Chapter 9

Use of Soil Analysis for Fertilizer Recommendation

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Introduction

Fruit quality was affected by several factors including cultivar, rootstock, climate, soil, pests, irrigation and plant nutrition, then the effects of nutrition on fruit quality were important and well accepted. Additional, the nutrients in tangerine production had been taken into several considerations by local growers for a number of years. The management of plant nutrition and fertilizer application on farmer's knowkedge in traditional agriculture (see the Results in Chapter 3) has proved to increase the profitability and sustainability of the national citrus industry (Chang *et al.*, 2006). Consequently, the optimum fertilization for nutrient status in their orchard is probably unbalanced or over an optimum range. This practice leads to inefficient and environmental unfriendly use of fertilizers. Therefore, the efficiency of fertilizer management was one of the key success factors to increase the competitive opportunity of tangerine production in the world market (Supakamnerd, 2004). More fertilizers, being left behind or reserve in soil than the standard values, may cause direct disadvantages to the plants as well as inhibit the availability of other nutrients.

Citrus tree nutritional status could be determined by using leaf and soil analysis. The leaf and soil sampling analysis showed the effectiveness of the fertilizer application program for the previous year. The analytical data of leaf and soil analysis were used to adjust the plant nutrition program for the following year. The soil analysis was a useful tool to evaluate soil nutritional status for fertilizer applications to the plants (Buasap, 2001). The fruit production research in Thailand generally do not engage soil analysis tool for application of fertilizer. The addition of fertilizer to most citrus crops may not afford high yield and quality of fruit. Therefore, this experiment aims to examine the effectiveness of soil analysis based fertilizer application on yield and quality of tangerine.

Materials and Methods

The experiment was conducted at 2 private orchards, where soil texture is loam and clay, located at Mae Soon Noi subdistrict, Fang district of Chiang Mai province. The study duration was during December 2005 – December 2007. Five-year-old tangerine trees of cv. Sainampueng were selected for the study.

Soil properties of each orchard was determined as a method previously described in Chapter 4 before the experimental trial inorder to obtain basic data for fertilizer application design.

The experiment was laid out in a completely randomized design (CRD) with five replications (trees). Six treatments of fertilizer application were as follows;

Treatment 1: Addition only the element that its concentration in soil was below the optimum level; soil application of macro-elements and foliar application of micro-element.

Treatment 2: Addition only the element that its concentration in soil was below the optimum level; soil application of both macro and micro-element.

Treatment 3: Adjustment of N:P₂O₅:K₂O ratio as 4:2:5 in fertilizer and apply micro-elements by foliar application as in Treatment 1.

Treatment 4: Adjustment of N:P₂O₅:K₂O ratio as 4:2:5 in fertilizer and apply micro-elements by soil application as in Treatment 2.

Treatment 5: Fertilizers application in accordance to farmer's practice.

Treatment 6: Similarity to treatment 5, except minor and micro-elements were soil application.

The 25 tangerine fruits per treatment were collected in the middle of the wet season (collected in August 26, 2006), cool dry season (collected in November 25, 2006) and hot dry season (collected in April 28, 2007) at the age of 10 months. The fruit qualities and nutrient concentration in fruit composition were determined (by the procedures) as previously described in Chapter 6.

The nutrient concentration in collected soil and leaves were determined (by the procedures) as previously described in Chapter 4.

The data were statistically analyzed using ANOVA. A least significant difference (LSD) was used to test the effects of treatments when the F-test was statistically significant at $p \le 0.05$.

The data of applied fertilizer based on soil analysis (treatment 1, 2, 3 and 4) and fermer's procedure (treatment 5 and 6) were statistically analyzed using T-test.

The data of only the element that its concentration in soil was below the optimum level (treatment 1 and 2) and apply 4:2:5 ratio (treatment 3 and 4) were statistically analyzed using T-test.

Results and Discussion

1. Nutrient concentration in soil

1.1 Before experiment

The soil properties in loam soil before the experimental trial are shown in Table 9.1. The soil at the experimental site had optimum of pH at 6.06, with high OM (4.04 %). The soil macronutrient concentration showed low N (12.87 mg/kg) but high of P, K, Ca and Mg at 44.64, 470.68, 1,213.82, 158.40 mg/kg, respectively. The soil micronutrient concentration indicated high of Fe, Mn and Zn at 91.57, 30.97 and 6.0 mg/kg, respectively. However lower of Cu at 0.67 mg/kg and the absence of B was found.

The soil properties in clay soil before the experimental trial are shown in Table 9.2. The soil had optimum of pH at 6.13 and 3.01 % of OM. This is because of the organic fertilizer was applied last year. The soil macronutrient concentration bared low of N at 12.31 mg/kg but high of P, K, Ca and Mg at 198.05, 285.44, 1,439.80, 187.86 mg/kg, respectively. The soil micronutrient concentration showed high of Fe, Mn, Cu and Zn at 137.59, 18.11, 3.44 and 4.93 mg/kg, respectively. But B was not defected.

The soil properties in loam and clay soil came from chemical and organic fertilizer applied by growers (see Table 2 in Appendix).

Nutrient	Soil nutrient	Optimum	Demark
Nutrient	concentration	concentration ^{1/}	Kelliark
рН	6.06	6.0-7.0	-
OM (%)	4.04	2.5-3.0	-
P (mg/kg)	44.64	26.0-42.0	-
K (mg/kg)	470.68	130	- 3
Ca (mg/kg)	1,213.82	1,040	
Mg (mg/kg)	158.40	135	-
Fe (mg/kg)	91.57	11.0-16.0	24
Mn (mg/kg)	30.97	9.0-12.0	775
Cu (mg/kg)	0.67	0.9-1.2	added
Zn (mg/kg)	6.0	1.1-3.0	7
B (mg/kg)	0	0.6-1.2	added
^{1/} Supakamnerd, 2005	5		

 Table 9.1 Properties of the loam soil before the experiment trial and their optimum nutrient concentration.

The soil analysis in loam soil barely lower Cu and B but other nutrients showed in range of optimum nutrient concentration (Table 9.1), but N was fed on the soil because of the easy loss in the environment. As we know soil has much more K (Table 9.1) and the range of N, P to K is largely different. Thus in treatment 3 and 4, the fertilizer must apply only N and P. Therefore, the six treatments of fertilizer application were arranged as shown in Table 9.3.

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Nutriont	Soil nutrient	Optimum	Domortz
Nutrient	concentration	concentration ^{1/}	Kellialk
рН	6.13	6.0-7.0	-
OM (%)	3.01	2.5-3.0	-
P (mg/kg)	198.05	26.0-42.0	30
K (mg/kg)	285.44	130	
Ca (mg/kg)	1,439.80	1,040	-
Mg (mg/kg)	187.86	135	-
Fe (mg/kg)	137.59	11.0-16.0	2022
Mn (mg/kg)	18.11	9.0-12.0	225
Cu (mg/kg)	3.44	0.9-1.2	-
Zn (mg/kg)	4.93	1.1-3.0	×/
B (mg/kg)	0	0.6-1.2	added

 Table 9.2 Properties of the clay soil before the experiment trial and their optimum nutrient concentration.

^{1/} Supakumnerd, 2005

The soil analysis in clay soil showed low values B while other nutrients were in range of optimum nutrient concentrations (Table 9.2), but N was fed on the soil because of the easy loss in the environment. As we know soil has much more K (Table 9.3) and the range of N, P to K is largely different. Thus in treatment 3 and 4, the fertilizer must apply only N and P. Therefore, the six treatments of fertilizer application were arranged as shown in Table 9.4.

Copyright[©] by Chiang Mai University AII rights reserved Table 9.3 Application rate of fertilizers among the treatments which were conducted in loam soil.

	9	81	219	-b <i>G</i>	57					
			Quar	tity of f	ertilizer (g	g or pp	m/tree/y	year)		
Treatment	N	P_2O_5	K ₂ O	Ca	Mg	Fe	Mn	Cu	Zn	В
1. Applied only nutrients which present below	170	-			_	-		960	-	2,400
optimum level and foliar application of	g	ىيىتىر						ppm	<i>י</i> ן ר	ppm
microelements	G							CS.	25	
2. Applied only nutrients which present below	170	-2		5	-	-	-	1.92		11.04
optimum level and soil application of	g			14))			g	~ /	g
microelements			4	7				6		
3. Adjustment N:P ₂ O ₅ :K ₂ O ratio of the soil	1,340	530		1		_		960	_	2,400
(4:2:5) and foliar application of microelements	g	g	20000			5		ppm		ppm
4. Adjustment N:P ₂ O ₅ :K ₂ O ratio of the soil	1,340	530	JN	FV	E	-	-	1.92	-	11.04
(4:2:5) and soil application of microelements	g	g						g		g
5. Application of fertilizers in accordance with	895	665	920	2,400	2,400		R	SI 2	2,400	2,400
farmer's practice	g	g	g	ppm	ppm				ppm	ppm
6. Application of fertilizers in accordance with	895	665	920	11.04	11.04	ai		niv	11.04	11.04
farmer's practice and soil application of	g	g	Sg	g 🔽	g	S	e	r	g	eg C
microelements										

Table 9.4 Application rate of fertilizers among the treatments which were conducted in clay soil.

