Results

1. Fruit Growth

The average weight increase from 0.36 gm at the 2nd week after full bloom to 189.22 gm at the 16th week after full bloom. The weight shawed slowly increased in the first 4 weeks after full bloom then it steadily increased rapidly. (Fig.9 and Table 3). The size and shape of Anna apple are shown in Fig.22 to Fig.26.

The average width steadily increased from 0.679 cm. at 2nd WAFB to 7535 cm. at 16th WAFB. (Fig.10 and Table 4).

The average lenght followed similar pattern to the width. It increased from 1.303 cm. at 2nd WAFB to 7.867 cm. at 16th WAFB. (Fig.11 and Table 5).

The average volume followed a similar pattern to the weight. It increased from 0.55 cm^3 at 2nd WAFB to 235.30 cm^3 at 16th WATB. (Fig.12 and Table 6).

The average specific gravity (SG) is 0.596 at the 2nd WAFB and increased reaching a maximum 0.902 at 5th WAFB and then slightly decreased. (Fig.13 and Table 7).

2. Qualities change during growth

2.1 Physical changes

The average flesh firmness was hihgest, 19.52 lbs., at 7th WAFB then decreased rapidly to 14.88 lbs. in 8th

WAFB then decreases slowly until 14th WAFB and then decreased rapidly again in the last two weeks to 7.50 lbs. at 16th WAFB (Fig.14 Table 8).

The development of the red color occured at 12th WAFB about 1-20 % of skin area and increased more than 80 % in some fruits at 16th WAFB.

2.2 Chemical changes

The percentage of total soluble solids increase from 7.25 in 5th WAFB to a high constant level from 13th to 16th WAFB average about 10.95. The average values of TSS from 13th to 16th were not significant difference (p.01). (Fig.15 and Table 9).

The average percentage of acids content decreased from 1.77 at 5th and 6th WAFB to 0.95 in 13th WAFB and increased to1.42 in 14th WAFB then decreased to 0.71 in 16th WAFB. (Fig.16 and Table 10).

The TSS/TA ratio increased from 4.15 in 5th WAFB to 11.80 in 13th WAFB then decreased to 7.55 in 14 th WAFB and then rapidly increased again to 14.90 in 16th WAFB. (Fig.17 and Table 11).

The vitamin C content seperated into three levels. The initial level, among 5th to 7th, was low and average about 8.826 mg/100 gm flesh weight. The second level,

among 8st to 14 st, was about 14.883 mg/100 gm flesh weight and then increased rapidlly to the last level during 15th and 16th average 22.595 mg/100 gm flesh weight and then increased rapidly to the last level during 15th and 16th average 22.595 mg/100 gm flesh weight. (Fig.18 and Table 12).

The chlorophyll content was 0.101 mg/gm peel in 5th WAFB and decreased rapidly to 0.077 in 10th WAFB then increased reaching a maximum 0.151 in 9th WAFB and then decreased again to 0.037 in 16th WAFB. (Fig.19, Table 13).

The starch-iodine tests are shown in Fig.27-32.

3. Qualities change after harvest.

The qualities change after harvest are shown in Fig.20 and the average sensory scores are shown in Table 15.

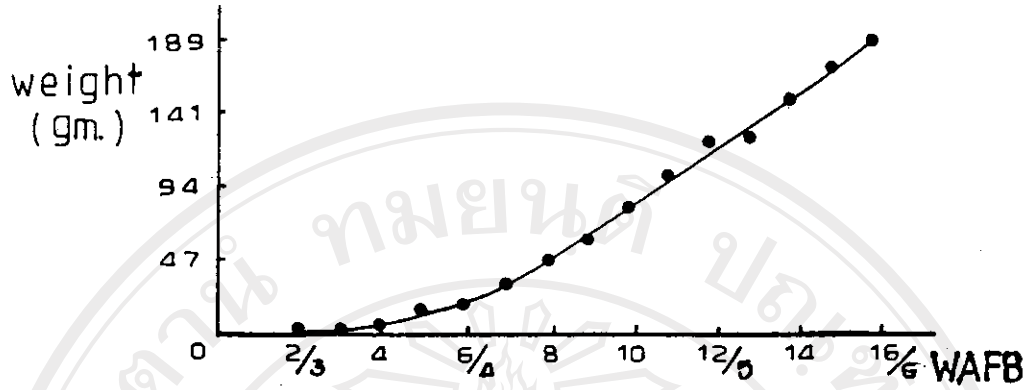

Fig.9 Increase in fresh weight (gm) of fruit of Anna apple from 2nd to 16th week after full bloom (WAFB).

Table 3 Changes in fresh weight (gm) of fruit of Anna apple during 2nd to 16th week after full bloom

WAFB	weight (mean±SD)	WAFB	weight (mean±SD)
2	0.36 ± 0.18	9	60.11 ± 14.93
3	1.05 ± 0.32	10	81.55 ± 23.93
4	4.17 ± 1.68	11	101.37 ± 26.41
5	15.25 ± 3.23	12	124.21 ± 31.54
6	18.86 ± 5.04	13	126.54 ± 34.48
7	31.59 ± 8.49	14	151.16 ± 38.15
8	47.12 ± 10.12	15	170.61 ± 38.82
		16	189.22 ± 42.73

