ant brood. *Camponotus* sp. (Hymenoptera: Formicidae). No evidence of stylops development has been observed. Most triungulins died before they could impregnate the larvae of the ant. The ant colonies of *Camponotus* continued to be maintained. both in the laboratory and on oil palms at Dami.

The first record of a strepsipteran parasitising a katydid in West New Britain was found at Lavege in the Hoskins area in February. The female strepsipteran. possibly a species of *Stichotrema* was found parasitising a broadwing katydid. *Phyllophora lanceolata* on a coconut palm. However. no male of the endoparasite or its host was found. Attempts to keep the katydid alive for further observation was unsuccessful. The dead specimen was delivered in August to Dr. J. Kathirithamby (a Senior Research Fellow of the University of Oxford. specialising in entomophagus parasitoids) at Oxford. United Kingdom for identification and confirmation of its taxa.

There is still no record of *Stichotrema* parasitising *Segestidea defoliaria* and *Segestes decoratus* in West New Britain

INVESTIGATION 606 CONTROL OF BAGWORMS (LEPIDOPTERA:PSYCHIDAE).

PURPOSE

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

PROGRESS

West New Britain Province

Damage by the 'rough' bagworm, *Mahasena corbetti* Tams was recorded at Togulo, Kumbango and Bilomi plantation. Light damage to the foliage was observed at Togulo and Kumbango while moderately heavy infestation was observed at Bilomi in Kapiura. Monthly observations were carried out for the Bilomi infestation which revealed an increasing density of its natural enemies, mainly parasitic tachinid flies (Diptera:Tachinidae) and chalcid wasps (Hymenoptera:Chalcididae). Monthly sampling of bagworms from the site showed a relatively high mortality rate of 97%, with 56% due to parasitism by tachinids and wasps. Effective natural control of the pest was achieved by the end of the year. This resulted in a low pest population in the Field (G) at Bilomi. The successful control of the pest was due to the good management practices employed, mainly in rational herbicide usage and the encouragement of the beneficial weeds to flourish in the affected fields particularly, *Ageratum conyzoides* ('Goat weed') and various Euphorbia species ('Milk weeds') as recommended by OPRA.

Oro Province

Light infestation by *Mahasena corbetti*, *Clania* sp. and the 'icecream cone' bagworm continue to occur on both estates and smallholdings in the province. A relatively a high mortality rate of 75% was observed with 23% being due to parasitism by various parasitic wasps and tachnid flies.

New Ireland Province

Damage by bagworm on oil palm foliage continue to remain at a very low level of no economic significance

Milne Bay Province

No report of damage by bagworms was reported from Milne Bay in 1993.

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

PURPOSE

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

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 palm are replanted from old oil palm stands or from coconuts the old trunks should be covered by a fast growing legume to hide them so that the beetles do not lay their eggs there. Rhinoceros beetles from neighbouring jungle can attack palms on the edges of plantations. *Scapanes* is widely distributed in PNG, but *Oryctes* has only been observed in East New Britain and New Ireland.

PROGRESS

West New Britain Province

Light damage by *Scapanes australis* Boids. continued to occur throughout Kapiura Plantations. Young fronds and rachis of spears appear to be the target area of attack by this beetle. Damage remain economically insignificant.

No reports of damage by either *Scapanes* or *Oryctes* was reported from Milne Bay, New Ireland or Oro Provinces.

INVESTIGATION 605 OBSERVATION ON OTHER PESTS.

PURPOSE

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

PROGRESS

West New Britain Province

(a) Bunch-moth, *Tirathaba rufivena* Wlk. (Lepidoptera: Pyralidae).

The bunch-moth or coconut spike-moth continued to cause light damage to young developing fruits and to post-anthesing male inflorescences (3-4 days old) at Bebere (1990 planting) and at Kautu Plantation (1988 planting) in Kapiura. A good control by its natural enemies is expected, particularly by the various parasitic wasps. This pest still has a minor pest status on oil palm.

(b) Oil Palm Skipper butterfly, *Cephrenes* sp. (Lepidoptera: Hesperiidae)

An increase in the number of skipper butterflies and its damage on the oil palm foliage was observed at Kaurausu and Bebere Plantations. A high population was observed earlier in the year but then declined towards the end of the year, this suggests its seasonal occurrence. Damage has remained light. Numerous parasitic flies and wasps were reared from its larvae and pupae. These specimens will be sent to the International Institute of Entomology (IIE) in the United Kingdom for identification.

New Ireland Province

Significant damage by rats continued to occur on both developing bunches and post-anthesing male inflorescences at Poliamba, New Ireland Province. However, the damage was not extensive.

Oro Province

(a) The Oil Palm Stickinsect, *Eurycantha* sp. (Phasmatodea: Phasmatidae).

Light damage by this insect was reported occurring at Waseta and Awowota areas.