	9	81	2196	Ø				
_			Quantity	of fertilizer (g or pp	m/tree/y	year)	
Treatment	N	P_2O_5	K ₂ O Ca	Mg	Fe	Mn	Cu Zn	В
1. Applied only nutrients which present below	170	-		-	-		-93-	2,400
optimum level and foliar application of	g	,,,,,,,					2	ppm
nicroelements	e						224	
2. Applied only nutrients which present below	170		-3	-	-	-	- 7205	11.04
pptimum level and soil application of	g			<i>y</i>))			A	g
nicroelements							5	
. Adjustment N:P ₂ O ₅ :K ₂ O ratio of the soil	1,410	770			_		- /-	2,400
4:2:5) and foliar application of microelements	g	g	20100		5			ppm
A Adjustment N:P $_2O_5$:K $_2O$ ratio of the soil	1,410	770	JNE	VE	-			11.04
4:2:5) and soil application of microelements	g	g						g
. Application of fertilizers in accordance with	895	665	920 2,40	0 2,400		8	2,400	2,400
armer's practice	g	g	g ppr	n ppm			ppm	ppm
. Application of fertilizers in accordance with	895	665	920 11.0	4 11.04	lai		- 11.04	11.04
armer's practice and soil application of	g	g	Sg g	r ge	S	e	g	eg
nicroelements								

1.2 After experiment

The values of most soil properties in loam soil was relativelt higher than those of at the beginning (Table 9.1) such as 6.07 - 6.13 of pH (Table 9.5), 4.29 - 4.58 % of OM (due to manure applied by grower); 17.2 - 19.4 mg/kg of N, 47.8 - 52.9 mg/kg of P, 475.9 - 481.2 mg/kg of K, 1,227.3 - 1,232.9 mg/kg of Ca, 159.1 - 162.1 mg/kg of Mg, 96.5 - 99.2 mg/kg of Fe, 32.4 - 34.6 mg/kg of Mn, 0.83 - 0.91 mg/kg of Cu, 6.72 - 8.02 mg/kg of Zn and 0 - 0.20 mg/kg of B. The increasing trend of nutrient concentration came directly from application rates of fertilizers in the treatments (Table 9.3), as well as dolomite, bio-fertilizer and pesticides given by the grower.

The values of all soil properties in clay soil increased after the experimental trial such as 6.16 - 6.18 of pH (Table 9.6), 3.24 - 3.41 % of OM (due to manure applied by grower); 13.5 - 15.1 mg/kg of N, 197.8 - 200.2 mg/kg of P, 287.1 - 290.7 mg/kg of K, 1,447.4 - 1,451.1 mg/kg of Ca, 187.2 - 189.0 mg/kg of Mg, 139.3 - 141.9 mg/kg of Fe, 17.5 - 18.2 mg/kg of Mn, 3.57 - 3.86 mg/kg of Cu, 4.68 - 4.90 mg/kg of Zn and 0 - 0.11 mg/kg of B. The rising of nutrient concentration came from application fertilizers in the treatments (Table 9.4), while the grower applied only dolomite, bio-fertilizer and pesticides.

The result indicated that the application fertilizers in the treatments were not different of the values of all soil properties in both soil areas. So, the growers used the soil analysis for the application of fertilizer in the both soil.

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				010	9 9							
		OM	N	Р	K	Ca	Mg	Fe	Mn	Cu	Zn	В
Treatment	рН	(%)			SI D		mg	g/kg				
1) 170 g N + 960 ppm Cu + 2,400	6.07	4.42	17.9	50.9	478.5	1,229.6	159.1	97.2	33.0	0.83	6.72	0
ppm B					演					3		
2) 170 g N + 1.92 g Cu + 11.04 g	6.08	4.30	17.2	47.8	476.3	1,227.3	161.5	96.5	32.6	0.85	7.23	0.13
B			e			2				-35	20	
3) 1,340 g N + 530 g P ₂ O ₅ + 960	6.13	4.58	19.4	48.1	475.9	1,228.4	159.7	98.1	33.7	0.91	6.84	0
ppm Cu + 2,400 ppm B					X P))				_ /	
4) 1,340 g N + 530 g P ₂ O ₅ + 1.92	6.11	4.29	18.9	51.5	480.4	1,230.5	162.1	97.9	32.4	0.87	7.14	0.05
g Cu + 11.04 g B							1			\sim '		
5) 895 g N + 665 g P ₂ O ₅ + 920 g	6.12	4.51	18.3	52.9	479.3	1,232.9	161.8	98.8	34.6	0.83	7.75	0
K ₂ O + 2,400 ppm Ca + 2,400			11					25)				
ppm Mg + 2,400 ppm Zn + 2,400					JN	IV						
ppm B	~											
6) 895 g N + 665 g P ₂ O ₅ + 920 g	6.11	4.46	18.8	50.2	481.2	1,331.1	160.2	99.2	32.8	0.86	8.02	0.20
K ₂ O + 11.04 g Ca + 11.04 g Mg +			2.12									
11.04 g Zn + 11.04 g B	sht		by	C	hia	ng		a	U	niv	ers	ITY
Optimum concentration ^{1/}	6.0-7.0	2.5-3.0	20-60 ^{2/}	26-42	130	1,040	135	11-16	9-12	0.9-1.2	1.1-3.0	0.6-1.2
^{1/} Supakamnerd, 2005												

Table 9.5 Soil properties of the treatments after the experiment which was conducted in loam soil and at the optimum nutrient concentration.

^{2/} Thaiagrotech, 2005

Table 9.6 Soil properties of the treatments after the experiment which was conducted in clay soil and at the optimum nutrient

concentration.		0	9	81	219	ŀļĆ	2	9/				
		ОМ	N	Р	K	Ca	Mg	Fe	Mn	Cu	Zn	В
Treatment	рН	(%)					mg	g/kg				
1) 170 g N + 2,400 ppm B	6.16	3.24	14.2	198.9	288.4	1,449.6	188.5	141.9	18.1	3.57	4.74	0
2) 170 g N + 11.04 g B	6.18	3.30	13.5	197.8	287.6	1,451.1	187.6	139.3	17.9	3.65	4.82	0.06
3) 1,410 g N + 770 g P ₂ O ₅ +	6.16	3.41	14.7	198.1	288.9	1,447.4	189.0	140.0	18.2	3.71	4.68	0
2,400 ppm B				Z	~ ?					3		
4) 1,410 g N + 770 g P ₂ O ₅ +	6.17	3.29	15.1	199.5	287.1	1,450.2	187.2	139.7	18.0	3.77	4.77	0.04
11.04 g B								C		5		
5) 895 g N + 665 g P ₂ O ₅ + 920	6.18	3.35	14.6	199.1	289.3	1,448.2	187.6	141.1	17.5	3.60	4.71	0
g K ₂ O + 2,400 ppm Ca + 2,400		S A			20100			-5				
ppm Mg + 2,400 ppm Zn +			A	Τ 7	TN	TI	TE					
2,400 ppm B												
6) 895 g N + 665 g P ₂ O ₅ + 920	6.17	3.26	14.8	200.2	290.7	1,449.3	188.4	140.5	18.1	3.86	4.90	0.11
g K ₂ O + 11.04 g Ca + 11.04 g	5	Uľ		51	18	J	6	IJ	B	B	D LI	пIJ
Mg + 11.04 g Zn + 11.04 g B	sht ⁽	C	by	С	hia	ng	\sim	1ai	U	niv	/ers	sity
Optimum concentration ^{1/}	6.0-7.0	2.5-3.0	20-60 ^{2/}	26-42	130	1,040	135	11-16	9-12	0.9-1.2	1.1-3.0	0.6-1.2
^{1/} Supakamnerd, 2005		- 0										

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^{2/} Thaiagrotech, 2005

3. Nutrient concentration in leaf of tangerine

The nutrient concentrations in leaf of tangerine trees growing on loam and clay soil after the fertilizer application of six treatments showed in Table 9.7 and 9.8. The concentration of N, P, K, Ca and Mg were not significantly different among six fertilizer treatments. The tangerine trees did not respond to the quantity fertilization of N, P and K because of heavy consumption of P, K, Ca and Mg during growth and development of tangerine (Table 9.1, 9.2, 9.5 and 9.6). The micronutrient concentrations were significantly different among treatments because the micro-elements by foliar application were utilized better than soil application. Therefore, the treatments of foliar application of micro-element gave the highest rate of the micronutrient concentrations in soil application. The application of fertilizer in accordance to farmer's practice (treatment 5) gave the high micronutrient concentrations in leaf. This result may come from the foliar application of the most micronutrient by farmers (see Table 2 in Appendix).

After the nutrient content in leaf among treatments and adequate concentration in Taiwan (Table 9.7) were compared, it was found that most nutrients element concentration in leaf of all ratio appeared in range of the optimum level except K, Ca and Cu in both soil areas (Table 9.7 and 9.8). These three elements found rather than high concentration because of the extremely high K and Ca in soil (Table 9.5 and 9.6). It consequently caused luxury consumption by the tree (Osotsapar, 2000). Besides this, the grower also sprayed some pesticides with copper constituent (see the Results in Chapter 3).

The research results apparently showed that an addition of the only deficient elements gave nutrient elements for plant growth sufficiently.

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			~ 9	18	194	â				1/
Treatment	Cor	ncentration of	macronutri	ent element	t (%)	Concent	Concentration of micronutrient element (ppm) ^{1/}			
ricament	N	Р	К	Ca	Mg	Fe	Mn	Zn	Cu	В
1) 170 g N + 960 ppm Cu + 2,400	2.95	0.14	2.18	5.89	0.37	79.3 a	57.6 a	60.2 b	25.7 bc	62.0 a
ppm B	- /								S,	
2) 170 g N + 1.92 g Cu + 11.04 g B	2.84	0.14	2.24	5.79	0.35	78.3 ab	55.4 b	44.8 d	24.7 c	55.7 b
3) 1,340 g N + 530 g P_2O_5 + 960	2.91	0.15	2.21	5.73	0.34	77.5 ab	54.1 c	58.1 b	26.6 b	62.6 a
ppm Cu + 2,400 ppm B		<								3-11
4) 1,340 g N + 530 g P_2O_5 + 1.92 g	2.86	0.15	2.17	5.92	0.40	76.4 b	52.2 d	45.3 d	25.4 c	56.9 b
Cu + 11.04 g B					2	4			Z	
5) 895 g N + 665 g P_2O_5 + 920 g	2.93	0.15	2.26	5.83	0.37	77.0 ab	58.0 a	74.4 a	27.9 a	63.8 a
K ₂ O + 2,400 ppm Ca + 2,400 ppm	Z1.				17			1		
Mg + 2,400 ppm Zn + 2,400 ppm B				600	6000	600		\mathbf{S}		
6) 895 g N + 665 g P ₂ O ₅ + 920 g	2.86	0.15	2.24	5.85	0.35	75.6 b	54.3 c	52.1 c	26.1 b	58.5 b
$K_2O + 11.04 \; g \; Ca + 11.04 \; g \; Mg \; + \;$					NI					
11.04 g Zn + 11.04 g B										
Adequate concentration	81	114	2		SIC	A A		RS		
Taiwan ^{2/}	2.9-3.1	0.12-0.18	1.4-1.7	2.5-4.5	0.26-0.5	60-120	25-200	25-100	5-16	25-150
LSD _{0.05}	ns	ns	ns	ns		2.80	0.75	3.27	1.17	2.97
% CV	7.53	3.24	7.22	6.91	6.26	10.97	5.93	11.36	4.34	9.58

Table 9.7 Nutrient concentration in leaf of tangerine cv. Sainampueng as affected by various fertilizer applications in loam soil.