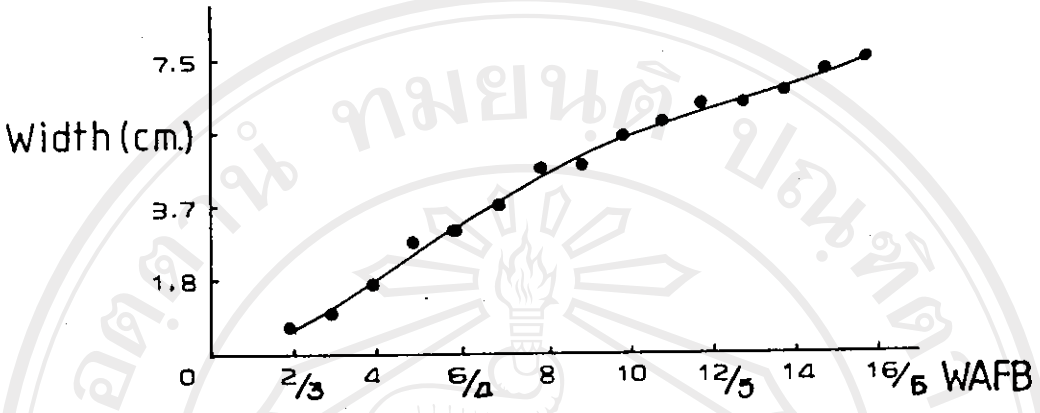

Fig.10 Increase in width (cm) of fruit of Anna apple from 2nd to 16th week after full bloom.

Table 4 Change in width (cm) of fruit of Anna apple during 2nd to 16th week after full bloom.

WAFB	Width (cm)	WAFB	Width (cm)
2	0.679	10	5.507
3	1.006	11	5.901
4	1.768	12	6.380
5	2.805	13	6.390
6	3.103	14	6.723
7	3.736	15	7.229
8	4.706	16	7.535
9	4.784		

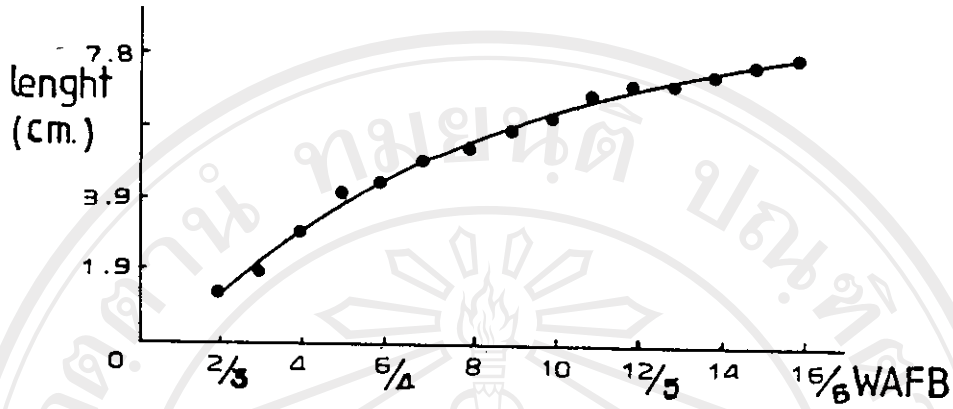

Fig.11 Increase in length (cm) of fruit of Anna apple from 2nd to 16th week after full bloom.

Table 5 Change in lenght(cm) of fruit of Anna apple during 2nd to 16th week after full bloom.

WAFB	Lenght (cm)	WAFB	Lenght (cm)
2	1.303	10	6.164
3	1.882	11	6.758
4	3.958	12	7.053
5	4.048	13	7.046
6	4.344	14	7.348
7	4.950	15	7.620
8	5.294	16	7.867
9	5.842		

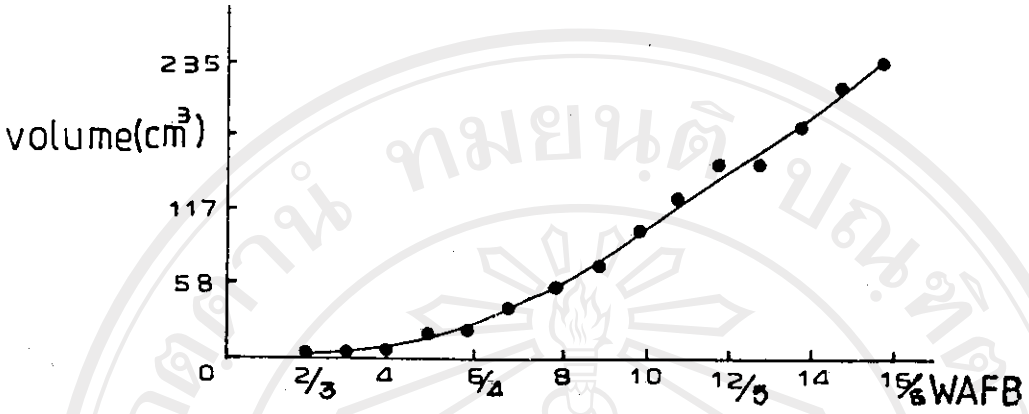

Fig.12 Increase in volume (cm^3) of fruit of Anna apple from 2nd to 16th week after full bloom (water displacement method).

Table 6 Change in volume (cm^3) of fruit of Anna apple during 2nd to 16th week after full bloom.

