SUPERIOR EFFECT OF COMPOST DERIVED FROM PALM OIL MILL BY-PRODUCTS AS A REPLACEMENT FOR INORGANIC FERTILISERS APPLIED TO OIL PALM

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ABSTRACT

Trials by Sumatra Bioscience have shown that high quality compost can be produced by composting empty oil palm fruit bunches with oil mill effluent in an open windrow system over 25 days. Fifteen tonnes of the final product typically contains 105 kg N, 16 kg P, 168 kg K and 26 kg Mg, which is close to the average nutrient levels applied to oil palm in Sumatra as inorganic fertiliser per year, except for P which is lower in the compost. Thus, compost applied alone clearly has the potential to replace the inorganic fertilisers usually applied to oil palm. Two trials have been carried out to compare the effectiveness of compost and inorganic fertilisers applied to oil palm on a typical volcanic ash soil in North Sumatra and to determine the optimal rate and method of application of the compost.

The first trial tested a factorial combination of three rates of compost, urea, rock phosphate and muriate of potash. The highest rate of compost (10 t ha^{-1} yr^{-1}) applied alone increased the FFB yield from 23.1 up to 26.8 t ha^{-1} yr^{-1} over a three-year period, which is an increase of 0.37 t ha^{-1} yr^{-1} FFB per tonne of compost applied each year. A similar yield was achieved with 2 kg urea plus 1 kg rock phosphate (there was no response to K fertiliser), which based on the nutrient content of the two materials, indicates that the N and P in the compost were 66% and 37% more effective than the nutrients in the inorganic fertiliser (and confirms that the P content in the compost is more than adequate). The greater efficiency of compost compared to the inorganic fertilisers in supplying N and P to the oil palms was also confirmed by the higher recovery of these nutrients into the palm fronds. The highest yield of 28.7 t ha^{-1} yr^{-1} in this trial was achieved with 10 t ha^{-1} yr^{-1} compost plus 2 kg urea and 2 kg rock phosphate, indicating that if only compost is applied, the highest rate will be needed to achieve the optimal yield.

In the second trial, compost alone was tested at incremental rates of up to 20 t ha^{-1} yr^{-1}, applied as a patch between the avenues and as 1, 2 and 3 m bands down the avenues. The optimal yield over three years was achieved with 15 t ha^{-1} yr^{-1} compost, which increased FFB production from 26.9 to 32.6 t ha^{-1} yr^{-1}; which is an increase of 0.38 t ha^{-1} yr^{-1} FFB per tonne of compost applied per year and this is in very close agreement with the response recorded in the first trial. There were no significant differences due to the different methods of application of the compost. As in the first trial, N and P nutrient contents in the fronds were very significantly increased by the compost, but not K, due to a high K nutrient reserve level in the soil.

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The cost of producing 1 t of compost by the windrow method and applying it in the field in Lonsum estates has been calculated as USD 10, so the application of 15 t ha^{-1} of compost in the second trial would cost USD 150. Application of inorganic fertilisers at the same nutrient rates as 15 t compost ha^{-1} yr^{-1} at 65% moisture content is approximately twice as expensive as compost. Taking into account the greater efficiency of compost in supplying nutrients, replacement of inorganic fertilisers with compost would save the costs of inorganic fertilisers almost three times as much. However in the trial area, K and Mg fertilisers were not required, so savings by switching to compost at this particular location would be less.

Keywords*:* compost, efficiency, oil palm, yield, nutrients.

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INTRODUCTION

Good oil palm yields depend on an adequate supply of nutrients. The four major N, P, K and Mg nutrients all play an important role in increasing and sustaining oil palm yield. Tohiruddin *et al.* (2006) found large yield responses to N and P fertilisers on volcanic soils in North Sumatra, whilst N, P, K and Mg fertilisers are needed to obtain the optimum yield on sandstone soils. The source of nutrients can be obtained from both inorganic and organic fertilisers. However, as the prices of inorganic fertilisers are much higher compared to organic sources the use of organic fertilisers will be more economical. However, the cheapest fertiliser option available in the oil palm industry is the use of palm oil mill by-products.

Huge quantities of palm oil mill effluent (162 000 m^3) and pressed empty fruit bunches (35 100 t) are produced annually by a 45 t FFB ha^{-1} capacity mill operating for 20 hr daily. These materials are highly nutritive and can become a valuable nutrient source if treated correctly, such as composting. Conventional composting methods such as the windrow composting system have been developed by Schuchardt *et al.* (2002), Siregar *et al.* (2002) and Silalahi and Foster (2006). The latest system developed by Silalahi *et al.* (2010) is an Aerated Bunker Composting system in which the nutrient composition is stable throughout the year, nutrient losses are negligible and the area of the composting yard is minimal.

This article reports the superior effect of compost compared to inorganic fertilisers on oil palm yield performance observed in field trials.

MATERIALS AND METHODS

Two compost field trials were established on a typical volcanic ash (rhyolitic) soil in Begerpang Estate in North Sumatra. The main objective of the first trial (611) was to determine the optimal rate of compost in combination with inorganic fertilisers and to investigate the efficiency of compost to supply N, P and K compared with conventional fertilisers. The second trial (612) was aimed to determine the optimal rate and method of compost application.

The experimental design in the first trial (611) was one replicate of a 3^4 compost x N x P x K factorial, higher order interactions partially confounded with blocks of nine plots with multiple regression analysis, whilst the second trial (612) tests four rates of compost x 4 methods of application plus two nil treatment plots in three replicates. Each plot consisted of 49 palms (7x7) in which the data was recorded from nine (3x3) inner palms. Planting material used in these experiments is DxP BLRS where those planted in 2002 and 2003 respectively, with density of 135 palms ha^{-1}. Treatment details of each trial are shown in *Table 1* and the multiple regression analysis and analysis of variance (ANOVA) results for the first and second trials are shown in *Appendices 1* and *2.*

Treatments were applied once a year starting in 2006. The compost material used in these trials was derived from a conventional open windrow system (Silalahi and Foster, 2006) during the dry period (March – April) of each year. The nutrient content of 10 t compost with 65% moisture content used in these two trials over 2007-2010 is depicted in *Table 2*.

TABLE 1. TREATMENT DETAILS OF EXPERIMENT 611 AND 612 IN BEGERPANG ESTATE

Trial No.	Treatment levels	Compost (t ha^{-1} yr^{-1})	Fertiliser (kg palm^{-1} yr^{-1})		
			Urea	Muriate of potash	Rock phosphate
611	0	0	0	0	0
	1	5	1	1	1
	2	10	2	2	2
Trial No.	**Treatment levels**	**Compost (t ha^{-1} yr^{-1})**	**Methods of application**		
612	1	5	Placed in 1 patch per palm in the avenue		
	2	10	Spread in the avenue (1 m band)		
	3	15	Spread in the avenue (2 m band)		
	4	20	Spread in the avenue (3 m band)		

TABLE 2. NUTRIENT CONTENTS OF COMPOST USED IN EXPERIMENTS 611 AND 612

Year	Nutrient contents (kg 10 t compost^{-1} with 65% moisture content)			
	N	P	K	Mg
2007	75	12	127	19
2008	67	10	105	17
2009	59	9	89	14
2010	59	10	96	16

Yearly results and conventional statistical analysis of the parameters measured are given in the *Annual Reports of Bah Lias Research Station (BLRS, 2007 – 2010).*

RESULTS AND DISCUSSION

The main effects of treatment applications in Experiment 611 on both yield components and

TABLE 3. MAIN EFFECTS OF COMPOST AND FERTILISER TREATMENTS ON YIELD COMPONENTS IN EXPERIMENT 611 OVER 2008-2010

Main effects		Yield data 2008-2010		
		FFB (t ha^{-1} yr^{-1})	NOB (ha^{-1})	ABW (kg)
Compost (t ha^{-1} yr^{-1})	0	24.19	2 376	10.16
	5	26.00	2 437	10.68
	10	25.74	2 452	10.51
Urea (kg palm^{-1} yr^{-1})	0	24.62	2 421	10.17
	1	25.51	2 429	10.50
	2	25.80	2 415	10.68
CIRP (kg palm^{-1} yr^{-1})	0	24.08	2 357	10.21
	1	25.73	2 444	10.55
	2	26.12	2 464	10.59
MOP (kg palm^{-1} yr^{-1})	0	25.69	2 454	10.48
	1	25.12	2 385	10.52
	2	25.11	2 426	10.35
LSD 5%		1.26	94	0.46
CV (%)		9.10	7	7.97

Note: CIRP – Christmas Island rock phosphate.
MOP – muriate of potash.
FFB – fresh fruit bunches.