 $^{1/}$ Means followed by different letters within columns are significantly different at the 5 % level by LSD $_{0.05}$

^{2/} source: Chang *et al.*, 1992

^{ns} not significant difference

				191	194	a					
Trantmont	Cor	centration of	f macronutri	ent element	t (%)	Concen	Concentration of micronutrient element (ppm) ^{1/}				
meathent	Ν	Р	К	Ca	Mg	Fe	Mn	Zn	Cu	В	
1) 170 g N + 2,400 ppm B	2.68	0.13	1.85	5.63	0.36	73.4	49.7 b	75.6 bc	26.6 a	49.0 b	
2) 170 g N + 11.04 g B	2.72	0.14	1.97	5.49	0.42	72.9	46.5 bc	73.3 c	25.0 b	42.8 d	
3) 1,410 g N + 770 g P_2O_5 + 2,400	2.85	0.15	1.91	5.50	0.34	70.5	47.6 b	74.7 bc	24.3 c	50.1 b	
ppm B			(\mathbf{X})						30	R	
4) 1,410 g N + 770 g P_2O_5 + 11.04 g	2.81	0.14	1.89	5.53	0.40	71.1	45.0 c	72.5 c	23.8 c	43.4 d	
В				Le la	-2.				30	6	
5) 895 g N + 665 g P_2O_5 + 920 g	2.79	0.14	2.04	5.57	0.36	71.8	52.5 a	82.8 a	27.1 a	52.3 a	
K ₂ O + 2,400 ppm Ca + 2,400 ppm					\sim				5		
Mg + 2,400 ppm Zn + 2,400 ppm B	71.				-17	62		1	~ /		
6) 895 g N + 665 g P_2O_5 + 920 g	2.82	0.14	2.01	5.45	0.38	72.1	48.2 b	77.6 b	25.7 b	46.5 c	
K ₂ O + 11.04 g Ca + 11.04 g Mg +		1	AT			TE	52				
11.04 g Zn + 11.04 g B				U	NI						
Nutrient standards											
Taiwan ^{2/}	2.9-3.1	0.12-0.18	1.4-1.7	2.5-4.5	0.26-0.5	60-120	25-200	25-100	5-16	25-150	
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	1.63	4.01	0.68	1.75	
C%cvyrig	9.63	2.78	11.75	12.12	6.16	B 13.81	8.82	13.14	12.86	13.35	
¹⁷ Means followed by different letters wi	thin colum	ns are signifi	icantly differ	ent at the 5	% level by]	LSD 0.05	S	e	r	e	
^{2/} source: Chang <i>et al.</i> , 1992	_	0									

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Table 9.8 Nutrient concentration in leaf of tangerine cv. Sainampueng as affected by various fertilizer applications in clay soil.

4. The quality and yield of tangerine fruit

From the overview in this experiment, the fertilizer applications are not different in quality and yield of tangerine fruits for both loam and clay soil in all harvesting season (Table 9.9-9.18), and it did not affect peel colour or juice colour (Table 9.21 and 9.27). While complained in each treatment, it showed applications fertilizers were different in the quality and yield of tangerine fruits (Table 9.19–9.30).

When studied in two 2 applications of microelements of each group; the addition of blow the optimum level suggestible by soil analysis and application fertilizer in accordance with the grower with foliar applications of microelements were better on growth, quality and yields of fruit than applied to the soil. But the adjustment of N:P₂O₅:K₂O in chemical soil ratio of 4:2:5 was not different in the both applications of microelements.

The results of the experiment indicated that foliar application of microelements provided better fruit quality and yield than soil application. The result conformed to the effects of N, P, K and trace elements on quality and yield of tangerine in Chiang Kan and Ban Chong soil series (Sirinun, 1996; Vorapitirangsee, 2000). They found that the treatment of N, P and K plus trace element spray gave the best fruit quality. However, fertilizer applications to the soil were subjected to various fates including leach, runoff and fixation to forms which are not available to plants. Therefore, foliar application should be considered as a possible supplement to soil application for some nutrients. Thus, foliar application can reduce overall fertilizer application rate and energy use and can improve the uptake efficiency of micronutrients because they are directly absorbed into the leaves (Zekri and Obereza, 2008).

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			Loam soil			Clay soil	
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
		season	season	season	season	season	season
	Fertilizer	6.18	6.13	6.19	6.27	6.26	6.36
	application by soil					6	
	analysis (Treatment			5			
	1, 2, 3 and 4)		, 11 min				
	Fertilizer	6.16	6.11	6.15	6.28	6.22	6.10
	application by			(12)		50	2
	farmer's practice		The			- SOU	
	(Treatment 5 and 6)				Y)	A	
	T - test	ns	ns	ns	ns	ns	ns
	% CV	4.81	6.04	10.72	4.93	4.86	7.95
	Applied only	6.29	6.18 a	6.15	6.26	6.28	6.40
	nutrients which				nS!		
	present below	CYA	TIT	VIV	En		
	optimum level						
	(Treatment 1 and 2)						
8	Adjustment	6.07	6.07 b	6.22	6.27	6.24	6.32
q	N:P ₂ O ₅ :K ₂ O ratio	JII	1 J H	U -IQ		000	III
C	of the soil (4:2:5)	b	/ Chi	ang	Mail	Inivo	rcity
	(Treatment 3 and 4)			ang			1 3 1 L Y
Α	T - test	ns		ns	e ns e	ns	ns
	% CV	4.52	4.35	9.14	4.64	4.58	6.92

Table 9.9 Fruit size of tangerine cv. Sainampueng between fertilizer application treatments.

 $T \leq 0.05$

-			Loam soil			Clay soil					
	Treatment	Hot dry season	Cool dry season	Wet season	Hot dry season	Cool dry season	Wet season				
_	Fertilizer	1.32	1.26	2.54	1.40	1.39	2.36				
	application by soil analysis (Treatment					3					
	1, 2, 3 and 4)		ىرىسىيىس								
	Fertilizer application by	1.23	1.24	2.40	1.38	1.43	2.40				
	farmer's practice		Rev.								
_	(Treatment 5 and 6)) //		A					
	T - test	ns	ns	ns	ns	ns	ns				
_	% CV	27.58	24.74	27.83	19.01	12.57	24.81				
	Applied only	1.34	1.27	2.53	1.40	1.41	2.40				
	nutrients which	M			RSY						
	present below optimum level			NIV	Elte						
	(Treatment 1 and 2)						-				
a	Adjustment N:P ₂ O ₅ :K ₂ O ratio	1.30	1.25	2.54	1.39	1.36	2.32				
C	of the soil (4:2:5) (Treatment 3 and 4)	by	y Chi	ang	Mai L	Jnive	rsity				
A	T - test	ns	ns S	ns	e ns e	ns	ns (
	% CV	26.15	22.71	26.21	18.88	20.06	23.14				

Table 9.10 Peel thickness of tangerine cv. Sainampueng between fertilizer application treatments.

 $T \leq 0.05$

			Loam soil			Clay soil	
	Treatment	Hot dry season	Cool dry season	Wet season	Hot dry season	Cool dry season	Wet season
	Fertilizer	118.9	116.2	132.0 a	120.6	121.1	126.7
	analysis (Treatment					-	
	1, 2, 3 and 4)		يسيبين				
	Fertilizer application by farmer's practice	118.0	115.8	124.0 b	120.6	119.8	119.1
	(Treatment 5 and 6)						
	T - test	ns	ns	*	ns	ns	ns
	% CV	14.42	13.82	21.71	10.38	12.51	20.03
	Applied only	125.1	119.0	133.1	119.2	121.8	134.3
	nutrients which	M			RSY		
	present below optimum level			NIV	EI		
	(Treatment 1 and 2)						
a	Adjustment N:P ₂ O ₅ :K ₂ O ratio	112.6	113.4	130.9	122.0	120.3	119.1
С	of the soil (4:2:5) (Treatment 3 and 4)	by	y Chi	ang	Mai L	Jnive	rsity
A	T - test	ns	ns S	ns	e ns e	ns	ns
	% CV	13.88	11.97	19.25	9.94	20.05	20.18

Table 9.11 Fruit weight of tangerine cv. Sainampueng between fertilizer application treatments.