(b) Chafer or night flying beetles (Coleoptera : Scarabaeidae- Melolonthinae)

Larvae (or caterpillars) of the chafer beetles, possibly a species of *Dermolopida* was reported damaging oil palm seedlings in the nursery at Arehe. The beetle larvae were confirmed as causing damage to the young roots as the result of their feeding action, this caused the seedlings to lodge and become desiccated. Its occurrence was sporadic and not extensive. The recommendation made was to identify the damaged seedlings and check the inside of the polybags and remove and destroy any white grubs found.

(c) Orthoptera: Acrididae.

i. *Valanga* sp. (Cyrtacanthacridinae)
ii. *Stenocatantops* sp. (Catantopinae)
iii. *Oedalus* sp. (Oedipodinae)

These three species of short-horned grasshoppers (ie. grasshoppers having short antennae relative to their body length) were reported and confirmed as causing significant damage to the transplanted seedlings at the Sambogo development of Higaturu Oil Palms Pty Ltd in September. While *Valanga* sp. is an occasional pest of oil palm foliage in Papua New Guinea especially at early growth stages, *Stenocatantops* sp. and *Oedalus* sp. are rare insect pests of oil palm foliage in Papua New Guinea.

Both *Stenocatantops* and *Oedalus* are usually found during long periods of dry weather. This should explain their seasonal occurrence in the area which coincided with a long dry period experienced in the province from June to October. Damage was severe on some of the transplanted seedlings which had their fronds completely stripped. The damage is likely to cause severe stress and retardation of growth in the young palms. Their camouflage against the background was most noted in both species. Adult and hopper specimens were obtained and shall be sent for identification. The source of infestation may have been nearby grassland (an ideal habitat for these grasshoppers). We can expect their numbers to decline at the start of the rainy season. No particular control measure was recommended, apart from periodic monitoring of the situation.

(d) Significant damage on food crops by snails, possibly by the giant African snail, *Achatina fulica* Bowdich was reported from around Ambogo and Popondetta localities.

Milne Bay Province

(a) Coleoptera (Scarabaeidae - Dynastinae)

Oryctes centaurus Sternberg was reported from a fallen coconut palm at Sagarai estate, but no reports of oil palm infestation were recorded. This species of the rhinoceros beetle is morphologically similar to *O. rhinoceros* but is slightly larger in size (about 60 mm adult length) as compared with 40 mm in *O. rhinoceros*.

(b) Coleoptera (Cerambycidae)

A species of a longicorn beetle was obtained from a damaged frond due to the widespread wilting of the frond tips from Milne Bay. A larval specimen was also found tunnelling through the rachis of a wilting frond. Later it was concluded that the wide spread wilting of frond tips was probably due to nutritional deficiency rather than entomologically related. The larval specimen observed may have appeared as a secondary invader developing from a egg laid by an adult after possibly being attracted by the damaged tissues in the frond.

(c) Lepidoptera

Concern of damage to oil palm foliage by a lepidopterous species was reported, however it's identity, the level of damage and the extent of its spread is still not known.

MUSEUM

Adults, larvae and pupal specimens of the unidentified species of moth reported in 1991 were sent to the International Institute of Entomology (IIE), Natural History Museum, United Kingdom for identification in April. The identity of the moth was established as:

Order : Lepidoptera
Family : Xyloryctidae [G.S. Robinson (NHM) det.]
Genus : *Acria*
Species: near *emarginella* Donovan.

The identification report was received in August.

Therefore, the correct application of its name is *Acria* sp. near *emarginella* Donovan and may commonly be referred to as the 'Webworm' of oil palm. The pest is sexually dimorphic . The males are cream and females are grey in colour.

We acknowledge the identification services provided the staff of IIE at the Natural History Museum in London.

PATHOLOGY

West New Britain Province

At Bebere plantation (1990 planting) two young palms affected by stem wet rot were reported. A recommendation was issued for the excavation and the chopping of these palms.

Two palms (1988 plantings) affected by a spear and bud-rot complex were reported from Malilimi plantation. These were periodically monitored and observed to have fully recovered later in the year.

A high incidence of crown fracture (headbending) was observed on a large number of mature palms at Navarai plantation. Strong winds associated with the heavy rains during the December to January period would have caused this disorder. Most palms affected were those grown on the plateaus or interfluves, suggesting a possible wind related effect.

A wide spread incidence of algal growth, *Cephaleuros* sp. mainly on the lower fronds was observed at Navarai plantation. Both incidences appeared to have no significance to crop yield, though invasion of secondary insect pests, particularly by the Sugarcane weevil, *Rhabdocelis* and *Scapanes* sp. is possible.

New Ireland Province

The first report of *Ganoderma* infection on oil palm from the province was from Kapsu Estate at Poliamba. One palm was reported to have collapsed after suffering from Basal Stem Rot. Fruiting bodies of *Ganoderma* were confirmed developing from tissues of the affected palm.

Oro Province

Several palms in the smallholdings were reported as having basal rot-like symptoms, though the actual causal agent is not known.

