Chapter V

Results of Field Experiment

5.1 Climatic data during the period of grafting

5.1.1 Rainfall

Since, field experiment was carried out from June 2002 to February 2003, the maximum monthly rainfall during that time was 1328.4 mm. Much greater rainfall was recorded at 281.2 mm in September 2002. In contrast, the less rainfall was obtained at 24.0 mm in January 2003 and no rains was found in February 2003. The month, which had many rainy days was August (25 days) and the total rainy days was 107 days (Figure 9A)

5.1.2 Temperature

Temperature data of Irrigated Agricultural Research Station (IARS) during the period of the experiment is presented in Figure 9B. The data showed that the monthly average temperature was 25.8^{o}C. Average minimum temperature was recorded at 20.7^{o}C and monthly minimum temperature was found at 15.8^{o}C in February 2003. And in this month maximum monthly temperature was 33.1^{o}C .

Figure 10 presents temperature in the nursery during the period of stone grafting from July to October. The data showed that minimum temperature was recorded at 20 ^{o}C in October and maximum temperature was recorded at 37^{o}C in July and August. However, average monthly minimum temperature was 24.0^{o}C and average monthly maximum temperature was 34.9^{o}C. And 29.4^{o}C was recorded as mean temperature. As observed, the mean temperature in the nursery was higher than temperature in the IARS by 3.7^{o}C, due to 80% shading material covered.

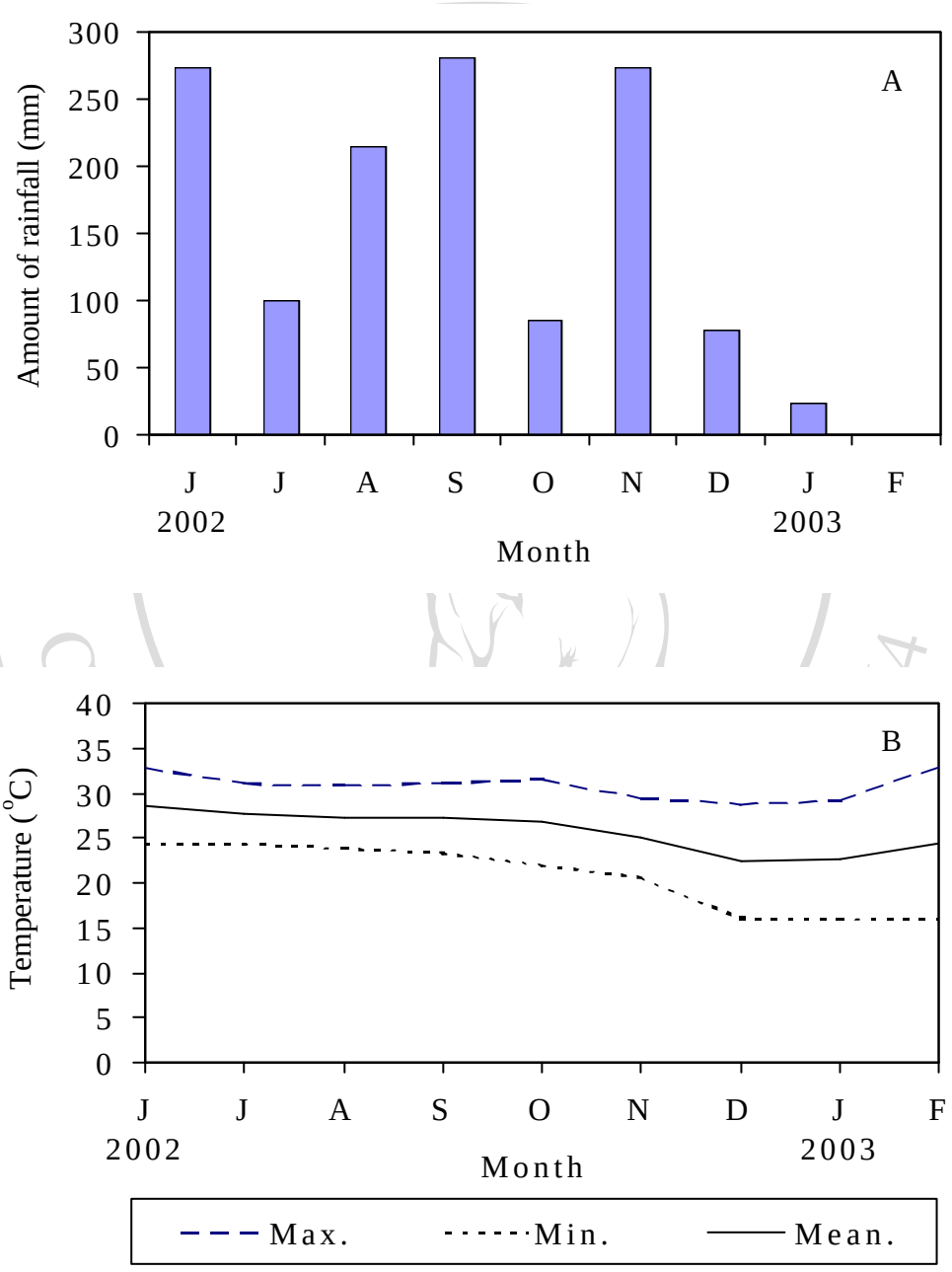


Figure 9 Monthly climatic data at the Irrigated Agricultural Research Station, Faculty of Agriculture, Chiang Mai University, Chiang Mai Province during June 2002 to February 2003 (A) Amount of rainfall (mm) and (B) average of maximum, minimum and mean temperature (^{o}C)

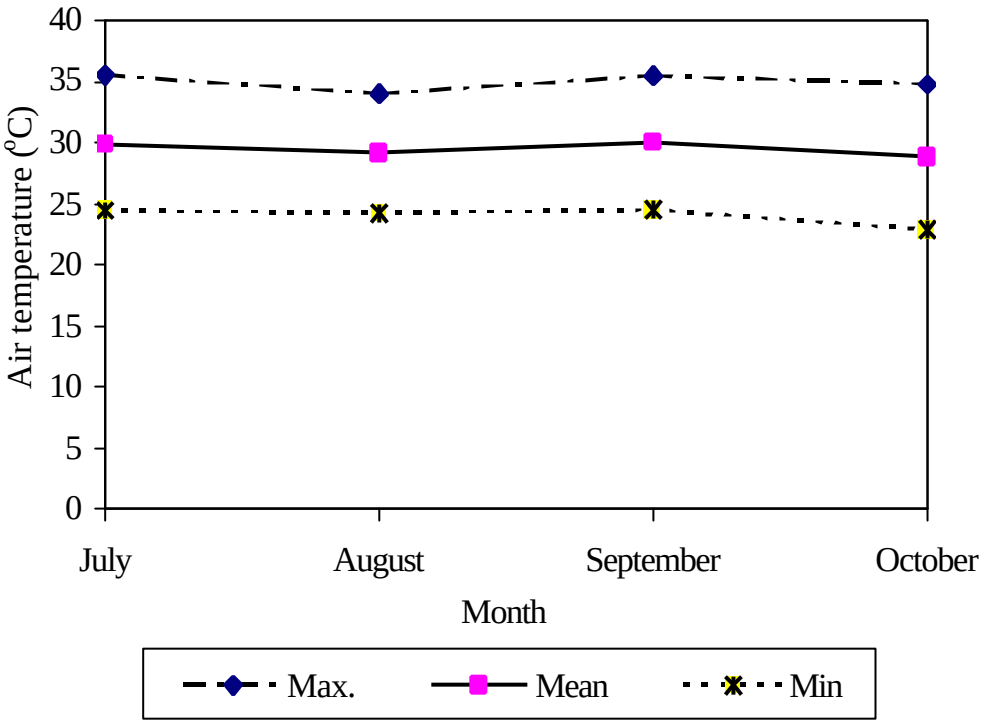


Figure 10 Average of maximum, minimum and mean air temperature (°C) during the period of stone grafting in the nursery

5.2 Grafting of cv. Kaew scions on old seedlings

5.2.1 Survival of cv. Kaew scions

Survival of cv. Kaew scions at 20 DAG

Grafting of Kaew scions on old Tlap-Nak seedling rootstocks was done on July 13, 2002. The data in Table 5.1 showed that at 20 DAG (days after grafting) the survival rate ranged from 87.5 to 100%. The 2 and 3 year-old seedling rootstocks had the highest survival rate of 100%, followed by the 1 year-old seedling rootstocks (87.5%), which was significantly different from the first two seedling rootstock ages. During this time Kaew scion were still green, and did not flush yet.