TABLE 4. MAIN EFFECTS OF COMPOST AND METHODS OF APPLICATION ON LEAF NUTRIENT LEVELS IN EXPERIMENT 611 OVER 2008-2010

Main effects		Leaf (%)				Leaf (ppm)			
		N	P	K	Mg	Ca	B	Cu	Zn
Compost (t ha^{-1} yr^{-1})	0	2.52	0.143	0.78	0.19	0.66	13.0	3.8	15.8
	5	2.57	0.147	0.76	0.20	0.67	13.0	4.0	15.9
	10	2.60	0.148	0.79	0.20	0.66	13.1	4.0	16.0
Urea (kg palm^{-1} yr^{-1})	0	2.53	0.144	0.77	0.21	0.67	13.1	4.1	16.4
	1	2.58	0.146	0.77	0.20	0.65	13.1	3.9	15.5
	2	2.58	0.149	0.78	0.19	0.66	12.9	3.7	15.8
CIRP (kg palm^{-1} yr^{-1})	0	2.55	0.143	0.79	0.20	0.64	12.9	3.9	15.7
	1	2.59	0.148	0.77	0.20	0.68	13.1	4.0	16.1
	2	2.56	0.147	0.78	0.20	0.67	13.1	3.9	15.9
MOP (kg palm^{-1} yr^{-1})	0	2.56	0.146	0.78	0.19	0.65	13.0	3.9	15.4
	1	2.58	0.148	0.77	0.20	0.68	13.2	3.9	16.1
	2	2.56	0.145	0.78	0.20	0.66	12.9	4.0	16.1
LSD 5%		0.03	0.003	0.02	0.01	0.02	0.3	0.3	1.0
CV (%)		2.17	3.55	5.06	9.94	6.75	3.6	13.0	11.4

Note: CIRP – Christmas Island rock phosphate.

TABLE 5. FITTED DATA FOR SPECIFIC TREATMENT COMBINATIONS IN EXPERIMENT 611 OVER 2008-2010

Compost x NPK	FFB (t ha^{-1} yr^{-1})	NOB (ha^{-1})	ABW (kg)	% Leaf					% Rachis			
				N	P	K	Mg	Ca	P	K	Mg	Ca
0000	23.14	2 303	10.04	2.51	0.142	0.77	0.20	0.67	0.050	1.44	0.06	0.31
1000	25.42	2 480	10.28	2.53	0.142	0.74	0.19	0.66	0.053	1.43	0.07	0.32
2000	26.80	2 631	10.22	2.53	0.138	0.75	0.18	0.63	0.054	1.41	0.07	0.32
0100	25.75	2 420	10.63	2.54	0.142	0.78	0.19	0.61	0.055	1.47	0.06	0.28
0110	26.01	2 431	10.69	2.56	0.145	0.77	0.19	0.65	0.065	1.41	0.06	0.31
0210	26.57	2 437	10.92	2.57	0.146	0.77	0.18	0.64	0.073	1.33	0.06	0.30
2220	28.70	2 584	11.11	2.62	0.150	0.85	0.18	0.67	0.084	1.44	0.07	0.30

Note: FFB – fresh fruit bunches.

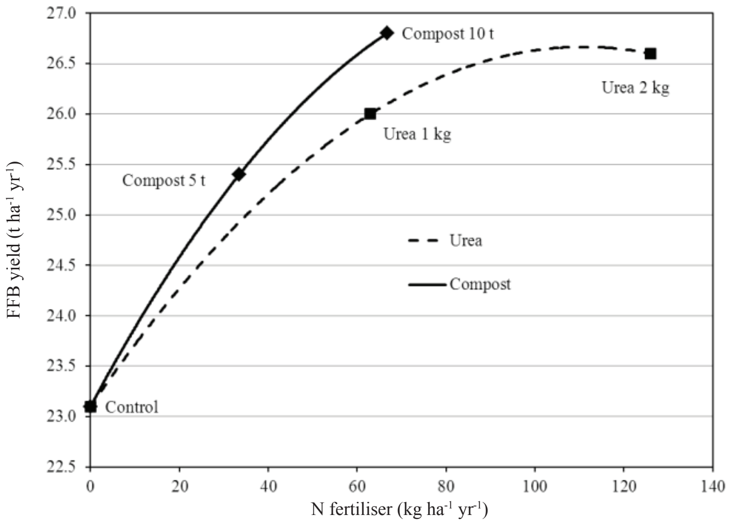

Figure 1. Fresh fruit bunches (FFB) yield response to compost and urea fertiliser in Experiment 611 over 2008-2010.

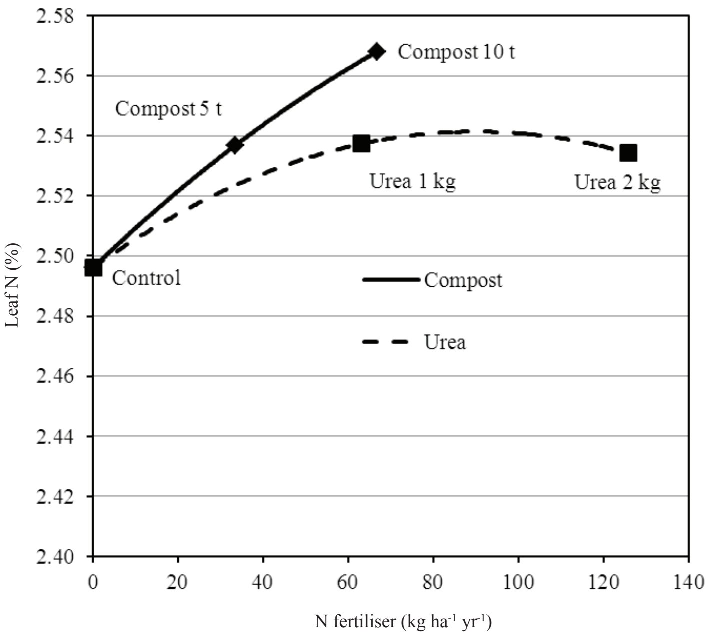

Figure 2. Leaf N response to compost and urea fertiliser in Experiment 611 over 2008-2010.

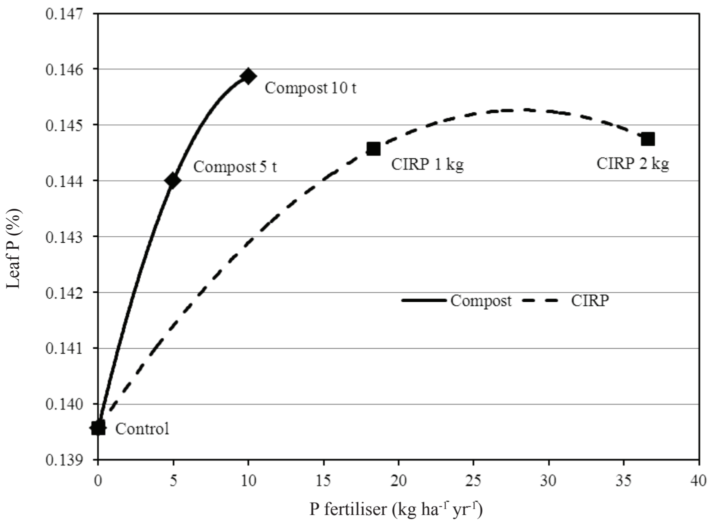

Figure 3. Leaf P response to compost and Christmas Island rock phosphate (CIRP) fertiliser in Experiment 611 over 2008-2010.