WAFB	Volume (cm^3)	WAFB	Volume (cm^3)
2	0.55	10	99.80
3	1.25	11	125.25
4	5.00	12	151.70
5	16.95	13	152.30
6	21.55	14	182.25
7	38.02	15	213.70
8	55.15	16	235.30
9	71.62		

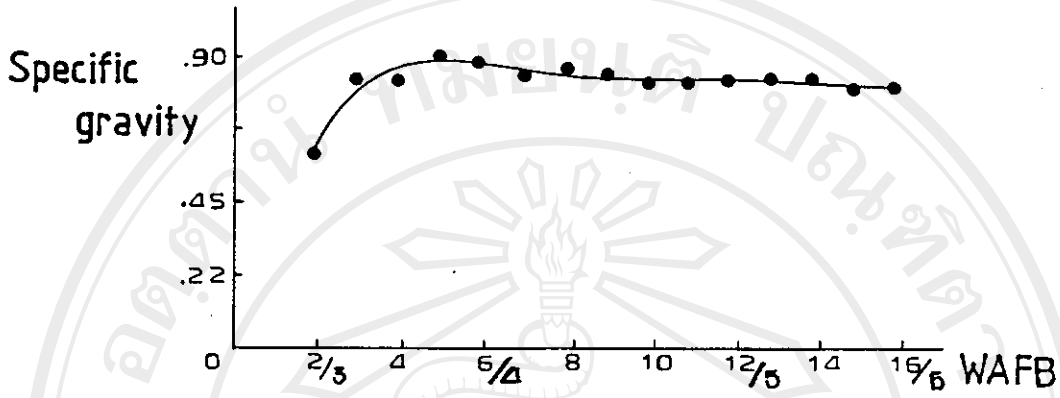

Fig.13 Specific gravity change in fruit of Anna apple during 2nd to 16th week after full bloom.

Table 7 The average specific gravity of fruit of Anna apple during 2nd to 16th week after full bloom.

WAFB	SG	WAFB	SG
2	0.596	10	0.812
3	0.830	11	0.810
4	0.822	12	0.822
5	0.902	13	0.831
6	0.881	14	0.831
7	0.832	15	0.796
8	0.858	16	0.805
9	0.838	$F = 8.657^{**}$	$LSD_{.01} = 0.027$

** significant difference at p.01

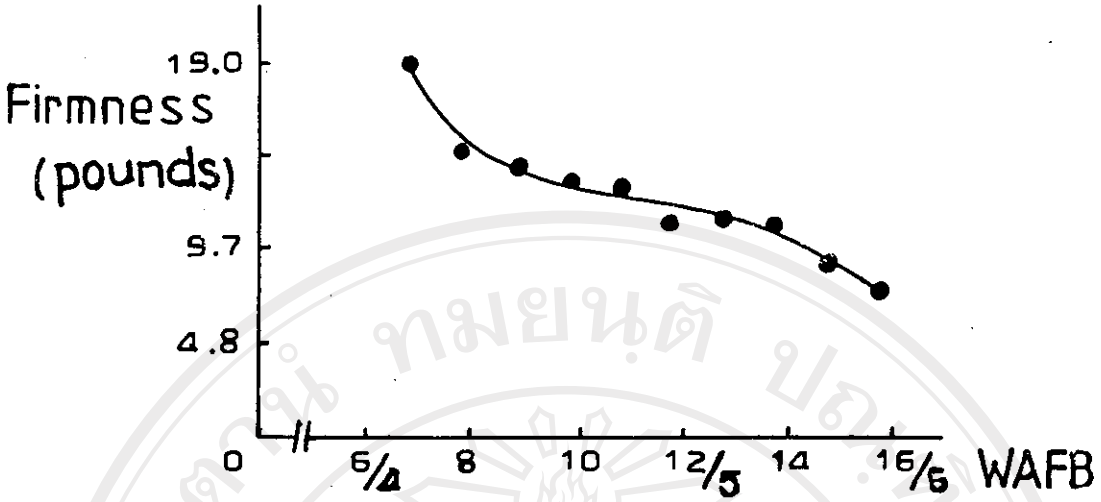

Fig.14 Decrease in fruit firmness (pound) of Anna apple from 7^{th} to 16^{th} week after full bloom.

Table 8 The average flesh firmness (lb.) of fruit of Anna apple during 7^{th} to 16^{th} week after full bloom by using Effegi pressure tester (0.8 cm diameter plunger).

WAFB	firmness Lbs.	
7	19.52	
8	14.88	
9	13.97	
10	13.32	
11	12.85	
12	11.07	F = 9.566**
13	11.22	$LSD_{.01}$ = 2.198
14	10.97	**significant difference at p.01
15	8.87	
16	7.50	

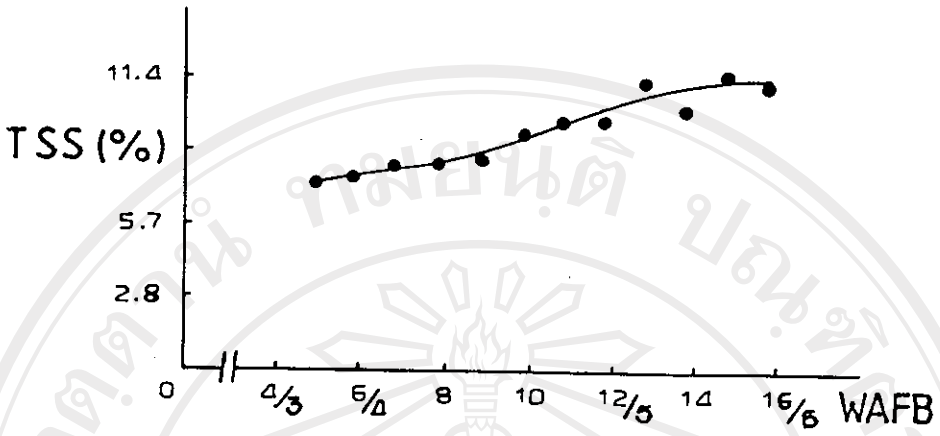

Fig.15 Changing in percentage of sugar content in fruit of Anna apple from 5th to 16th week after full bloom.