Survival of Kaew scions at 60 DAG

The change in survival rate of Kaew scions on the three aged seedling rootstocks at 60 DAG was presented in Table 18. It was found that the survival rate of all rootstocks declined. However high declining survival rate was recorded on 1 year-old rootstocks (60%), but it was not different from the 3 and 2 year-old rootstocks, which had survival rate of 92.5% and 80% respectively.

Table 18 Survival of Kew scions on old Tlab-Nak seedling rootstocks at 20 and 60 DAG

Age of seedling rootstocks	% of survival[1]	
	20 DAG	60 DAG
1 year-old	87.5 b	60.0
2 year-old	100.0 a	80.0
3 year-old	100.0 a	92.5
$LSD_{0.05}$	9.6	ns
C.V. (%)	5.8	22.2

[1] Different alphabets represent statistical significance

5.2.2 Duration of new flushing

After Kaew scions were grafted on all old aged Tlap-Nak rootstocks and green scions started flushing. It is noted that, scions on the 3 year-old rootstocks took relatively shorter time than the other (58.3 days), while scions on the 2 and 1 year-old rootstocks took 60.7 and 66.4 days respectively (Table 19). However, there was no significant difference among the treatments.

Table 19 Duration for the new flushing of Kaew scions after grafting on old Tlab-Nak seedling rootstocks

Age of seedling rootstocks	Duration for flushing (days)
1 year-old	66.4
2 year-old	60.7
3 year-old	58.3
LSD 0.05	ns
C.V. (%)	12.4

5.2.3 Growth

5.2.3.1 Stem diameter of old aged rootstocks

As observed, stem diameter of all aged rootstocks was not the same at the beginning of grafting. Among them stem diameter of the 2 year-old rootstocks was bigger than the other (1.5 cm), followed by the 3 and 1 year-old rootstocks, which had stem diameter of 1.2 and 0.86 cm respectively. After Kaew scions were grafted in July 2002 and continued until December 2002 (150 days), stem diameter growth rate of all three aged rootstocks increased in the same direction. However, there was no difference among them (Figure 11).

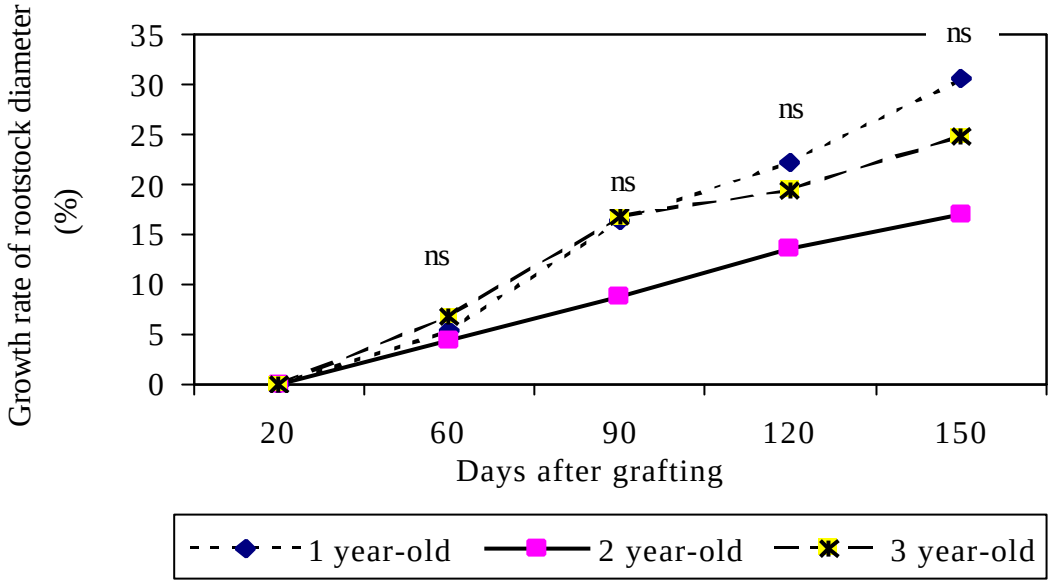


Figure 11 Growth rate of rootstock diameter of the old Tlap-Nak seedling rootstocks

5.2.3.2 Grafted union diameter

Grafted union diameters of all aged grafted seedlings were different from one another, due to various rootstock diameter at the beginning of grafting. From the measurement at 20 DAG, it was noticed that grafted union diameter of the 2 year-old rootstocks (2.0 cm) was relatively bigger than the other, followed by 3 and 1 year-old grafted seedlings, which had grafted union diameter of 1.6 cm and 1.0 cm respectively. Thereafter till the 150 DAG, it was found that grafted union diameter growth rate of all aged grafted seedlings increased in the same direction. There was no difference among the treatments at 60 DAG. At 90 and 120 DAG, the difference of grafted union diameter growth rate was found among the 1 and 2 year-old grafted seedlings 18.6, 24.5% and 4.2, 6.2% respectively, while the grafted union growth rate of the 3 year-old grafted seedlings was different from two aged rootstocks mentioned above. Thereafter, at 150 DAG, the grafted union diameter growth rate of the 1 year-old grafted seedlings was significantly higher than those on the 3 and 2 year-old grafted seedlings as 35.3, 19.3 and 12.5% respectively (Figure 12).

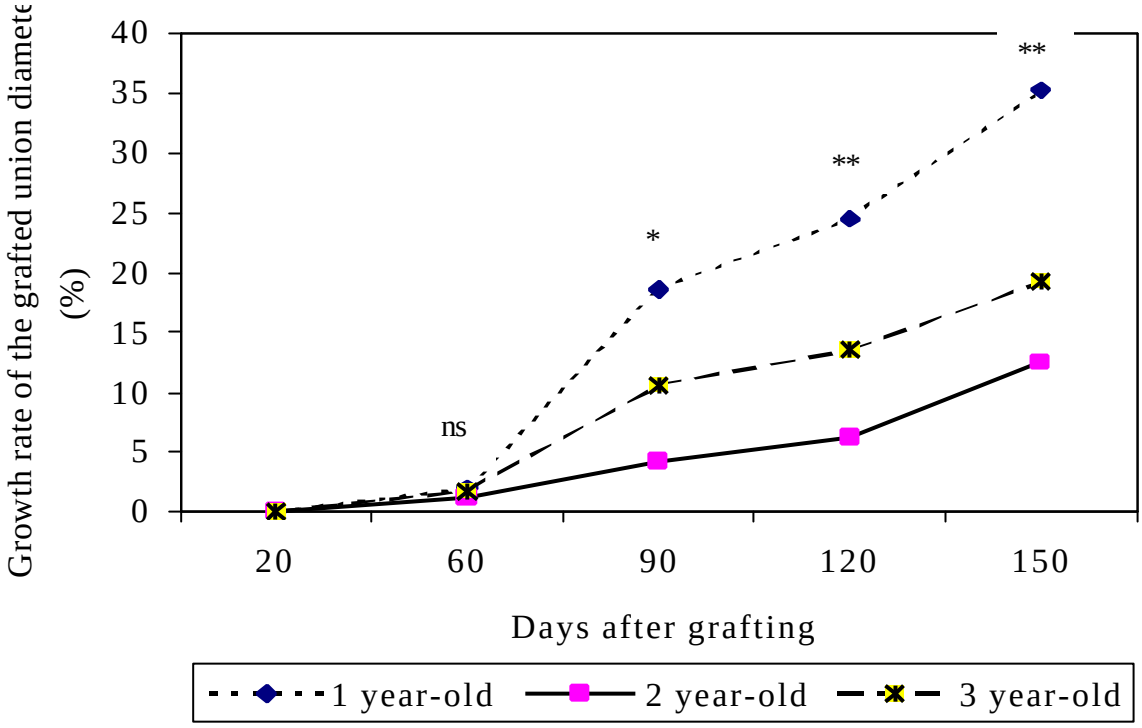


Figure 12 Growth rate of the grafted union diameter for the old seedling rootstocks

