Chapter 5

Change of Leaf and Twig Nutrient Concentration During Fruit Development

Introduction

Root absorbing nutrients are changed to organic substances by plant metabolism. Thereafter these nutrients are stored in various parts of plants (Kumlung *et al*., 2003). The reserve nutrients in plant organs are food for growing shoot tips, flowers, and fruits (Supakamnerd, 2001; Kumlung *et al*., 2003). At present, it is accepted that the concentration of nutrients in plants is a better useful indicator of the elements than soil analysis only (Kaosumain *et al*., 2002). In lychee, approximately, 50 % of nutrients stored in leaves while 8 and 16 % stored in large and small twigs, respectively (Menzel *et al*., 1992a). Similarly, Menzel *et al*. (1992b and 1992c) reported that lychee leaves accumulated relative high amount of nutrients around 40-80 %. The stalks, small twigs, and medium twigs reserve 5-15, 15-20 and 5-10 % of all nutrients, respectively. In addition, nitrogen-15 was applied to study the N absorption and distribution in Navel orange trees (Legaz and Primo-Millo, 1988). About 63-77% of nitrogen requirement of new organs during the early stages of growth and flowering are supplied from mature organs of the tree. The rest 23-27 % of the nitrogen came from soil (Legaz and Primo-Millo, 1988).

In case of Valencia, leaves deposited about 30-50 % of elements in plants (Cameron and Campton, 1945). Mature leaves, main storage organs, contributed 40-50 % of the total N and it was approximately 57 % of the N accumulated during the preceding year (Legaz *et al*., 1995). Although the nutrient concentrations in soil keep on changing, it does not have any immediately impact on plant growth. The leaves were source of the nutrients to fruit demand during the fruit set (Menzel *et al*., 1988). This research aims to study the effect of fruit development on the concentration of nutrients in leaves and twigs of tangerine.

Materials and Methods

The experiment was conducted at a private orchard at Mae Soon Noi subdistrict, Fang district of Chiang Mai province during April 2005 – April 2006. Five-year-old tangerine cv. Sainampueng trees were selected for the study.

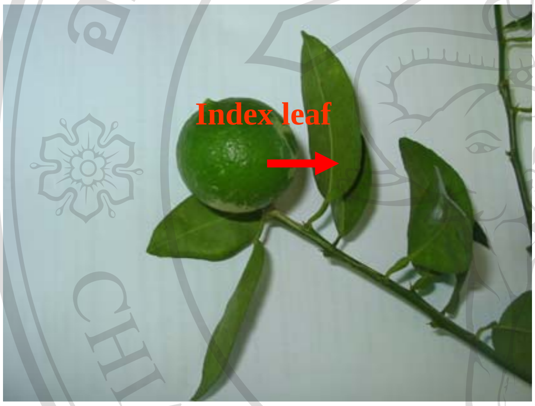
The leaf samplings, the 3rd leaf collected from shoot apex (see Chapter 4), four treatments were arranged in the completely randomized design, consisted of 1) non bearing twig (taken on May 21, 2005; 3-month-old leaf) (Figure 5.1), 2) bearing twig with two-month-old fruits (taken on April 21, 2005; 5-month-old leaf), 3) bearing twig with five-month-old fruits (taken on July 21, 2005; 8-month-old leaf) and 4) bearing twig with eight-month-old fruits (taken on October 21, 2005; 11-month-old leaf). The treatment consisted of 5 replicates, each tree for one replicate. The 50 leaves around the tree canopy were taken in a periodic mentioned plan. The nutrient concentration in collected leaves were determined (by the procedures) as previously described in Chapter 4.

The twig samples were used with 3 treatments which were twigs at 50 (taken on March 27, 2005; non-bearing twigs), 100 (taken on May 15, 2005; non-bearing twigs) and 200 (taken on August 24, 2005; bearing twigs with young fruit) days old. The treatment consisted of 5 replicates, each tree represented for one replicate. The 10 tangerine twigs around the tree canopy were taken in a periodic mentioned plan. For nutrient concentration in collected twig were determined (by the procedures) as previously described in Chapter 4.

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

(a) non bearing twig

(b) bearing twig with two-month-old fruit



(c) bearing twig with five-month-old fruit

(d) bearing twig with eight-month-old fruit

Figure 5.1 Sampled leaves taken for nutrient concentration analysis.

Results and Discussion

1. Leaf nutrient concentration

The concentrations of N, P, K, Mg, Cu and B in leaf decreased with the increasing of fruit size except at the latest stage (Table 5.1). The results indicated that the source–sink relationship regulated the amount of nutrients in fruit imported from leaves. The result agreed with the experiment done in lychee by Menzel *et al*. (1988). It is suggested that the leaves, twigs and small branches are the large pools of nutrients in the tree. Mobile nutrients such as N, P and K should be applied well before fruit set to build up tree reserves for flowering and fruiting. Less mobile nutrients probably need to be supplied during the flowering and fruiting season.

Therefore, concentrations of the 6 elements in leaf decreased rapidly during fruit growth period, especially for those trees which had more fruits.

Contrastively, Ca concentration in leaves of bearing twigs increased as fruit aged and decreased when fruit approached maturity. It increased when the fruit developed. This may be come from spraying water-soluble calcium (see the Results in Chapter 3) or washing sample untidy. Meanwhile the Ca of concentration was decreased when 8-month-old fruit. Since the samples were collected, it was a rainy season. Calcium concentrations in leaves may be washed.