TABLE 6. MAIN EFFECTS OF COMPOST AND METHODS OF APPLICATIONS ON YIELD COMPONENTS IN EXPERIMENT 612 OVER 2008-2010

Treatments		Yield data 2008 - 2010		
		FFB ($t\ ha^{-1}\ yr^{-1}$)	NOB (ha^{-1})	ABW (kg)
Compost ($t\ ha^{-1}\ yr^{-1}$)	0	26.88	2 413	11.13
	5	29.96	2 558	11.73
	10	29.87	2 664	11.22
	15	32.60	2 778	11.77
	20	31.29	2 648	11.83
Methods	Patch	31.64	2 655	11.92
	1 m band	30.98	2 693	11.52
	2 m band	30.46	2 668	11.41
	3 m band	30.63	2 632	11.68
LSD 1 (5%)		1.48	147	0.53
LSD 2 (5%)		1.62	160	0.58
CV (%)		5.62	6	5.30

Note: LSD 1: Comparison between compost or method.
LSD 2: Comparison between control *vs.* method or control *vs.* compost.

leaf nutrient levels are given in *Tables 3* to *4*. Application of compost, urea and rock phosphate (CIRP) fertiliser, as depicted in *Table 3*, significantly increased fresh fruit bunches (FFB) yield over 2008-2010 (at P = 0.05, 0.10 and 0.01 respectively). These significant yield increases correspond to the significant increases in leaf nutrient levels shown in *Table 4*. There was no significant response of FFB yield or leaf K to muriate of potash fertiliser,

TABLE 8. EFFECT OF COMPOST AND METHODS OF APPLICATION ON FRESH FRUIT BUNCHES YIELD IN EXPERIMENT 612 OVER 2008-2010

Compost ($t\ ha^{-1}\ yr^{-1}$)	Methods of application			
	Patch	1 m band	2 m band	3 m band
5	29.29	30.13	29.16	30.39
10	30.76	31.03	30.56	29.45
15	32.87	31.97	32.07	32.01
20	33.72	31.68	31.30	32.25
LSD (5%)	-	2.81		-

TABLE 7. MAIN EFFECTS OF COMPOST AND METHODS OF APPLICATION ON LEAF NUTRIENT CONTENTS IN EXPERIMENT 612 OVER 2008-2010

Treatments		Leaf (%)				Leaf (ppm)			
		N	P	K	Mg	Ca	B	Cu	Zn
Compost ($t\ ha^{-1}\ yr^{-1}$)	0	2.52	0.138	0.81	0.18	0.61	11.7	4.2	14.0
	5	2.57	0.144	0.82	0.19	0.62	13.0	4.5	15.5
	10	2.63	0.148	0.81	0.19	0.62	12.9	4.6	15.7
	15	2.60	0.151	0.79	0.20	0.64	13.2	4.5	15.1
	20	2.64	0.150	0.81	0.21	0.64	13.1	4.6	16.5
Methods	Patch	2.62	0.148	0.81	0.20	0.62	13.0	4.2	15.3
	1 m band	2.62	0.149	0.81	0.20	0.64	13.1	4.3	16.8
	2 m band	2.59	0.148	0.81	0.19	0.61	12.9	5.2	15.1
	3 m band	2.61	0.149	0.80	0.20	0.64	13.2	4.6	15.6
LSD 1 (5%)		0.05	0.004	0.05	0.01	0.03	0.6	0.6	5.4
LSD 2 (5%)		0.06	0.004	0.05	0.01	0.04	0.6	0.6	6.1
CV (%)		2.54	2.90	6.87	8.04	5.90	5.2	15.6	29.7

Note: LSD 1: Comparison between compost or method.
LSD 2: Comparison between control *vs.* method or control *vs.* compost.

TABLE 9. COSTS COMPARISON BETWEEN COMPOST AND INORGANIC FERTILISERS

Fertilisers	At equal efficiency		Efficiency	At higher compost efficiency	
	Rp.	USD		Rp.	USD
Compost at 15 t ha^{-1} yr^{-1}	1 350 000	150		1 350 000	150
Urea 1.9 kg $palm^{-1}$ yr^{-1}	886 977	99	+66%	1 447 173	161
RP 1.0 kg $palm^{-1}$ yr^{-1}	148 500	17	+37%	207 900	23
MOP 2.5 kg $palm^{-1}$ yr^{-1}	1 444 500	161	+20%	1 733 400	193
S. Dolomite 1.8 kg $palm^{-1}$ yr^{-1}	109 350	12	+20%	131 220	14
Application costs per ha	74 385	8	-	98 854	11
Transportation costs (Begerpang)	86 022	10	-	120 623	13
Total inorganic costs	2 749 734	306		3 739 170	415

Note: Fertiliser prices (USD t^{-1}): urea = 387; rock phosphate (RP) = 122; MOP = 476; super dolomite = 50. Density ha^{-1} = 135 palms.

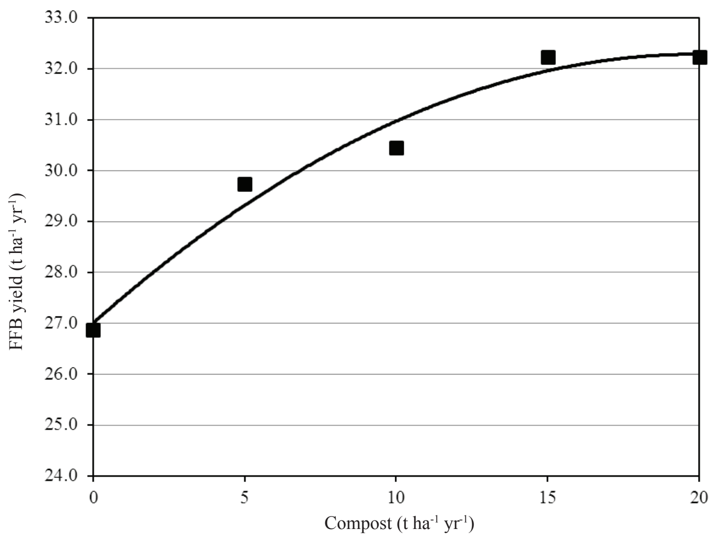

Figure 4. Fresh fruit bunches (FFB) yield response to different rates of compost in Experiment 612 over 2008-2010.

which agrees with the results of a previous study by Tohiruddin *et al.* (2006) at a nearby site where the topsoil reserve K level was very high, exceeding 4 cmol (+)/kg.

In addition application of 10 t ha^{-1} yr^{-1} compost increased exchangeable K in the 0 – 40 cm topsoil from 0.36 to 0.90 meq 100 g^{-1} and exchangeable Mg from 0.51 to 1.19 cmol (+)/kg over 2007-2010. Gurmit *et al.* (1999) and Darmosarkoro and Sutarta (2002) also reported significant increases in soil exchangeable cations after compost application in Malaysia and Sumatra respectively.