5.2.3.3 Scion diameter

Scion diameters were measured at the marked level on stem of scions at five centimeter above the point of flushing. From observation, scions on all aged rootstocks flushed almost at the same time in the middle of September (60 DAG). The result in Figure 13 showed that scion diameters on all aged rootstocks had the same pattern of growth within the first 150 DAG. However, scion diameters on the 2 and 3 year-old rootstocks (as 0.4, 0.5, 0.5 and 0.6 cm and 0.4, 0.4, 0.5 and 0.5 cm) were greater than one on 1 year-old rootstocks (as 0.2, 0.3, 0.3 and 0.4 cm) respectively throughout the period of the study.

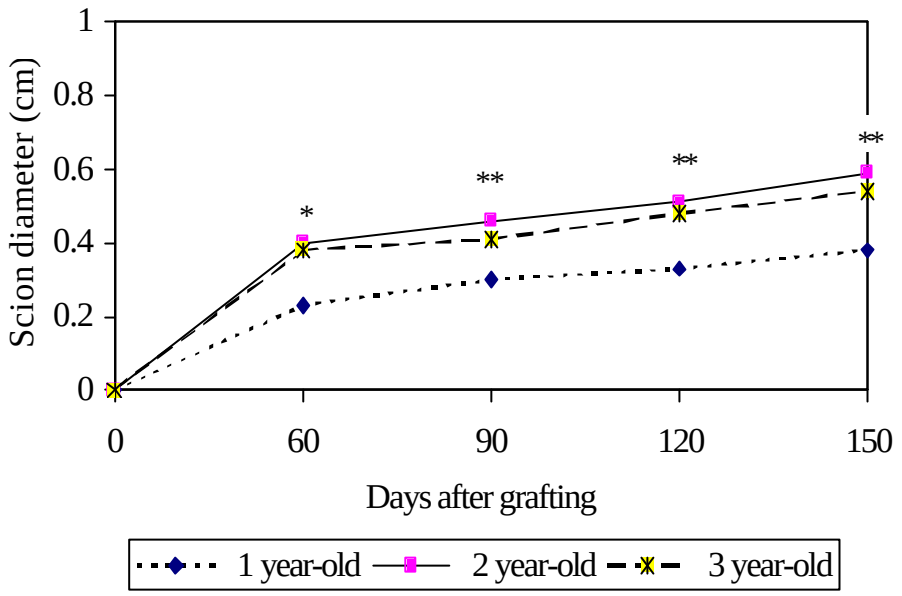


Figure 13 Diameter of Kaew scions on the old Tlap-Nak rootstocks at different days after grafting

5.2.3.4 Length of new scions

Since scions on all aged rootstocks flushed nearly at the same time at the 60 DAG in September 2002, but the new scion length on 1 year-old rootstocks was the shortest (3.0, 7.0, 8.8 and 11.5 cm) at 60, 90, 120 and 150 DAG, while the 2 and 3 year-old rootstocks, which had the longer scion length of 11.6, 14.7, 25.4 and 28.2 cm, and 11.1, 13.7, 21.9 and 24.5 cm respectively (Figure 14).

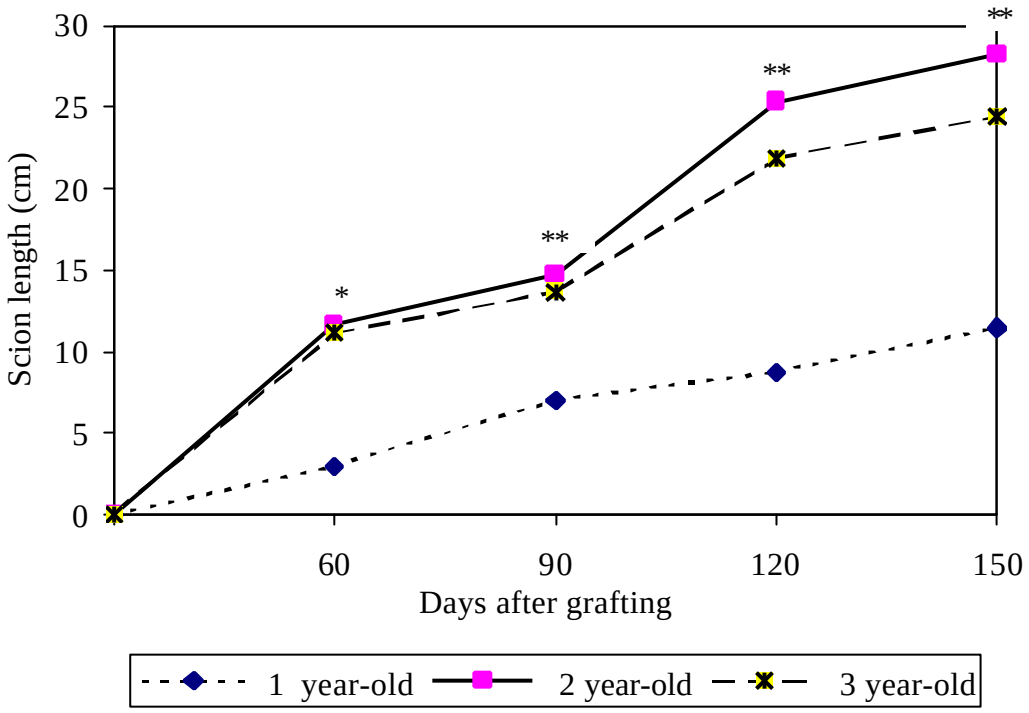


Figure 14 Length of Kaew scions on the old Tlap-Nak rootstocks at different days after grafting

5.2.3.5 Number of new leaves

As observed, scions on the 3 year-old rootstocks firstly flushed as early as 58 DAG, followed by the 2 and 1 year-old rootstocks, which flushed later at 60 and 66 DAG respectively. It was noticed that numbers of new leaves on the 3 and 2 year-old rootstocks at 60 DAG were different from the 1 year-old rootstocks. Of which 9.5 leaves, were accounted for the scion on the 3 year-old rootstocks, 9.3 leaves were accounted for the 2 year old rootstocks and the smallest number of 5.8 leaves were accounted for the 1 year-old rootstocks (Figure 15). The difference of number of leaves was also found among the 3 and 1 year-old rootstocks at 90 DAG (9.5 and 5.6 leaves respectively), while the leaf number of the 2 year-old rootstock (8.3 leaves) was not different from two aged rootstocks mentioned above. Thereafter, number of leaves of all aged rootstocks were

not different. It was observed that at the 150 DAG the number of leaves of all aged rootstocks slighly dropped.