 $T \leq 0.05$

			Loam soil		Clay soil				
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet		
		season	season	season	season	season	season		
	Fertilizer	14.4	29.9	8.51	24.8	56.9	12.4		
	analysis (Treatment	/ <			$> $ \`	3			
	1, 2, 3 and 4)					65			
	Fertilizer	15.0	29.7	8.68	25.3	56.8	12.6		
	application by farmer's practice		a			505			
	(Treatment 5 and 6)		They are	S.	\mathcal{D}	200			
-	T - test	ns	ns	ns	ns	ns	ns		
	% CV	7.84	11.39	11.03	10.45	12.97	12.19		
	Applied only nutrients which	14.5	30.5	8.54	25.0	57.1	12.5		
	present below optimum level	MA		VIV	ERS1,				
	(Treatment 1 and 2)								
	Adjustment	14.3	29.2	8.47	24.3	56.6	12.3		
ິ	$N:P_2O_5:K_2O$ ratio of the soil (4:2:5)	่งหา	i Sn	ยาย	ลัยเชิ	GB	์ไหม		
C	(Treatment 3 and 4)	b	v Chi	ang	Mai I	Inive	rsitv		
	T - test	ns	ns	ns	ns	ns	ns		
Α	% CV	6.76	10.83	10.72	e 10.22 e	11.47	12.03		

Table 9.12 Yield of tangerine cv. Sainampueng between fertilizer application treatments.

* Means within the same column followed by different alphabets were significantly different at

 $T \leq 0.05$

				Clay soil			
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
		season	season	season	season	season	season
	Fertilizer	52.4	53.5 b	44.3	55.4	49.9	55.5
	application by soil					-	
	analysis (Treatment			5			
	1, 2, 3 and 4)		Junio				
	Fertilizer	53.5	55.9 a	44.7	56.4	44.1	54.5
	application by			(12)		50	2
	farmer's practice		Ty-	ST .		202	
	(Treatment 5 and 6))	4	
-	T - test	ns	*	ns	ns	ns	ns
	% CV	12.53	15.73	14.86	15.32	16.01	11.52
	Applied only	49.6 b	52.1 b	42.0	56.3	56.6 a	56.4
	nutrients which	1			- SY		
	present below	NA	/ TTT	VII	ER		
	optimum level						
	(Treatment 1 and 2)						
8	Adjustment	55.2 a	54.8 a	46.5	54.5	43.2 b	54.6
d	N:P ₂ O ₅ :K ₂ O ratio	JN'	IJП	8'16		ÛŬ	เทม
С	of the soil (4:2:5) (Treatment 3 and 4)	by	/ Chi	ang	Mai L	Inive	rsity
A	T - test	8	* S	ns	e ns e	*	ns
	% CV	11.98	14.57	13.45	14.74	15.26	10.78

 Table 9.13 Juice percentage of tangerine cv. Sainampueng fruit between fertilizer application treatments.

 $T \leq 0.05$

			Loam soil			Clay soil	
	Treatment	Hot dry season	Cool dry season	Wet season	Hot dry season	Cool dry season	Wet season
	Fertilizer application by soil	3.70	3.73	4.04	3.71	3.96	3.71
	analysis (Treatment						
	1, 2, 3 and 4)	1	, HILLING				
	Fertilizer application by farmer's practice	3.73	3.69	4.07	3.73	4.08	3.73
	(Treatment 5 and 6)					4	
-	T - test	ns	ns	ns	ns	ns	ns
	% CV	2.01	1.84	6.72	0.98	2.07	12.22
	Applied only	3.70	3.73	4.01	3.67 b	3.70 b	3.70
	nutrients which	M			RSY		
	present below			VIV	E		
	optimum level						
	(Treatment 1 and 2)						
a	Adjustment	3.70	3.72	4.06	3.76 a	4.21 a	3.72
С	of the soil (4:2:5) (Treatment 3 and 4)	by	Chi	ang	Mai L	Inive	rsity
A	T - test	ns	ns S	ns	e s e	*	ns (
	% CV	1.72	1.46	5.08	0.63	15.35	11.95

Table 9.14 The pH of tangerine cv. Sainampueng juice between fertilizer application treatments.

 $T \leq 0.05$

-			Loam soil			Clay soil	
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
		season	season	season	season	season	season
	Fertilizer	24.3	24.8	24.0	24.5	24.6	24.8
	application by soil analysis (Treatment					3	
	1, 2, 3 and 4)		ىسىيىل				
	Fertilizer	24.3	24.9	24.0	24.5	24.4	24.8
	application by			(12)		50	2
	farmer's practice		-ty	ST .		200	
	(Treatment 5 and 6)				X	A	
-	T - test	ns	ns	ns	ns	ns	ns
	% CV	1.47	2.08	1.21	1.41	2.28	7.83
-	Applied only	24.3	24.9	24.0	24.5	24.8	24.8
	nutrients which				nS'		
	present below	(MA	III	VIV	En		
	optimum level						
	(Treatment 1 and 2)						
ິລ	Adjustment	24.3	24.7	24.0	24.5	24.4	24.8
CI	N:P ₂ O ₅ :K ₂ O ratio	JII	JII				ιIIIJ
С	of the soil (4:2:5) (Treatment 3 and 4)	by	y Chi	ang	Mai L	Jnive	rsity
Α	T - test	ns	ns S	ns	e ns e	ns	ns C
	% CV	1.15	1.68	1.03	1.29	1.83	7.74

 Table 9.15
 Vitamin C of tangerine cv. Sainampueng fruit between fertilizer application treatments.

 $T \leq 0.05$

-			Loam soil			Clay soil				
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet			
		season	season	season	season	season	season			
	Fertilizer	11.0	11.0	9.36	11.3	10.8	11.1			
	application by soil					6				
	analysis (Treatment			5						
	1, 2, 3 and 4)		, 11 min							
	Fertilizer	11.0	11.1	9.04	11.6	11.6	11.7			
	application by					-5201	2			
	farmer's practice		They.			200				
	(Treatment 5 and 6)				<i>Y</i>)	A				
-	T - test	ns	ns	ns	ns	ns	ns			
	% CV	6.22	6.92	13.68	5.85	7.74	10.87			
-	Applied only	11.1	10.9	9.54	11.3	11.1	11.1			
	nutrients which				nS'					
	present below	<u> </u>	J TT	VII	En					
	optimum level									
	(Treatment 1 and 2)									
6	Adjustment	10.8	11.1	9.18	11.2	10.4	11.1			
C	N:P ₂ O ₅ :K ₂ O ratio	Jn	IJП			000	IUN			
С	of the soil (4:2:5)	b	v Chi	ang	Mai l	Jnive	rsitv			
	(Treatment 3 and 4)			0						
A	T - test	ns	ns S	ns	e ns e	ns	ns			
	% CV	5.84	6.32	11.64	5.64	7.17	10.44			

Table 9.16 Total soluble solids (TSS) of tangerine cv. Sainampueng fruit between fertilizer application treatments.

 $T \leq 0.05$

			Loam soil			Clay soil	
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
_		season	season	season	season	season	season
	Fertilizer application by soil	0.57	0.58	0.73	0.54	0.60 b	0.53
	analysis (Treatment 1, 2, 3 and 4)		, munin		\mathcal{O}	2	
	Fertilizer application by farmer's practice	0.63	0.63	0.66	0.54	0.70 a	0.50
	(Treatment 5 and 6)				<i>Y</i>	A	
	T - test	ns	ns	ns	ns	*	ns
	% CV	8.69	11.65	22.75	11.79	12.21	12.02
	Applied only	0.56	0.57	0.74	0.55	0.54 b	0.54
	nutrients which present below optimum level	MA	IU	NIV	ERSI		
	(Treatment 1 and 2)						
ິຄ	Adjustment N:P ₂ O ₅ :K ₂ O ratio	0.57	0.58	0.71	0.53	0.66 a	0.52
С	of the soil (4:2:5) (Treatment 3 and 4)	by	y Chi	ang	Mai U	Jnive	rsity
A	T - test	ns	ns S	ns	e ns e	*	ns (
	% CV	8.39	10.89	20.09	11.55	11.75	11.63

Table 9.17 Titratable acidity (TA) of tangerine cv. Sainampueng fruit between fertilizer application treatments.

 $T \leq 0.05$

			Loam soil			Clay soil	
	Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
_		season	season	season	season	season	season
	Fertilizer	19.6 a	19.1	12.9	20.9	18.3	20.9
	application by soil					6	
	analysis (Treatment		2	5	>		
	1, 2, 3 and 4)		, 11 min				
	Fertilizer	17.3 b	17.8	13.7	21.5	16.7	23.4
	application by			(n)		50	
	farmer's practice		- Cu			202	-
	(Treatment 5 and 6)				<i>)</i>	4	
-	T - test	*	ns	ns	ns	ns	ns
	% CV	8.62	12.79	13.04	10.11	11.63	11.39
	Applied only	20.1	19.1	12.9	20.6	20.7 a	20.6
	nutrients which	· Ar			nS! '		
	present below	Ľ ľ A	TIT	VTT	ERC		
	optimum level			NI V			
	(Treatment 1 and 2)						
2	Adjustment	19.0	19.1	12.9	21.1	15.9 b	21.2
9	N:P ₂ O ₅ :K ₂ O ratio	JN.	IJII	U .I	01010	UU	INJ
C	of the soil (4:2:5)	h	/ Chi	ano	Mail	Inive	rcitv
	(Treatment 3 and 4)			ang			isity
A	T - test	ns	ns S	ns	e ns e	*	ns
	% CV	8.12	12.14	11.25	9.84	10.88	9.96

Table 9.18 The TSS/TA ratio of tangerine cv. Sainampueng fruit between fertilizer application treatments.

 $T \leq 0.05$

Table 9.19 Fruit size and peel thickness of tangerine cv. Sainampueng between fertilizer application treatments in loam soil.