Application of 10 t compost ha^{-1} yr^{-1} alone increased the FFB yield from 23.1 up to 26.8 t ha^{-1} yr^{-1} over a three-year period, which is an increase of 0.37 t ha^{-1} yr^{-1} FFB per tonne of compost applied each year. A similar yield was achieved with 2 kg urea plus 1 kg rock phosphate as shown in *Figure 1*. Based on the nutrient content of the fertiliser materials, these yield responses indicate that the N and P in the compost were 66% and 37% more effective than the nutrients in the inorganic fertiliser (and confirms that the P content in the compost is more than adequate). The greater efficiency of uptake of N and P from compost compared with inorganic fertilisers is depicted in *Figures 2* and *3*. No N volatilisation, slow release of N and a low C/N ratio (20-25) compared with empty fruit bunches (60-70) are factors which make compost more efficient than urea, whilst Budianta *et al.* (2010) found that application of oil palm compost significantly reduced Al-P and Ca-P fractions which in turn increased soil P availability. *Table 5* shows that the maximum FFB yield of 28.7 t ha^{-1} yr^{-1} was obtained by the application of 10 t ha^{-1} yr^{-1} compost plus 2 kg urea and 2 kg RP fertilisers, which indicates that if only compost is applied, the optimal rate would be higher than the maximum (10 t ha^{-1} yr^{-1}) tested in this trial.

In the second trial (Experiment 612) compost application at the highest rate (20 t ha^{-1} yr^{-1}) significantly increased bunch number and bunch weight which in turn increased FFB yield (*Table*

6). However, there was no significant difference in FFB yield between compost applied at 15 t ha^{-1} yr^{-1} and 20 t ha^{-1} yr^{-1}, indicating that at this location compost application at 15 t ha^{-1} yr^{-1} with 65% of moisture level is the optimal rate as shown in *Figure 4*. The yield increase in this trial corresponds to a significant increase in leaf N, P and Mg levels (*Table 7*). Further analysis revealed that compost also had a significant effect on increasing leaf B levels. In this trial, as in Experiment 611, compost application had little effect on K uptake in the leaf tissue, indicating that the palms had sufficient K, as previously observed in this location by Tohiruddin *et al.* (2006). Whilst there was no significant yield difference between the two highest compost rates and the different methods of compost application (*Table 6*), the maximum yield in this trial was obtained with 20 t ha^{-1} yr^{-1} compost applied in patches, as shown in the two-way *Table 8*, suggesting that patch application may be the best method.

The benefit of using compost as a substitute for inorganic fertiliser can be calculated economically. On average the nutrient content of 15 t compost used in this trial is equal to 105 kg N, 16 kg P, 168 kg K and 26 kg Mg. *Table 9* shows that application of inorganic fertilisers at the same nutrient rates as 15 t compost at 65% moisture content is 104% more expensive than compost. Assuming the greater efficiency of N (66%) and P (37%) supplied by compost found in trial 611 and assuming only a slightly higher efficiency (20%) of K and Mg when supplied by compost, then the cost of inorganic fertiliser application per hectare would be much more expensive by 177% relative to 15 t compost ha^{-1} yr^{-1} at 65% moisture. However as K and Mg fertilisers are not required at this location (Tohiruddin *et al.*, 2006) applying 15 t compost ha^{-1} yr^{-1} only reduces the cost of fertilisation by 39%. In most areas in Sumatra, K and Mg are required (Tohiruddin *et al.*, 2006), in which case savings would be much higher (177%), as indicated above.

CONCLUSION

1. The application of compost at the same nutrient levels of urea and rock phosphate gave much higher recovery efficiency of N and P in the leaf, which in turn gave higher FFB yield compared to urea and rock phosphate treatments.

2. The FFB yield obtained by 10 t compost ha^{-1} yr^{-1} was relatively the same as the FFB yield obtained with 2 kg urea and 1 kg RP per palm per year. The maximum yield and optimal leaf levels of N, K and Mg were obtained with 10 t compost combined with 2 kg urea and 2 kg RP per palm per year, indicating that the optimal rate of compost is higher than 10 t ha^{-1} yr^{-1}.

3. In the second trial the main effect of 15 t compost ha^{-1} yr^{-1} gave the optimal FFB yield of 32.60 t ha^{-1} yr^{-1} and there was no significant difference between methods of application. However, patch application tended to give the highest FFB yield of 33.72 t ha^{-1} yr^{-1} at a compost rate of 20 t ha^{-1} yr^{-1}.

4. Application of inorganic fertilisers at the same nutrient rates as 15 t ha^{-1} yr^{-1} compost is approximately twice as expensive as compost. Taking into account the greater efficiency of compost in supplying nutrients as shown in these trials, the higher cost of inorganic fertilisers is almost three times as much. However in the trial area, K and Mg fertilisers were not required, so savings by switching to compost at this particular location would be much less.

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Appendix 1

MULTIPLE LINEAR REGRESSION ANALYSIS RESULTS OF COMPOST AND N, P, K FERTILISERS TRIAL (611)

Fresh Fruit Bunch (FFB ha^{-1} yr^{-1})

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
FFB	25.31000	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.24095	0.77610	0.32261	0.21331	2.40567	0.01973
UR_L	0.00000	0.82158	0.15137	0.58841	0.31479	0.16172	1.86922	0.06723
CI_L	0.00000	0.82158	0.27236	1.01616	0.31407	0.27929	3.23542	0.00211
MO_L	0.00000	0.82158	-0.09024	-0.29067	0.31479	-0.07989	-0.92337	0.36008
CO_Q	0.00000	1.42302	-0.16715	-0.34270	0.18111	-0.16314	-1.89224	0.06403
UR_Q	0.00000	1.42302	-0.02116	-0.09894	0.18564	-0.04710	-0.53295	0.59634
CI_Q	0.00000	1.42302	-0.10429	-0.21066	0.18111	-0.10029	-1.16319	0.25006
MO_Q	0.00000	1.42302	0.03465	0.09362	0.18168	0.04457	0.51530	0.60853
CO_UR	0.00000	0.67082	-0.02936	-0.18733	0.38632	-0.04204	-0.48491	0.62977
CO_CI	0.00000	0.67082	-0.01216	-0.09202	0.38502	-0.02065	-0.23901	0.81204
CO_MO	0.00000	0.67082	0.03902	0.17389	0.38395	0.03902	0.45290	0.65251
UR_CI	0.00000	0.67082	-0.01552	-0.12567	0.38632	-0.02820	-0.32529	0.74627
UR_MO	0.00000	0.67082	-0.06789	-0.35900	0.38632	-0.08057	-0.92927	0.35704
CI_MO	0.00000	0.67082	0.05698	0.36689	0.39337	0.08234	0.93269	0.35529
CO_UR_CI	0.00000	0.54772	-0.10116	-0.37121	0.55298	-0.06802	-0.67128	0.50501
CO_UR_MO	0.00000	0.54772	0.04214	-0.02795	0.54830	-0.00512	-0.05097	0.95954
CO_CI_MO	0.00000	0.54772	0.02084	0.26248	0.55484	0.04810	0.47307	0.63814
UR_CI_MO	0.00000	0.54772	0.15040	-0.51080	0.54507	-0.09360	-0.93713	0.35303
CO_UR_CI_M	0.00000	0.44721	-0.23377	-1.68963	0.58391	-0.25278	-2.89363	0.00555
deadc	0.04531	0.20257	-0.01958	-2.03403	1.54026	-0.13784	-1.32057	0.19243