Table 9 The average total soluble solids (%) of fruit of Anna apple during 5th to 16th week after full bloom by using Atago hand refractometer.

WAFB	TSS(%)
5	7.25
6	7.50
7	7.95
8	8.00
9	8.15
10	9.15
11	9.65
12	9.65
13	11.20
14	10.15
15	11.40
16	11.05

F = 3.35 NS
$LSD_{.01}$ = 1.018
NS : none significant difference

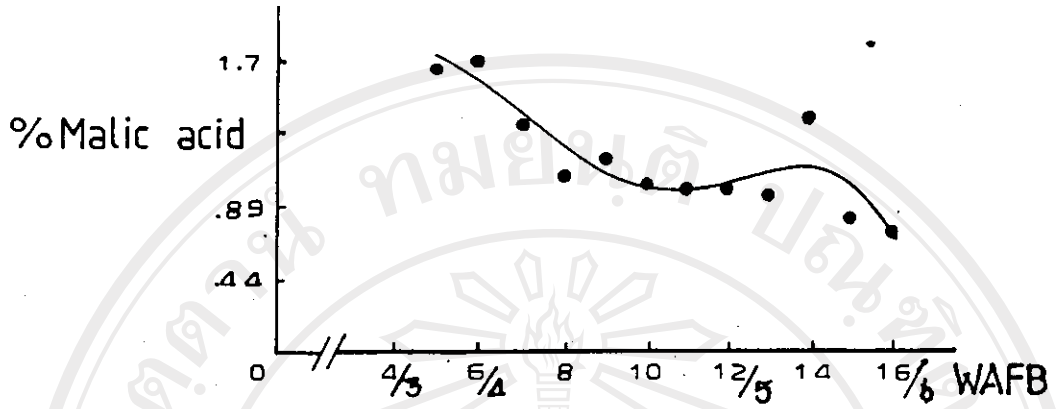

Fig.16 Changing in percentage of malic acid content in fruit of Anna apple from 5th to 16th week after full bloom.

Table 10 The average titratable acidity (% malic acid) of fruit of Anna apple during 5th to 16th week after full bloom.

WAFB	TA (% Malic acid)	
5	1.75	
6	1.79	
7	1.39	
8	1.08	
9	1.18	
10	1.13	
11	0.99	$F = 8.034^{**}$
12	0.99	$LSD_{.01} = 0.339$
13	0.95	** significant difference
14	1.42	at p.01
15	0.81	
16	0.71	

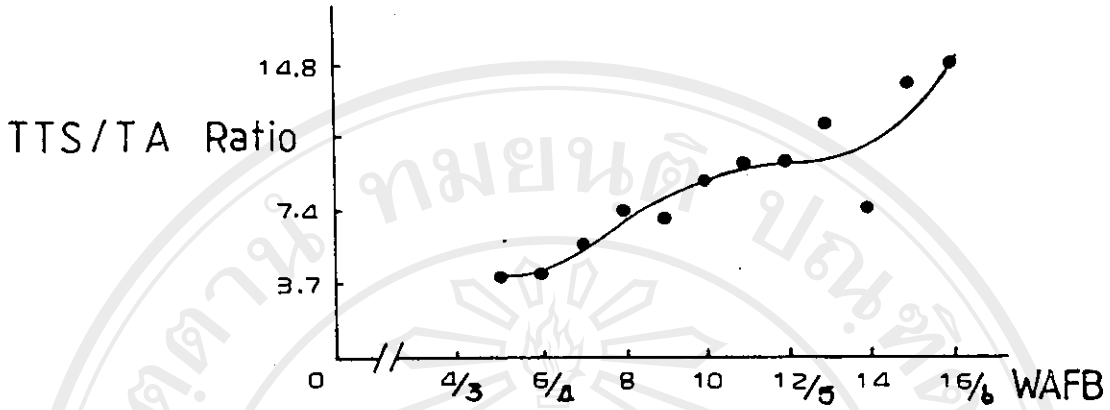

Fig.17 Changing in sugar and acid ratio (TSS/TA Ratio) of fruit of Anna apple from 5th to 16th week after full bloom.

Table 11 The average total soluble solids and titratable acidity ratio (TSS/TA ratio) of fruit of Anna apple during 5th to 16th week after full bloom.

WAFB	TSS/TA ratio
5	4.15
6	4.18
7	5.74
8	7.42
9	6.94
10	8.89
11	9.73
12	9.82
13	11.80
14	7.55
15	13.92
16	14.90