Milne Bay Province

For the first time, *Ganoderma* infection on oil palm was reported from the province in August from Waigani estate at Milne Bay Estates. Four mature palms were reported being attacked by the potentially serious fungal disease of palms. This suggests the presence of a large inoculum of this in the area. The disease has appeared about seven years after the palms were planted in 1987 on land previously planted with coconut. A disease survey was commenced at Waigani estate by OPRA and shall continue for other estates and shall also extend to surrounding smallholdings.

Palms affected by *Ganoderma* should be uprooted and burned. This reduces the volume of inoculum present.

APPENDICES

APPENDIX I

METEOROLOGICAL DATA

TABLE 141 Meteorological Data from Dami, 1970 -1993

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1970-1993	1993	1970-1993	1993	1970-1993	1993
January	611	501	24	18	113	108
February	635	775	24	23	106	81
March	536	324	24	23	120	127
April	344	163	21	18	147	132
May	216	82	17	8	167	161
June	163	389	15	19	157	74
July	186	217	16	12	147	118
August	163	157	15	6	176	212
September	161	69	13	5	177	166
October	173	60	15	9	177	10
November	236	260	17	14	175	169
December	422	307	22	21	125	132
Total	3846	3304	222	176	1787	1490

Table 142 Meteorological Data from Higaturu, 1981-1993

	Rainfall (mm)		Rainy Days (per month)		Sunshine (hrs/mnth)	
	1981-1993	1993	1981-1993	1993	1981-1993	1993
January	325	238	21	17	172	151
February	271	118	18	16	140	107
March	338	337	26	18	183	205
April	309	360	21	19	174	153
May	183	189	18	19	189	172
June	146	39	15	9	189	172
July	107	82	12	15	173	127
August	107	50	14	11	200	185
September	163	78	13	10	189	164
October	257	81	18	9	192	137
November	252	243	17	14	200	192
December	331	426	21	20	163	168
Total	2789	2241	214	177	2164	1761

Table 143 Rainfall (mm) at all sites in 1993

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
West New Britain Province													
Dami	501	775	324	163	82	389	217	157	69	60	259	307	3303
Bebere	558	511	493	193	95	329	310	121	60	79	123	261	3133
Kumbango	433	635	434	147	121	215	255	148	56	61	246	453	3106
Malilimi	276	506	408	244	123	504	296	259	39	41	164	517	2860
Togulo	484	921	1050	330	86	403	260	99	29	57	223	412	4354
Kautu	473	643	407	277	237	540	281	222	233	97	162	331	3903
Hargy	1287	768	385	192	271	502	437	288	203	135	76	660	5204
Navo	694	654	839	348	118	117	247	337	144	66	0	658	4223
Oro Province													
Sangara	461	116	309	298	186	33	18	55	83	57	102	462	2180
Ambogo	275	69	266	198	357	62	69	20	88	61	112	360	1937
OPRA Higaturu	238	118	337	360	189	39	82	50	78	83	243	425	2242
Milne Bay Province													
Hagita	160	317	339	325	413	129	78	31	38	89	80	207	2206
Waigani	148	287	145	362	597	153	82	40	44	123	51	183	2215
GiliGili	151	219	214	344	490	120	118	29	54	100	84	261	2184
New Ireland Province													
Lakuramau	312	272	230	309	253	609	-	0	100	111	50	294	2540

APPENDIX II

SOIL ANALYSIS DATA

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

Table 144 Soil Analysis Summary, Islands Provinces, 1993

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

KAPIURA																
401	0-20	6.2	18.50	3.17	0.63	0.08	24.3	2.4	52	9.3	2.16	0.22	10	40	35	25
	40-60	6.1	16.40	3.20	0.52	0.12	36.4	4.1	42	8.7				47	27	27
POLIAMBA																
251	0-20	6.1	11.1	1.69	0.12	0.04	17.3	7.6	68	7.4	2.48	0.23	10	9	15	77
252	0-20	5.8	13.5	1.25	0.23	0.06	19.1	8.5	75	9.3	3.37	0.33	10	11	14	75

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).

Table 145 Soil Analysis Summary: Mainland Provinces, 1993

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	6.0	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	6.1	8.0	2.23	0.62	0.03	13.1	10.0	40	9.1	2.82	0.26	11	58	36	6
	40-60	6.3	2.2	0.75	0.24	0.03	3.6	4.4	12	8.0	0.22	0.03	9	72	25	3
MAMBA																
317	0-20	5.3	1.8	0.17	0.09	0.03	14.9	11	83	na	5.04	0.52	10	65	22	14
	40-60	5.5	0.65	0.05	0.03	0.02	6.9	11	74	na	1.64	0.19	9	67	23	10
318	0-20	4.8	0.7	0.13	0.08	0.01	8.5	12.9	42	8.8	2.41	0.25	10	52	29	19
	40-60	5.6	0.2	0.03	0.03	0.01	3.1	7.7	26	8.9	0.45	0.07	7	69	19	13
MILNE BAY																
502b	0-20	6.2	34.2	14.5	0.15	0.63	47.1	5.2	47	na	3.36	0.31	11	16	40	44
	40-60	6.8	33.8	13.8	0.07	0.66	46.4	1.5	40	na	0.74	0.09	9	21	36	43

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