The concentration of Fe, Mn and Zn in leaf increased when twigs started bearing fruited and thereafter decreased as fruit aged. Similarly, Supakamnerd *et al*. (2005) indicated that leaves different ages the concentrations of Fe, Mn and Zn in leaf increased until they were 5-month-old, and they decreased. Menzel and Simpson (1987) reported that the concentration of Fe and Zn were lower in leaves behind the fruit than non bearing shoots. Fe, Mn and Zn were immobile elements (Osotsapar, 2000), they did not decrease. The concentrations of Fe, Mn and Zn increased with 5-month-old leaves owing to foliar fertilizer spray applied to foliage at the time (April). Fe, Mn and Zn concentrations decreased with 8- and 11-month-old leaves because Fang district had rainwater 200-400 mm volume between July to October, 2005 (Department of Meteorology, 2006). It caused the loss of elements by washing leaves (Suksawat, 2001).

In the comparison between nutrient concentration in leaves of non bearing twig and adequate concentration of leaves tangerines in Taiwan (Table 5), it was documented that N was lower than adequate concentration. This result may be due to N which dissolves easily and leaches to the deeper ground soil (Suksawat, 2001). While the concentration of K, Ca, Fe and Cu were higher than of the standard value. Because soil had much K, the tangerine trees could absorb more into the tissue (Osotsapar, 2000). Ca and Cu appeared high in leaf because farmers sprayed Ca and Cu containing fungicide (see the Results in Chapter 3). Other elements are in the proper range of adequate concentration.

2. Twig nutrient concentration

The concentration of N, P, Ca, Mg, Fe, Mn, and Cu in twig increased during 50- to 100-day-old and decreased with 100- to 200-day-old (Table 5.2). By contrast, K and Zn in twig decreased as twig aged. The concentration of B was contrastive.

In comparison between twig aged, it was shown that the 100-day-old twig contained higher the most of nutrients concentration than 50- and 200-day-old twig because it should be taken the new shoot emerges flushes. Similarly, Supakamnerd (2002) indicated that the small twig contained higher nutritional concentration than the large twig. Most nutrient concentrations decreased in 200 days old twigs which already bore young fruit. There are at least two factors that have an impact on the concentration of nutrient in a twig. They are twig age and sink-source relationship. During the development of fruit, the young fruit behaves as nutrient importer (Menzel *et al*., 1988). The nutrient elements were drawn back from the leaves, twigs and small branches. Mobile nutrients should be applied well before fruit set to build up tree reserves for flowering and fruiting (Menzel *et al*., 1988). Because these mobile nutrients are unstable, and able to move continuously to other strong sink such as younger fruits and new shoots.

Conclusions and Recommendations

From the experiment, the decrease of nutrient concentration in leaf and twig will occur during the fruit development. Therefore, during this period, the orchard should increase and maintain the necessary nutrient concentration carefully in order to achieve the highly retuned yield and good product quality.

Table 5.1 Concentration of elements in tangerine cv. Sainampueng leaf at different time of taking samples.

Leaf taking time	Concentration of macronutrient element (%)[1/]					Concentration of micronutrient element (ppm)[1/]				
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
Non bearing twigs	2.58 a	0.15 b	2.46 a	5.66 c	0.35 a	131.80 b	71.17 c	26.28 ab	98.11 a	66.14 a
Bearing twigs /2 months fruits	2.04 b	0.12 c	2.13 ab	6.14 b	0.30 b	165.96 a	107.24 a	27.31 a	46.95 b	59.26 b
Bearing twigs /5 months fruits	1.86 b	0.12 c	1.76 b	6.92 a	0.31 b	135.88 b	87.33 b	25.71 ab	20.71 d	49.14 c
Bearing twigs /8 months fruits	2.54 a	0.16 a	2.04 ab	5.03 d	0.37 a	100.24 c	46.55 d	24.74 b	28.40 c	57.94 b
$LSD_{0.05}$	0.25	0.0093	0.43	0.34	0.02	7.42	8.91	2.21	6.25	5.28
% CV	8.74	5.21	15.22	4.31	4.28	4.14	8.50	15.63	9.59	6.77
Adequate concentration										
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

[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)

Table 5.2 The nutrient concentration in tangerine cv. Sainampueng twig at different ages.

Twig age (day)	Concentration of macronutrient element (%)[1/]					Concentration of micronutrient element (ppm)[1/]				
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
50 (non-bearing twigs)	0.30 c	0.16 b	2.34 a	0.91 c	0.09 b	38.23 c	7.85 c	28.46 a	17.50 c	23.50 c
100 (non-bearing twigs)	0.52 a	0.19 a	1.98 b	2.42 a	0.19 a	81.18 a	17.93 a	23.14 b	55.40 a	25.76 b
200 (bearing twigs with young fruit)	0.41 b	0.15 b	1.85 c	1.68 b	0.07 b	45.53 b	12.01 b	21.11 b	26.51 b	28.14 a
$LSD_{0.05}$	0.09	0.01	0.12	0.19	0.02	5.01	1.27	2.36	1.94	1.60
% CV	5.37	3.01	4.17	8.38	11.26	6.61	7.34	7.06	4.26	4.50
Adequate concentration										
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

[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)