Chapter 7

Relationship between Fertilizer Application and Leaf Nutrient Concentrations for Yield and Quality

Introduction

At present, the utilization of fertilizer is a key factor to increase tangerine productivity, raise economic return and reduce negative environmental impact. In practice, it depends on the growers' experience coming from knowledge in traditional agriculture (see the Results in Chapter 3). Consequently, the optimum fertilization for nutrient status in their orchard is probably unbalanced. This practice leads to inefficient and environmental unfriendly use of fertilizers. The excess of untaken nutrient can be accumulated in various parts of the plant and supply further to metabolism pathway for unhealthy growth (Kumlung *et al*., 2003). The reserved nutrients in leaves could behave as the sources for growing the plant even if the nutrients in soil were changed in the form. The leaves nutrients were exported into fruits for growth and development (see the Results in Chapter 5 and 7). The fruits are the sink of nutrients, meanwhile leaves are the source of nutrients (Menzel *et al*., 1988). This study aims to describe the relationship between fertilizer application (nitrogen, phosphorous and potassium) and leaf nutrient concentrations of tangerine.

Materials and Methods

Seven of eight sub-districts in Fang district, Chiang Mai province with five-year-old tangerine trees cv. Sainampueng growers were randomly selected for the study and the 30 selected orchards were chosen. In each orchard, the 5 trees were selected to find out soil sample (at 0-30 cm depth under tangerine canopy, collected at December 5, 2006), leaf sample (the 3rd leaf from shoot apex) and fruits quality.

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

The fruit qualities and nutrient concentration in fruit composition were determined (by the procedures) as previously described in Chapter 6.

The relationship between fertilizer application (N, P and K) and leaf nutrient concentrations was done by regression analysis. The survey and interview were conducted during December 2, 2006 –April 31, 2007.

Results and Discussion

In the present experiment there was a lower level of the coefficient of determination (R^2) with 0.0001-0.0663 (Figure 7.1-7.3). The relationship had not been found between the fertilizer application (Table 7.1) and fruit quality (Table 7.3) in experiment. The result showed that the difference of quantity in N, P and K had no impact on fruit size, fruit weight, juice percentage, TSS, TA and yield. Not only were the nutrient concentrations in soil over optimum (Table 7.2) but the foliar application of macronutrient and micronutrient was done by farmers. The results also indicated that fertilizer application (N, P and K) could not improve fruit size, fruit weight, juice percentage, TSS, TA and yield of tangerine.

There was a lower level of the coefficient of determination (R^2) with 0.00002-0.1954 (Figure 7.4-7.13). The relationship had not been found between the concentration of nutrient in leaves (Table 7.4) and fruit quality (Table 7.3) in experiment. The similar experiment by Supakamnerd *et al*. (2005) pointed that the nutrient concentrations in leaves did not relate to TSS and citric acid (CA) in juice. The result showed that fruit size, fruit weight, juice percentage, TSS, TA and yield of tangerine were not different if the nutrient concentrations in leaves were sufficient.

Conclusions and Recommendations

The relationship between the fertilizer application (N, P and K) and fruit quality as well as yield of tangerine did not detected in this study. These should be the effect of the over fertilized soil.

Table 7.1 The quantity of nitrogen, phosphorus and potassium fertilizer of tangerine cv. Sainampueng in the selected farmers' orchard.

Orchard	Nitrogen (g)	Phosphorus (g)	Potassium (g)
1	1,980	1,440	1,920
2	1,140	1,300	880
3	580	580	660
4	120	120	120
5	730	730	810
6	1,220	840	1,120
7	1,220	840	1,120
8	1,110	1,110	1,350
9	1,220	840	1,120
10	1,030	1,030	1,350
11	300	300	300
12	2,190	2,190	2,430
13	297	369	180
14	900	900	900
15	230	240	240
16	1,140	1,140	1,140
17	1,500	420	420
18	2,160	1,920	2,280
19	1,920	2,180	2,820
20	360	160	400
21	1,230	690	690
22	3,250	1,962	2,382
23	960	960	960
24	900	540	2,040
25	2,200	2,100	2,320
26	1,280	1,120	1,600
27	1,790	1,300	2,670

Table 7.1 (Cont.) The quantity of nitrogen, phosphorus and potassium fertilizer of tangerine cv. Sainampueng in the selected farmers' orchard.

Orchard	Nitrogen (g)	Phosphorus (g)	Potassium (g)
28	225	225	225
29	672	1152	864
30	1980	1440	1440

Table 7.2 The concentration of elements in soil of tangerine cv. Sainampueng in the selected farmers' orchard.

Orchard	OM (%)	Concentration of macronutrient element (mg/kg)				Concentration of micronutrient element (mg/kg)				
		P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
1	3.00	101.6	205	655	170	63	14	1.1	2.17	0.41
2	2.75	96.4	294	1440	165	23	31	1.2	1.83	0.41
3	2.55	84.1	199	1092	138	49	23	0.5	2.37	0.42
4	3.05	117.1	444	1447	144	43	19	0.9	1.36	0.62
5	2.90	62.3	374	1017	179	45	61	1.1	1.33	0.53
6	2.40	96.9	271	1654	172	29	62	1.2	1.06	0.42
7	2.75	53.8	223	1423	153	51	78	0.9	2.20	0.56
8	2.90	55.7	264	1153	164	80	85	1.2	1.39	0.46
9	3.30	96.0	440	1587	176	25	29	1.4	1.56	0.46
10	4.25	80.9	346	1684	174	20	91	1.2	1.93	0.77
11	4.50	106.5	582	1531	149	13	54	0.6	1.92	0.53
12	4.45	107.5	556	1510	174	76	81	1.5	1.50	0.53
13	4.00	128.1	331	1626	145	21	46	0.6	1.64	0.88
14	3.80	95.0	490	1139	157	48	41	0.9	1.57	0.51

Table 7.2 (Cont.) The concentration of elements in soil of tangerine cv. Sainampueng in the selected farmers' orchard.

Orchard	OM (%)	Concentration of macronutrient element (mg/kg)				Concentration of micronutrient element (mg/kg)				
		P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
15	4.45	160.9	682	1674	138	82	49	1.5	1.35	1.10
16	3.55	108.1	635	1910	169	52	54	0.9	1.98	0.56
17	3.00	104.6	319	1234	139	53	80	1.2	1.37	0.49
18	3.10	78.8	359	1457	167	16	56	1.1	1.65	0.86
19	3.00	63.3	409	1473	158	41	78	0.8	1.82	0.83
20	3.00	115.4	460	1307	165	44	69	1.3	1.96	0.38
21	3.20	50.7	324	1561	179	54	93	1.4	1.21	0.62
22	3.40	77.7	277	1396	165	37	50	1.2	1.68	0.72
23	3.25	81.3	539	1769	169	57	54	0.7	1.93	0.54
24	4.45	80.8	519	1180	149	57	63	1.6	1.13	0.54
25	3.50	89.8	321	1810	174	15	43	1.6	1.79	0.56
26	3.50	103.8	857	1017	193	34	51	1.5	1.40	0.65
27	2.95	59.5	381	1732	141	22	98	1.5	1.27	0.70
28	2.95	116.6	214	1293	149	25	65	1.4	2.52	0.45

Table 7.2 (Cont.) The concentration of elements in soil of tangerine cv. Sainampueng in the selected farmers' orchard.

Orchard	OM (%)	Concentration of macronutrient element (mg/kg)				Concentration of micronutrient element (mg/kg)				
		P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
27	2.95	59.5	381	1732	141	22	98	1.5	1.27	0.70
28	2.95	116.6	214	1293	149	25	65	1.4	2.52	0.45
29	2.70	87.8	389	1688	136	16	59	1.5	1.69	0.59
30	3.90	27.2	173	1067	152	16	59	1.2	1.72	0.51
Optimum concentration[1/]										
	2.5 -3	26 – 42	130	1040	130	11 -16	9 – 12	1.1 – 3	0.9 – 1.2	0.6 – 3

[1/] Supakumnerd, 2004

Table 7.3 The quality (fruit size, thickness of peel, fruit weight, juice percentage, pH of juice, total soluble solids (TSS), titratable acidity (TA), vitamin C, yield and taste) of tangerine cv. Sainampueng.

