

## CHAPTER IV

### RESULTS

#### 4.1 Mangrove seedlings

##### 4.1.1 Average percent survival rate of three mangrove seedlings (Table IV-1, Figure IV-1)

After one year old plantation, *R. apiculata* had the highest survival rate (66.67±12.66 percents), but *C. tagal* had the lowest survival rate which none has survived after ten months period. The average percent survival rate of *B. gymnorrhiza* was 41.33±13.32 percents. Average percent survival rate of *R. apiculata* at each study period were higher than survival of *B. gymnorrhiza* rate and *C. tagal*. The average percent survival rate of *B. gymnorrhiza* at each study period were also higher than survival rate of *C. tagal*. There were at least one study period observed from each species that the percent survival rate had greatly decreased. For *R. apiculata*, the observed period was in December, 1993 and for *B. gymnorrhiza*, in June, 1993. While the observed period for *C. tagal* was in the last month of plantation in February, 1994 that there was not any seedling survived. However, in all three species, there were at least four study months (June to August, 1993) of stabled survival rate prior to the decreased survival rate. The mean differences of the survival rate of mangrove

seedlings when compared among months and species were significant when tested by Analysis of Variance (two-way) shown in Table IV-3.

#### 4.1.2 Average height growth (Table IV-2, Figure IV-2)

After one year old plantation, *R. apiculata* had the highest average height growth at  $45.73 \pm 1.90$  centimeters (Figure IV-3). But *C. tagal* had the lowest average height growth at  $11.22 \pm 1.25$  centimeters (Figure IV-3). While *B. gymnorrhiza* was with the median average height growth at  $44.87 \pm 0.92$  centimeters (Figure IV-3). The statistic test as in Table IV-4 showed the significant differences in the average height growth of *R. apiculata* and *C. tagal*. The height growth of *C. tagal* slowly increased with times. However in *R. apiculata* and *B. gymnorrhiza*, the height growth of both species were drastically increased within the first two months and in the last month of plantation. However, the height growth of all three mangrove species showed similar trends that there were at least one study period that the height sharply increased before the stable period. For both *R. apiculata* and *B. gymnorrhiza*, these period were in June, 1993, the fourth month of plantation. It was observed that the height growth of *R. apiculata* sharply increased again in December, 1993. This increasing rate was lower than the increasing rate observed in June, 1993.

Table IV-1 Percent survival of three mangrove seedling planted on the abandoned shrimp pond at Tambon Klongkone, Changwat Sanutsongkran.

mangrove seedlings	m o n t h						
	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.	Feb.
<i>R. apiculata</i>	100.00	91.00 $\pm$ 1.73	84.67 $\pm$ 3.05	84.67 $\pm$ 3.05	84.00 $\pm$ 3.00	71.67 $\pm$ 10.41	66.67 $\pm$ 12.66
<i>B. gymnorrhiza</i>	100.00	72.67 $\pm$ 14.47	59.33 $\pm$ 15.31	59.00 $\pm$ 14.47	59.00 $\pm$ 14.93	57.00 $\pm$ 16.09	41.33 $\pm$ 13.32
<i>C. tagal</i>	100.00	75.33 $\pm$ 2.31	59.00 $\pm$ 3.46	58.33 $\pm$ 4.04	48.00 $\pm$ 20.66	35.67 $\pm$ 27.46	nil*

Table IV-2 Average height growth (centimeters) of three mangrove seedling planted on the abandoned shrimp pond at Tambon Klongkone, Changwat Sanutsongkran.

mangrove seedlings	m o n t h						
	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.	Feb.
<i>R. apiculata</i>	0.00	8.68 $\pm$ 1.05	19.72 $\pm$ 2.08	26.92 $\pm$ 1.20	30.59 $\pm$ 1.52	38.53 $\pm$ 0.50	45.73 $\pm$ 1.90
<i>B. gymnorrhiza</i>	0.00	8.01 $\pm$ 2.49	26.71 $\pm$ 1.25	33.18 $\pm$ 0.52	36.53 $\pm$ 0.76	40.03 $\pm$ 0.66	44.87 $\pm$ 0.92
<i>C. tagal</i>	0.00	1.26 $\pm$ 0.76	4.59 $\pm$ 0.88	6.95 $\pm$ 0.81	10.23 $\pm$ 1.50	11.22 $\pm$ 1.25	nil*

\* They all died out after ten months period.-

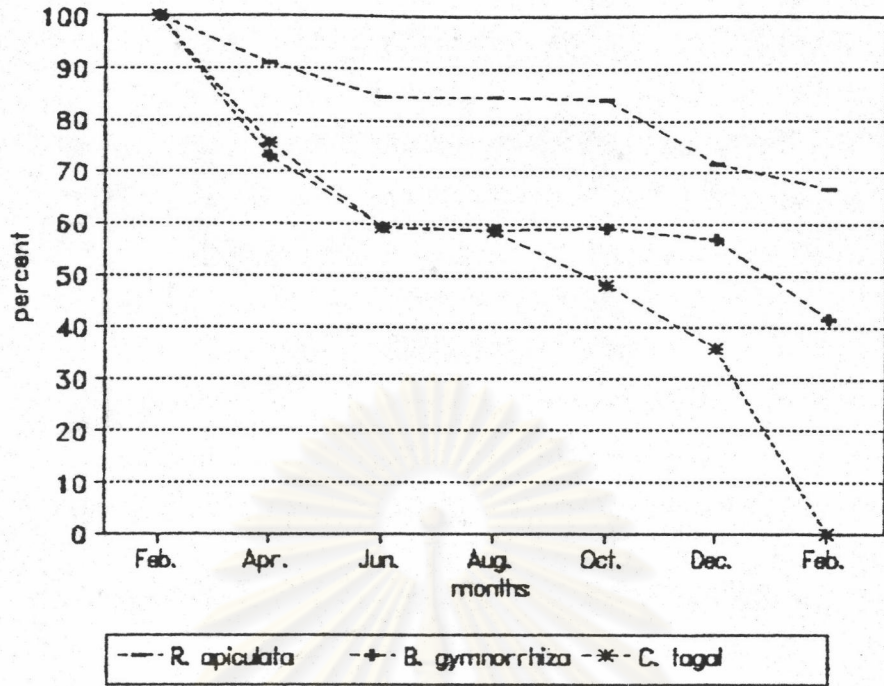


Figure IV-1 The average percent survival of three mangrove seedlings.

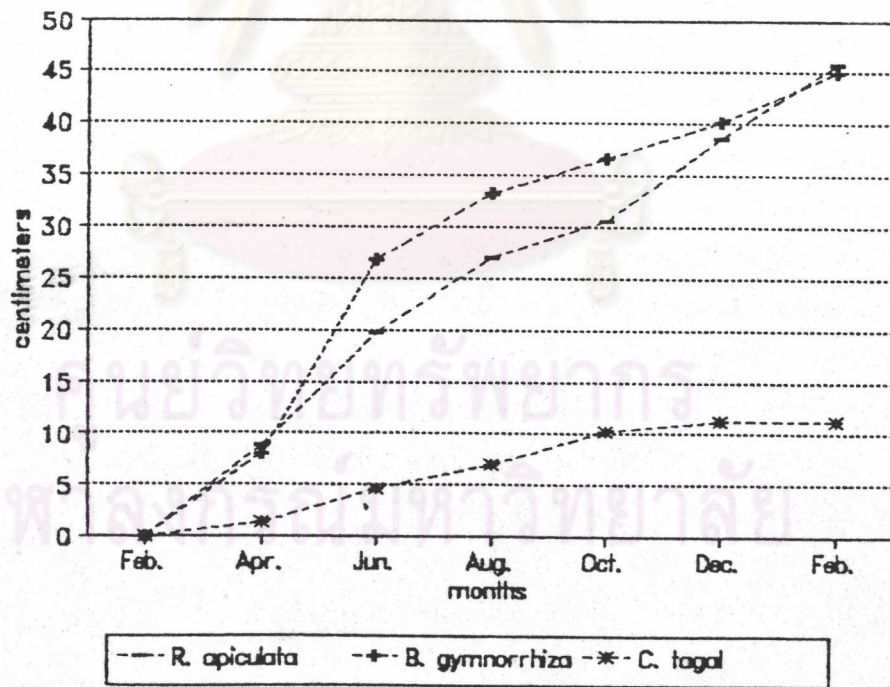


Figure IV-2 The average height growth of three mangrove seedlings.