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

Average Bunch Weight (kg)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
ABW	10.45037	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.18234	0.17540	0.11669	0.16293	1.50319	0.13884
UR_L	0.00000	0.82158	0.23188	0.25746	0.11386	0.23914	2.26123	0.02795
CI_L	0.00000	0.82158	0.17029	0.18858	0.11360	0.17516	1.66003	0.10293
MO_L	0.00000	0.82158	-0.07070	-0.06829	0.11386	-0.06343	-0.59975	0.55128
CO_Q	0.00000	1.42302	-0.18651	-0.11418	0.06551	-0.18370	-1.74304	0.08724
UR_Q	0.00000	1.42302	-0.02264	-0.02540	0.06714	-0.04086	-0.37823	0.70680
CI_Q	0.00000	1.42302	-0.08044	-0.04825	0.06551	-0.07763	-0.73662	0.46467
MO_Q	0.00000	1.42302	-0.06644	-0.03697	0.06571	-0.05947	-0.56254	0.57617
CO_UR	0.00000	0.67082	0.07963	0.09326	0.13973	0.07073	0.66743	0.50745
CO_CI	0.00000	0.67082	-0.02044	-0.03481	0.13926	-0.02640	-0.24997	0.80360
CO_MO	0.00000	0.67082	0.14536	0.19167	0.13887	0.14536	1.38018	0.17344
UR_CI	0.00000	0.67082	0.01770	0.01159	0.13973	0.00879	0.08298	0.93419
UR_MO	0.00000	0.67082	0.00295	-0.00785	0.13973	-0.00595	-0.05618	0.95541
CI_MO	0.00000	0.67082	0.11334	0.17292	0.14228	0.13115	1.21538	0.22971
CO_UR_CI	0.00000	0.54772	-0.09469	0.10039	0.20001	0.06217	0.50192	0.61785
CO_UR_MO	0.00000	0.54772	0.00697	0.14941	0.19832	0.09252	0.75341	0.45460
CO_CI_MO	0.00000	0.54772	0.01548	0.12777	0.20068	0.07912	0.63668	0.52713
UR_CI_MO	0.00000	0.54772	0.08411	-0.02434	0.19715	-0.01507	-0.12345	0.90223
CO_UR_CI_M	0.00000	0.44721	-0.19687	-0.41579	0.21120	-0.21023	-1.96872	0.05433
deadc	0.04531	0.20257	0.00279	-0.42260	0.55710	-0.09678	-0.75858	0.45153

Number of Bunches (ha^{-1})

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
NOB	2421.84605	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.16734	37.99421	24.19332	0.14936	1.57044	0.12238
UR_L	0.00000	0.82158	-0.01812	-2.89756	23.60665	-0.01139	-0.12274	0.90278
CI_L	0.00000	0.82158	0.20667	53.71776	23.55318	0.21118	2.28070	0.02669
MO_L	0.00000	0.82158	-0.06054	-13.68627	23.60665	-0.05380	-0.57976	0.56458
CO_Q	0.00000	1.42302	-0.05521	-7.72550	13.58164	-0.05260	-0.56882	0.57193
UR_Q	0.00000	1.42302	-0.00913	-3.81774	13.92152	-0.02600	-0.27423	0.78499
CI_Q	0.00000	1.42302	-0.07925	-11.25642	13.58164	-0.07665	-0.82880	0.41101
MO_Q	0.00000	1.42302	0.11776	18.24177	13.62475	0.12421	1.33887	0.18644
CO_UR	0.00000	0.67082	-0.12514	-41.55504	28.97141	-0.13338	-1.43435	0.15746
CO_CI	0.00000	0.67082	-0.00661	-3.78026	28.87333	-0.01213	-0.13093	0.89634
CO_MO	0.00000	0.67082	-0.08453	-26.33361	28.79319	-0.08453	-0.91458	0.36463
UR_CI	0.00000	0.67082	-0.03117	-12.27810	28.97141	-0.03941	-0.42380	0.67346
UR_MO	0.00000	0.67082	-0.10058	-33.90477	28.97141	-0.10883	-1.17028	0.24722
CI_MO	0.00000	0.67082	-0.02975	-4.13130	29.49961	-0.01326	-0.14005	0.88916
CO_UR_CI	0.00000	0.54772	-0.04916	-60.60641	41.46953	-0.15884	-1.46147	0.14990
CO_UR_MO	0.00000	0.54772	0.04743	-37.01403	41.11829	-0.09701	-0.90018	0.37217
CO_CI_MO	0.00000	0.54772	0.01272	-4.20104	41.60893	-0.01101	-0.10096	0.91997
UR_CI_MO	0.00000	0.54772	0.13360	-39.01998	40.87611	-0.10226	-0.95459	0.34420
CO_UR_CI_M	0.00000	0.44721	-0.13317	-68.01010	43.78898	-0.14553	-1.55313	0.12646
deadc	0.04531	0.20257	-0.02507	-92.46160	115.50797	-0.08962	-0.80048	0.42708

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

N leaf (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
N leaf	2.56309	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.47423	0.03889	0.00757	0.47423	5.13474	0.00000
UR_L	0.00000	0.82158	0.26873	0.02204	0.00757	0.26873	2.90969	0.00528
CI_L	0.00000	0.82158	0.05420	0.00444	0.00757	0.05420	0.58683	0.55981
MO_L	0.00000	0.82158	-0.01129	-0.00093	0.00757	-0.01129	-0.12226	0.90316
CO_Q	0.00000	1.42302	-0.03390	-0.00160	0.00437	-0.03390	-0.36704	0.71505
UR_Q	0.00000	1.42302	-0.15515	-0.00735	0.00437	-0.15515	-1.67991	0.09886
CI_Q	0.00000	1.42302	-0.23729	-0.01123	0.00437	-0.23729	-2.56927	0.01304
MO_Q	0.00000	1.42302	-0.13951	-0.00660	0.00437	-0.13951	-1.51051	0.13685
CO_UR	0.00000	0.67082	0.03042	0.00306	0.00928	0.03042	0.32941	0.74314
CO_CI	0.00000	0.67082	-0.02213	-0.00222	0.00928	-0.02213	-0.23957	0.81159
CO_MO	0.00000	0.67082	0.06361	0.00639	0.00928	0.06361	0.68877	0.49397
UR_CI	0.00000	0.67082	0.05808	0.00583	0.00928	0.05808	0.62887	0.53213
UR_MO	0.00000	0.67082	-0.03596	-0.00361	0.00928	-0.03596	-0.38930	0.69861
CI_MO	0.00000	0.67082	-0.00830	-0.00083	0.00928	-0.00830	-0.08984	0.92875
CO_UR_CI	0.00000	0.54772	-0.04742	-0.00259	0.01312	-0.02108	-0.19764	0.84409
CO_UR_MO	0.00000	0.54772	-0.04742	0.00704	0.01312	0.05721	0.53644	0.59390
CO_CI_MO	0.00000	0.54772	-0.11517	-0.02037	0.01312	-0.16561	-1.55286	0.12641
UR_CI_MO	0.00000	0.54772	0.04065	-0.00833	0.01312	-0.06775	-0.63526	0.52799
CO_UR_CI_M	0.00000	0.44721	0.05393	0.00812	0.01391	0.05393	0.58395	0.56173

P leaf (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
P leaf	0.14617	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.34143	0.00259	0.00071	0.34143	3.67588	0.00055
UR_L	0.00000	0.82158	0.29265	0.00222	0.00071	0.29265	3.15076	0.00268
CI_L	0.00000	0.82158	0.26827	0.00204	0.00071	0.26827	2.88819	0.00560
MO_L	0.00000	0.82158	-0.04878	-0.00037	0.00071	-0.04878	-0.52513	0.60169
CO_Q	0.00000	1.42302	-0.14080	-0.00062	0.00041	-0.14080	-1.51591	0.13548
UR_Q	0.00000	1.42302	0.02816	0.00012	0.00041	0.02816	0.30318	0.76294
CI_Q	0.00000	1.42302	-0.18304	-0.00080	0.00041	-0.18304	-1.97068	0.05399
MO_Q	0.00000	1.42302	-0.22529	-0.00099	0.00041	-0.22529	-2.42545	0.01873
CO_UR	0.00000	0.67082	-0.02987	-0.00028	0.00086	-0.02987	-0.32157	0.74904
CO_CI	0.00000	0.67082	-0.05974	-0.00056	0.00086	-0.05974	-0.64315	0.52290
CO_MO	0.00000	0.67082	0.11948	0.00111	0.00086	0.11948	1.28629	0.20393
UR_CI	0.00000	0.67082	0.02987	0.00028	0.00086	0.02987	0.32157	0.74904
UR_MO	0.00000	0.67082	-0.02987	-0.00028	0.00086	-0.02987	-0.32157	0.74904
CI_MO	0.00000	0.67082	0.05974	0.00056	0.00086	0.05974	0.64315	0.52290
CO_UR_CI	0.00000	0.54772	0.00000	-0.00056	0.00122	-0.04878	-0.45477	0.65113
CO_UR_MO	0.00000	0.54772	-0.14633	-0.00185	0.00122	-0.16259	-1.51591	0.13548
CO_CI_MO	0.00000	0.54772	-0.07316	-0.00130	0.00122	-0.11381	-1.06114	0.29344
UR_CI_MO	0.00000	0.54772	0.03658	0.00074	0.00122	0.06503	0.60636	0.54686
CO_UR_CI_M	0.00000	0.44721	0.04480	0.00063	0.00130	0.04480	0.48236	0.63154