Orchard	Fruit size (cm)	Thickness of peel (mm)	Fruit weight (g)	Juice percentage (%)	pH of juice	TSS (°Brix)	TA (%)	Vitamin C (mg/ 100 ml)	Yield (kg/tree)	Taste[1/]
1	6.72	1.66	137.9	54.1	3.76	10.6	0.75	22.7	58.6	5
2	6.43	1.50	133.5	59.0	3.55	12.2	0.74	22.9	56.8	5
3	6.61	1.98	139.4	57.1	3.68	12.1	0.83	23.1	59.2	5
4	6.57	1.58	135.7	58.4	3.84	11.6	0.83	23.2	57.7	5
5	6.61	1.64	133.4	56.5	3.72	11.3	0.87	23.2	56.7	5
6	6.57	1.40	138.4	60.7	3.52	11.8	1.00	24.0	58.8	5
7	6.58	1.54	138.7	56.7	3.87	9.7	0.80	23.0	58.9	4
8	6.67	1.46	148.2	57.1	3.59	12.0	0.84	23.2	63.0	5
9	7.07	1.70	171.2	58.8	3.66	11.1	0.78	23.0	72.7	5
10	6.55	1.34	143.7	56.5	3.45	11.9	1.14	24.2	61.1	5
11	6.43	1.28	127.4	59.9	3.93	10.8	0.85	23.3	54.2	5
12	6.86	1.66	152.4	47.9	4.02	9.0	0.67	22.1	64.8	4
13	6.93	1.40	156.1	58.5	3.86	11.4	0.85	23.3	66.4	5

Table 7.3 (Cont.) The quality (fruit size, thickness of peel, fruit weight, juice percentage, pH of juice, total soluble solids (TSS), titratable acidity (TA), vitamin C, yield and taste) of tangerine cv. Sainampueng.

Orchard	Fruit size (cm)	Thickness of peel (mm)	Fruit weight (g)	Juice percentage (%)	pH of juice	TSS (°Brix)	TA (%)	Vitamin C (mg/ 100 ml)	Yield (kg/tree)	Taste[1/]
14	6.5	1.54	134.1	57.6	3.85	10.6	0.57	22.1	57.0	4
15	6.53	1.66	141.8	55.7	3.81	9.6	0.78	22.9	60.2	4
16	6.43	1.40	133.0	60.2	3.84	10.4	0.99	23.9	56.5	4
17	5.95	1.34	107.8	58.8	3.80	11.7	0.73	22.8	45.8	5
18	6.59	1.52	137.8	55.1	4.10	11.2	0.67	22.4	58.6	5
19	6.62	1.52	138.3	55.1	3.93	11.5	0.80	22.9	58.8	5
20	6.45	1.80	133.0	49.0	4.12	9.3	0.63	22.1	56.5	4
21	6.44	1.22	132.4	55.1	3.82	12.4	0.63	22.3	56.3	5
22	6.5	1.76	133.5	58.7	3.86	11.9	0.82	23.1	56.7	5
23	6.12	1.22	113.0	58.1	3.87	11.7	0.87	23.3	48.0	5
24	6.66	1.66	141.9	53.7	3.91	10.5	1.28	22.7	60.3	4
25	6.32	1.52	123.9	55.5	3.83	11.9	0.86	23.1	52.7	5
26	6.5	1.32	133.3	58.1	3.77	11.5	0.77	22.9	56.7	5

Table 7.3 (Cont.) The quality (fruit size, thickness of peel, fruit weight, juice percentage, pH of juice, total soluble solids (TSS), titratable acidity (TA), vitamin C, yield and taste) of tangerine cv. Sainampueng.

Orchard	Fruit size (cm)	Thickness of peel (mm)	Fruit weight (g)	Juice percentage (%)	pH of juice	TSS (°Brix)	TA (%)	Vitamin C (mg/ 100 ml)	Yield (kg/tree)	Taste[1/]
14	6.5	1.54	134.1	57.6	3.85	10.6	0.57	22.1	57.0	4
27	6.22	1.26	120.0	57.2	3.74	12.4	1.01	23.8	51.0	5
28	6.76	1.38	155.4	55.6	3.78	11.9	0.71	22.6	66.0	5
29	6.4	1.24	131.9	57.5	3.80	12.1	0.89	23.4	56.1	5
30	6.27	1.48	122.1	44.9	4.06	13.0	0.66	22.0	51.9	5

[1/] 1 = Objectionable, 2 = Fairly good, 3 = Moderately, 4 = Good and 5 = Excellent

Table 7.4 The concentration of elements in tangerine cv. Sainampueng leaf.

Orchard	Concentration of macronutrient element (%)					Concentration of micronutrient element (ppm)				
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
1	3.00	0.14	1.49	6.11	0.35	88.0	75.5	31.0	77.5	56.6
2	2.67	0.14	1.95	6.19	0.32	88.3	71.0	34.5	111.5	66.4
3	2.50	0.14	1.73	6.38	0.37	81.5	96.0	30.0	113.0	52.4
4	3.16	0.16	1.49	6.86	0.34	84.5	66.5	31.0	122.0	48.9
5	2.75	0.20	1.95	5.81	0.49	86.2	51.0	30.5	116.5	78.9
6	2.58	0.12	1.68	5.10	0.45	86.5	68.5	49.0	113.8	81.1
7	2.42	0.12	1.51	5.46	0.44	84.1	81.5	35.0	110.3	66.1
8	2.22	0.16	1.85	6.38	0.47	83.5	48.5	39.0	106.5	47.6
9	2.22	0.12	1.67	6.63	0.34	82.0	29.0	61.0	126.5	65.5
10	2.24	0.12	1.82	5.61	0.35	88.5	70.0	59.0	127.0	55.0
11	2.14	0.14	1.81	5.19	0.44	84.0	53.5	45.0	102.0	62.1
12	2.06	0.18	1.78	6.55	0.40	70.5	65.0	79.0	108.3	62.0
13	1.98	0.14	1.75	6.56	0.33	76.5	95.5	77.0	116.5	30.8
14	1.89	0.16	1.84	6.93	0.48	82.5	40.5	26.0	119.5	64.2
15	2.67	0.12	1.99	6.97	0.42	73.5	62.0	30.5	104.8	45.9

Table 7.4 (Cont.) The concentration of elements in tangerine cv. Sainampueng leaf.

Orchard	Concentration of macronutrient element (%)					Concentration of micronutrient element (ppm)				
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
16	2.55	0.14	1.90	6.37	0.35	68.0	64.5	58.5	121.4	63.9
17	2.88	0.16	1.78	5.43	0.38	79.5	66.0	53.5	123.3	53.1
18	2.03	0.14	1.56	5.33	0.37	71.1	75.5	33.5	107.5	83.6
19	2.83	0.16	1.97	5.57	0.38	77.0	56.0	69.0	122.0	57.8
20	2.58	0.14	1.63	5.75	0.39	79.5	31.5	38.0	122.3	32.3
21	2.24	0.14	1.88	5.44	0.41	68.5	82.0	38.5	91.0	52.4
22	3.42	0.16	1.99	5.45	0.45	88.5	31.0	63.0	114.3	32.7
23	3.41	0.16	1.96	5.42	0.39	67.5	88.0	25.0	115.6	34.9
24	3.33	0.16	1.75	5.49	0.37	80.5	33.5	39.5	119.5	64.1
25	2.27	0.14	1.93	5.94	0.38	86.2	61.5	31.5	127.0	88.1
26	3.38	0.16	1.73	5.86	0.39	78.6	31.5	34.0	83.0	38.9
27	3.36	0.14	1.76	5.48	0.41	66.5	54.0	63.5	121.5	69.0
28	2.65	0.16	1.79	5.38	0.45	55.5	93.5	37.5	120.5	41.9
29	2.93	0.14	1.62	5.48	0.38	85.0	55.0	29.0	114.0	60.4
30	2.88	0.14	1.62	6.47	0.40	65.3	44.0	32.5	88.0	32.7