	90	3181	26			
	F I	ruit size (cm) ^{1/}		Pee	l thickness (mm) ^{1/}
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
S	season	season	season	season	season	season
1) 170 g N + 960 ppm Cu + 2,400 ppm B	6.34 a	6.25 a	6.63 a	1.22 b	1.15 b	2.67 ab
2) 170 g N + 1.92 g Cu + 11.04 g B	6.23 ab	6.12 ab	5.66 b	1.56 a	1.40 a	2.39 ab
3) 1,340 g N + 530 g P ₂ O ₅ + 960 ppm Cu	6.02 b	6.03 b	6.47 a	1.32 ab	1.30 ab	2.75 a
+ 2,400 ppm B			F J#	Y		-
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	6.12 ab	6.08 b	5.97 b	1.28 ab	1.21 b	2.34 ab
11.04 g B			11	3	A	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	6.34 a	6.22 ab	6.37 ab	1.31 ab	1.30 ab	2.70 a
2,400 ppm Ca + 2,400 ppm Mg + 2,400	YA.	I UI	VIV	En		
ppm Zn + 2,400 ppm B						
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	6.05 b	5.99 b	5.93 b	1.15 b	1.18 b	2.10 b
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +	12.1					
11.04 gB Opyright	by	Chi	ang	Mai	Univ	ersity
LSD _{0.05}	0.26	0.15	0.49	C 0.31 S	0.17	0.57 🗨 🔘
% CV	4.65	4.48	8.87	26.75	23.62	26.71

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

Table 9.20 Fruit weight and yield of tangerine cv. Sainampueng between fertilizer application treatments in loam soil.

Treatment 1) 170 g N + 960 ppm Cu + 2,400 ppm B 2) 170 g N + 1 92 g Cu + 11 04 g B	Hot dry season	Cool dry season	Wet	Hot dry	Cool dry	Wet
1) 170 g N + 960 ppm Cu + 2,400 ppm B 2) 170 g N + 1 92 g Cu + 11 04 g B	season	season				
1) 170 g N + 960 ppm Cu + 2,400 ppm B 2) 170 g N + 1 92 g Cu + 11 04 g B	1267.2		season	season	season	season
2) 170 g N + 1 92 g Cu + 11 04 g B	120.7 a	120.8 a	136.3 a	14.7	30.9 a	8.62
2) 170 g IV + 1.72 g Cu + 11.04 g D	123.5 ab	117.2 ab	129.8 b	14.3	30.1 ab	8.54
3) 1,340 g N + 530 g P ₂ O ₅ + 960 ppm Cu +	111.5 b	110.9 b	134.3 ab	14.5	28.6 b	8.47
2,400 ppm B		Z S	X V		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu + 11.04	113.7 b	115.8 ab	127.4 b	14.1	29.7 ab	8.47
g B				E	5	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O + 2,400	129.7 a	121.6 a	125.7 bc	15.1	31.1 a	8.71
ppm Ca + 2,400 ppm Mg + 2,400 ppm Zn +		000,00		S		
2,400 ppm B	AI	TIN	JIVE			
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O + 11.04 g	106.2 b	109.9 b	122.5 c	14.8	28.3 b	8.64
Ca + 11.04 g Mg + 11.04 g Zn + 11.04 g B						- 7-
LSD _{0.05}	11.93	7.97	4.62	ns	2.01	ns ns
Cop [%] CV ight [©]	11.21	12.28	19.35	6.31	10.78	10.67
⁷ Means within the same column followed by differer	nt alphabets wer	re significantly	different at $P \le 0$	0.05 by LSD	e r	

Table 9.21 Peel colour and juice colour of tangerine cv. Sainampueng fruit between fertilizer application treatments in loam soil.

		281	21940				
		Peel colour		2/3	Juice colour		
Treatment	Hot dry	Cool dry season	Wet	Hot dry	Cool dry	Wet	
	season		season	season	season	season	
1) 170 g N + 960 ppm Cu + 2,400	$9.4 \text{ GY}^1 - 6.3 \text{ Y}^2$	7.2 GY – 8.2 Y	9.7 GY – 8.0 Y	$7.1 - 9.2 \text{ YR}^3$	7.1 – 9.1YR	9.1 – 9.2 YR	
ppm B		Sum					
2) 170 g N + 1.92 g Cu + 11.04 g B	9.3 GY – 8.2 Y	8.0 GY – 8.2 Y	6.9 GY – 8.0 Y	7.1 – 9.2 YR	7.1 – 9.1YR	9.1 – 9.2 YR	
3) 1,340 g N + 530 g P ₂ O ₅ + 960	7.8 GY – 5.7 Y	7.2 GY – 8.2 Y	8.4 GY – 8.0 Y	7.1 – 9.2 YR	7.1 – 9.1YR	9.1 – 9.2 YR	
ppm Cu + 2,400 ppm B				<i>Y</i>		-	
4) 1,340 g N + 530 g P_2O_5 + 1.92 g	9.3 GY – 8.2 Y	7.2 GY – 8.0 Y	9.3 GY – 8.0 Y	7.1 – 9.2 YR	7.1 – 9.1YR	9.1 – 9.2 YR	
Cu + 11.04 g B							
5) 895 g N + 665 g P_2O_5 + 920 g	9.2 GY – 9.2 Y	7.2 GY – 8.0 Y	9.9 GY – 8.0 Y	7.1 – 9.2 YR	7.1 – 9.1YR	9.1 – 9.2 YR	
K ₂ O + 2,400 ppm Ca + 2,400 ppm				ERS			
Mg + 2,400 ppm Zn + 2,400 ppm B			JNIV				
6) 895 g N + 665 g P_2O_5 + 920 g	6.9 GY – 8.0 Y	7.2 GY – 8.2 Y	7.2 GY – 8.0 Y	7.1 – 9.2 YR	7.1 - 9.1 YR	9.1 – 9.2 YR	
$K_2O + 11.04 g Ca + 11.04 g Mg +$	ลิ์แห	1951	2812	ă	Rei	alk	
11.04 g Zn + 11.04 g B							
GY was ratio of yellow and green	ht [©]	by C	hiang	Mai	Univ	versit	
² Y was level of yellow	r i g	ht	s r	es	e r	ve	
³ YR was ratio of red and yellow	0					_	

Table 9.22 Juice percentage and pH of juice of tangerine cv. Sainampueng fruit between fertilizer application treatments in loam

soil.	978	1219	40	91-		
	Juice p	ercentage (%) ^{1/}	10	p	H of juice ¹	
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
a	season	season	season	season	season	season
1) 170 g N + 960 ppm Cu + 2,400 ppm B	50.4 b	53.4 c	38.4 c	3.72 a	3.72 a	4.25 a
2) 170 g N + 1.92 g Cu + 11.04 g B	48.6 b	50.6 d	44.9 b	3.68 b	3.73 a	3.77 c
3) 1,340 g N + 530 g P_2O_5 + 960 ppm Cu +	54.5 a	54.8 b	45.2 b	3.66 c	3.73 a	4.11 a
2,400 ppm B						t //
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	55.9 a	54.9 b	46.3 b	3.74 a	3.71 ab	4.01 b
11.04 g B					4	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O + 2,400	53.2 a	55.8 a	37.8 c	3.73 a	3.69 b	4.18 ab
ppm Ca + 2,400 ppm Mg + 2,400 ppm Zn +	YAI	TIN	ITVE			
2,400 ppm B						
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O + 11.04	53.7 a	55.8 a	51.0 a	3.73 a	3.69 b	3.96 bc
g Ca + 11.04 g Mg + 11.04 g Zn + 11.04 g B	K M M	SUDE	งกา	SIG	580) I K I
	2.77	0.72	1.49	0.03	0.02	e ^{0.20} sitv
% CV	11.75	14.83	12.95	1.37	1.66	5.42

 $^{1/}$ Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

Table 9.23 Vitamin C and total soluble solids (TSS) of tangerine cv. Sainampueng fruit between fertilizer application treatments in

loam soil.	9	1318	40	91		
	Vita	min C (mg/100 n	ml) ^{1/}		TSS ([°] Brix) ^{1/}	
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
a	season	season	season	season	season	season
1) 170 g N + 960 ppm Cu + 2,400 ppm B	24.3	24.9	24.0	11.0 ab	10.9 b	10.08 a
2) 170 g N + 1.92 g Cu + 11.04 g B	24.3	24.8	24.0	11.2 ab	10.9 b	9.00 b
3) 1,340 g N + 530 g P_2O_5 + 960 ppm Cu +	24.3	24.7	23.9	10.8 b	11.2 ab	9.40 ab
2,400 ppm B			At 1			5 /
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	24.3	24.7	24.0	10.8 b	11.0 ab	8.95 b
11.04 g B			336		A'	
5) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O + 2,400	24.2	24.8	24.0	11.3 a	11.3 a	9.62 ab
ppm Ca + 2,400 ppm Mg + 2,400 ppm Zn +	YA.	Ι	VIV	EIL		
2,400 ppm B						
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O + 11.04	24.3	24.9	24.0	10.7 b	10.9 b	8.45 b
g Ca + 11.04 g Mg + 11.04 g Zn + 11.04 g B	n -1	JII	9.12			JINI
CopLSD _{0.05} ight	ns	ns	ansg	0.40	0.36	e1.015it
% CV	e ^{1.28} h	1.43 S	1.10	e ^{5.16}	e ^{5.81}	12.15

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

Table 9.24 Titratable acidity (TA) and TSS/TA ratio of tangerine cv. Sainampueng fruit between fertilizer application treatments in

loam soil.	91	1316	40	91			
		TA (%) ^{1/}	00	T	SS/TA ratio ^{1/}		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	
a	season	season	season	season	season	season	
1) 170 g N + 960 ppm Cu + 2,400 ppm B	0.50 d	0.53 c	0.66 b	22.0 a	20.6 a	15.3 a	
2) 170 g N + 1.92 g Cu + 11.04 g B	0.62 ab	0.61 ab	0.81 a	18.1 bc	17.9 b 🛒	12.3 bc	
3) 1,340 g N + 530 g P ₂ O ₅ + 960 ppm Cu +	0.58 bc	0.57 b	0.73 ab	18.6 bc	19.7 a	12.9 b	
2,400 ppm B) the second sec	X		t //	
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	0.56 c	0.59 b	0.69 a	19.3 b	18.9 ab	13.0 b	
11.04 g B			20 00		A'		
5) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O + 2,400	0.66 a	0.63 a	0.59 b	17.1 c	17.9 b	16.3 a	
ppm Ca + 2,400 ppm Mg + 2,400 ppm Zn +	YA1	TIT	JIVY				
2,400 ppm B							
6) 895 g N + 665 g P_2O_5 + 920 g K_2O + 11.04	0.61 b	0.63 a	0.73 ab	17.5 c	17.3 b	11.6 c	
g Ca + 11.04 g Mg + 11.04 g Zn + 11.04 g B	h	9 na	9.19	U	580	JINU	
	0.04	0.03	a 0.13 g	1.52	2.21	elisity	
% CV	8.17	10.50	20.75	7.47	11.72	11.32	