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

K leaf (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
K leaf	0.77728	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.09068	0.00537	0.00535	0.09068	1.00288	0.32048
UR_L	0.00000	0.82158	0.08443	0.00500	0.00535	0.08443	0.93371	0.35469
CI_L	0.00000	0.82158	-0.08443	-0.00500	0.00535	-0.08443	-0.93371	0.35469
MO_L	0.00000	0.82158	-0.04378	-0.00259	0.00535	-0.04378	-0.48415	0.63028
CO_Q	0.00000	1.42302	0.18234	0.00623	0.00309	0.18234	2.01656	0.04882
UR_Q	0.00000	1.42302	0.04152	0.00142	0.00309	0.04152	0.45922	0.64796
CI_Q	0.00000	1.42302	0.10651	0.00364	0.00309	0.10651	1.17799	0.24406
MO_Q	0.00000	1.42302	0.03611	0.00123	0.00309	0.03611	0.39932	0.69126
CO_UR	0.00000	0.67082	0.00000	0.00000	0.00656	0.00000	0.00000	1.00000
CO_CI	0.00000	0.67082	0.00000	0.00000	0.00656	0.00000	0.00000	1.00000
CO_MO	0.00000	0.67082	-0.01532	-0.00111	0.00656	-0.01532	-0.16942	0.86611
UR_CI	0.00000	0.67082	-0.06893	-0.00500	0.00656	-0.06893	-0.76237	0.44922
UR_MO	0.00000	0.67082	-0.11106	-0.00806	0.00656	-0.11106	-1.22827	0.22477
CI_MO	0.00000	0.67082	-0.19148	-0.01389	0.00656	-0.19148	-2.11770	0.03891
CO_UR_CI	0.00000	0.54772	0.06566	0.01648	0.00928	0.18553	1.77696	0.08131
CO_UR_MO	0.00000	0.54772	-0.11257	-0.01963	0.00928	-0.22097	-2.11639	0.03903
CO_CI_MO	0.00000	0.54772	0.02345	-0.00833	0.00928	-0.09381	-0.89847	0.37300
UR_CI_MO	0.00000	0.54772	-0.06097	0.00593	0.00928	0.06671	0.63891	0.52563
CO_UR_CI_M	0.00000	0.44721	0.01149	0.00125	0.00984	0.01149	0.12706	0.89937

Mg leaf (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
Mg leaf	0.19889	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.18653	0.00500	0.00269	0.18653	1.85813	0.06871
UR_L	0.00000	0.82158	-0.31779	-0.00852	0.00269	-0.31779	-3.16571	0.00256
CI_L	0.00000	0.82158	0.01382	0.00037	0.00269	0.01382	0.13764	0.89105
MO_L	0.00000	0.82158	0.21417	0.00574	0.00269	0.21417	2.13341	0.03754
CO_Q	0.00000	1.42302	-0.03590	-0.00056	0.00155	-0.03590	-0.35760	0.72206
UR_Q	0.00000	1.42302	0.04786	0.00074	0.00155	0.04786	0.47680	0.63547
CI_Q	0.00000	1.42302	-0.19146	-0.00296	0.00155	-0.19146	-1.90719	0.06192
MO_Q	0.00000	1.42302	-0.10769	-0.00167	0.00155	-0.10769	-1.07279	0.28822
CO_UR	0.00000	0.67082	0.10153	0.00333	0.00330	0.10153	1.01144	0.31640
CO_CI	0.00000	0.67082	0.15230	0.00500	0.00330	0.15230	1.51716	0.13517
CO_MO	0.00000	0.67082	-0.05923	-0.00194	0.00330	-0.05923	-0.59001	0.55769
UR_CI	0.00000	0.67082	-0.01692	-0.00056	0.00330	-0.01692	-0.16857	0.86677
UR_MO	0.00000	0.67082	-0.09307	-0.00306	0.00330	-0.09307	-0.92715	0.35805
CI_MO	0.00000	0.67082	0.05923	0.00194	0.00330	0.05923	0.59001	0.55769
CO_UR_CI	0.00000	0.54772	-0.03109	-0.00463	0.00466	-0.11514	-0.99333	0.32506
CO_UR_MO	0.00000	0.54772	-0.07254	0.00148	0.00466	0.03685	0.31786	0.75184
CO_CI_MO	0.00000	0.54772	-0.14508	-0.00278	0.00466	-0.06909	-0.59600	0.55371
UR_CI_MO	0.00000	0.54772	0.23835	0.00759	0.00466	0.18883	1.62906	0.10923
CO_UR_CI_M	0.00000	0.44721	0.10153	0.00500	0.00494	0.10153	1.01144	0.31640

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

Ca leaf (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
Ca leaf	0.66272	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.00283	0.00019	0.00609	0.00283	0.03042	0.97584
UR_L	0.00000	0.82158	-0.09041	-0.00593	0.00609	-0.09041	-0.97356	0.33470
CI_L	0.00000	0.82158	0.16951	0.01111	0.00609	0.16951	1.82543	0.07357
MO_L	0.00000	0.82158	0.09041	0.00593	0.00609	0.09041	0.97356	0.33470
CO_Q	0.00000	1.42302	-0.08645	-0.00327	0.00351	-0.08645	-0.93095	0.35610
UR_Q	0.00000	1.42302	0.10439	0.00395	0.00351	0.10439	1.12417	0.26601
CI_Q	0.00000	1.42302	-0.20879	-0.00790	0.00351	-0.20879	-2.24834	0.02874
MO_Q	0.00000	1.42302	-0.18921	-0.00716	0.00351	-0.18921	-2.03756	0.04660
CO_UR	0.00000	0.67082	0.11073	0.00889	0.00745	0.11073	1.19236	0.23843
CO_CI	0.00000	0.67082	-0.01384	-0.00111	0.00745	-0.01384	-0.14905	0.88208
CO_MO	0.00000	0.67082	-0.08997	-0.00722	0.00745	-0.08997	-0.96880	0.33705
UR_CI	0.00000	0.67082	0.16609	0.01333	0.00745	0.16609	1.78855	0.07940
UR_MO	0.00000	0.67082	-0.12803	-0.01028	0.00745	-0.12803	-1.37867	0.17379
CI_MO	0.00000	0.67082	0.09689	0.00778	0.00745	0.09689	1.04332	0.30154
CO_UR_CI	0.00000	0.54772	-0.06357	-0.01333	0.01054	-0.13561	-1.26469	0.21151
CO_UR_MO	0.00000	0.54772	-0.00848	-0.01500	0.01054	-0.15256	-1.42278	0.16066
CO_CI_MO	0.00000	0.54772	0.14833	0.00889	0.01054	0.09041	0.84313	0.40295
UR_CI_MO	0.00000	0.54772	-0.11442	-0.00111	0.01054	-0.01130	-0.10539	0.91646
CO_UR_CI_M	0.00000	0.44721	0.02595	0.00312	0.01118	0.02595	0.27946	0.78098