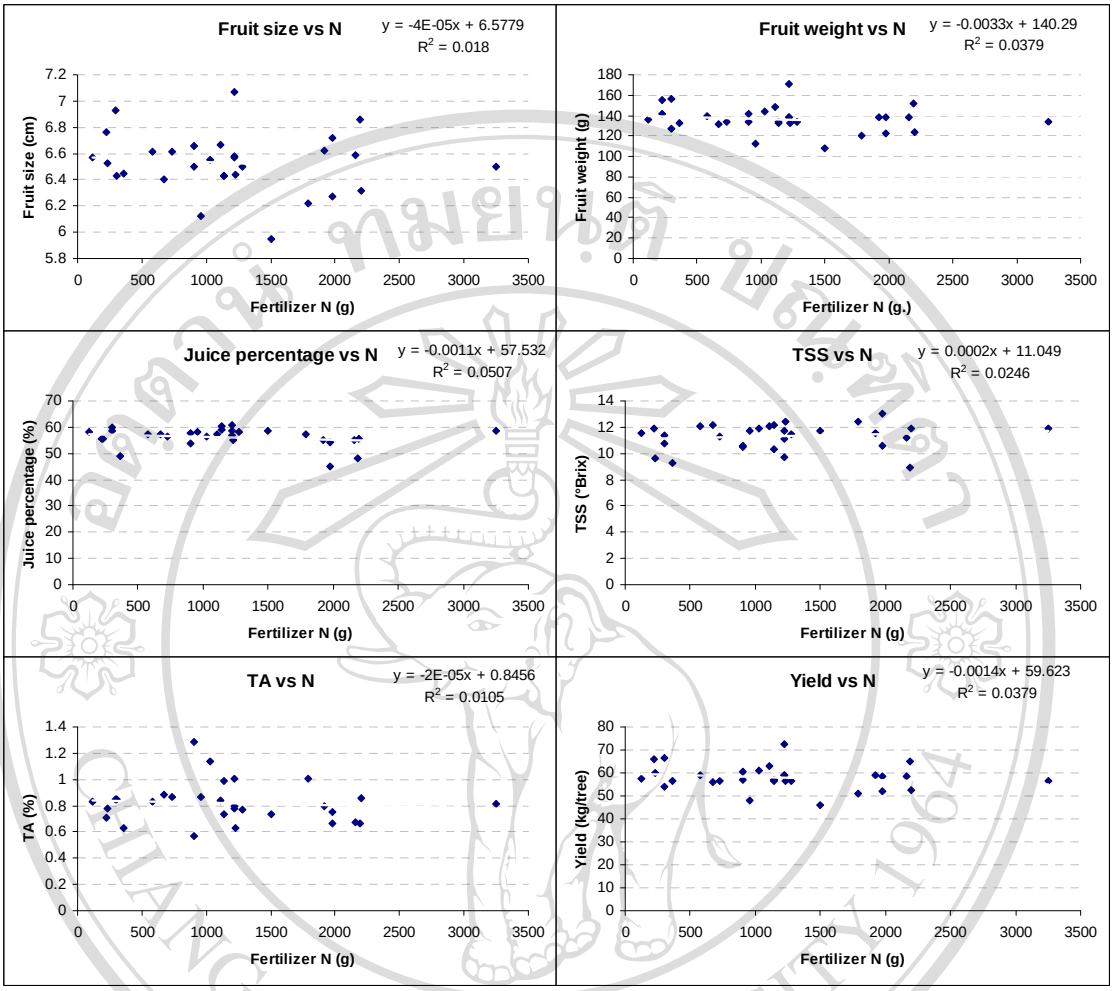

Figure 7.1 Relationship between N fertilizer and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

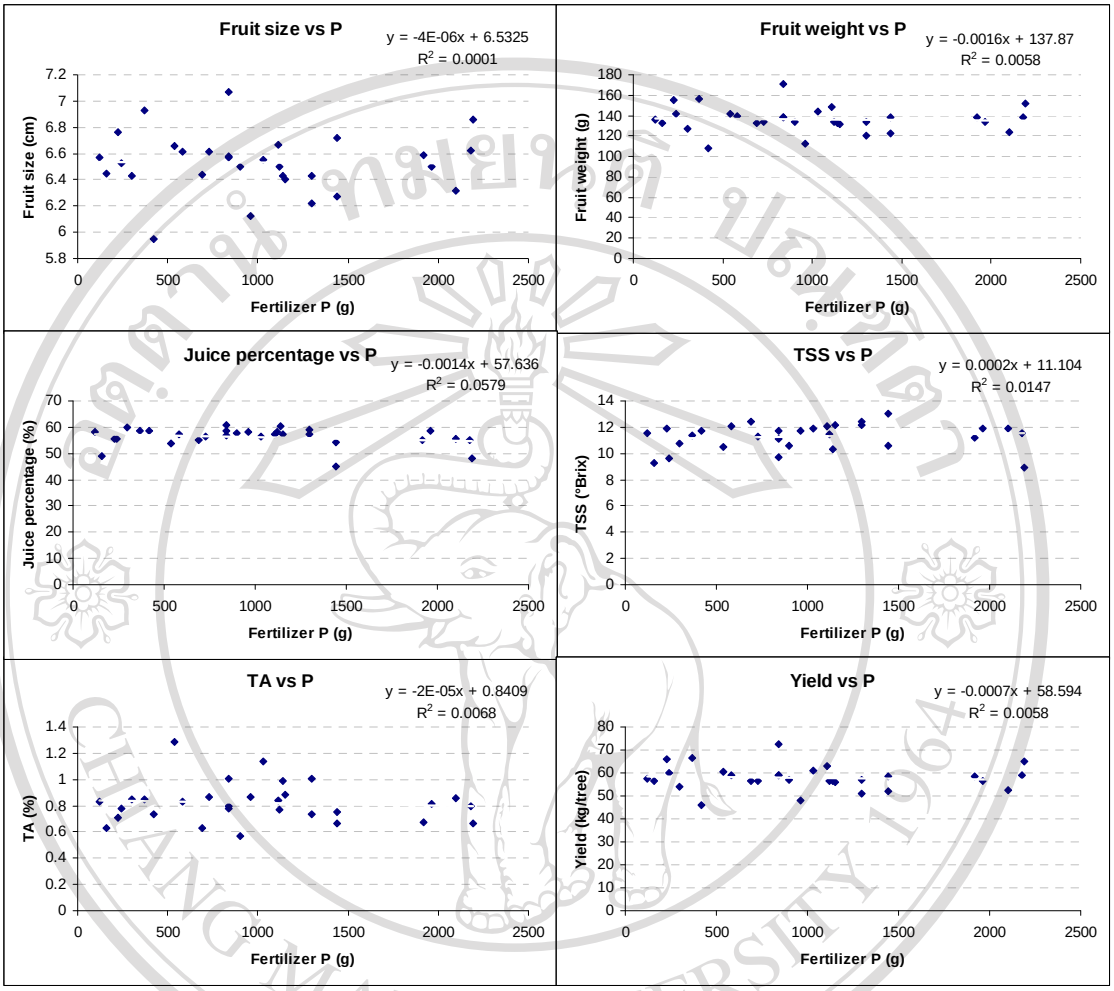

Figure 7.2 Relationship between P fertilizer and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