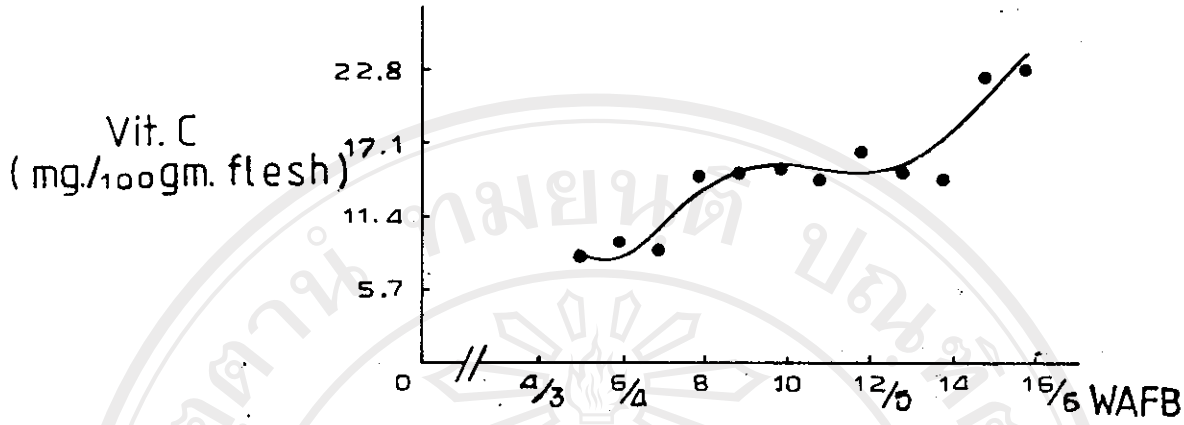

Fig.18 Changing in vitamin C content (mg/100 gm flesh) in fruit of Anna apple during 5th to 16th week after full bloom.

Table 12 The average Vitamin C content (mg/100 gm fresh weight) of fruit of Anna apple during 5th to 16th week after full bloom.

WAFB	Vit.C (mg/100 gm flesh wt.)
5	8.314
6	9.429
7	8.737
8	14.577
9	14.692
10	15.173
11	14.318
12	16.335
13	14.787
14	14.299
15	22.343
16	22.847

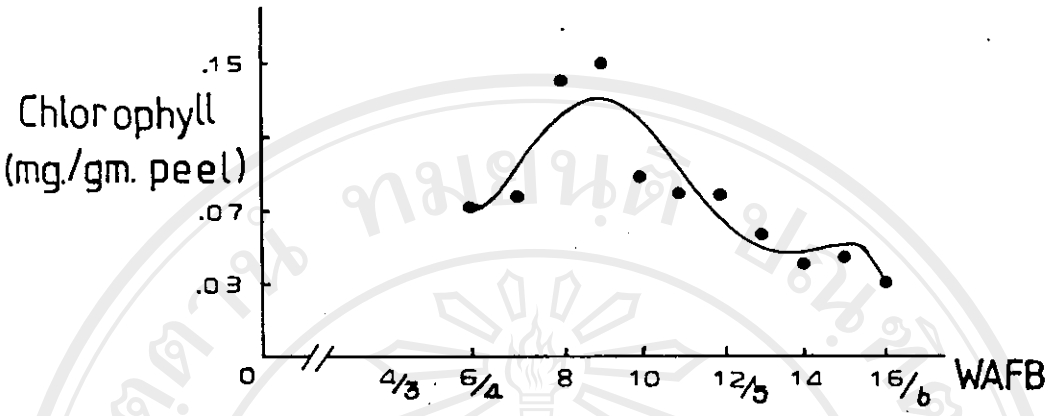

Fig.19 Chlorophyll content (mg/gm peel) change in the peel of Anna apple during 5th to 16th week after full bloom.

Table 13 The average total chlorophyll content (mg/gm peel) of fruit of Anna apple during 5th to 16th week after full bloom.

WAFB	Chlorophyll (mg/gm pell)
5	0.101
6	0.077
7	0.083
8	0.142
9	0.151
10	0.092
11	0.084
12	0.082
13	0.062
14	0.047
15	0.050
16	0.037

Table 14 Showing the average qualities after harvest of Anna apple fruit.

Harvest time (WAFB)	Day after harvest	Skin* ground color (Munsell scales)	flesh firmness (lbs.)	TA (% Malic acid by volume)	TSS (% Brix)	TSS/TA ratio	Vit.C (mg/100 gm fresh wt.)	Total chlorophyll (mg/gm peel)	General appearance
13	1	8/6	11.22	0.95	11.20	11.78	14.78	0.062	normal, unripe
	7	8/10	9.75	0.90	12.75	14.16	14.55	0.105	shrivel
	14	8/12	5.05	0.61	14.25	23.36	25.49	0.044	shrivel
14	1	8/6	10.97	1.42	10.15	7.14	14.29	0.047	normal, unripe
	7	8/10	11.31	0.95	12.30	12.94	19.09	0.078	normal ripening
	14	8/12	3.68	0.48	14.25	25.52	18.47	0.032	over ripe and brown softening at calyx end
15	1	8/8	8.87	0.81	11.40	14.07	22.34	0.050	normal
	7	8/12	8.93	1.53	13.15	8.59	11.86	0.038	normal
	14	8/12	2.00	0.53	12.50	23.58	20.75	0.023	over ripe and brown softening at calyx end
16	1	8/8	7.50	0.71	11.05	15.56	22.84	0.037	normal
	7	8/12	6.97	1.47	13.65	9.28	12.29	0.023	normal
	14	8/12	0.30	0.35	13.00	37.14	20.40	0.028	over ripe and brown softening at calyx end

*2.5 GY 8/... is value, .../6-12 chroma

Yellowish color is intensify from the chroma 6-12.