Table IV-3 Mean comparison tested by Analysis of Variance (two-way) on survival by mangrove species and months.

mangrove species	February	April	June	August	October	December	February
<i>R. apiculata</i>	$^{a}100.00 \pm 0.00^a$	$^{a}91.00 \pm 1.73^{ab}$	$^{a}84.67 \pm 3.06^{bc}$	$^{a}84.67 \pm 3.10^{bc}$	$^{a}84.00 \pm 3.00^{bc}$	$^{a}71.67 \pm 10.41^d$	$^{a}66.67 \pm 12.66^d$
<i>B. gymnorhiza</i>	$^{a}100.00 \pm 0.00^a$	$^{a}72.67 \pm 14.47^b$	$^{b}59.33 \pm 15.31^{bc}$	$^{b}58.67 \pm 14.74^{bc}$	$^{a}59.00 \pm 14.93^{bc}$	$^{a}57.00 \pm 16.10^{bc}$	$^{b}41.33 \pm 13.32^c$
<i>C. tagal</i>	$^{a}100.00 \pm 0.00^a$	$^{a}75.67 \pm 2.31^b$	$^{b}59.33 \pm 4.04^{bc}$	$^{b}58.33 \pm 4.04^{bc}$	$^{a}48.00 \pm 20.67^c$	$^{a}35.67 \pm 27.46^c$	$^{c}0.00 \pm 0.00^c$

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- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

Table IV-4 Mean comparison tested by Analysis of Variance (two-way) on height growth by mangrove species and months.

mangrove species	February	April	June	August	October	December	February
<i>R. apiculata</i>	$^{a}0.00 \pm 0.00^a$	$^{a}8.68 \pm 1.05^a$	$^{a}19.72 \pm 2.08^c$	$^{a}26.92 \pm 1.20^d$	$^{a}30.53 \pm 0.44^e$	$^{a}38.53 \pm 0.49^f$	$^{a}45.73 \pm 1.90^g$
<i>B. gymnorhiza</i>	$^{a}0.00 \pm 0.00^a$	$^{a}8.01 \pm 2.49^b$	$^{b}26.71 \pm 1.24^c$	$^{b}33.18 \pm 0.52^d$	$^{b}36.53 \pm 0.76^e$	$^{a}40.03 \pm 0.62^f$	$^{a}44.87 \pm 0.92^g$
<i>C. tagal</i>	$^{a}0.00 \pm 0.00^a$	$^{b}1.26 \pm 0.76^a$	$^{c}4.59 \pm 0.88^b$	$^{c}6.95 \pm 0.80^c$	$^{c}10.23 \pm 1.50^d$	$^{b}11.22 \pm 1.25^d$	$^{b}11.25 \pm 1.25^d$

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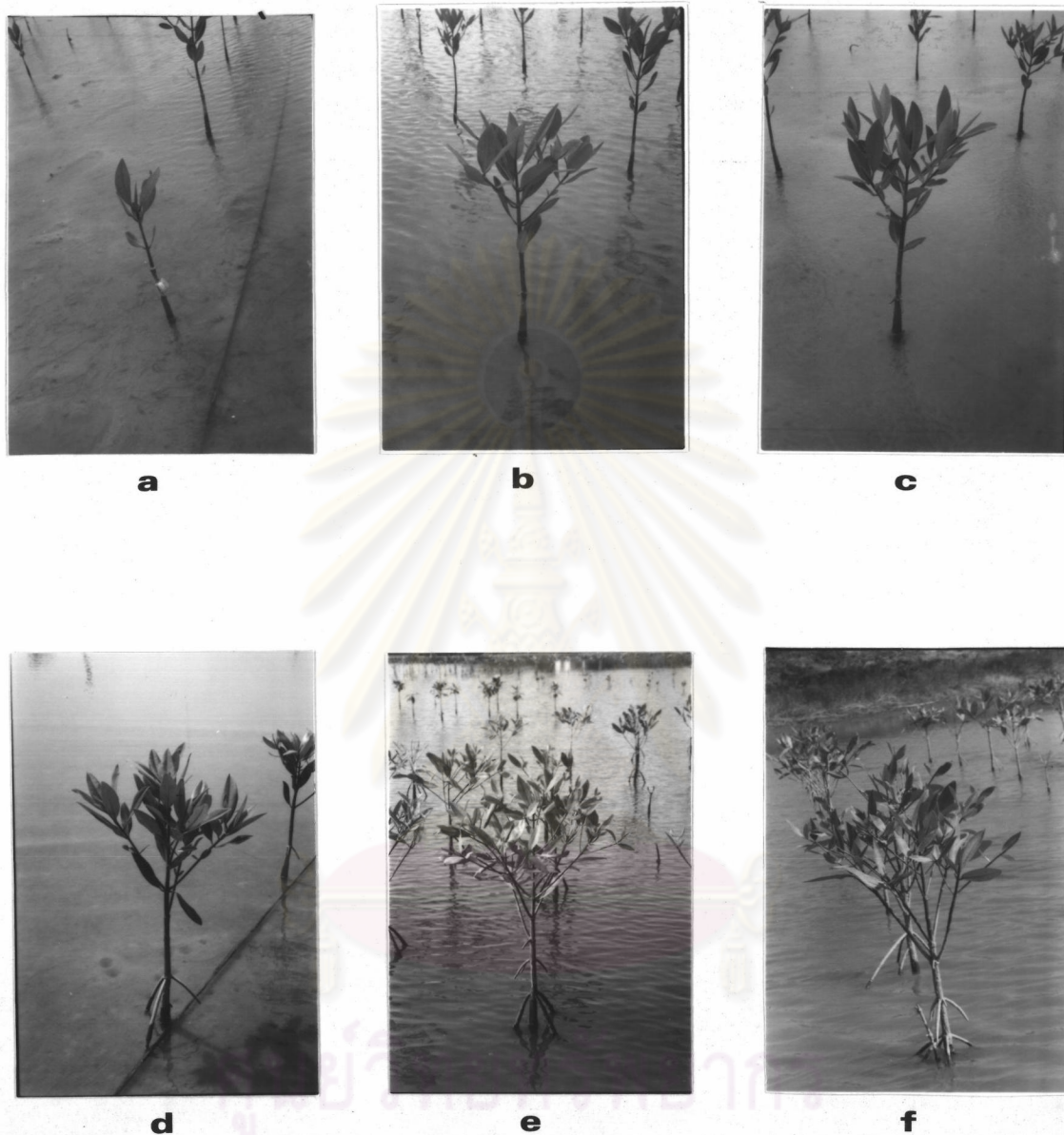


Figure IV-3 *R. apiculata* seedlings at different ages.