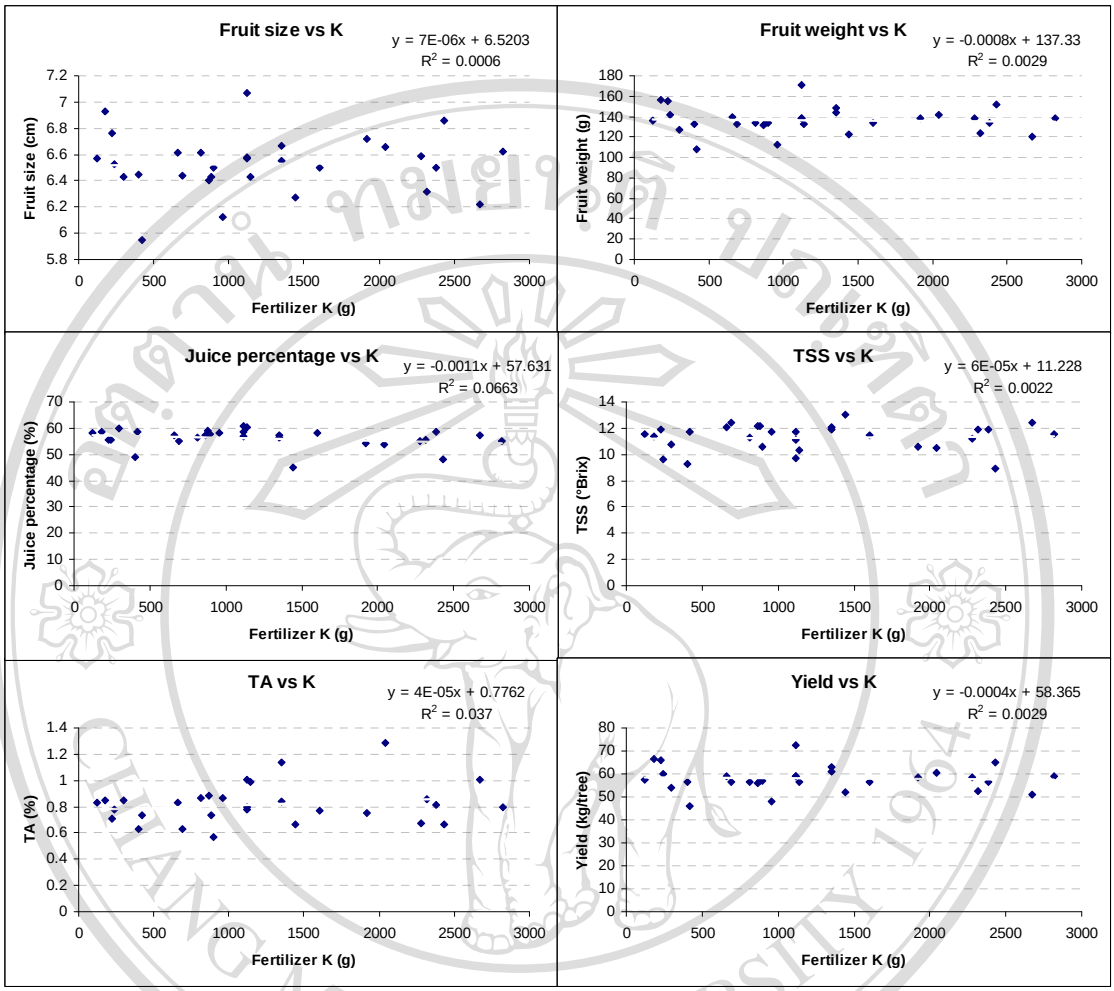

Figure 7.3 Relationship between K fertilizer and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

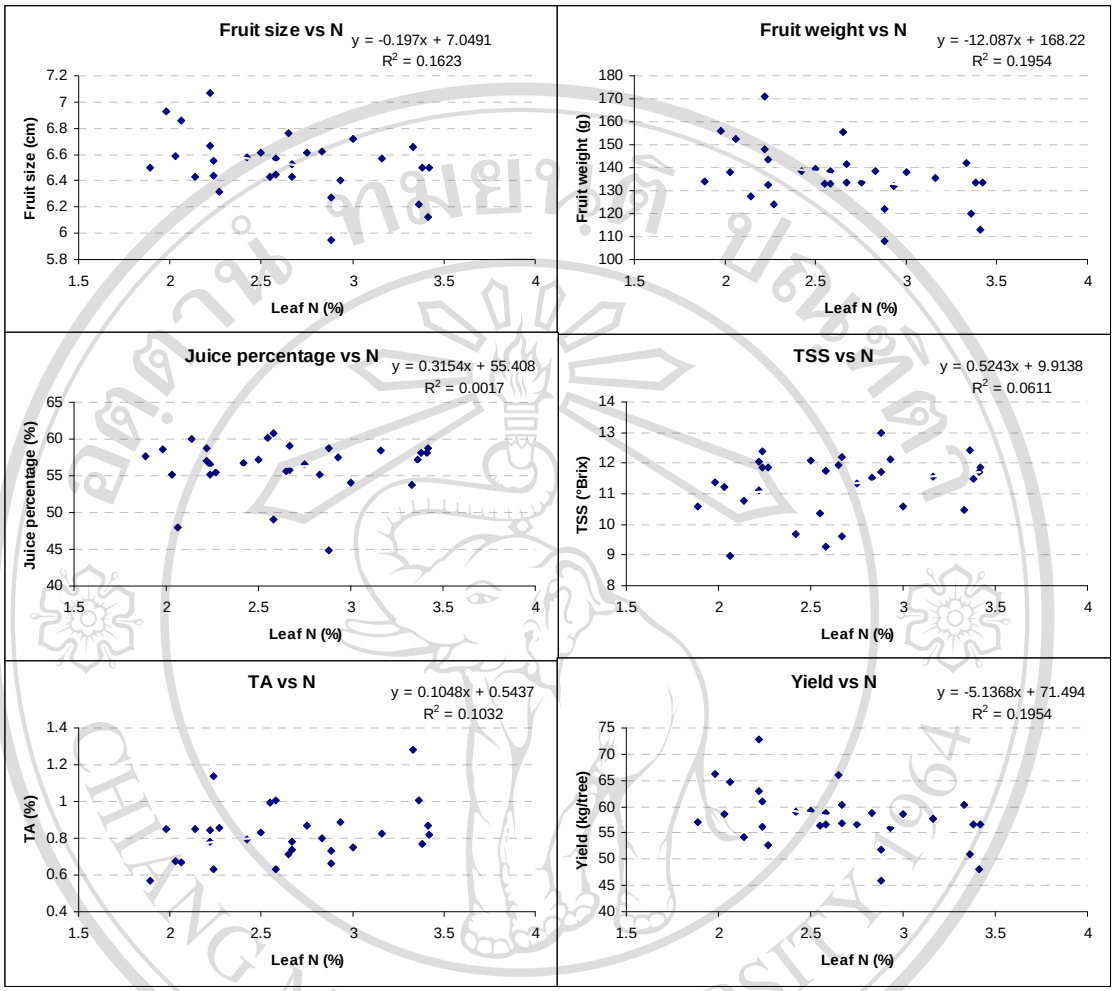

Figure 7.4 Relationship between N concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