Table 15 Showing the average sensory scores of anna apples harvested at 13, 14, 15 and 16 weeks after full bloom. Sensory scores ranged from 1 to 5 for taste, aroma and firm ness and from 1 to 9 for acceptability

Harveste date (WAFB)	Taste (sweetnesa and acidity)			aroma			textures			acceptability		
Day(s) after harvest	1	7	14	1	7	14	1	7	14	1	7	14
13	1.7	2.5	3.4	1.0	1.1	1.3	4.9	3.9	3.4	2.8	3.3	2.6
14	2.4	3.6	3.9	1.0	2.2	3.4	4.8	3.9	2.8	3.7	4.2	3.3
15	2.6	3.9	-*	1.4	2.7	4.6	4.5	3.7	-*	4.0	5.2	-*
16	2.6	3.7	-*	1.1	2.6	4.5	4.2	3.1	-*	4.1	3.1	-*

taste : 1 = very sour 2 = moderate sour 3 = less sour 4 = sweet sour 5 = sweet

aroma : 1 = fresh aroma 2 = slightly ripe 3 = moderate ripe 4 = very ripe 5 = over ripe

texture : 1 = very soft 2 = slightly soft 3 = less crispy 4 = moderate crispy 5 = very crispy

acceptability : 1 = dislike extremely 2 = dislike very much 3 = dislike moderately 4 = dislike slightly 5 = neither like nor dislike 6 = like slightly 7 = like moderately 8 = like very much 9 = like extremely

*quality lost

Fig.20 Showing the flowers of Anna apple that were tagged on 19 Feb.1986.

Fig.21 Showing the fruits of Anna apple that were wrapped at 9th week after full bloom.

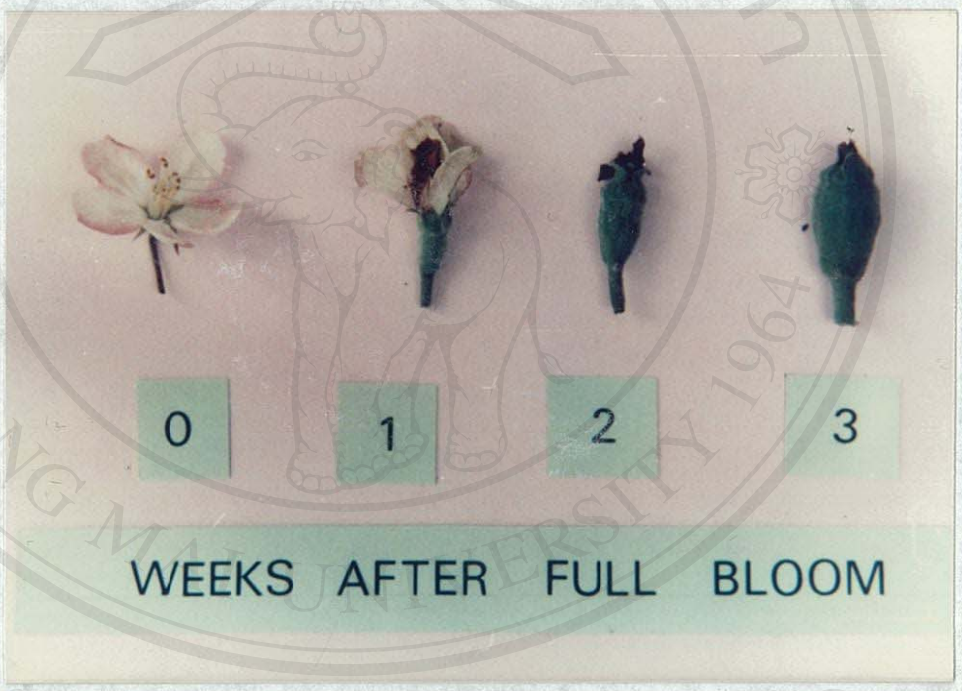

Fig. 22 Showing the stage of fruit growth and development of Anna apple after full bloom to 3 weeks after full bloom (WAFB).

Fig. 23 Showing the changes of fruit shape and size of Anna apple from 4 to 7 weeks after full bloom.

Fig. 24 Showing the changes of fruit shape and size of Anna apple from 8 to 11 weeks after full bloom.

Fig.25 Showing the changes of fruit shape and size of Anna apple from 12 to 14 weeks after full bloom.

Fig.26 Showing the changes of fruit shape and size of Anna apple from 15 to 16 weeks after full bloom.