- |                    |                       |
|--------------------|-----------------------|
| a - two months old | b - four months old   |
| c - six months old | d - eight months old  |
| e - ten months old | f - twelve months old |

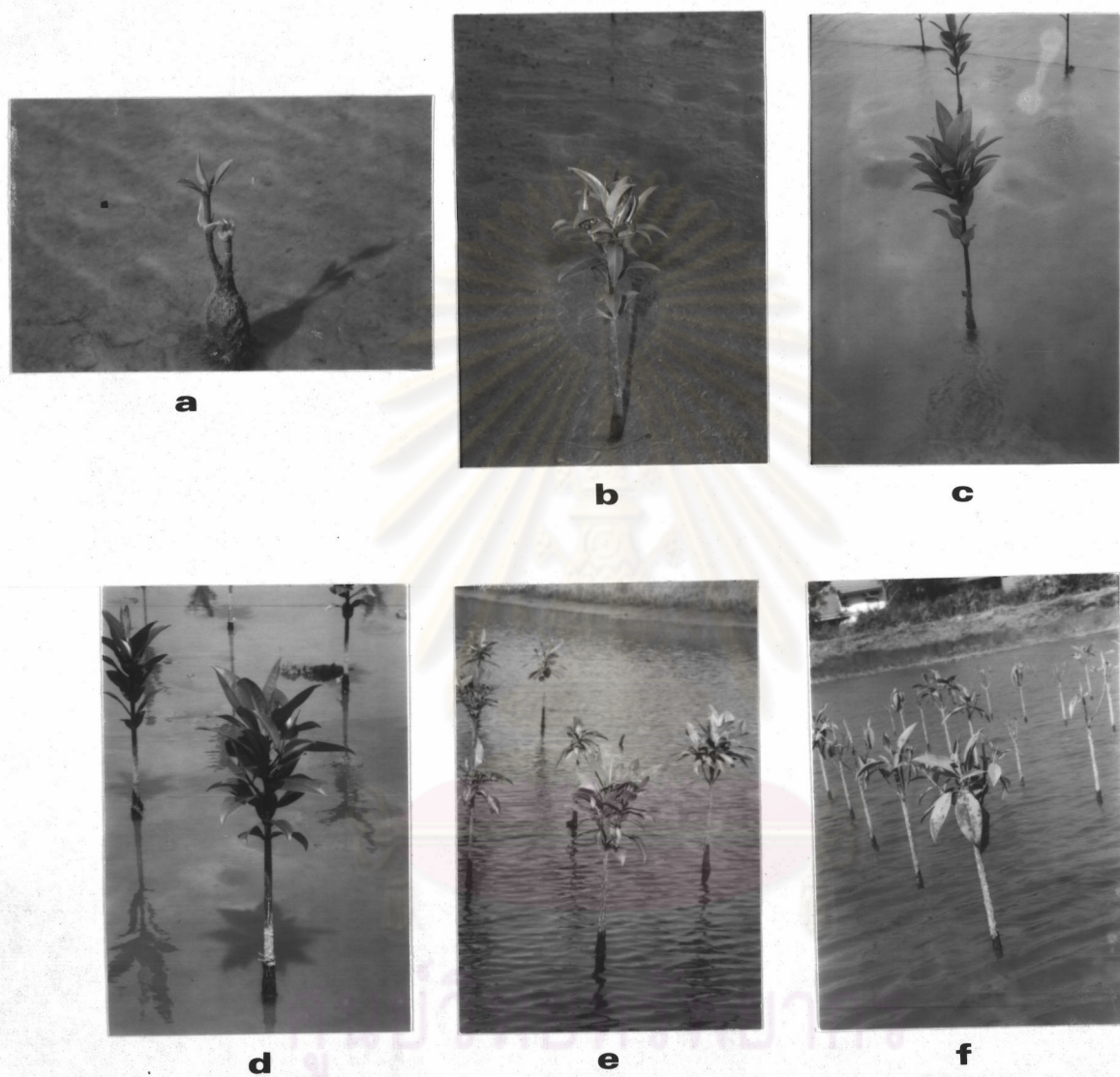


Figure IV-4 *B. gymnorhiza* seedlings at different ages.

- |                    |                       |
|--------------------|-----------------------|
| a - two months old | b - four months old   |
| c - six months old | d - eight months old  |
| e - ten months old | f - twelve months old |

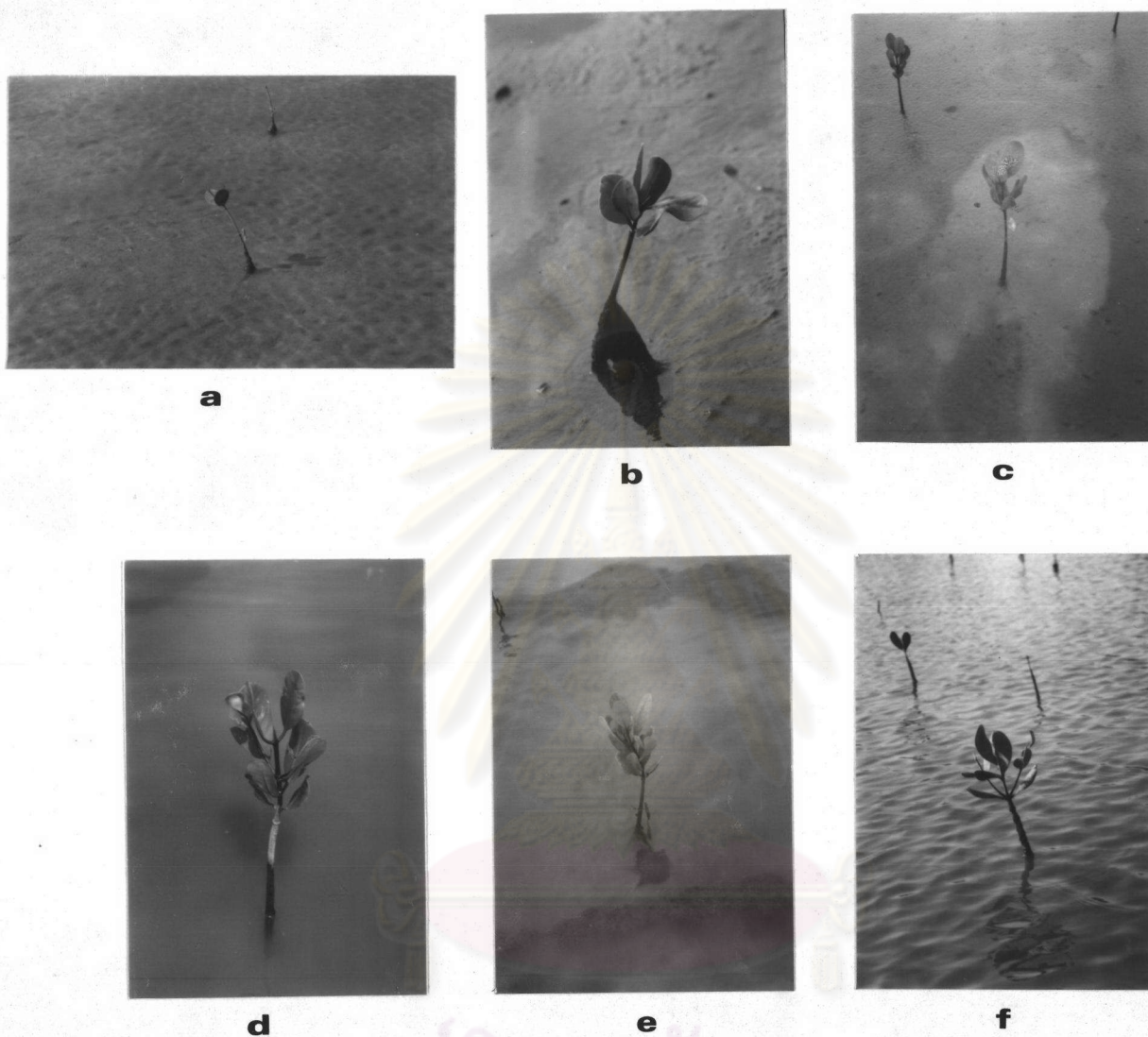


Figure IV-5 *C. tagal* seedlings at different ages.