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

		3180	196	5			
		Fruit size (cm) ^{1/}	•	Peel t	Peel thickness (mm) ^{1/}		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	
5.	season	season	season	season	season	season	
1) 170 g N + 2,400 ppm B	6.22	6.21 ab	6.49 a	1.36	1.36	2.36 b	
2) 170 g N + 11.04 g B	6.31	6.35 a	6.31 ab	1.44	1.45	2.44 ab	
3) 1,410 g N + 770 g P ₂ O ₅ + 2,400	6.31	6.28 ab	6.49 a	1.35	1.32	2.08 c	
ppm B							
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	6.23	6.20 ab	6.15 b	1.42	1.39	2.56 a	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O	6.25	6.27 ab	6.35 a	1.39	1.44	2.30 b	
+ 2,400 ppm Ca + 2,400 ppm Mg +		600	6000	6			
2,400 ppm Zn + 2,400 ppm B		AIII	NIT	VERS			
6) 895 g N + 665 g P_2O_5 + 920 g K_2O	6.31	6.18 b	5.85 c	1.37	1.41	2.50 ab	
+ 11.04 g Ca + 11.04 g Mg + 11.04 g		080	CIO	501	50	2.2	
Zn + 11.04 g B				ICI DI	00	oing	
COLSD _{0.05} night	ns	0.16 h	0.23	g M _{ns} ai	L _{ns} n	iv 0.17 Sity	
% CV	4.52	4.42	7.54	18.76	19.94	23.56	

Table 9.25 Fruit size and peel thickness of tangerine cv. Sainampueng between fertilizer application treatments in clay soil.

^{1/} Means within the same column followed by different alphabets were significantly different at $P \le 0.05$ by LSD

Table 9.26 Fruit weight and yield of tangerine cv. Sainampueng between fertilizer application treatments in clay soil.

		912	126				
	Fru	it weight (g) ^{1/}		Yield (kg/tree) ^{1/}			
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	
5.	season	season	season	season	season	season	
1) 170 g N + 2,400 ppm B	111.6 b	118.4 ab	132.3 a	25.2	56.4 b	12.7	
2) 170 g N + 11.04 g B	126.8 a	125.2 a	136.2 a	24.8	57.8 a	12.3	
3) 1,410 g N + 770 g P ₂ O ₅ + 2,400	128.9 a 🥌	123.1 ab	128.8 ab	24.7	57.3 ab 🍡	12.3	
ppm B			5 ×)			- //	
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	115.1 b	117.5 ab	109.3 bc	24.2	55.8 b	12.2	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O	125.4 ab	124.0 a	120.5 ab	25.3	57.9 a	12.6	
+ 2,400 ppm Ca + 2,400 ppm Mg +		6			S *//		
2,400 ppm Zn + 2,400 ppm B	1A	T TT	NIV	ERS			
6) 895 g N + 665 g P_2O_5 + 920 g K_2O	115.9 b	115.6 b	117.6 b	25.2	55.6 b	12.6	
+ 11.04 g Ca + 11.04 g Mg + 11.04 g	1120	80	000			2.2.	
Zn + 11.04 g B	Jn-I	Г Э П	9.1C			JINI	
COLSD _{0.05}	10.59	7.96	11.53	ns	1.32	ensity	
% CV	9.78	11.77 S	17.92	10.15	11.48	11.73	

^{1/} Means within the same column followed by different alphabets were significantly different at $P \le 0.05$ by LSD

		800	12126	0		
	at	Peel colour	•		Juice colour	
Treatment	Hot dry	Cool dry	Wet	Hot dry season	Cool dry	Wet
2	season	season	season		season	season
1) 170 g N + 2,400 ppm B	$8.2 - 1.5 \text{ GY}^{1/}$	7.4 GY – 4.3 Y	7.2 GY – 5.7 Y	$7.1 - 9.2 \text{ YR}^{3/2}$	6.4 – 7.1YR	9.1 – 9.2 YR
2) 170 g N + 11.04 g B	$5.4 \text{ GY} - 4.3 \text{ Y}^{2/}$	7.4 GY – 5.6 Y	7.4 – 1.7 GY	7.1 – 9.2 YR	6.4 – 7.1YR	9.1 – 9.2 YR
3) 1,410 g N + 770 g P ₂ O ₅ +	8.3 – 5.4 GY	6.9 GY – 1.6 Y	8.7 – 1.8 GY	7.1 – 9.2 YR	6.4 – 7.1YR	9.1 – 9.2 YR
2,400 ppm B		1	The second second			2.5
4) 1,410 g N + 770 g P ₂ O ₅ +	8.7 GY – 8.0 Y	6.9 GY – 1.4 Y	8.7 – 5.4 GY	7.1 – 9.2 YR	6.4 – 7.1YR	9.1 – 9.2 YR
11.04 g B	5					\sim
5) 895 g N + 665 g P ₂ O ₅ +	8.3 – 1.8 GY	6.9 GY – 1.4 Y	8.7 GY – 5.7 Y	7.1 – 9.2 YR	6.4 – 7.1YR	9.1 – 9.2 YR
920 g K ₂ O + 2,400 ppm Ca +	G		00060	S		
2,400 ppm Mg + 2,400 ppm		AI	TINI	JEK		
Zn + 2,400 ppm B						
6) 895 g N + 665 g P ₂ O ₅ +	8.7 GY – 5.7 Y	6.9 GY – 1.4 Y	8.7 GY – 6.3 Y	7.1 – 9.2 YR	6.4 – 7.1YR	9.1 – 9.2 YR
920 g K ₂ O + 11.04 g Ca +	15 U	K79	ทยา		BB	OIK
11.04 g Mg + 11.04 g Zn +	ght [©]	by C	Chians	g Mai	Uni	versit
11.04 g B	ri	ph t		res	er	VP
^{1/} GY was ratio of yellow and g	reen					

Table 9.27 Peel colour and juice colour of tangerine cv. Sainampueng fruit between fertilizer application treatments in clay soil.

^{2/} Y was level of yellow

^{3/} YR was ratio of red and yellow

Table 9.28 Juice percentage and pH of juice of tangerine cv. Sainampueng fruit between fertilizer application treatments in clay soil.

	9	180	1960	3					
	Ji	uice percentage (%	ó) ^{1/}	_ 2/2	pH of juice ¹				
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet			
5.	season	season	season	season	season	season			
1) 170 g N + 2,400 ppm B	56.0 ab	55.6 a	55.6 ab	3.67 c	3.72 d	3.72			
2) 170 g N + 11.04 g B	55.8 ab	57.3 a	57.3 a	3.66 c	3.67 e	3.67			
3) 1,410 g N + 770 g P ₂ O ₅ + 2,400	52.0 c	43.2 c	55.3 ab	3.80 a	4.18 b	3.71			
ppm B)))		\prec			
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	56.7 ab	43.2 c	54.0 b	3.72 b	4.23 a	3.72			
5) 895 g N + 665 g P_2O_5 + 920 g K_2O	55.1 b	49.9 b	54.8 ab	3.72 b	4.16 b	3.73			
+ 2,400 ppm Ca + 2,400 ppm Mg +		6	5000 0						
2,400 ppm Zn + 2,400 ppm B		47 1	TTA	IERS					
6) 895 g N + 665 g P_2O_5 + 920 g K_2O	57.3 a	38.3 d	54.4 b	3.74 b	3.99 c	3.73			
+ 11.04 g Ca + 11.04 g Mg + 11.04 g		08.		~~~	5	2.2			
Zn + 11.04 g B	Jn				0 2	oint			
COLSD _{0.05}	1.82	1.75	112.24	0.02	0.03	Venssity			
% CV	14.21	14.78	10.54	e ^{0.60} s	e ^{1.54}	11.74 C			

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

Table 9.29 Vitamin C and total soluble solids (TSS) of tangerine cv. Sainampueng fruit between fertilizer application treatments in

clay soil.	9	13181	94 <i>6</i>	7 91		
	Vit	amin C (mg/100 m	l) ^{1/}		ΓSS ([°] Brix) ^{1/}	
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
	season	season	season	season	season	season
1) 170 g N + 2,400 ppm B	24.5	25.0 a	25.0	11.4 ab	10.9 c	10.9
2) 170 g N + 11.04 g B	24.5	24.5 b	24.5	11.3 ab	11.2 b 🚬	11.2
3) 1,410 g N + 770 g P ₂ O ₅ + 2,400 ppm B	24.5	24.4 b	24.8	11.4 ab	10.5 c	11.1
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	24.4	24.4 b	24.7	11.0 b	10.2 c	11.0
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	24.5	24.4 b	24.8	11.4 ab	11.1 b	11.7
2,400 ppm Ca + 2,400 ppm Mg + 2,400			39 6		\leftarrow	
ppm Zn + 2,400 ppm B	M	1 7		ERSI		
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	24.5	24.4 b	24.8	11.8 a	12.0 a	11.8
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +					_	
11.04 g B J Ans J	111	าวิท	ยาส	ลัยเล	BU	0[11]
LSD _{0.05}	ns	0.18	ns	0.63	0.40	ns
% CV	1.26	1.62	7.52	5.60	6.93	10.23
	2		1 11/00	D 10051 LOD	e r	$\mathbf{v} \in 0$

['] Means within the same column followed by different alphabets were significantly different at $P \le 0.05$ by LSD