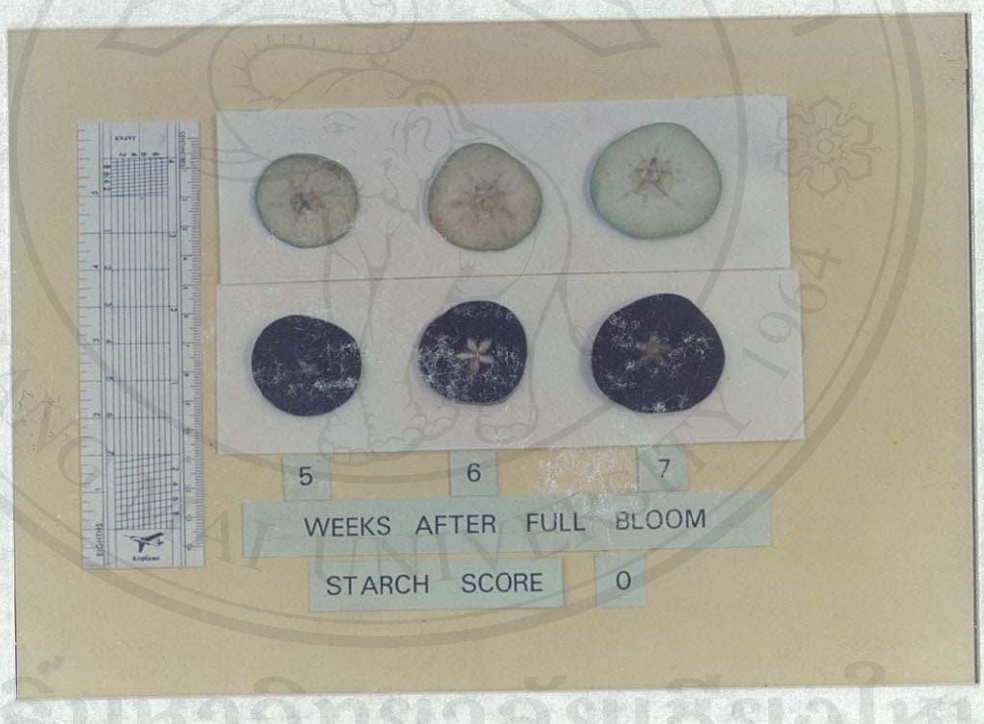

Fig.27 Showing the starch-iodine test of 5, 6 and 7 weeks after full bloom Anna apple.

Fig. 28 Showing the starch-iodine test of 8, 9, 10 and 11 weeks after full bloom Anna apple.

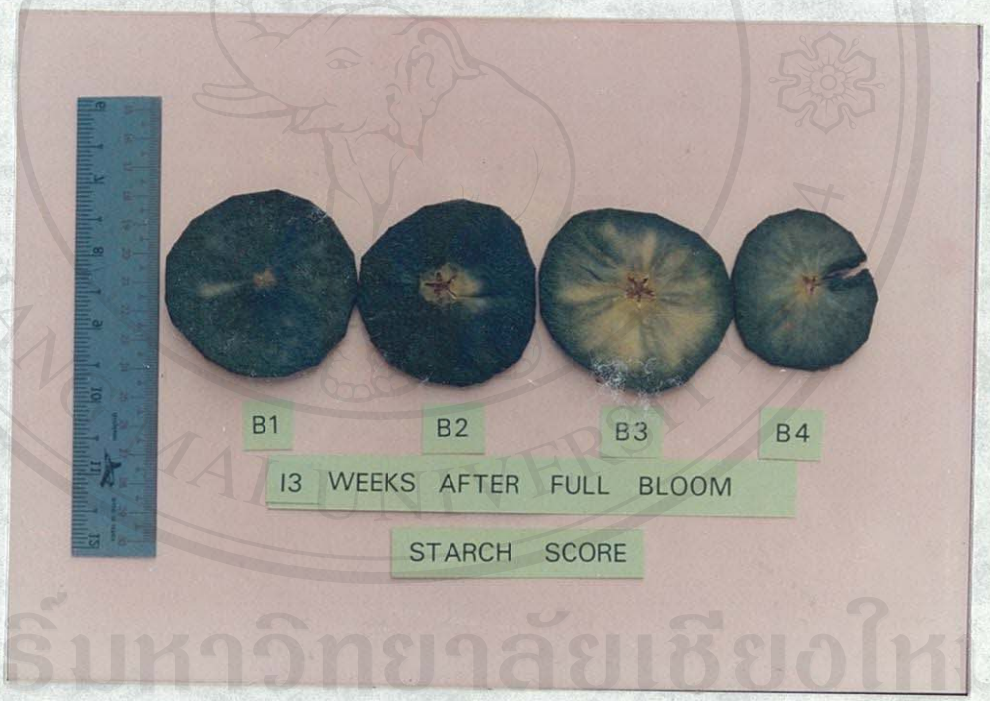

Fig.29 Showing the starch-iodine test of 13 weeks after full bloom Anna apple.

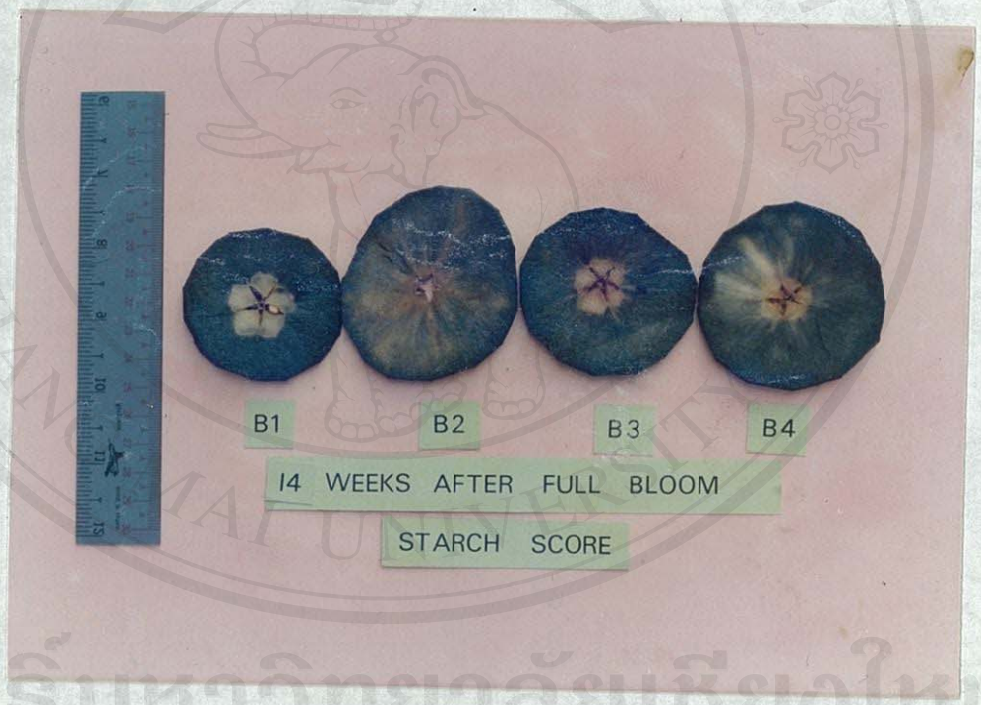

Fig.30 Showing the starch-iodine test of 14 weeks after full bloom Anna apple.