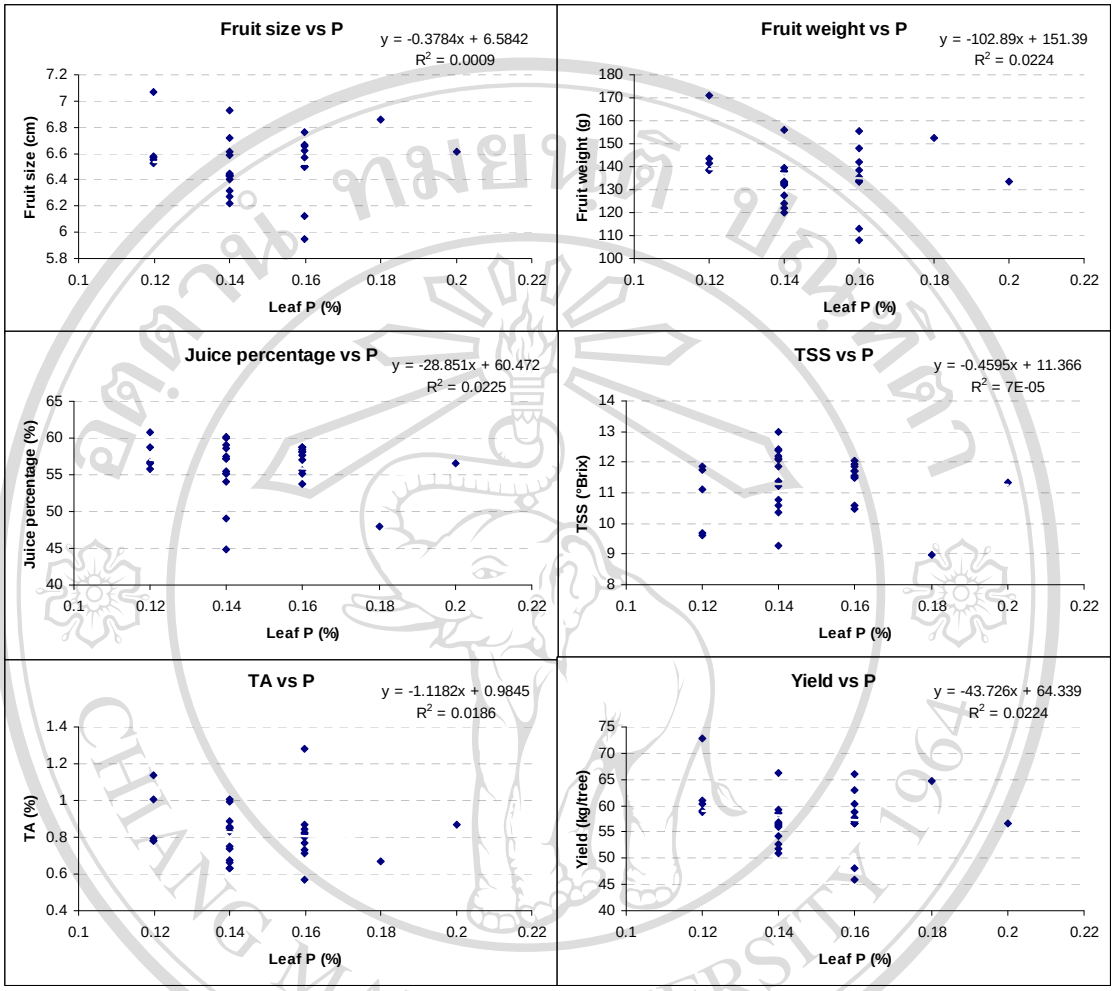

Figure 7.5 Relationship between P concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

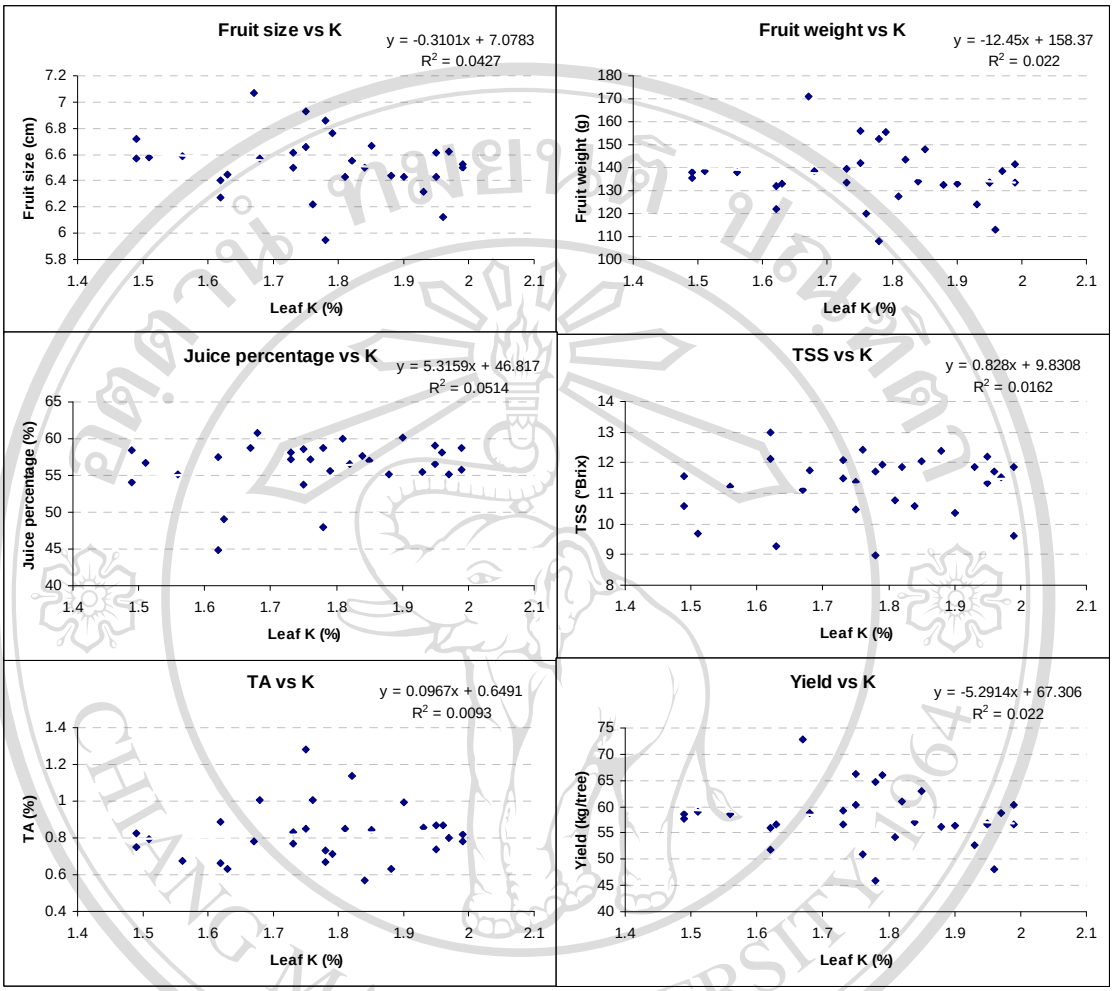

Figure 7.6 Relationship between K concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