- |                    |                       |
|--------------------|-----------------------|
| a - two months old | b - four months old   |
| c - six months old | d - eight months old  |
| e - ten months old | f - twelve months old |



## 4.2 Soil parameters.

### 4.2.1 Average concentration of inorganic nitrogen in soil under three mangrove seedlings.

Average ammonia concentration in soil under *R. apiculata*, *B. gymnorhiza* and *C. tagal* (Figure IV-6, Table IV-6) were varied from one another throughout the whole study period. The concentration of ammonia in soil under *B. gymnorhiza* was lower than the other two species in the range of 0.488-1.755 ppm.. The highest ammonia concentration in soil were found in February, 1994. The ammonia concentration under *R. apiculata* and *C. tagal* were in the range of 0.607-2.392 and 0.916-1.961 ppm. respectively.

The nitrite concentrations in soil under three mangrove species showed similar trends (Figure IV-7, Table IV-7). The highest nitrite concentrations in soil were in February, 1994 and the lowest concentrations were in June, 1993. The nitrite concentrations in *B. gymnorhiza* was lower than the other two species in the range of 0.001-0.034 ppm..

The lowest nitrate concentration under all three species were found in February, 1993 (Figure IV-8, Table IV-8). The highest nitrate concentration in soil from both *R. apiculata* and *C. tagal* were in June, 1993, while the highest concentration in soil of *B. gymnorhiza* was in February, 1994. The nitrate concentrations recorded for *R. apiculata*, *B. gymnorhiza* and

Table IV-5 Summarized data of soil parameters from February, 1993 - February, 1994 in abandoned shrimp pond at Tambon Klongkone, Changvat Samutsongkram.

mangrove seedlings	soil parameters	m o n t h			
		February	June	October	February
<i>R. apiculata</i>	NH <sub>3</sub> -N(ppm.)	1.869±0.6311	0.607±0.3524	0.617±0.5103	2.392±1.8115
	NO <sub>2</sub> -N(ppm.)	0.005±0.0023	0.001±0.0006	0.002±0.0015	0.044±0.0262
	NO <sub>3</sub> -N(ppm.)	0.056±0.0300	0.355±0.0142	0.251±0.1728	0.157±0.0335
	PO <sub>4</sub> <sup>3-</sup> (ppm.)	2.539±1.1123	4.620±0.9274	5.188±1.3822	3.988±1.0143
	K(ppm.)	710.72±62.24	1035.12±250.02	1740.79±31.42	1599.02±60.47
	Ca(ppm.)	8216.40±873.52	5867.71±1921.43	6813.66±1747.05	4184.35±1391.46
	Mg(ppm.)	1337.05±607.75	3558.99±1241.78	2593.07±982.48	8786.60±1598.16
	Na(ppm.)	9561.17±326.21	11029.13±710.96	5256.47±288.38	8493.16±158.34
	pH	7.5±0.00	7.0±0.16	6.8±0.10	7.3±0.05
	Moisture content(%)	55.86±3.48	54.81±3.25	57.28±3.20	63.51±1.22
	% sand	14.39±1.36	14.08±0.75	16.08±0.21	23.83±0.32
	% silt	47.43±13.42	46.21±2.28	44.49±1.07	38.77±0.66
	% clay	38.19±1.94	39.71±1.53	39.43±1.15	37.40±0.36
	Texture	silty clay loam	silty clay loam	silty clay loam	clay loam

Table IV-5 Summarized data of soil parameters from February, 1993 - February, 1994 in abandoned shrimp pond at Tambon Klongkone, Changwat Samutsongkran. (cont.)

mangrove seedlings	soil parameters	m o n t h			
		February	June	October	February
<i>B. gymnorrhiza</i>	NE <sub>3</sub> -N(ppm.)	1.677±0.1418	0.488±0.2796	0.586±0.4531	1.755±1.4679
	NO <sub>2</sub> -N(ppm.)	0.004±0.0004	0.001±0.0002	0.001±0.0003	0.034±0.0151
	NO <sub>3</sub> -N(ppm.)	0.039±0.0046	0.195±0.2144	0.207±0.1257	0.238±0.1214
	PO <sub>4</sub> <sup>3-</sup> (ppm.)	1.539±0.4811	3.754±0.9068	6.311±1.9110	3.501±0.8199
	K (ppm.)	723.39±80.58	1295.72±483.28	1746.07±41.19	1536.40±40.23
	Ca(ppm.)	7681.87±809.72	6262.48±2904.94	7481.60±2448.93	3607.20±901.08
	Mg(ppm.)	1742.22±1167.98	3208.91±1753.22	2755.13±1403.54	6738.73±151.58
	Na(ppm.)	9996.12±376.68	10050.48±1311.63	5091.88±212.06	7000.00±172.38
	pH	7.4±0.06	7.27±0.25	6.93±0.12	7.23±0.06
	Moisture content(%)	54.77±3.22	55.62±2.21	54.17±5.74	59.41±3.70
	% sand	15.39±0.7	12.20±0.21	15.96±0.00	22.77±1.20
	% silt	46.76±0.67	48.09±1.38	45.52±2.04	39.41±1.19
	% clay	37.85±0.95	39.71±1.53	38.52±2.04	37.87±0.37
	Texture	silty clay loam	silty clay loam	silty clay loam	clay loam

Table IV-5 Summarized data of soil parameters from February, 1993 - February, 1994 in abandoned shrimp pond at Tambon Klongkone, Changvat Samut Songkram. (cont.)

mangrove seedlings	soil parameters	m o n t h s			
		February	June	October	February
<i>C. tagal</i>	NH <sub>3</sub> -N(ppm.)	1.701±0.5487	0.938±0.2133	0.916±0.5672	1.961±0.6805
	NO <sub>2</sub> -N(ppm.)	0.004±0.0003	0.001±0.0004	0.002±0.0006	0.035±0.0053
	NO <sub>3</sub> -N(ppm.)	0.047±0.0200	0.316±0.1572	0.228±0.0357	0.297±0.0704
	PO <sub>4</sub> <sup>3-</sup> (ppm.)	2.185±1.5983	4.859±1.8292	7.900±2.6856	3.683±0.2439
	K (ppm.)	837.44±108.68	875.45±123.49	1454.78±152.38	1522.99±162.59
	Ca(ppm.)	6813.60±1218.99	4617.22±1606.72	5744.80±1977.10	4040.06±499.83
	Hg(ppm.)	1539.37±701.54	5075.93±700.13	3484.43±506.05	7788.92±546.54
	Na(ppm.)	9398.06±983.16	10594.17±1061.24	5376.07±237.44	8002.56±606.46
	pH	7.5±0.12	7.2±0.23	6.9±0.15	7.2±0.05
	Moisture content(%)	56.21±5.06	56.79±4.69	58.03±4.93	62.13±4.07
	% sand	14.05±1.38	13.29±1.00	16.63±1.15	23.10±2.10
	% silt	47.21±1.94	46.67±1.00	46.61±1.16	38.62±2.40
	% clay	38.73±0.58	40.04±0.00	36.76±0.00	38.28±0.42
	Texture	silty clay loam	silty clay loam	silty clay loam	clay loam