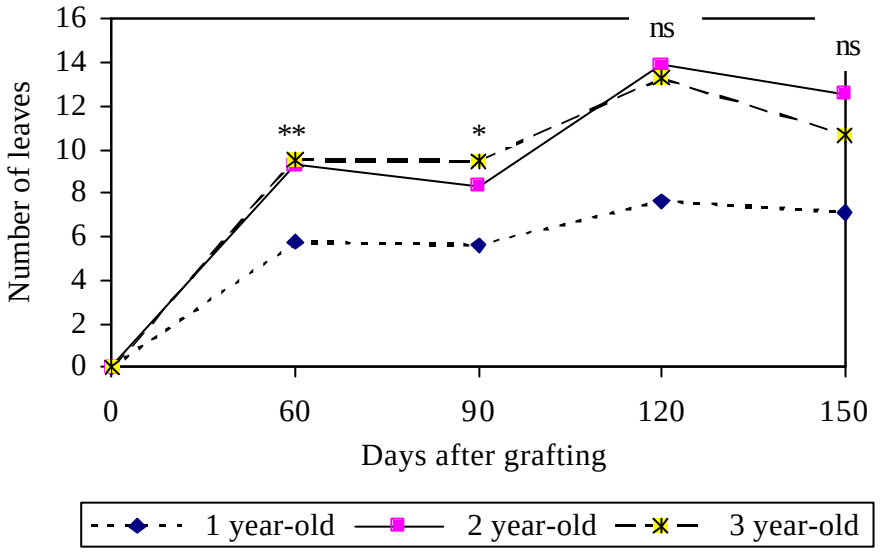


Figure 15 Number of leaves of Kaew scions on the old Tlap-Nak rootstocks at different days after grafting

5.3 Grafting of cv. Kaew scions on young seedling rootstocks (stone grafting)

For stone grafting the seeds of mango cv. Tlap-Nak were sown to get young seedling rootstocks with seven different ages, which ranged from 5 to 35 day-old and with five days interval. In this case, the mango fruits were bought from Chiang Dao district. Before sowing fruit weight, fruit size, seed weight and seed size were measured in order to find out the correlation between these parameters and seed germination and scion survival rate and growth parameters after stone grafting was done.

5.3.1 Fruit weight and fruit size

Data of fruit weight and fruit size of mango cv. Tlap-Nak was presented in Table 20. From the measurement, it was found that the maximum weight was recorded at 569.8

g/fruit and minimum weight was 149.9 g/fruit. And 346.3 g/fruit was accounted as average weight.

Fruit length ranged from 6.6 to 11.8 cm, and the average fruit length was measured at 9.2 cm. Fruit width varied from 6.8 to 11.4 cm, with an average fruit width of 9.1 cm. The maximum fruit thickness was recorded at 8.9 cm, while the minimum thickness was 5.3 cm and 7.6 cm was accounted as average fruit thickness. It was found that fruit weight had high correlation with its size and seed parameters (Appendix B3)

Table 20 Fruit weight and fruit size of mango cv. Tlap-Nak (rootstock cultivar)

Fruit item	Maximum	Minimum	Mean	SD
Weight (g)	569.8	149.9	346.3	± 88.9
Length (cm)	11.8	6.6	9.2	± 1.0
Width (cm)	11.4	6.8	9.1	± 0.9
Thickness (cm)	8.9	5.3	7.6	± 0.8

5.3.2 Seed weight and seed size

Data of seed weight and seed size of mango cv. Tlap-Nak is presented in the Table 21. From the measurement, it was found that the maximum weight was recorded at 39.3 g/seed and minimum weight was 8.3 g/seed. And 24.7 g/seed was accounted as average weight.

Seed length ranged from 4.1 to 7.5 cm and the average seed length was measured at 5.9 cm. Seed width varied from 1.9 to 4.6 cm with an average seed width of 3.2 cm. The maximum seed thickness was recorded at 2.5 cm, while the minimum thickness was 1.2 cm and 1.8 cm was accounted as average seed thickness.

It was noticed that as the fruit weight, fruit length, fruit width and fruit thickness were high; the seed weight, seed length, seed width and seed thickness also had a trend in the same manner, and high correlation was found between seed weight and its size parameters (Appendix B3).

Table 21 Seed weight and seed size of mango cv. Tlab-Nak (rootstock cultivar)

Seed item	Maximum	Minimum	Mean	SD
Weight (g)	39.3	8.3	24.7	± 6.4
Length (cm)	7.5	4.1	5.9	± 0.7
Width (cm)	4.6	1.9	3.2	± 0.4
Thickness (cm)	2.5	1.2	1.8	± 0.2

5.3.3 Percentage and duration of seed germination

Seed sowing was done totally four times at different time due to different maturity of fruits and there was not enough seedling rootstocks for stone grafting. The data in Table 22 showed that percent of seed germination of mango cv. Tlap-Nak, which was sown at the second and fourth time was as high as 83.8 and 83.3% respectively, while the seeds, which were sown at the first and third time had low per cent of seed germination as 82.9 and 72.2 respectively. However, the average percent of seed germination was recorded at 80.5.

As observed, seeds of mango cv. Tlap-Nak used at least 10 days for germination, and it could be extended to 27 days as maximum duration. However, average time of 13.9 days (nearly two weeks) were needed for seed germination (Table 23).

5.3.4 Number of shoots per seed

Seeds of mango c.v. Tlap-Nak performed a different pattern of change in number of sprouts per seed. It was found that number of seedlings per seed varied from one to five. A total 2.4 shoots per seed was accounted as average number (Table 23).

Table 22 Seed germination of mango cv. Tlab-Nak (rootstock cultivar)

Time of sowing	Date of sowing	No. of seeds sown	Percent of seed germination
1st time	16/6/2002	70	82.9
2 nd time	20/6/2002	240	83.8
3 rd time	10/8/2002	36	72.2
4th time	17/8/2002	12	83.3
Mean		358	80.5

Table 23 Duration of seed germination, number of shoots per seed and stem diameter of Tlap-Nak seedlings

Item	Maximum	Minimum	Mean	SD
• Duration of seed germination (days)	27.0	10.0	13.9	±4.5
• No. of shoots per seed	5.0	1.0	2.4	±1.1
• Stem diameter (cm)	0.5	0.2	0.4	±0.1

5.3.5 Stem diameter of young Tlap-Nak seedlings at grafting day

Before stone grafting was done, stem diameter of all seedling ages were measured. It was found that stem diameter of seedlings ranged from 0.2 to 0.5 cm, and majority of seedlings had stem diameter of 0.4 cm, which was big enough and suitable for grafting (Table 23).

5.3.6 Survival of cv. Kaew scions

Survival of Kaew scions at 20 DAG

Grafting of Kaew scions on young Tlap-Nak seedling rootstocks was done at different time when the seedlings reached the specified ages. The suvival rate of Kaew scions on all young aged seedlings at 20 DAG is presented in Table 24. It showed that at 20 DAG the survival rate ranged from 23.3 to 56.7%, which was no significant difference.

Survival of Kaew scions at 60 DAG

The change in survival rate of Kaew scions on the seven young aged seedling rootstocks at 60 DAG is presented in Table 24. The use of different young ages of rootstocks affected significant differences in scion survival rate. The data showed that the survival rate of all young aged seedling rootstocks declined, in which the highest survival rate among them was recorded on 5 day-old seedling rootstocks (47.6%), while the lowest survival rate was found on the 20 and 25 day-old seedling rootstocks (3.3 and 6.7% respectively). Since the 20 day-old seedling rootstocks (Treatment No. 4) had the lowest scion survival rate and as a consequence, a large number of missing data especially the growth data, which will be a cause of error for the experiment, so it was dropped from the experiment. So calculation and analysis of duration of first flushing and growth data were done only for the six remaining treatments.