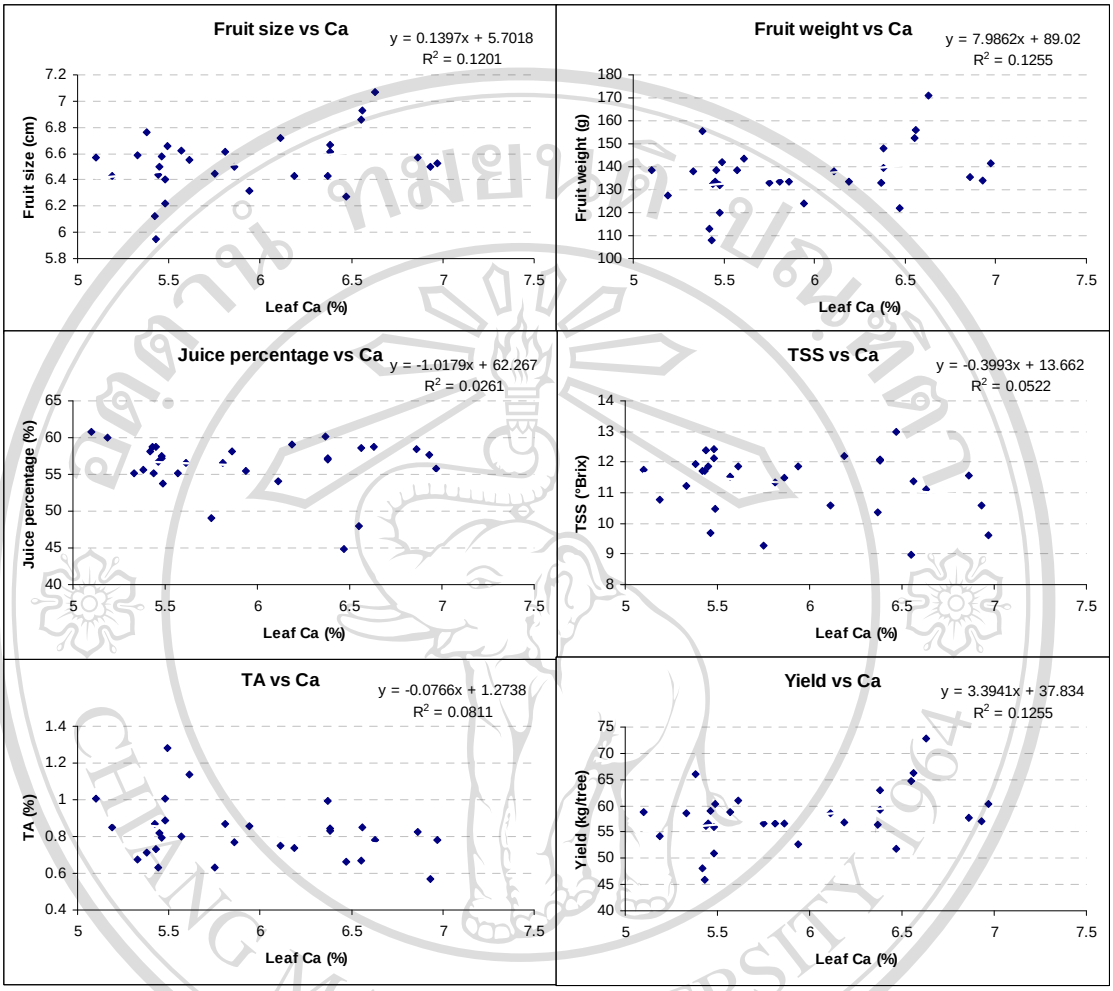

Figure 7.7 Relationship between Ca concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

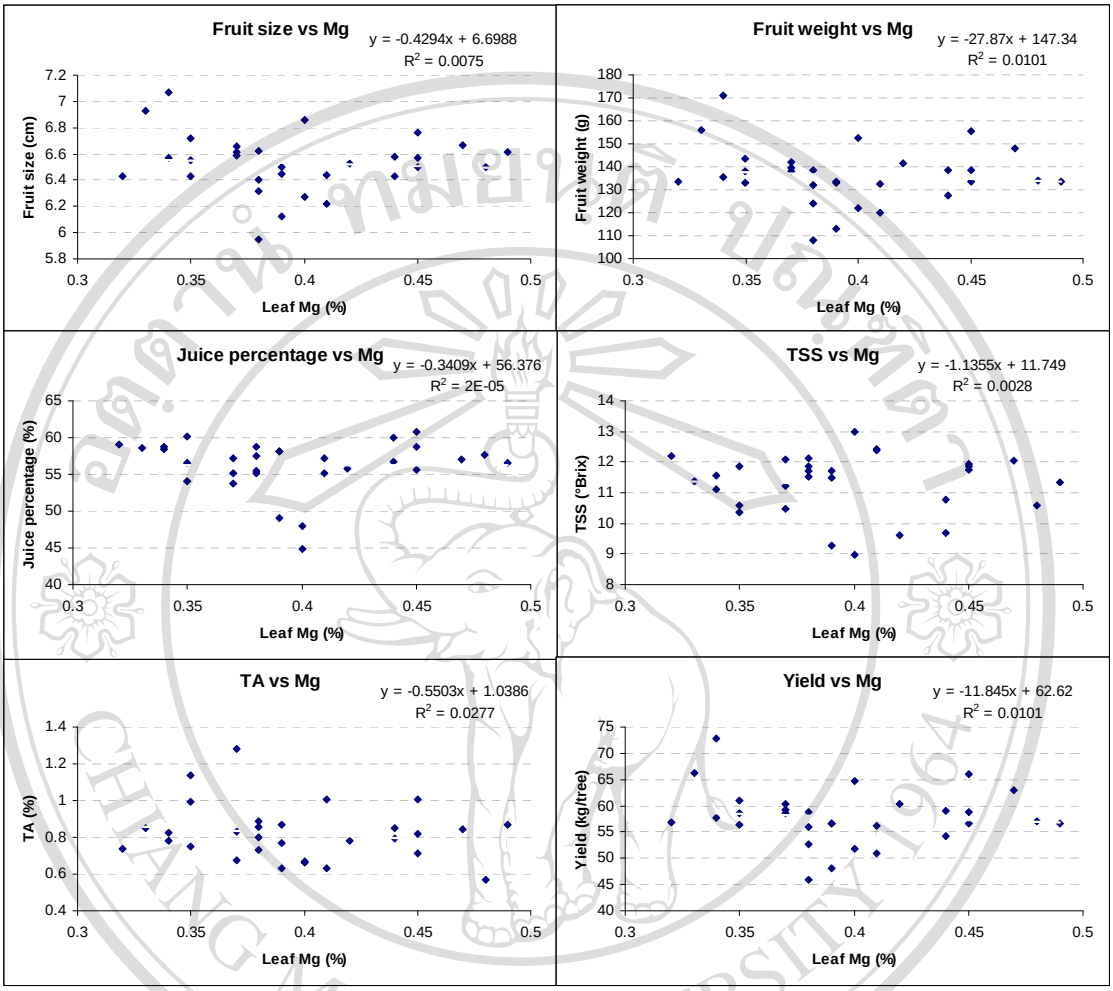

Figure 7.8 Relationship between Mg concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