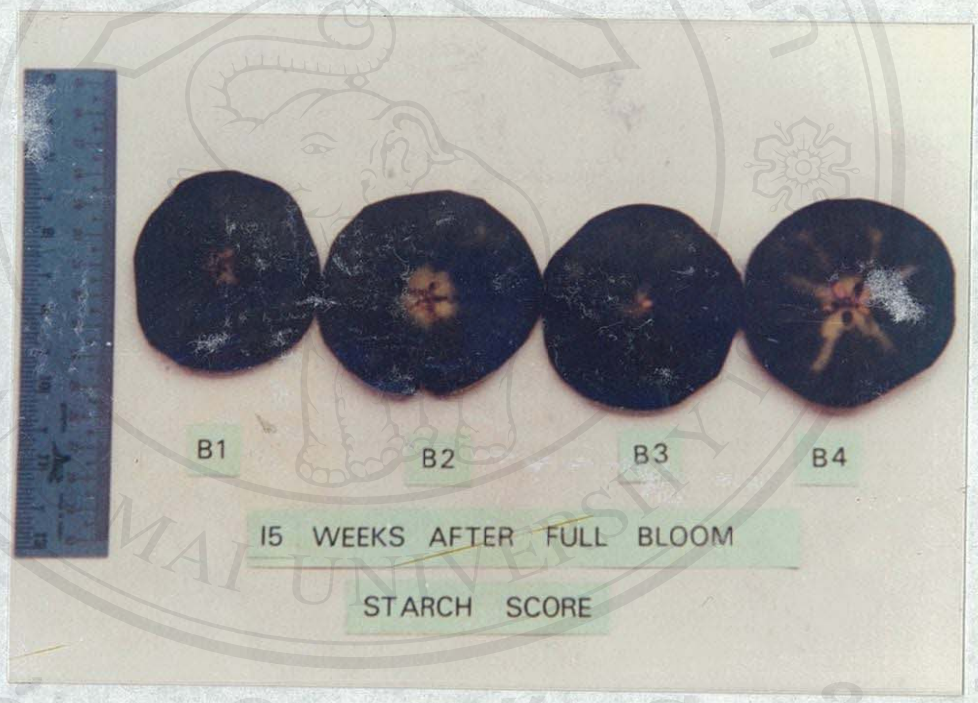

Fig.31 Showing the starch-iodine test of 15 weeks after full bloom Anna apple.

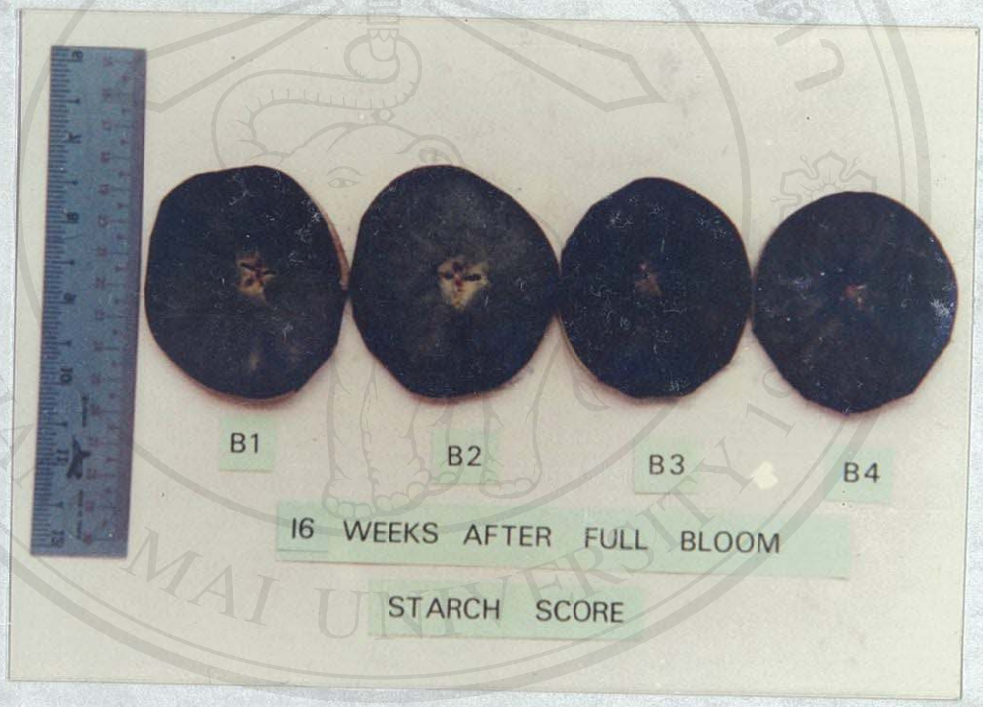

Fig.32 Showing the starch-iodine test of 16 weeks after full bloom Anna apple.