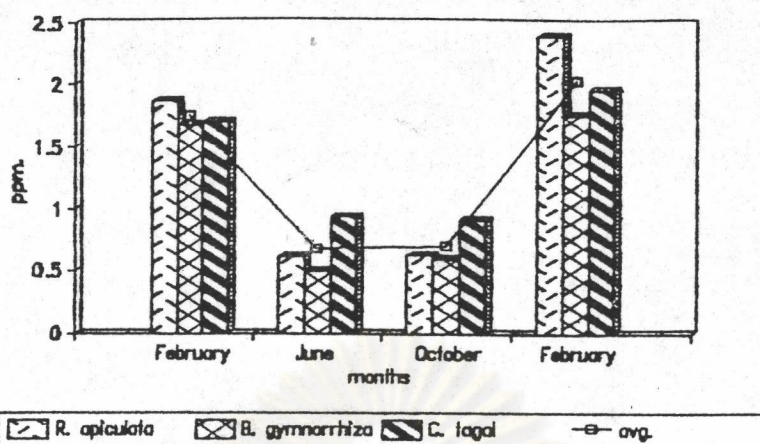


Figure IV-6 Comparison on ammonia concentration in soil under three mangrove seedlings.

Table IV-6 Mean comparison tested by Analysis of Variance (two-way) on ammonia by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$1.8690 \pm 0.6311^a$	$0.6073 \pm 0.3524^a$	$0.6171 \pm 0.5103^a$	$2.3920 \pm 1.8115^a$
<i>B. gymnorrhiza</i>	$1.6765 \pm 0.1418^a$	$0.4878 \pm 0.2798^a$	$0.5856 \pm 0.4531^a$	$1.7550 \pm 1.4680^a$
<i>C. tagal</i>	$1.7010 \pm 0.5487^a$	$0.9378 \pm 0.2133^a$	$0.9164 \pm 0.5672^a$	$1.9607 \pm 0.6805^a$

- the different alphabet on the left corner means there is significance at 95% confidence within the same column.
- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

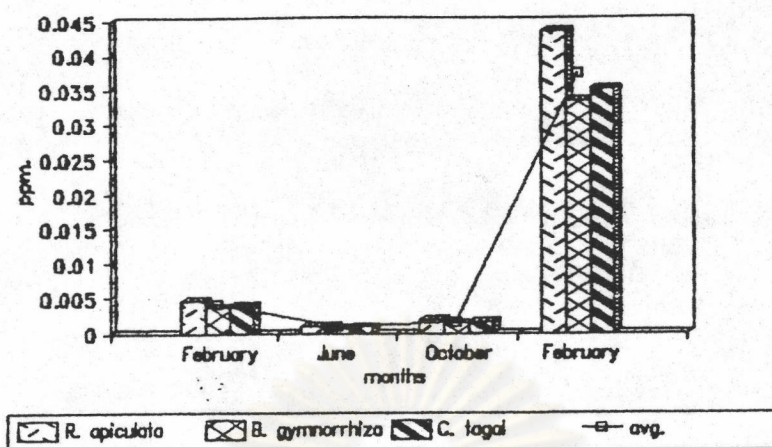


Figure IV-7 Comparison on nitrite concentration in soil under three mangrove seedlings.

Table IV-7 Mean comparison tested by Analysis of Variance (two-way) on nitrite by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$0.0047 \pm 0.0023^a$	$0.0010 \pm 0.0006^a$	$0.0019 \pm 0.0015^a$	$0.0436 \pm 0.0262^b$
<i>B. gymnorrhiza</i>	$0.0036 \pm 0.0004^a$	$0.0006 \pm 0.0002^a$	$0.0013 \pm 0.0003^a$	$0.0335 \pm 0.0151^b$
<i>C. tagal</i>	$0.0039 \pm 0.0003^a$	$0.0009 \pm 0.0003^a$	$0.0016 \pm 0.0006^a$	$0.0351 \pm 0.0053^b$

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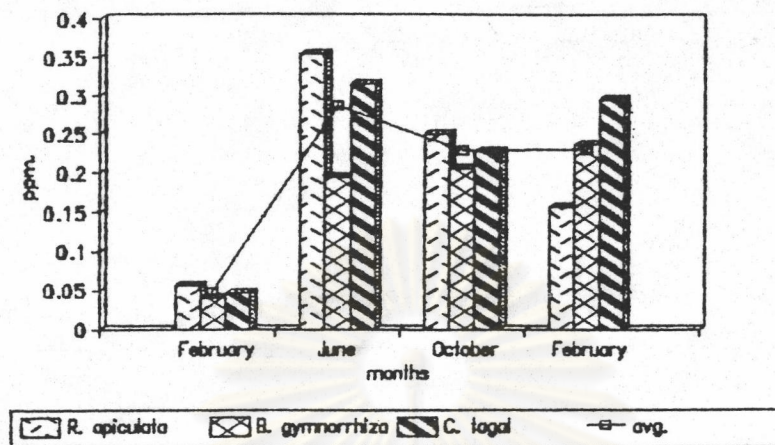


Figure IV-8 Comparison on nitrate concentration in soil under three mangrove seedlings.

Table IV-8 Mean comparison tested by Analysis of Variance (two-way) on nitrate by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$0.0560 \pm 0.0300^a$	$0.3549 \pm 0.0142^{bc}$	$0.2511 \pm 0.1728^{bd}$	$0.1570 \pm 0.0336^{ad}$
<i>B. gymnorrhiza</i>	$0.0391 \pm 0.0046^a$	$0.1952 \pm 0.2145^a$	$0.2065 \pm 0.1257^a$	$0.2379 \pm 0.1214^a$
<i>C. tagal</i>	$0.0468 \pm 0.0200^a$	$0.3159 \pm 0.1572^b$	$0.2278 \pm 0.0357^b$	$0.2968 \pm 0.0704^b$

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*C. tagal* were 0.056–0.355, 0.039–0.238 and 0.047–0.316 ppm. respectively.

#### 4.2.2 Average concentration of phosphate in soil under three mangrove seedlings.

The phosphate concentrations of all three mangrove seedlings increased during the eight months of plantation (Figure IV-9, Table IV-9). These concentrations were high in the range of 2.539–5.188, 1.539–6.311 and 2.185–7.900 ppm. for *R. apiculata*, *B. gymnorrhiza* and *C. tagal* respectively. The highest concentrations of phosphate in soil from all three mangrove species were in October, 1993, while the lowest concentrations were found in February, 1993.

#### 4.2.3 Average concentration of extractable potassium in soil under three mangrove seedlings.

Average extractable potassium concentration in soil under each mangrove species were very high. The highest potassium concentration in soil under *R. apiculata* and *B. gymnorrhiza* were in October, 1993 of 710.717–1740.793 and 723.389–1746.070 ppm. respectively. While in February, 1994, the highest concentrations of extractable potassium in soil under *C. tagal* was 837.437–1522.990 ppm. (Figure IV-10, Table IV-10). The lowest concentration of extractable potassium in soil under all three species were found during the first month (February, 1993).