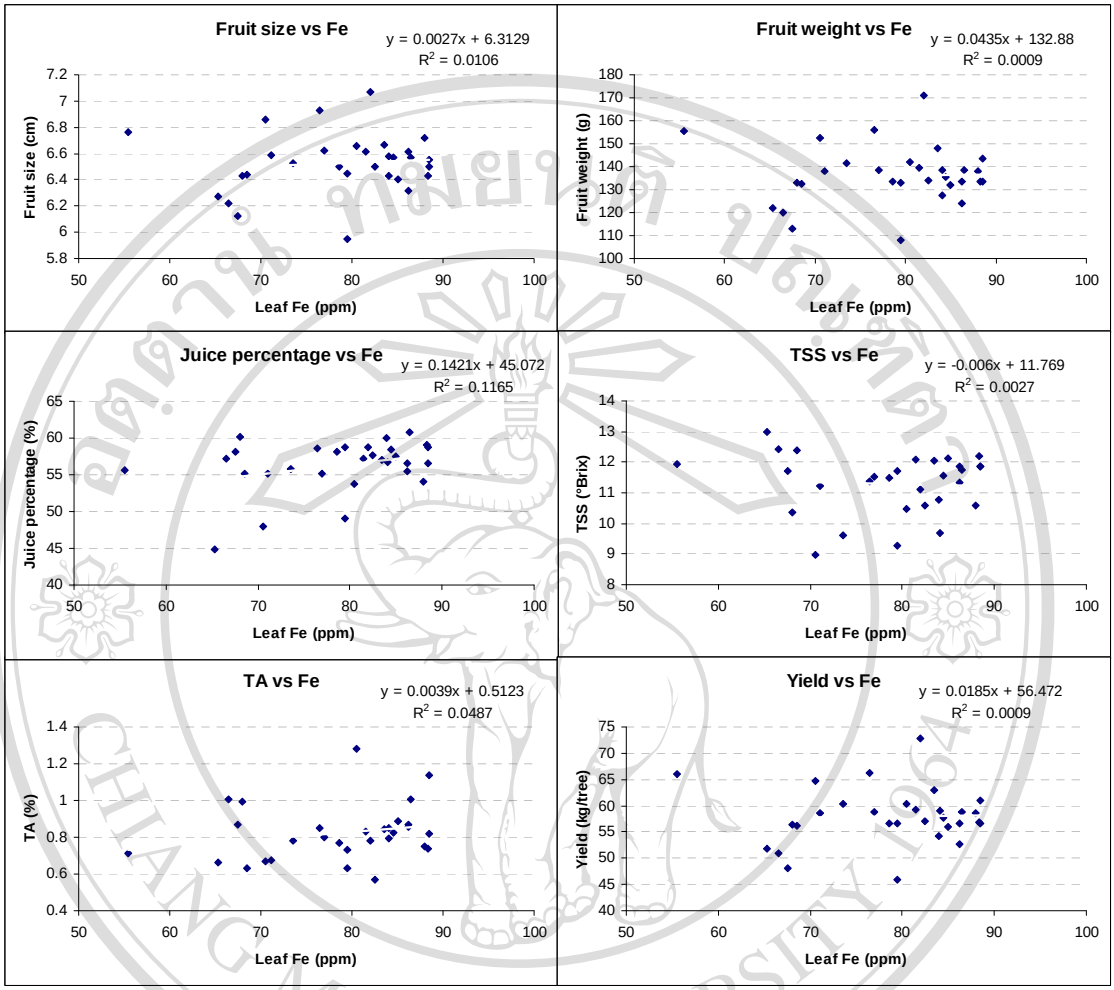

Figure 7.9 Relationship between Fe concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

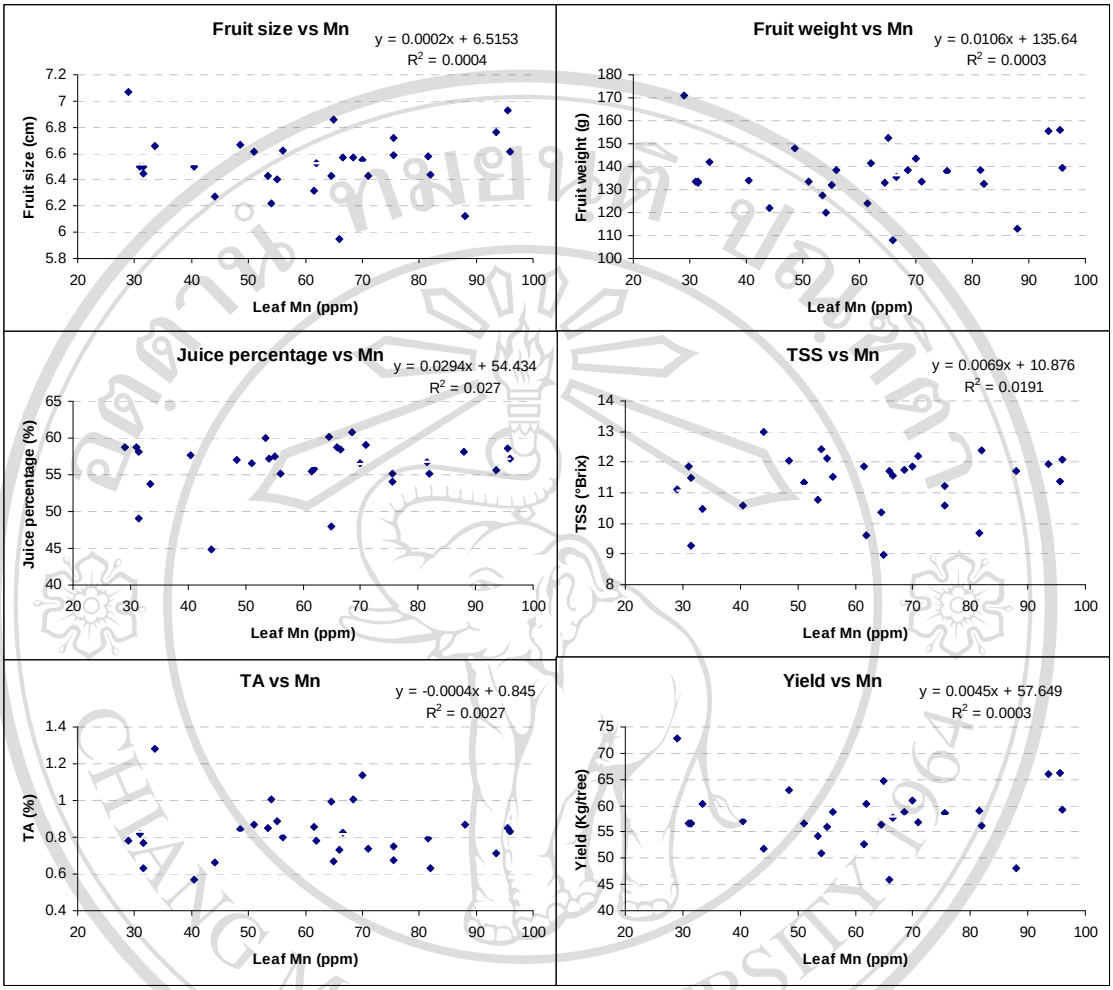

Figure 7.10 Relationship between Mn concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

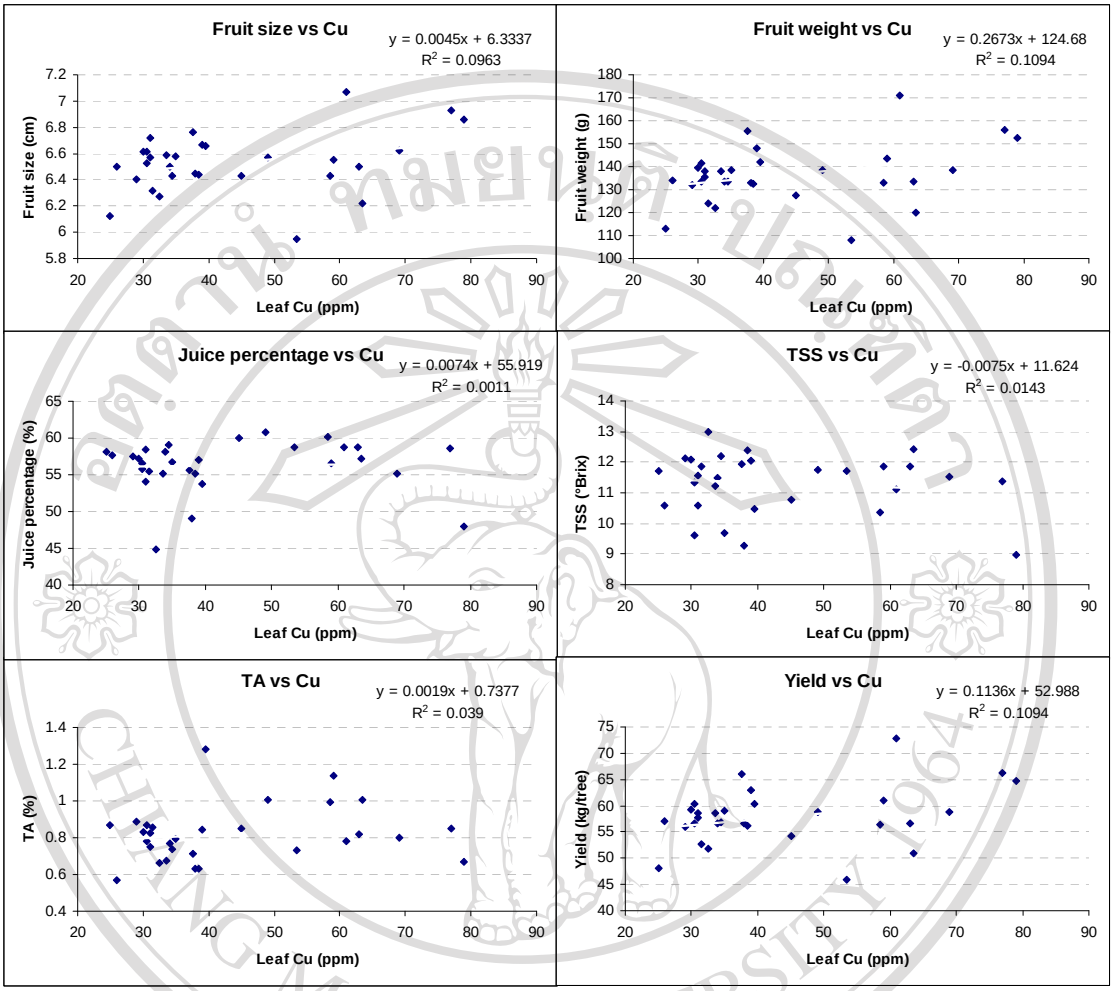

Figure 7.11 Relationship between Cu concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