P rachis (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
P rachis	0.06679	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.26925	0.00463	0.00161	0.26925	2.87730	0.00577
UR_L	0.00000	0.82158	0.32310	0.00556	0.00161	0.32310	3.45276	0.00110
CI_L	0.00000	0.82158	0.44157	0.00759	0.00161	0.44157	4.71877	0.00002
MO_L	0.00000	0.82158	0.09693	0.00167	0.00161	0.09693	1.03583	0.30499
CO_Q	0.00000	1.42302	-0.03109	-0.00031	0.00093	-0.03109	-0.33224	0.74102
UR_Q	0.00000	1.42302	0.06218	0.00062	0.00093	0.06218	0.66448	0.50926
CI_Q	0.00000	1.42302	-0.18032	-0.00179	0.00093	-0.18032	-1.92700	0.05935
MO_Q	0.00000	1.42302	-0.06840	-0.00068	0.00093	-0.06840	-0.73093	0.46804
CO_UR	0.00000	0.67082	0.10552	0.00222	0.00197	0.10552	1.12767	0.26454
CO_CI	0.00000	0.67082	-0.01319	-0.00028	0.00197	-0.01319	-0.14096	0.88844
CO_MO	0.00000	0.67082	0.13190	0.00278	0.00197	0.13190	1.40958	0.16450
UR_CI	0.00000	0.67082	0.11871	0.00250	0.00197	0.11871	1.26862	0.21012
UR_MO	0.00000	0.67082	-0.05276	-0.00111	0.00197	-0.05276	-0.56383	0.57525
CI_MO	0.00000	0.67082	0.06595	0.00139	0.00197	0.06595	0.70479	0.48403
CO_UR_CI	0.00000	0.54772	-0.03231	-0.00019	0.00279	-0.00718	-0.06645	0.94727
CO_UR_MO	0.00000	0.54772	0.14539	0.00204	0.00279	0.07898	0.73093	0.46804
CO_CI_MO	0.00000	0.54772	-0.09693	-0.00222	0.00279	-0.08616	-0.79738	0.42879
UR_CI_MO	0.00000	0.54772	0.04846	0.00093	0.00279	0.03590	0.33224	0.74102
CO_UR_CI_M	0.00000	0.44721	-0.07914	-0.00250	0.00296	-0.07914	-0.84575	0.40150

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

K rachis (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
K rachis	1.50321	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.14743	0.02722	0.01567	0.14743	1.73669	0.08825
UR_L	0.00000	0.82158	-0.04212	-0.00778	0.01567	-0.04212	-0.49620	0.62181
CI_L	0.00000	0.82158	-0.23167	-0.04278	0.01567	-0.23167	-2.72908	0.00860
MO_L	0.00000	0.82158	0.31290	0.05778	0.01567	0.31290	3.68603	0.00054
CO_Q	0.00000	1.42302	-0.01448	-0.00154	0.00905	-0.01448	-0.17052	0.86525
UR_Q	0.00000	1.42302	-0.15518	-0.01654	0.00905	-0.15518	-1.82801	0.07318
CI_Q	0.00000	1.42302	0.00984	0.00105	0.00905	0.00984	0.11596	0.90813
MO_Q	0.00000	1.42302	-0.08222	-0.00877	0.00905	-0.08222	-0.96857	0.33716
CO_UR	0.00000	0.67082	0.09581	0.02167	0.01920	0.09581	1.12861	0.26414
CO_CI	0.00000	0.67082	-0.02825	-0.00639	0.01920	-0.02825	-0.33280	0.74060
CO_MO	0.00000	0.67082	-0.13143	-0.02972	0.01920	-0.13143	-1.54822	0.12752
UR_CI	0.00000	0.67082	-0.18916	-0.04278	0.01920	-0.18916	-2.22828	0.03013
UR_MO	0.00000	0.67082	-0.07247	-0.01639	0.01920	-0.07247	-0.85369	0.39712
CI_MO	0.00000	0.67082	0.00368	0.00083	0.01920	0.00368	0.04341	0.96554
CO_UR_CI	0.00000	0.54772	0.16247	0.01833	0.02715	0.06619	0.67527	0.50244
CO_UR_MO	0.00000	0.54772	-0.14743	-0.01500	0.02715	-0.05416	-0.55250	0.58293
CO_CI_MO	0.00000	0.54772	-0.14592	-0.02333	0.02715	-0.08424	-0.85944	0.39397
UR_CI_MO	0.00000	0.54772	-0.14592	-0.01389	0.02715	-0.05014	-0.51157	0.61108
CO_UR_CI_M	0.00000	0.44721	0.11792	0.04000	0.02880	0.11792	1.38906	0.17062

Mg rachis (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
Mg rachis	0.07185	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.24822	0.00370	0.00142	0.24822	2.61383	0.01163
UR_L	0.00000	0.82158	-0.08688	-0.00130	0.00142	-0.08688	-0.91484	0.36442
CI_L	0.00000	0.82158	0.27304	0.00407	0.00142	0.27304	2.87521	0.00580
MO_L	0.00000	0.82158	0.16134	0.00241	0.00142	0.16134	1.69899	0.09518
CO_Q	0.00000	1.42302	-0.04299	-0.00037	0.00082	-0.04299	-0.45273	0.65259
UR_Q	0.00000	1.42302	0.06449	0.00056	0.00082	0.06449	0.67909	0.50003
CI_Q	0.00000	1.42302	-0.08599	-0.00074	0.00082	-0.08599	-0.90546	0.36932
MO_Q	0.00000	1.42302	-0.15048	-0.00130	0.00082	-0.15048	-1.58455	0.11902
CO_UR	0.00000	0.67082	0.04560	0.00083	0.00174	0.04560	0.48019	0.63307
CO_CI	0.00000	0.67082	0.10640	0.00194	0.00174	0.10640	1.12045	0.26758
CO_MO	0.00000	0.67082	-0.03040	-0.00056	0.00174	-0.03040	-0.32013	0.75013
UR_CI	0.00000	0.67082	-0.07600	-0.00139	0.00174	-0.07600	-0.80032	0.42710
UR_MO	0.00000	0.67082	0.04560	0.00083	0.00174	0.04560	0.48019	0.63307
CI_MO	0.00000	0.67082	0.15200	0.00278	0.00174	0.15200	1.60064	0.11540
CO_UR_CI	0.00000	0.54772	0.07447	0.00037	0.00245	0.01655	0.15091	0.88062
CO_UR_MO	0.00000	0.54772	0.01862	0.00222	0.00245	0.09929	0.90546	0.36932
CO_CI_MO	0.00000	0.54772	0.01862	0.00130	0.00245	0.05792	0.52818	0.59958
UR_CI_MO	0.00000	0.54772	0.20478	-0.00037	0.00245	-0.01655	-0.15091	0.88062
CO_UR_CI_M	0.00000	0.44721	0.00000	0.00000	0.00260	0.00000	0.00000	1.00000

Note: CO = compost; UR = urea; CI = Christmas Island rock phosphate (CIRP); MO = muriate of potash (MOP); L = linear; Q = quadratic.