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Table 9.30 Titratable acidity (TA) and TSS/TA ratio of tangerine cv. Sainampueng fruit between fertilizer application treatments in

9	1818	1940	9 91		
6	TA (%) ^{1/}	10		TSS/TA ratio ^{1/}	
Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
season	season	season	season	season	season
0.51b	0.52 d	0.52	22.4 b	21.0 a	21.0 c
0.59 a	0.55 d	0.55	19.2 c	20.4 a 💙	20.4 c
0.57 a	0.63 c	0.55	20.0 c	16.7 c	20.2 c
0.48 b	0.68 b	0.49	22.9 ab	15.1 d	22.5 b
0.50 b	0.72 a	0.49	22.8 ab	15.4 d	23.9 a
		336			
M			FRS		
0.50 b	0.67 b	0.50-	23.6 a	17.9 b	23.6 a
าหา	าวิท	PB	ລັຍເ	BU	อไหเ
0.05	0.03	ns	1.07	0.82	1.01
11.43	11.48	11.55	9.65	10.51	9.75
	Hot dry season 0.51b 0.59 a 0.57 a 0.48 b 0.50 b 0.50 b 0.50 b	TA (%) ^{1/} Hot dry Cool dry season season 0.51b 0.52 d 0.59 a 0.55 d 0.57 a 0.63 c 0.48 b 0.68 b 0.50 b 0.72 a 0.50 b 0.67 b 0.05 0.03 11.43 11.48	TA (%)1/Hot dryCool dryWetseasonseasonseason0.51b0.52 d0.520.59 a0.55 d0.550.57 a0.63 c0.550.48 b0.68 b0.490.50 b0.72 a0.490.50 b0.67 b0.500.050.03ns11.4311.4811.55	TA (%) ^{1/} TA (%) ^{1/} Hot dry Cool dry Wet Hot dry season season season season 0.51b 0.52 d 0.52 22.4 b 0.59 a 0.55 d 0.55 19.2 c 0.57 a 0.63 c 0.55 20.0 c 0.48 b 0.68 b 0.49 22.9 ab 0.50 b 0.72 a 0.49 22.8 ab 0.50 b 0.67 b 0.50 23.6 a 0.05 0.03 ns 1.07 11.43 11.48 11.55 9.65	TA $(\%)^{1/}$ TSS/TA ratioHot dryCool dryWetHot dryCool dryseasonseasonseasonseasonseason0.51b0.52 d0.5222.4 b21.0 a0.59 a0.55 d0.5519.2 c20.4 a0.57 a0.63 c0.5520.0 c16.7 c0.48 b0.68 b0.4922.9 ab15.1 d0.50 b0.72 a0.4922.8 ab15.4 d0.50 b0.67 b0.5023.6 a17.9 b0.050.03ns1.070.8211.4311.4811.559.6510.51

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

5. Nutrient content in tangerine fruit

ATC MAI

The nutrient in fruits of tangerine trees growing on loam and clay soil showed in Table 9.31 – 9.38. The concentration of N, P, Ca, Mg, Fe, Mn, Cu, Zn and B were not significantly different among six fertilizer treatments except K. The tangerine trees did not respond to the quantity fertilization because of the heavy consumption of nutrients during growth and development of tangerine (Table 9.1, 9.2, 9.5 and 9.6). The K concentration in fruit was high among six fertilizer treatments because of the luxury consumption from high K concentration in both loam and clay soil (Table 9.5 and 9.6) (Osotsapar, 2000).

It was indicated that the application of fertilizer suggested by soil analysis and application fertilizer in accordance with the grower were not different in nutrient concentrations in fruits at all harvesting seasons. Because the nutrients in soil were available in high concentration (Table 9.1 and 9.2) for plant growth and developed fruit for best quality and yield. However, the concentration of input cost between the two approaches will be discussed in the next.

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 Table 9.31 Concentrations of nitrogen (N), phosphorus (P) and potassium (K) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in loam soil.

	Concent	ration of N ((g/kg) ^{1/}	Concentration of P (g/kg)			Concentration of K (g/kg) ^{1/}		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
G /	season	season	season	season	season	season	season	season	season
1) 170 g N + 960 ppm Cu + 2,400 ppm B	1.66 b	1.68	1.34	0.18	0.19	0.15	1.70 b	1.71 b	1.37
2) 170 g N + 1.92 g Cu + 11.04 g B	1.70 ab	1.66	1.37	0.17	0.19	0.15	1.73 ab	1.73 ab	1.38
3) 1,340 g N + 530 g P_2O_5 + 960 ppm Cu +	1.78 a	1.69	1.36	0.19	0.21	0.14	1.78 a	1.78 a	1.35
2,400 ppm B				X				\leq	
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	1.74 ab	1.66	1.36	0.18	0.19	0.15	1.78 a	1.67 b	1.39
11.04 g B				30			4		
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	1.66 b	1.65	1.35	0.18	0.18	0.16	1.73 ab	1.70 b	1.37
2,400 ppm Ca + 2,400 ppm Mg + 2,400		AI	TT	NT	JE				
ppm Zn + 2,400 ppm B									
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O +	1.76 a	1.69	1.35	0.18	0.19	0.15	1.75 ab	1.71 b	1.37
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +	Uľ		JN	PB		JIC	S EJ	ΟLI	hIJ
11.04 g Bopyright	C	by	Chi	ianş	3 M	ai I	Uni	vers	sity
LSD _{0.05}	0.09	ns	ns s	ns	ns	ns	0.07	0.06	ns
% CV	12.76	9.53	7.67	11.84	16.71	13.22	8.05	11.86	8.73

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

 Table 9.32
 Concentrations of calcium (Ca) and magnesium (Mg) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in loam soil.

	C	Concentration of Ca (g	g/kg)	Concer	Concentration of Mg (g/kg)			
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet		
	season	season	season	season	season	season		
1) 170 g N + 960 ppm Cu + 2,400 ppm B	0.22	0.23	0.27	0.08	0.08	0.05		
2) 170 g N + 1.92 g Cu + 11.04 g B	0.22	0.23	0.28	0.08	0.08	- 0.05		
3) 1,340 g N + 530 g P_2O_5 + 960 ppm Cu	0.23	0.21	0.29	0.08	0.09	0.05		
+ 2,400 ppm B			1 Att		2			
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	0.23	0.23	0.26	0.08	0.08	0.06		
11.04 g B			200		4'/			
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	0.22	0.24	0.28	0.08	0.07	0.06		
2,400 ppm Ca + 2,400 ppm Mg + 2,400		AIU	NIV	En				
ppm Zn + 2,400 ppm B			X X Z					
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	0.23	0.23	0.27	0.09	0.08	0.05		
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +	Jh	-1-211			000	INU		
11.04 gBopyright	\bigcirc	by Ch	iang	Mai L	Jnive	ersity		
F-test	ns	ns s	ns	e ^{ns}	ns	ns		
% CV	9.18	8.83	8.52	11.76	9.56	7.92		

 Table 9.33 Concentrations of iron (Fe), manganese (Mn) and copper (Cu) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in loam soil.

Concentration of Fe (g/kg)				Concentra	ation of Mn	(g/kg) ^{1/}	Concentr	Concentration of Cu (g/kg)		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	
	season	season	season	season	season	season	season	season	season	
1) 170 g N + 960 ppm Cu + 2,400 ppm B	2.49	2.48	1.78	1.03	1.24	0.87 c	1.18	1.24	1.39	
2) 170 g N + 1.92 g Cu + 11.04 g B	2.51	2.48	1.77	1.03	1.21	0.92 b	1.16 - 2	1.23	1.39	
3) 1,340 g N + 530 g P_2O_5 + 960 ppm Cu +	2.51	2.49	1.78	0.99	1.23	0.89 c	1.17	1.25	1.39	
2,400 ppm B								3 /		
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	2.52	2.48	1.80	1.04	1,22	0.94 ab	1.16	1.24	1.41	
11.04 g B			2	20	End)		A			
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	2.49	2.49	1.79	1.02	1.23	0.95 a	1.16	1.23	1.41	
2,400 ppm Ca + 2,400 ppm Mg + 2,400		(A)	U	NI	JE					
ppm Zn + 2,400 ppm B										
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	2.50	2.48	1.78	1.04	1.24	0.90 bc	1.15	1.23	1.40	
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +								Οι	nIJ	
11.04 g Bopyright	\bigcirc	by	Ch	iang	B M	lai	Univ	ver	sity	
LSD _{0.05}	ns	ns	t ^{ns} s	ns	r ^{ns} e	0.02	e ^{ns} r	ns	e ^{ns} d	
% CV	12.43	9.27	9.25	9.96	10.54	9.81	13.35	12.03	9.76	

^{1/} Means within the same column followed by different alphabets were significantly different at P \leq 0.05 by LSD

 Table 9.34
 Concentrations of zinc (Zn) and boron (B) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in loam soil.

	C	Concentration of Zn (g/	/kg)	Conce	Concentration of B (g/kg)			
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet		
a l	season	season	season	season	season	season		
1) 170 g N + 960 ppm Cu + 2,400 ppm B	2.05	2.32	1.61	1.28	1.40	1.17		
2) 170 g N + 1.92 g Cu + 11.04 g B	2.03	2.31	1.62	1.30	1.38	3- 1.16		
3) 1,340 g N + 530 g P ₂ O ₅ + 960 ppm Cu	2.04	2.33	1.60	1.29	1.39	1.16		
+ 2,400 ppm B) Att		2			
4) 1,340 g N + 530 g P_2O_5 + 1.92 g Cu +	2.04	2.32	1.62	1.29	1.38	1.17		
11.04 g B			336		4			
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	2.04	2.35	1.65	1.31	1.38	1.18		
2,400 ppm Ca + 2,400 ppm Mg + 2,400		AIT	NIV	ER				
ppm Zn + 2,400 ppm B								
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	2.05	2.34	1.64	1.29	1.38	1.19		
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +	Jh				060	INU		
11.04 gBopyright	\bigcirc	by Chi	iang	Mai L	Jnive	ersity		
F-test	ns	ns s	ns	e ^{ns} e	ns	ns		
% CV	12.08	9.31	11.95	12.56	8.87	7.92		

 Table 9.35 Concentrations of nitrogen (N), phosphorus (P) and potassium (K) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in clay soil.