5.3.7 Duration of new flushing

After Kaew scions were grafted on all young aged Tlap-Nak rootstocks, number of days was counted until the green scions started flushing. From the record, scions on the 25 day-old rootstocks took time for flushing as short as 30.3 days. However, the scions flushed within 30.3-70.9 days, which were no statistical difference among the treatments (Table 25).

Table 24 Survival rate of Kaew scions on young Tlab-Nak seedling rootstocks at 20 and 60 DAG

Age of seedling rootstocks	% of survival	
	20 DAG	60 DAG
5 day-old	52.4	47.6a
10 day-old	46.7	26.7abc
15 day-old	30.0	23.3bcd
20 day-old	23.3	3.3d
25 day-old	30.0	6.7cd
30 day-old	56.7	23.3bcd
35 day-old	56.7	30.0ab
$LSD_{0.05}$	ns	22.9
C.V. (%)	38.2	55.2

Table 25 Duration of the new flushing of Kaew scions after grafting on young Tlab-Nak seedling rootstocks

Age of seedling rootstocks	Duration (days)
5 day-old	68.8
10 day-old	70.9
15 day-old	59.2
25 day-old	30.3
30 day-old	65.4
35 day-old	35.7
$LSD_{0.05}$	ns
C.V. (%)	39.7

5.3.8 Growth

5.3.8.1 Stem diameter of young Tlap-Nak seedlings

Stem diameter of all young rootstocks was not statistically different among them at the 20 DAG. Although stem diameter of the 35 day-old rootstocks was relatively bigger than the other (0.48 cm). After Kaew scions were grafted from 20 DAG till 150 DAG the stem diameter growth rate of all young rootstocks increased in the same direction. The change of growth rate in term of stem diameter is illustrated in Figure 16. The result showed that at the 120 and 150 DAG, stem diameter growth rate of the 5, and 10 day-old rootstocks were higher 63.8 and 82.3%, and 58.9 and 80.4% respectively, which was significantly different from another treatments.

5.3.8.2 Grafted union diameter

Grafted union diameter of all aged grafted seedlings were not different from one another. Although at the 20 DAG, it was noticed that grafted union diameter of the 30-day-old rootstocks (0.66 cm) was relatively bigger than the other. Thereafter, it was found that grafted union diameter growth rate of all aged grafted seedlings increased in the same direction with non-significant different values till 150 DAG. Although, the grafted union diameter growth rate of the 5 day-old grafted seedlings was relatively outstanding at all observed days (Figure 17).

5.3.8.3 Scion diameter

Data in Figure 18 showed that scion diameter on all aged rootstocks had slightly increased in the same direction from 20 DAG to 150 DAG. In which scion diameter on the 15 day-old rootstocks was relatively greater (0.62 cm) than those on the 25, 5, 35, 30 and 10 day-old rootstocks. However there was no significant difference from one another.

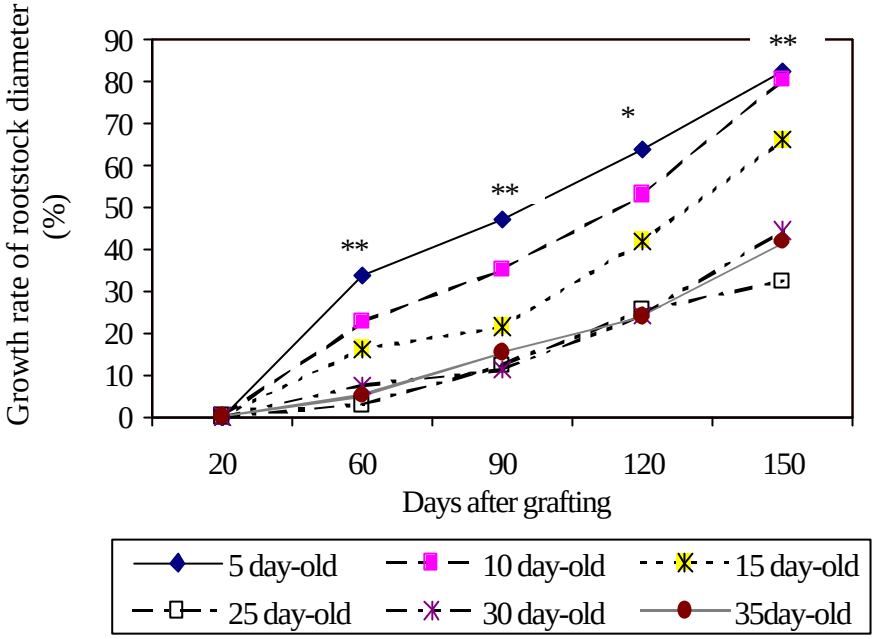


Figure 16 Growth rate of rootstock diameter of the young Tlap-Nak seedlings

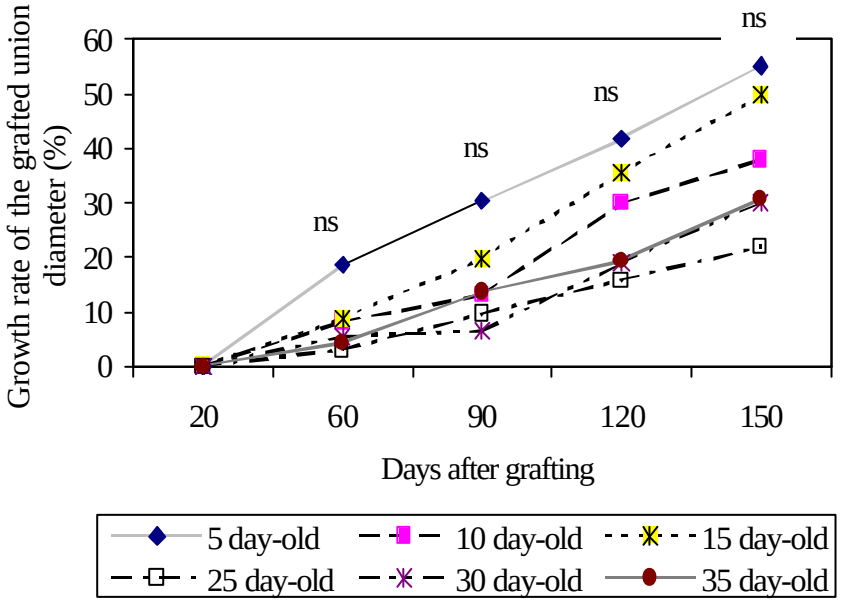


Figure 17 Growth rate of the grafted union diameter of the young grafted seedlings

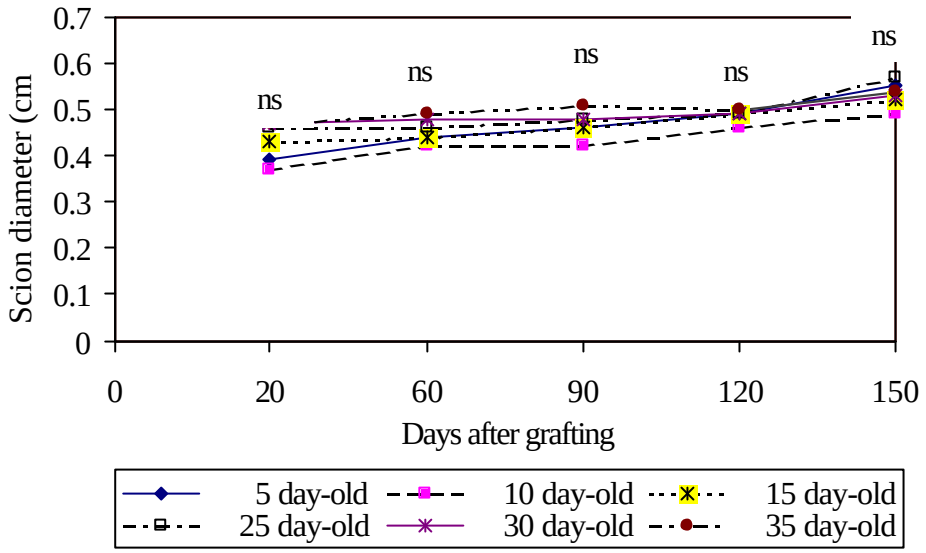


Figure 18 Scion diameter on the young Tlap-Nak rootstocks at different days after grafting

5.3.8.4 Length of scions

Since scions on all aged rootstocks flushed at different time, which started from 35.7 DAG (35 day-old rootstocks) to 70.9 DAG (10 day-old rootstocks). There were no statistical difference among the treatments. The maximum value, however, was 20.1 cm as observed on 35 day-old rootstocks at 150 DAG. While, the smallest value was 13.8 cm as observed on the 10-day-rootstocks (Figure 19).