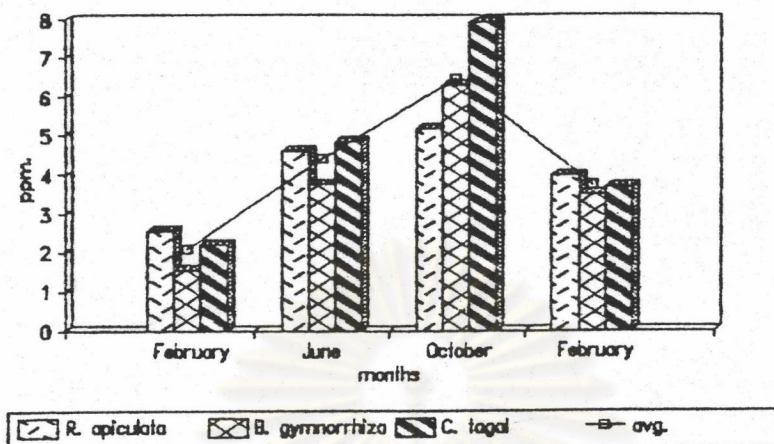


Figure IV-9 Comparison on phosphate concentration in soil under three mangrove seedlings.

Table IV-9 Mean comparison tested by Analysis of Variance (two-way) on phosphate by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$2.5394 \pm 1.1123^a$	$4.6197 \pm 0.9274^a$	$5.1876 \pm 1.3822^a$	$3.9876 \pm 1.0143^a$
<i>B. gymnorrhiza</i>	$1.5390 \pm 0.4811^a$	$3.7535 \pm 0.9068^a$	$6.3111 \pm 1.9107^b$	$3.5009 \pm 0.8199^a$
<i>C. tagal</i>	$2.1850 \pm 1.5983^a$	$4.8589 \pm 1.8292^{ab}$	$7.9000 \pm 2.6856^b$	$3.6827 \pm 0.2440^a$

- the different alphabet on the left corner means there is significance at 95% confidence within the same column.
- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

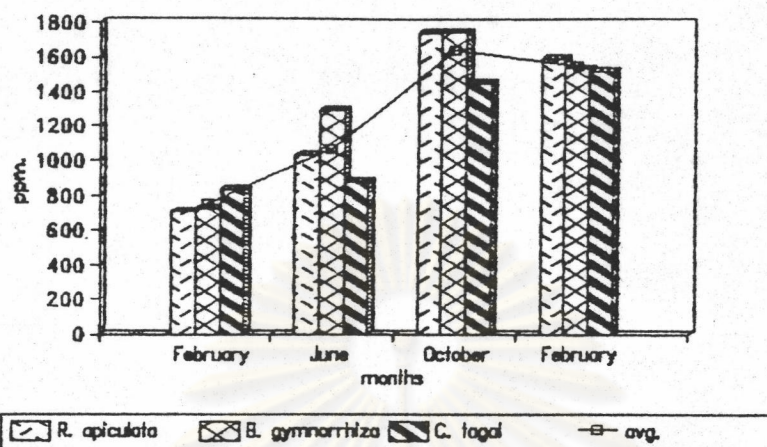


Figure IV-10 Comparison on potassium concentration in soil under three mangrove seedlings.

Table IV-10 Mean comparison tested by Analysis of Variance (two-way) on potassium by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$^{a}710.72 \pm 62.26^a$	$^{a}1035.12 \pm 250.02^b$	$^{a}1740.13 \pm 30.89^c$	$^{a}1599.02 \pm 60.47^c$
<i>B. gymnorrhiza</i>	$^{a}723.39 \pm 80.58^a$	$^{a}1295.73 \pm 483.28^b$	$^{a}1746.07 \pm 41.19^b$	$^{a}1536.40 \pm 40.23^b$
<i>C. tagal</i>	$^{a}837.44 \pm 108.68^a$	$^{a}875.45 \pm 123.85^a$	$^{a}1454.78 \pm 152.38^b$	$^{a}1522.99 \pm 162.59^b$

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- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

#### 4.2.4 Average concentration of extractable calcium in soil under three mangrove seedlings.

The highest average extractable calcium concentration in soil under all three mangrove seedlings were found in February, 1993, while the lowest concentrations were in February, 1994. The calcium concentrations under all three mangrove species showed similar trends(Figure IV-11, Table IV-11).

#### 4.2.5 Average concentration of extractable magnesium in soil under three mangrove seedlings.

The highest extractable magnesium concentration in soil under all three mangrove seedlings were in February, 1994 in the range of 1337.050-8786.603, 1742.217-6738.735 and 1539.367-7788.923 ppm. for *R. apiculata* , *B. gymnorrhiza* and *C. tagal* respectively. The lowest magnesium concentration in soil under all three mangrove seedlings were found in February,1994 (Figure IV-12, Table IV-12).

#### 4.2.6 Average concentration of extractable sodium in soil under three mangrove seedlings.

The highest concentrations of extractable sodium in soil under all three mangrove seedlings were in June, 1993, while the lowest concentrations of sodium in soil under all three mangrove seedlings were in October, 1993(Figure IV-13, Table IV-13). The sodium concentrations for *R. apiculata*, *B. gymnorrhiza* and

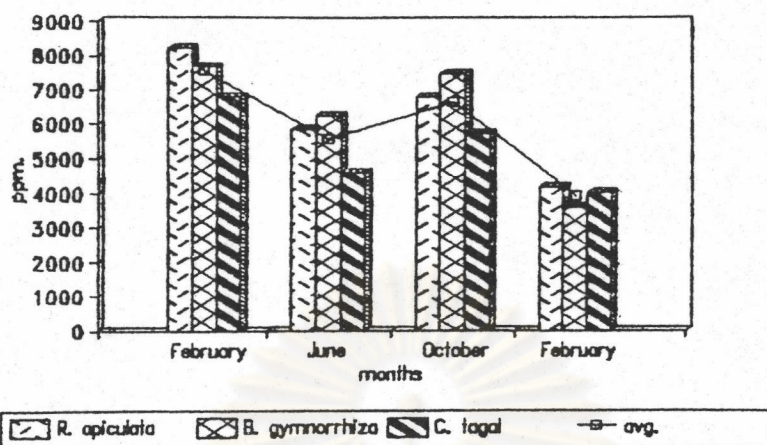


Figure IV-11 Comparison on calcium concentration in soil under three mangrove seedlings.