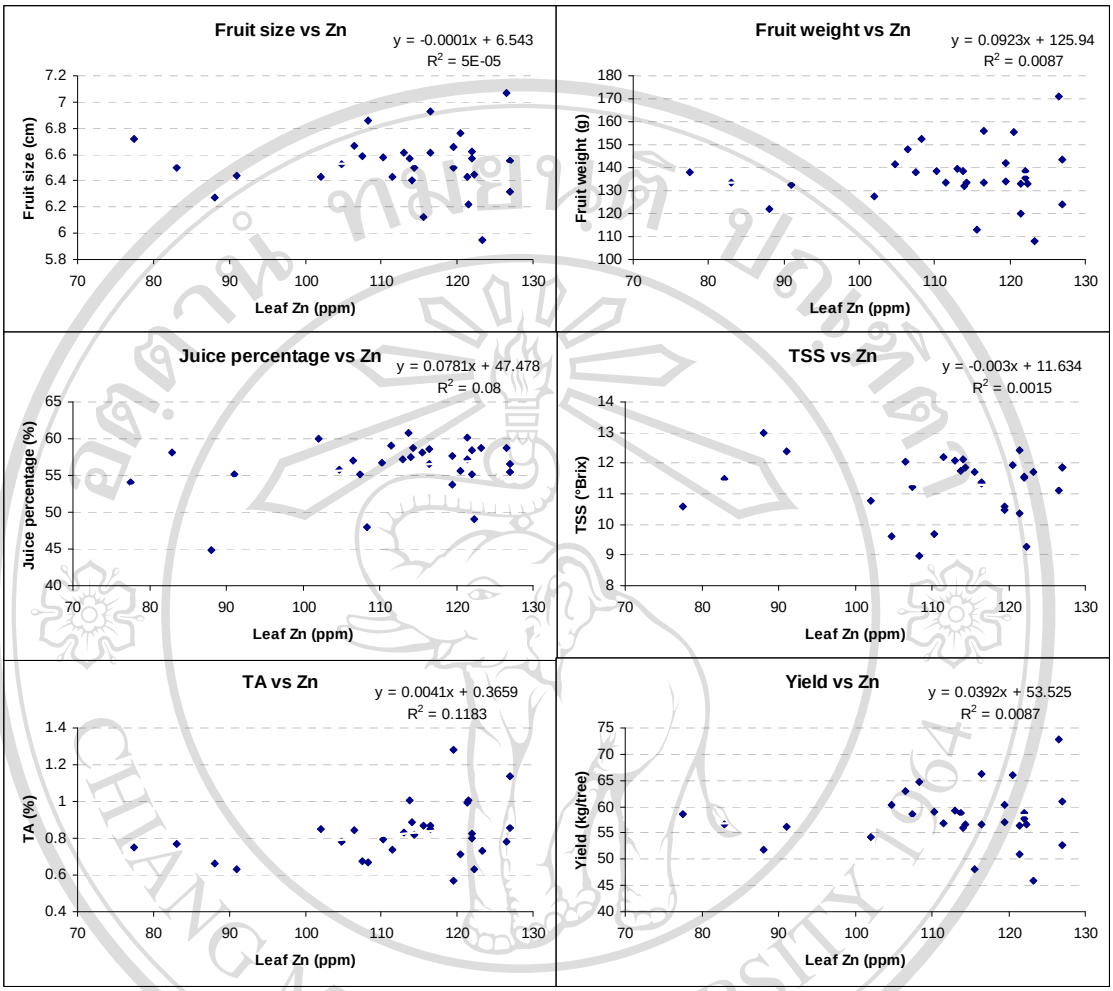

Figure 7.12 Relationship between Zn concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.

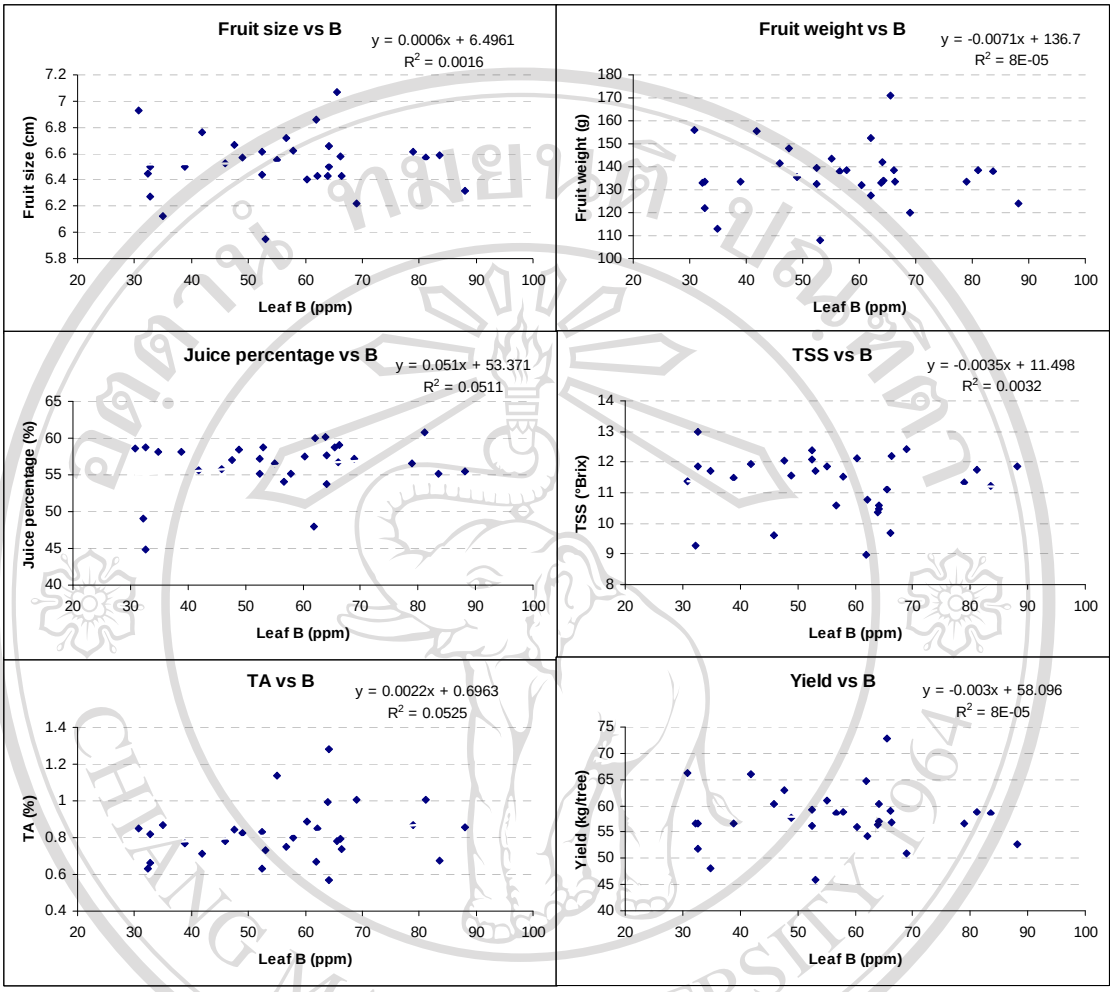

Figure 7.13 Relationship between B concentration in leaves and fruit size, fruit weight, juice percentage, total soluble solids (TSS), titratable acidity (TA) and yield of tangerine cv. Sainampueng.