Ca rachis (%)

Descriptive statistics	Mean	Std. deviation	Correlation	Regression coeff.	Std error of reg coeff.	Standardised beta	T value	Sig.
Ca rachis	0.31914	-	-	-	-	-	-	-
CO_L	0.00000	0.82158	0.03091	0.00148	0.00432	0.03091	0.34325	0.73277
UR_L	0.00000	0.82158	-0.05409	-0.00259	0.00432	-0.05409	-0.60069	0.55061
CI_L	0.00000	0.82158	0.28979	0.01389	0.00432	0.28979	3.21798	0.00220
MO_L	0.00000	0.82158	0.15842	0.00759	0.00432	0.15842	1.75916	0.08432
CO_Q	0.00000	1.42302	-0.04908	-0.00136	0.00249	-0.04908	-0.54498	0.58805
UR_Q	0.00000	1.42302	0.11154	0.00309	0.00249	0.11154	1.23860	0.22095
CI_Q	0.00000	1.42302	-0.14946	-0.00414	0.00249	-0.14946	-1.65973	0.10288
MO_Q	0.00000	1.42302	-0.21639	-0.00599	0.00249	-0.21639	-2.40289	0.01980
CO_UR	0.00000	0.67082	0.05679	0.00333	0.00529	0.05679	0.63059	0.53102
CO_CI	0.00000	0.67082	-0.00473	-0.00028	0.00529	-0.00473	-0.05255	0.95829
CO_MO	0.00000	0.67082	0.00473	0.00028	0.00529	0.00473	0.05255	0.95829
UR_CI	0.00000	0.67082	0.08518	0.00500	0.00529	0.08518	0.94589	0.34850
UR_MO	0.00000	0.67082	0.06625	0.00389	0.00529	0.06625	0.73569	0.46516
CI_MO	0.00000	0.67082	0.18929	0.01111	0.00529	0.18929	2.10198	0.04032
CO_UR_CI	0.00000	0.54772	-0.05796	-0.00759	0.00748	-0.10561	-1.01565	0.31441
CO_UR_MO	0.00000	0.54772	0.05216	-0.00352	0.00748	-0.04894	-0.47067	0.63981
CO_CI_MO	0.00000	0.54772	0.24342	0.01241	0.00748	0.17259	1.65973	0.10288
UR_CI_MO	0.00000	0.54772	-0.06375	-0.00556	0.00748	-0.07728	-0.74316	0.46067
CO_UR_CI_M	0.00000	0.44721	-0.06389	-0.00562	0.00793	-0.06389	-0.70942	0.48117

Appendix 2

ANOVA OF OPTIMUM COMPOST APPLICATIONS TRIAL (612)

Variate: Fresh Fruit Bunch (t ha^{-1} yr^{-1})

d.f: a degree of freedom
s.s.: a sum of square
m.s: a mean square
v.r.: a variance ratio
cov. ef: a covariate efficiency
F pr: a F probability of variance ratio

Source of variation	d.f.	s.s.	m.s.	v.r.	cov.ef.	F pr.
REP stratum						
Covariate	1	3.483	3.483	2.88	-	0.339
Residual	1	1.210	1.210	0.44	1.94	-
REP.*Units* stratum						
COMPOST	3	56.650	18.883	6.86	0.98	0.001
METHOD	3	5.878	1.959	0.71	0.96	0.553
COMPOST. METHOD	9	13.345	1.483	0.54	0.98	0.834
Covariate	1	10.253	10.253	3.72	-	0.063
Residual	29	79.856	2.754	-	1.09	-
Total	47	185.698	-	-	-	-

Variate: Number of Bunches (ha^{-1})

Source of variation	d.f.	s.s.	m.s.	v.r.	cov. ef.	F pr.
REP stratum						
Covariate	1	13 007.43	13 007.43	1.21	-	0.470
Residual	1	10 759.13	10 759.13	0.70	1.10	-
REP.*Units* stratum						
COMPOST	3	301 657.16	100 552.39	6.51	0.98	0.002
METHOD	3	20 953.01	6 984.34	0.45	0.96	0.718
COMPOST.METHOD	9	63 340.33	7 038.82	0.46	0.98	0.892
Covariate	1	165 544.36	165 544.36	10.72	-	0.003
Residual	29	447 652.27	15 436.29	-	1.32	-
Total	47	1 116 592.13	-	-	-	-

Variate: Average Bunch Weight (kg^{-1})

Source of variation	d.f.	s.s.	m.s.	v.r.	cov.ef.	F pr.
REP stratum						
Covariate	1	0.0505	0.0505	13248.82	-	0.006
Residual	1	0.0000	0.0000	0.00	6624.91	-
REP.*Units* stratum						
COMPOST	3	1.4469	0.4823	2.15	0.98	0.115
METHOD	3	1.5897	0.5299	2.37	0.96	0.091
COMPOST. METHOD	9	0.7894	0.0877	0.39	0.98	0.929
Covariate	1	0.3986	0.3986	1.78	-	0.193
Residual	29	6.4958	0.2240	-	1.03	-
Total	47	10.5509	-	-	-	-

Variate: N Leaf (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.047017	0.023508	5.51	-
REP.*Units* stratum					
COMPOST	3	0.020723	0.006908	1.62	0.206
METHOD	3	0.005023	0.001674	0.39	0.759
COMPOST. METHOD	9	0.023385	0.002598	0.61	0.780
Residual	30	0.128050	0.004268	-	-
Total	47	0.224198	-	-	-

Variate: P Leaf (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.00012917	0.00006458	3.60	-
REP.*Units* stratum					
COMPOST	3	0.00033333	0.00011111	6.20	0.002
METHOD	3	0.00003333	0.00001111	0.62	0.607
COMPOST. METHOD	9	0.00013333	0.00001481	0.83	0.597
Residual	30	0.00053750	0.00001792	-	-
Total	47	0.00116667	-	-	-

Variate: K Leaf (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.007029	0.003515	1.14	-
REP.*Units* stratum					
COMPOST	3	0.006892	0.002297	0.74	0.535
METHOD	3	0.003442	0.001147	0.37	0.775
COMPOST. METHOD	9	0.033192	0.003688	1.19	0.336
Residual	30	0.092837	0.003095	-	-
Total	47	0.143392	-	-	-

Variate: K Rachis (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.01528	0.00764	0.57	-
REP.*Units* stratum					
COMPOST	3	0.04717	0.01572	1.18	0.336
METHOD	3	0.05427	0.01809	1.35	0.276
COMPOST. METHOD	9	0.09222	0.01025	0.77	0.648
Residual	30	0.40145	0.01338	-	-
Total	47	0.61040	-	-	-

Variate: Mg Leaf (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.0015167	0.0007583	2.94	-
REP.*Units* stratum					
COMPOST	3	0.0009667	0.0003222	1.25	0.310
METHOD	3	0.0005167	0.0001722	0.67	0.579
COMPOST. METHOD	9	0.0030167	0.0003352	1.30	0.279
Residual	30	0.0077500	0.0002583	-	-
Total	47	0.0137667	-	-	-

Variate: Mg Rachis (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.0010500	0.0005250	4.28	-
REP.*Units* stratum					
COMPOST	3	0.0002500	0.0000833	0.68	0.572
METHOD	3	0.0001167	0.0000389	0.32	0.813
COMPOST. METHOD	9	0.0011000	0.0001222	1.00	0.465
Residual	30	0.0036833	0.0001228	-	-
Total	47	0.0062000	-	-	-

Variate: Ca Leaf (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.018763	0.009381	6.58	-
REP.*Units* stratum					
COMPOST	3	0.004183	0.001394	0.98	0.416
METHOD	3	0.005167	0.001722	1.21	0.324
COMPOST. METHOD	9	0.010717	0.001191	0.84	0.590
Residual	30	0.042771	0.001426	-	
Total	47	0.081600	-	-	-

Variate: Ca Rachis (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.003050	0.001525	1.07	-
REP.*Units* stratum					
COMPOST	3	0.001273	0.000424	0.30	0.826
METHOD	3	0.005573	0.001858	1.31	0.290
COMPOST. METHOD	9	0.006019	0.000669	0.47	0.883
Residual	30	0.042617	0.001421	-	-
Total	47	0.058531	-	-	-

Variate: P Rachis (%)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.00106667	0.00053333	5.71	-
REP.*Units* stratum					
COMPOST	3	0.00145000	0.00048333	5.18	0.005
METHOD	3	0.00036667	0.00012222	1.31	0.290
COMPOST. METHOD	9	0.00038333	0.00004259	0.46	0.892
Residual	30	0.00280000	0.00009333	-	-
Total	47	0.00606667	-	-	-