Table IV-11 Mean comparison tested by Analysis of Variance (two-way) on calcium by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	<sup>a</sup> 8216.40 ± 873.52 <sup>a</sup>	<sup>a</sup> 5867.71 ± 1921.43 <sup>ab</sup>	<sup>a</sup> 6813.60 ± 1747.05 <sup>ab</sup>	<sup>a</sup> 4184.35 ± 1391.46 <sup>b</sup>
<i>B. gymnorrhiza</i>	<sup>a</sup> 7681.87 ± 809.72 <sup>a</sup>	<sup>a</sup> 6252.48 ± 2904.93 <sup>ab</sup>	<sup>a</sup> 7481.60 ± 1448.93 <sup>ab</sup>	<sup>a</sup> 3607.20 ± 901.08 <sup>b</sup>
<i>C. tagal</i>	<sup>a</sup> 6813.60 ± 1218.98 <sup>a</sup>	<sup>a</sup> 4617.22 ± 1606.72 <sup>a</sup>	<sup>a</sup> 5744.80 ± 1977.10 <sup>a</sup>	<sup>a</sup> 4040.06 ± 499.83 <sup>a</sup>

- the different alphabet on the left corner means there is significance at 95% confidence within the same column.
- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

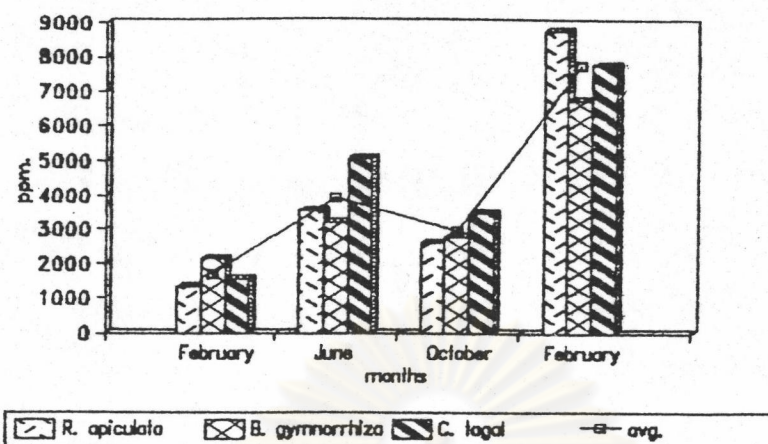


Figure IV-12 Comparison on magnesium concentration in soil under three mangrove seedlings.

Table IV-12 Mean comparison tested by Analysis of Variance (two-way) on magnesium by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$1337.05 \pm 607.75^a$	$3558.99 \pm 1241.78^a$	$2593.07 \pm 982.48^a$	$8786.60 \pm 1598.16^b$
<i>B. gymnorrhiza</i>	$2138.06 \pm 1239.45^a$	$3208.91 \pm 1753.22^a$	$2755.13 \pm 1403.54^a$	$6738.73 \pm 151.58^b$
<i>C. tagal</i>	$1539.37 \pm 701.54^a$	$5075.93 \pm 700.13^b$	$3484.43 \pm 506.05^c$	$7788.92 \pm 546.54^d$

- the different alphabet on the left corner means there is significance at 95% confidence within the same column.
- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

*C. tagal* were 5256.474–11029.130, 5091.883–10050.484 and 5376.071–10594.173 ppm. respectively.

#### 4.2.7 Average soil reaction(pH) under three mangrove seedlings.

The soil condition in this study site was neutral, pH range lined from 6.8–7.5 . Soil pH of each species was not much different from one another; the lowest pH of all three mangrove species were in October, 1993, but the highest pH values of all three species were in February, 1993. The trend of soil pH under all species decreased in the first eight months but increased in the last four months(Figure IV-14, Table IV-14).

#### 4.2.8 Average percent moisture content in soil under three mangrove seedlings.

Moisture content in soil under all study sites were in the same range of 54.607–63.513, 54.173–59.413 and 56.210–62.130 percent for *R. apiculata* , *B. gymnorhiza* and *C. tagal* respectively. The highest moisture content of all three species were observed during the last four months. The lowest moisture content of *R. apiculata* was found in June, 1993; of *B. gymnorhiza* in October, 1993; and of *C. tagal* in February, 1993 (Figure IV-15, Table IV-15).

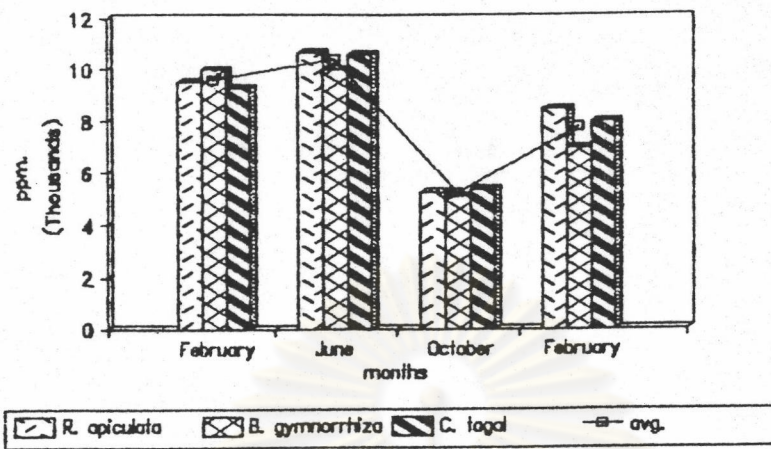


Figure IV-13 Comparison on sodium concentration in soil under three mangrove seedlings.

Table IV-13 Mean comparison tested by Analysis of Variance (two-way) on sodium by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$9561.17 \pm 326.21^a$	$10702.91 \pm 710.96^b$	$5256.82 \pm 288.38^c$	$8493.16 \pm 158.34^d$
<i>B. gymnorhiza</i>	$9996.12 \pm 376.68^a$	$10050.48 \pm 1606.41^a$	$5091.88 \pm 212.06^b$	$7000.00 \pm 211.12^c$
<i>C. tagal</i>	$9289.32 \pm 986.16^a$	$10594.17 \pm 1061.24^b$	$5376.07 \pm 237.44^c$	$8002.60 \pm 606.46^a$

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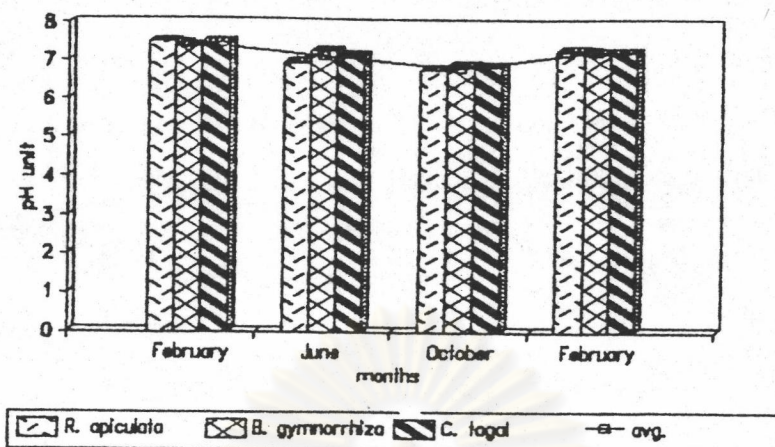


Figure IV-14 Comparison on soil pH in soil under three mangrove seedlings.

Table IV-14 Mean comparison tested by Analysis of Variance (two-way) on soil pH by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	7.5 $\pm$ 0.00 <sup>a</sup>	7.0 $\pm$ 0.12 <sup>b</sup>	6.8 $\pm$ 0.10 <sup>c</sup>	7.3 $\pm$ 0.05 <sup>d</sup>
<i>B. gymnorrhiza</i>	7.4 $\pm$ 0.06 <sup>a</sup>	7.3 $\pm$ 0.25 <sup>a</sup>	6.9 $\pm$ 0.12 <sup>b</sup>	7.2 $\pm$ 0.06 <sup>a</sup>
<i>C. tagal</i>	7.5 $\pm$ 0.12 <sup>a</sup>	7.2 $\pm$ 0.23 <sup>b</sup>	6.9 $\pm$ 0.15 <sup>c</sup>	7.2 $\pm$ 0.05 <sup>ab</sup>

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- the different alphabet on the right corner means there is significance at 95% confidence within the same row.