	Concentration of N (g/kg) ^{1/}			Concentration of P (g/kg)			Concentration of K (g/kg) ^{1/}		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
6	season	season	season	season	season	season	season	season	season
1) 170 g N + 2,400 ppm B	1.59	1.65	1.31 c	0.18	0.19	0.17	1.64 a	1.73 ab	1.50
2) 170 g N + 11.04 g B	1.56	1.64	1.32 c	0.17	0.19	0.16	1.60 b 🕇	1.68 b	1.47
3) 1,410 g N + 770 g P_2O_5 + 2,400	1.56	1.63	1.34 b	0.17	0.19	0.17	1.58 b	1.70 ab	1.49
ppm B								5 /	
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	1.59	1.64	1.35 bc	0.17	0.20	0.18	1.64 ab	1.72 ab	1.51
5) 895 g N + 665 g P_2O_5 + 920 g K_2O	1.58	1.63	1.40 a	0.17	0.19	0.17	1.61 b	1.69 ab	1.47
+ 2,400 ppm Ca + 2,400 ppm Mg +	S'A	1				25			
2,400 ppm Zn + 2,400 ppm B			U	NI	VE				
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O	1.60	1.64	1.41 a	0.18	0.20	0.18	1.65 a	1.74 a	1.48
+ 11.04 g Ca + 11.04 g Mg + 11.04 g	111	50	S n	erc	Š		Rei	27	1-51
Zn + 11.04 g B									
COLSD _{0.05}	ns	ns	0.02	E ans	B ns	ns	0.03	0.05	Snsty
% CV	14.43	9.85	6.84	13.21	11.59	12.76	e ^{7.89}	9.66	9.04

^{1/} Means within the same column followed by different alphabets were significantly different at $P \le 0.05$ by LSD

Table 9.36 Concentrations of calcium (Ca) and magnesium (Mg) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in clay soil.

	C	Concentration of Ca (g/l	kg)	Cone	Concentration of Mg (g/kg)			
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet		
3576	season	season	season	season	season	season		
1) 170 g N + 2,400 ppm B	0.22	0.26	0.26	0.09	0.08	0.07		
2) 170 g N + 11.04 g B	0.21	0.25	0.25	0.08	0.08	0.07		
3) 1,410 g N + 770 g P_2O_5 + 2,400 ppm B	0.21	0.26	0.26	0.08	0.08	0.06		
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	0.22	0.26	0.26	0.08	0.08	0.06		
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	0.23	0.26	0.27	0.09	0.09	0.07		
2,400 ppm Ca + 2,400 ppm Mg + 2,400	'A			PSI				
ppm Zn + 2,400 ppm B		AIUI	NIV	Ere				
6) 895 g N + 665 g P_2O_5 + 920 g K_2O +	0.22	0.26	0.27	0.08	0.08	0.06		
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +	11-5	050	cio	Sell	Reis	7		
11.04 g B				ασι				
CoF-test right	ns	oy ns hi		ns		ensity		
% CV	11.54	9.35	8.26	10.37	e ^{8.14}	8.65		

 Table 9.37 Concentrations of Iron (Fe), manganese (Mn) and copper (Cu) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in clay soil.

	Concentration of Fe (g/kg)			Concentration of Mn (g/kg)			Concentration of Cu (g/kg)		
Treatment	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet	Hot dry	Cool dry	Wet
6	season	season	season	season	season	season	season	season	season
1) 170 g N + 2,400 ppm B	2.03	2.01	1.97	1.05	1.06	1.03	1.24	1.18	1.13
2) 170 g N + 11.04 g B	2.01	2.00	1.98	1.04	1.04	1.03	1.26	1.18	1.11
3) 1,410 g N + 770 g P ₂ O ₅ + 2,400	1.99	2.03	2.01	1.01	1.05	1.01	1.24	1.17	1.10
ppm B					*			3	
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	1.98	2.01	1.98	1.03	1.03	1.00	1.25	1.16	1.12
5) 895 g N + 665 g P_2O_5 + 920 g K_2O	2.03	2.03	2.01	1.04	1.05	1.01	1.25	1.15	1.14
+ 2,400 ppm Ca + 2,400 ppm Mg +	G'A	1				25			
2,400 ppm Zn + 2,400 ppm B		(A)	U	NI	VE				
6) 895 g N + 665 g P_2O_5 + 920 g K_2O	2.02	2.02	2.00	1.04	1.04	1.02	1.26	1.16	1.12
+ 11.04 g Ca + 11.04 g Mg + 11.04 g		-	5 00	CIC	5			-7	
Zn + 11.04 g B				0			\mathbf{D}	OL	ΓłIJ
CoF-test/right	ns	ns	ns	I ans I	ns	ns	Inst	ns	S ns
% CV	10.83	9.68	^{11.04} S	8.75	11.43	10.81	e ^{8.47}	9.85	e ^{9.79}

 Table 9.38
 Concentrations of zinc (Zn) and boron (B) in tangerine cv. Sainampueng fruit as affected by various fertilizer application treatments in clay soil.

		Concentration of Zn	(g/kg)	Concentration of B (g/kg)			
Treatment	Hot dry	Cool dry	Wet	Hot dry season	Cool dry	Wet	
G	season	season	season		season	season	
1) 170 g N + 2,400 ppm B	2.23	1.97	2.04	1.25	1.28	1.21	
2) 170 g N + 11.04 g B	2.21	1.98	2.05	1.24	1.27	3 1.19	
3) 1,410 g N + 770 g P_2O_5 + 2,400 ppm B	2.22	1.99	2.02	1.23	1.30	1.22	
4) 1,410 g N + 770 g P_2O_5 + 11.04 g B	2.20	1.97	2.03	1.21	1.28	1.20	
5) 895 g N + 665 g P_2O_5 + 920 g K_2O +	2.22	2.01	2.06	1.23	1.30	1.21	
2,400 ppm Ca + 2,400 ppm Mg + 2,400			E		$ \rightarrow / $		
ppm Zn + 2,400 ppm B	× A			RSI			
6) 895 g N + 665 g P ₂ O ₅ + 920 g K ₂ O +	2.23	2.00	2.05	1.20	1.29	1.21	
11.04 g Ca + 11.04 g Mg + 11.04 g Zn +							
11.04 g B				ăcui	2012	7	
F-test	ns	ns	ns	ns	ns	ns	
Coperight	9.07	9.53	i a10.05 g	9.89	10.64	9.27 ty	
All ri	g	hts	s r	eso	erv	e d	

Treatment 1 was considered as the most suitable method because the general fruit quality and yield were better than with other treatments. Besides, the amount of fertilizers used (Table 9.2 and 9.5) and its cost were much chcapter than other treatments (Table 9.39).

It is strongly suggested that nutrient management is important and considered as the basic practices for fruit tree production. The optimum concentration of nutrients encourages healthy growth, high yield and good quality of the products (Wangnai, 2002; Kumlung *et al.*, 2003). Excessive amount of fertilizer application decreases the quality of fruit (Mongi *et al.*, 2008). The farmer experiences alone were ineffective to manage the crop because there is a tendency to apply more fertilizer than needed. This over application caused more expenses (Poovarodom *et al.*, 1998). The yield and quality of fruit of treatment 1 was as high as the other treatments but required less amount nutrient.

Conclusions and Recommendations

The fertilizer management programme should be applied fertilizer the basis of soil nutrient analysis. The fertilizer was applied once a month only for nutrients which present below optimum level. Soil application was used for N, P and K, and foliar application for all other elements. It provided better results for farmer's practices with not only the high yield but also the quality of fruit, including fruit size (6.21-6.63 cm), fruit weight (111.6-136.3 g), juice percentage (50.4-56.0 %), vitamin C (24.0-25.0 mg/100 ml of juice), TSS (10.08-11.4 [°]Brix), TA (0.50-0.66 %) and TSS/TA ratio (15.3-22.4) as well as yields (30.9-56.4 kg/tree). It also reduced input cost (69.87-126.50 baht/1 kg of yield/year) in both loam and clay soil for every harvesting season.

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		1318	- 160		CI 1		
		Loam soil	•	Clay soil			
Treatment	Expense	Yield	Average	Expense	Yield	Average	
39	(baht/tree/year)	(kg/tree/year)	(baht/kg/year)	(baht/tree/year)	(kg/tree/year)	(baht/kg/year)	
1. Applied only nutrients which present	480	54.22	8.85	480	94.3	5.09	
below optimum level and foliar application		Jun					
of microelements		3				2	
2. Applied only nutrients which present	480	52.94	9.07	480	94.9	5.06	
below optimum level and soil application of))		. //	
microelements					Sé l		
3. Adjustment N:P ₂ O ₅ :K ₂ O ratio of the soil	3,463	51.57	67.15	4,710	94.3	49.95	
(4:2:5) and foliar application of		6	1.30 E	2	\rightarrow		
microelements	M			RSI			
4. Adjustment N:P ₂ O ₅ :K ₂ O ratio of the soil	3,463	52.27	66.25	4,710	92.2	51.08	
(4:2:5) and soil application of							
microelements				50115		7	
5. Application of fertilizers in accordance	7,003	54.91	127.54	7,003	95.8	73.10	
with farmer's practice	© b	y Ch	niang	Mai I	Unive	ersity	
6. Application of fertilizers in accordance	7,003	51.74	135.35	7,003	93.4	74.98	
with farmer's practice and soil application	5		3				
of microelements							

Table 9.39 The expense of fertilizer applied in the treatments of the tangerine cv. Sainampueng experimented in loam and clay soil.