5.3.8.5 Number of new leaves

It was found that numbers of new leaves on all aged rootstocks at 60 DAG, 90 DAG and 120 DAG were not significantly different. However, the largest number of leaves was recorded at 14.4 leaves for the 35 day-old rootstocks at 150 DAG. And the smallest number was recorded at 8 leaves for the 10 day-old rootstocks (Figure 20). It was noticed that number of leaves of all aged rootstocks except the 5, 30 day-old rootstocks dropped at the 150 DAG due to leaf drop caused by insects and diseases.

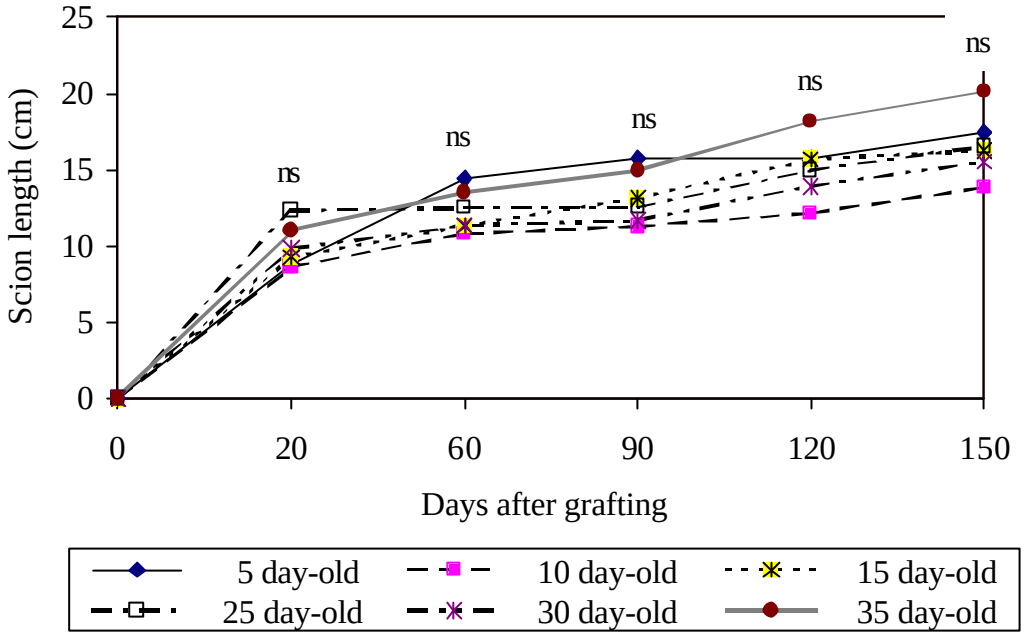


Figure 19 Length of Kaew scions on the young Tlap-Nak rootstocks at different days after grafting

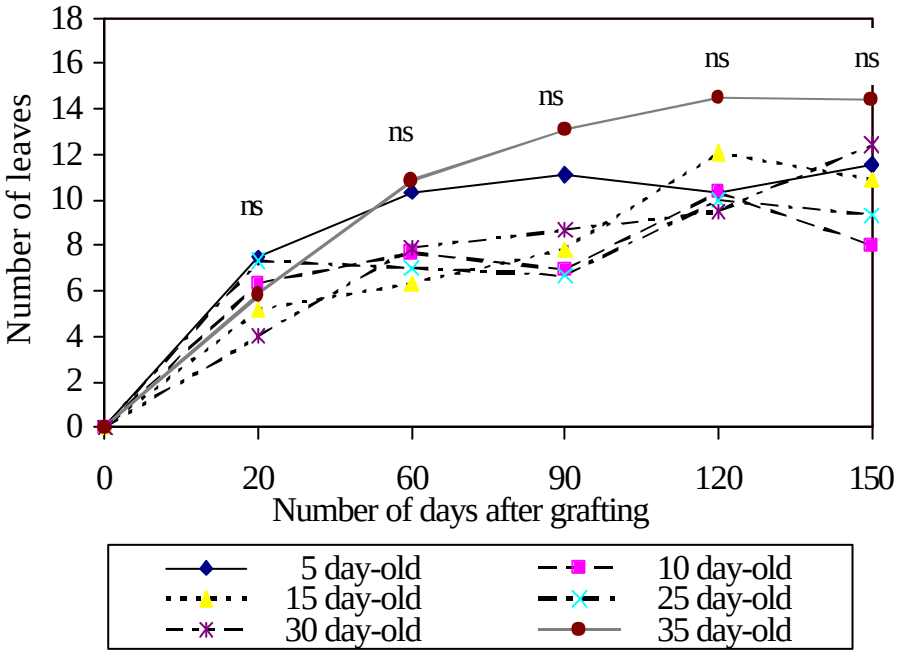


Figure 20 Number of new leaves of Kaew scions on the young Tlap-Nak rootstocks at different days after grafting

5.4 Economic assessment

The study consisted of two experiments i.e. grafting on old seedlings, which included three treatments and grafting on young seedlings (stone grafting), which included seven treatments. The invested costs and gross margin that vary for each management practice in treatments was calculated in US$ per 100 seedlings for both old and young seedlings.

For the grafting on old seedlings, the labor costs were equivalent to US$ 16.8 for each treatment. The amount of US$ 21.4, 31.4 and 41.4 were accounted for material cost of 1, 2 and 3 year-old rootstocks respectively (Table 26).

For the grafting on young seedlings, the labor costs were equivalent to $US 20 for each treatment. The amount of US$ 3.7 was counted for material cost of each treatment (Table 27).

The best treatment in term of economic aspect was assessed by the total costs that vary with treatment and gross margin that vary per surviving grafted seedling.

For the grafting on old seedlings, the results showed that the 3 year-old rootstocks which had relatively high survival rate or large number of surviving grafted seedlings. Its invested costs were the highest at US$ 0.6 per graft, but its gross margin/100 grafts was higher (US$ 34.8) than 2 and 1 year-old rootstocks. The two later treatments had relatively lower invested costs of US$ 48.2 and 38.2 respectively, while their gross margin/100 grafts was also lower as US$ 31.8 and 21.8 respectively, due to low survival rate (Table 26).

For the grafting on young seedlings, the results showed that all aged rootstocks had an equal invested costs of US$ 23.7. It was found that the 5 day-old rootstocks (1st treatment) had the highest gross margin (US$ 24.3/100 grafts) among them and closely followed by the 35 and 10 day-old rootstocks (7th and 2nd treatment), which showed the value of US$ 6.3 and 3.3/100 grafts respectively. In contrast the 20 day-old (4th treament) showed the negative value of US$ -20.7/100 grafts, because it had the lowest survival rate (only 3 seedlings survived). The rest of the treatments are arranged in order as shown in Table 27.