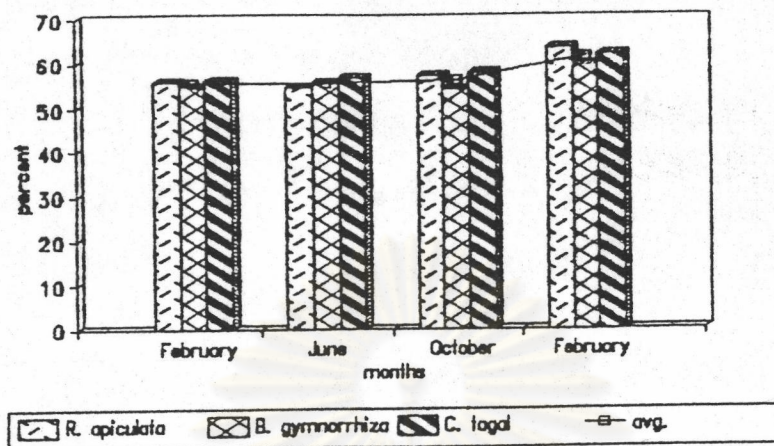


Figure IV-15 Comparison on percent moisture content in soil under three mangrove seedlings.

Table IV-15 Mean comparison tested by Analysis of Variance (two-way) on percent moisture content by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$55.86 \pm 3.44^a$	$54.61 \pm 3.25^a$	$57.28 \pm 3.20^a$	$63.51 \pm 1.22^b$
<i>B. gymnorrhiza</i>	$54.77 \pm 3.22^a$	$55.62 \pm 2.21^a$	$54.17 \pm 5.74^a$	$59.41 \pm 3.70^a$
<i>C. tagal</i>	$56.21 \pm 5.05^a$	$56.79 \pm 4.69^b$	$58.03 \pm 4.93^a$	$62.13 \pm 4.07^a$

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#### 4.2.9 Average soil texture under three mangrove species.

(Figure IV-16, Table IV-16 - Table IV-18)

The average soil texture for *R. apiculata* was silty clay loam. The percentage of sand, silt and clay were found in the range of 14.08-23.83, 38.77-47.43 and 37.40-39.71 respectively. It was observed percentage of sand increased in February, 1994.

The average soil texture under *B. gymnorhiza* and *C. tagal* were silty clay loam. The percentage of sand, silt and clay were found in the range of 12.20-22.77, 39.41-48.09 and 37.85-39.71 respectively for *B. gymnorhiza*. While the percentage of sand, silt and clay for *C. tagal* were found in the range of 13.29-23.1, 38.62-47.21 and 36.76-38.73 respectively. It was observed the percentage of sand also increased in February, 1994.

#### 4.3 Water quality (Table IV-17)

Water condition in this study site was neutral to slightly base, pH range lined between 7.2-8.2. The lowest pH value were in February and April, 1993, but the highest pH value was in June, 1993. Water salinity were found between 12-20 ppt. with the lowest salinity in June, 1993, The highest salinity were found in April and December, 1993 and February, 1994. The temperature variation did not occurred within the range of 28-31 degree celcius. The lowest temperature was in October and December, 1993, while the highest temperature in February, 1994. Dissolved oxygen value recorded in the range of 3.6-6.8 milligram per litre. The lowest dissolved oxygen was in June, 1993, and the highest value in October, 1993.

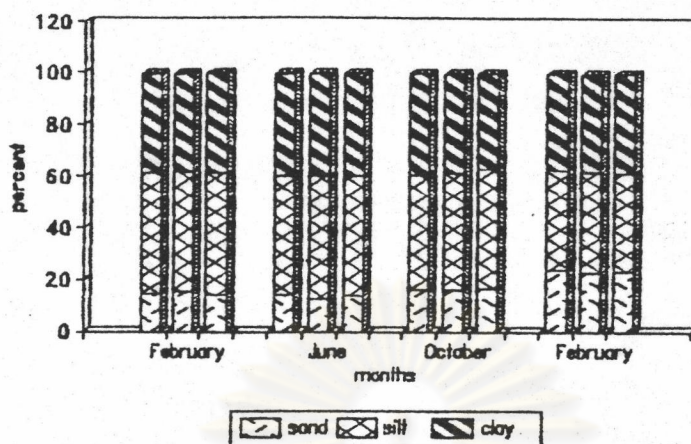


Figure IV-16 Comparison on percent sand, silt, clay in soil under three mangrove seedlings.

Table IV-16 Mean comparison tested by Analysis of Variance (two-way) on percent sand by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$^{a}14.39 \pm 1.36^a$	$^{a}14.08 \pm 0.75^a$	$^{a}16.08 \pm 0.21^b$	$^{a}23.83 \pm 0.32^c$
<i>B. gymnorrhiza</i>	$^{a}15.39 \pm 0.70^a$	$^{a}12.20 \pm 0.20^b$	$^{a}15.96 \pm 0.00^a$	$^{a}22.77 \pm 1.20^c$
<i>C. tagal</i>	$^{a}14.05 \pm 1.38^a$	$^{a}13.29 \pm 1.00^a$	$^{a}16.63 \pm 1.15^b$	$^{a}23.10 \pm 2.09^c$

- the different alphabet on the left corner means there is significance at 95% confidence within the same column.
- the different alphabet on the right corner means there is significance at 95% confidence within the same row.

Table IV-17 Mean comparison tested by Analysis of Variance(two-way)  
on percent silt by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$^{a}47.43 \pm 1.50^a$	$^{a}46.21 \pm 2.27^a$	$^{a}44.49 \pm 1.07^a$	$^{a}38.77 \pm 0.66^b$
<i>B. gymnorrhiza</i>	$^{a}46.76 \pm 0.67^a$	$^{a}48.09 \pm 1.38^a$	$^{a}45.52 \pm 2.04^a$	$^{a}39.41 \pm 1.19^b$
<i>C. tagal</i>	$^{a}47.21 \pm 1.94^a$	$^{a}46.67 \pm 1.00^a$	$^{a}46.61 \pm 1.15^a$	$^{a}38.62 \pm 2.39^b$

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Table IV-18 Mean comparison tested by Analysis of Variance(two-way) on  
percent clay by mangrove species and months.

mangrove species	February	June	October	February
<i>R. apiculata</i>	$^{a}38.19 \pm 1.94^a$	$^{a}39.71 \pm 1.53^a$	$^{a}39.43 \pm 1.15^a$	$^{a}37.40 \pm 0.36^a$
<i>B. gymnorrhiza</i>	$^{a}37.85 \pm 0.95^a$	$^{a}39.70 \pm 1.53^a$	$^{a}38.52 \pm 2.04^a$	$^{a}37.83 \pm 0.37^a$
<i>C. tagal</i>	$^{a}38.73 \pm 0.58^a$	$^{a}40.04 \pm 0.00^b$	$^{a}36.76 \pm 0.00^c$	$^{a}38.28 \pm 0.42^a$

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Table IV-17 Water quality in the abandoned shrimp pond at Tambon Klongkone, Changwat Samutsongkram.

water quality	m o n t h						
	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.	Feb.
pH	7.2	7.2	8.2	8.1	7.8	7.5	7.8
salinity (ppt.)	18	20	12	15	17	20	20
temperature (°C)	29	30	30	30	28	28	31
dissolved oxygen (mg./l)	4	4.4	3.6	6	6.8	6.5	6.2

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