It is evidence that invested costs and gross margin of each treatment in side veneer grafting varied from the ages of rootstocks and survival rate. While, for stone grafting they varied and depended only on their survival rate. As the survival rate of the grafts was high, the gross margin also performed in the same manner. In contrast, the more age of rootstocks the higher invested costs were obtained.

Table 26 Invested costs and gross margin of producing 100 grafts of side veneer grafting (in US$)

Item	Treatment		
	1 year-old	2 year-old	3 year-old
• Material costs			
1. Seedling rootstocks	20.0	30.0	40.0
2. Fertilizers	1.0	1.0	1.0
3. pesticides	0.4	0.4	0.4
Total of material cost	**21.4**	**31.4**	**41.4**
• Labor costs			
1. Nursery ground preparation	0.7	0.7	0.7
2. grafting	11.6	11.6	11.6
3. Spraying	1.4	1.4	1.4
4. Watering	2.4	2.4	2.4
5. Fertilizer application	0.7	0.7	0.7
Total of labor cost	**16.8**	**16.8**	**16.8**
Total costs/100 grafts	38.2	48.2	58.2
Invested costs per 1 graft	0.4	0.5	0.6
Price of 1 graft	1.0	1.0	1.0
Percent survival of the grafts	60.0	80.0	92.5
Number of surviving grafts	60.0	80.0	93.0
Revenue/100 grafts	60.0	80.0	93.0
Gross margin/100 grafts	21.8	31.8	34.8
Order	3	2	1

Note: US$ 1=43 Baht

Table 27 Invested costs and gross margin of producing 100 grafts of stone grafting

(in US$)

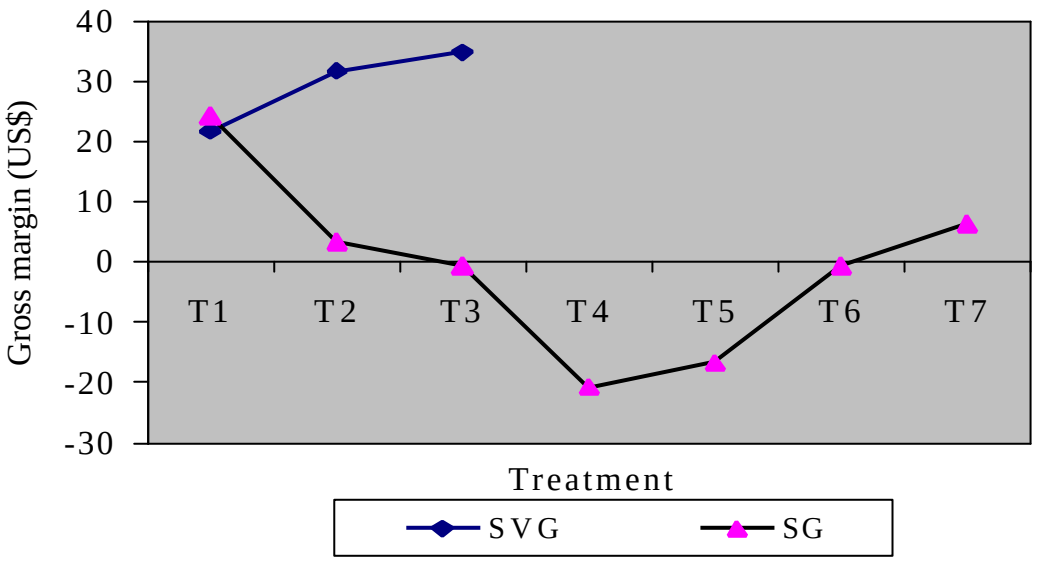
Item	Treatment						
	5 day-old	10 day-old	15 day-old	20 day-old	25 day-old	30 day-old	35 day-old
• Material costs							
1. Mango seeds	1.5	1.5	1.5	1.5	1.5	1.5	1.5
2. Black plastic bags	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3. Fertilizers	0.8	0.8	0.8	0.8	0.8	0.8	0.8
4. Pesticides	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total of material cost	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**
• Labor costs							
1. Nursery ground preparation	0.7	0.7	0.7	0.7	0.7	0.7	0.7
2. Media preparation	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3. Fruit peeling	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4. grafting	11.6	11.6	11.6	11.6	11.6	11.6	11.6
5. Spraying	1.4	1.4	1.4	1.4	1.4	1.4	1.4
6. Watering	2.4	2.4	2.4	2.4	2.4	2.4	2.4
7. Fertilizer application	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total of labor cost	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**
Total costs/100 grafts	23.7	23.7	23.7	23.7	23.7	23.7	23.7
Invested costs per 1 graft	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Price of 1 graft	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Percent survival of the grafts	47.6	26.7	23.3	3.3	6.7	23.3	30.0
Number of surviving grafts	48.0	27.0	23.0	3.0	7.0	23.0	30.0
Revenue/100 grafts	48.0	27.0	23.0	3.0	7.0	23.0	30.0
Gross margin/100 grafts	24.3	3.3	-0.7	-20.7	-16.7	-0.7	6.3
Order	1	3	4	7	6	4	2

Note: US$ 1=43 Baht

Comparison of gross margin of producing 100 side veneer grafts and stone

grafts.

In producing 100 side veneer grafts and stone grafts. It was found that gross margin of both grafting techniques performed in different pattern. All treatments in side veneer grafting had the higher gross margin than stone grafting, of which the 3 year-old seedling rootstocks had the highest gross margin of US$ 34.8. In contrast, gross margin of all treatments in stone grafting was low (US$ 3.3, -0.7, -20.7, -16.7, -0.7 and 6.3 respectively) except the 5 day-old seedling rootstocks, which had the highest gross margin of US$ 24.3 (Figure 21), It was noticed that gross margin of the 5 day-old seedling rootstocks in stone grafting was higher than gross margin of the 1 year-old seedling rootstocks in side veneer grafting by US$ 2.5.



Note: **SVG = Side veneer grafting**

T1 = 1 year-old rootstock, T2 = 2 year-old rootstock, T3 = 3 year-old rootstock

SG = Stone grafting

T1 = 5 day-old rootstock, T2 = 10 day- otstocks, T3 = 15 day- old rootstocks,

T4 = 20 day-old rootstock, T5 = 2 day-old rootstocks, T6 = 30 day-old rootstocks

T7 = 35 day-old rootstock

Figure 21 Comparison of gross margin of producing 100 side veneer grafts and stone grafts

5.5.1 Survival

Survival of the side veneer grafts

The survival of the side veneer grafts at 60 DAG was brought to consider as one important criteria for making decision which treatment was the best. The results of the first experiment indicated that the 3 year-old treatment had the highest survival rate of 92.5%, followed by the 2 year-old treatment (80%). The lowest survival rate was recorded at 60% for the 1 year-old treatment (Table 5.1)

Survival of the stone grafts

Survival rate of the stone grafts at 60 DAG was presented in the Table 5.7, which revealed that the highest survival rate of 47.6% was obtained from the 5 day-old treatment, and closely followed by the 35 day-old treatment (30%). While the rest of the treatments had the lower percentage, especially the 20 day-old treatment, which had the lowest survival, rate of 3.3% only.

5.5.2 Time consumption of producing grafted materials

5.5.2.1. Time consuming by side veneer grafting

In terms of time consuming, the 3 year-old treatment took the longest time (1,143 days or approximately 3 years and 3 months) from preparing of rootstocks to transplanting or distribution of grafts. While the 2 and 1 year-old treatments took a minimum of 805 days (approximately 2 years and 3 months) and 440 days (approximately 1 year and 3 months) respectively (Table 28). The differences of times were observed at the rootstock preparation period as 1, 2 and 3 years respectively, since care of seedlings was needed until they reached specified ages.

Table 28 Time consuming by the side veneer grafts preparing from different ages of

rootstocks

Treatment	Preparation of rootstocks (days)	Grafting period (days)	Establishing period (days)	Total time consumed (days)
1 year-old	365	45	30	440
2 year-old	730	45	30	805
3 year-old	1095	45	30	1143

5.5.2.2. Time consuming by stone grafting

The time consuming of all treatments varied from each other due mainly to preparation of rootstocks. Younger the seedlings, shorter the time was needed (85 and 91 days for 5 and 10 day-old seedlings). In contrast the more older seedlings the longer time needed to complete the process (111 and 116 days for 30 and 35 day-old seedlings respectively) (Table 29).

Table 29 Time consuming by the stone grafts preparing from different ages of rootstocks

Treatment	Preparation of rootstocks (days)	Grafting period (days)	Establishing period (days)	Total time consumed (days)
5 day-old	5	21	60	86
10 day-old	10	21	60	91
15 day-old	15	21	60	96
20 day-old	20	21	60	101
25 day-old	25	21	60	106
30 day-old	30	21	60	111
5 day-old	35	21	60	116

5.5.3 Feasibility assessment of grafting techniques by the farmers

Feasibility assessment of grafting techniques by the farmers was conducted in February 2003 at the Northern Agricultural and Forestry College, Luang Prabang province. The total of 40 farmers from five villages participated in the workshop. The workshop on feasibility assessment of grafting techniques provided knowledge and skills concerning mango propagating techniques, which were used in the experiment. Thereafter farmers were divided into four groups for the practices. Then farmers were interviewed using questionnaires, which focused mainly on the farmers' preferences i.e. easiness of doing, appropriateness of the grafting techniques to farmers' condition, and effectiveness in the real practices.

Farmers' background

The 40 farmers were selected from five villages in Luang Prabang province namely Wiengsavanh, Pakxeung, Phongnam, Thinchaleun and Phonhsawang. 80% of them were male and 20% were female (Table 30). Among them there were three ethnic groups i.e. Lao Loum (77.5%), Lao Soung (15%) and Lao Theung (7.5%). 100% of farmers were literate, of whom 62.6 had finished primary school, 30% and 7.5% had finished secondary and high school respectively (Table 31).

Table 30 Farmers' profile from five villages in Luang Prabang province

Name of villages	Number of farmers participated				
	Total	Male	%	Female	%
1. Wiengsavanh	10	6	60.0	4	40.0
2. Pakxeung	10	10	100.0	0	0.0
3. Phongnam	4	3	75.0	1	25.0
4. Thinchaleun	8	5	62.5	3	37.5
5. Phonhsawang	8	8	100.0	0	0.0
Total	40	32	80.0	8	20.0

Source: Workshop on technical feasibility assessment, 2003

Table 31 Farmers' education level of five villages in Luang Prabang province

Level of education	No. of farmers reported	Percentage
1. Primary school	25	62.5
2. Secondary school	12	30.0
3. High school	3	7.5
4. Illiterate farmers	0	0.0
Total	40	100.0

Source: Workshop on technical feasibility assessment, 2003

Farmers' knowledge

All farmers' orchards were mixed fruit tree systems. 65% of farmers grew mango for home consumption and the remaining 35% grew for both home consumption and supplementary income. Most farmers (82.5%) propagated mango by seedage method, only 17.5% of them practiced graftage method such as approach grafting, whip grafting, side veneer grafting and bark grafting with 40-80% of success. Farmers in the province have never practiced stone grafting before.

The farmers (85%) commonly grew local varieties i.e. Kaew-Loop and Kaew-Cho and these two local varieties were widely used as the rootstocks for grafting, because they are locally available. Khiew-Sawoer was more popularly among the improved varieties and it was used as the good scions for grafting, due to its good taste and high price.

Farmers are still lacking knowledge, equipment and materials for vegetative propagation. The results revealed that 85% of the farmers never attend training course on propagation techniques as well as general techniques of mango growing (77.5%) (Table 32). Because of this, they did not know what are the weaknesses of seedage method and what are the advantages of vegetative method of propagation, so most of them still propagate mango by seeding up to now.

Table 32 Farmers' access to extension services and training course on mango propagation

Group of farmers	No. of farmers	%
• Access to training to training on propagation	6	15.0
• Do not access	34	85.0
Total	40	100.0
• Access to extension services (general techniques of growing)	9	22.5
• Do not access	31	77.5
Total	40	100.0

Source: Workshop on technical feasibility assessment, 2003

Results of the feasibility assessment of the grafting techniques

The results of the feasibility assessment of the techniques were illustrated in Table 33. It is indicated that 60% of farmers reported that side veneer grafting was easy to do, while 70% of them accepted that stone grafting was easier. In terms of appropriateness of the techniques, farmers reported that both side veneer grafting (82.5%) and stone grafting (77.5%) were appropriate to farmer's condition, because these two techniques were effective in the real practices (80% and 85% respectively). All farmers (100%) preferred side veneer to stone grafting (95%) (Table 34).

Through the workshop, they understood that mango trees grown by seeding will take a long time to give the fruits (>5 years), the trees will be taller and have a big shape that lead to difficulty of management. In contrast, those mango trees propagated by vegetative techniques exhibit a small shape and medium height, which are easy to manage. And the trees will bear fruits within the short time of 3-4 years, which can give early return to investment.

Table 33 The opinion of farmers on feasibility of the mango grafting techniques

Farmers' opinion	Side veneer grafting		Stone grafting	
	No. of farmers reported	%	No. of farmers reported	%
1. Easy to perform	24	60	28	70
2. Appropriate to farmers' condition	33	82.5	31	77.5
3. Effective for practice	32	80	34	85

Source: Workshop on technical feasibility assessment, 2003

Table 34 Farmers' preferences on feasibility of the mango grafting techniques

Farmers' preferences	Side veneer grafting		Stone grafting	
	No. of farmers reported	%	No. of farmers reported	%
Farmers' preferences	40	100	38	95

Source: Workshop on technical feasibility assessment, 2003

The opinion that farmer gave to the importance to improve their knowledge and skills in mango propagation in the future were presented in Table 35. The results revealed that firstly, farmers need to practice by themselves as much as possible in order to have a high skill of grafting. Secondly they require equipment and materials for propagation i.e. cutter, spring-loaded shears, plastic tape and plastic bags to enhance their grafting, due to these equipment and materials are not available in the local market, so they have to be ordered and imported. Thirdly they have to learn from experienced persons, who have practiced vegetative methods of propagation and were successful. Lastly they need further training, which can provide them new knowledge and ideas for improving their

mango production systems as a whole. The further training not only on vegetative methods of propagation, but they need to train and learn on how to grow and manage their mango orchards, especially techniques on mango growing, fertilizer application, pest management, pruning techniques processing and marketing management. However, training course on stone grafting was requested to organized again to help them to gain deep understanding and refinement. And after each training, they also require extension services to monitor and evaluate and give them comments and suggestions.

In addition, farmers also request the related agencies, organizations and institutions to pay more attention on the promotion of mango growing systematically in plantation with supporting grafted materials of good varieties, which are economically feasible and can help farmers to get high income.

Table 35 The opinion of farmers on future improvement of mango propagation

Means	Level of importance and % of farmers reported				Order
	1	2	3	4	
• More practices	50	22.5	17.5	10	1
• Provision of equipment and materials	25	20	17.5	37.5	2
• Learning from expertise person	15	35	10	40	3
• Further training	10	22.5	55	12.5	4

Note: 1= most important, 2 = very important, 3 = important, 4 = least important

Source: Workshop on technical feasibility assessment, 2003