

CHAPTER 4

RESULTS

1. Toxicity of Thai neem extract and cyhalothrin on *A. florea* and *A. cerana*.

1.1 Toxicity of cyhalothrin on *A. florea* and *A. cerana*.

1.1.1 Contact toxicity of cyhalothrin on *A. florea*.

Contact toxicity of cyhalothrin on *A. florea* by topical application is shown in Table 4.1. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 0.00003 % (0.00002-0.00004), and the LD_{50} value is 0.0003 $\mu\text{g}/\text{bee}$.

1.1.2 Contact toxicity of cyhalothrin on *A. cerana*.

Contact toxicity of cyhalothrin on *A. cerana* by topical application is shown in Table 4.2. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 0.00039 % (0.0002-0.00075), and the LD_{50} value is 0.0039 $\mu\text{g}/\text{bee}$.

1.1.3 Oral toxicity of cyhalothrin on *A. florea*.

Oral toxicity of cyhalothrin on *A. florea* by feeding methods is shown in Table 4.3. The results are presented as the

% mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 0.00005 % (0.00002-0.00033), and the LD_{50} is 0.0005 $\mu\text{g}/\text{bee}$.

1.1.4 Oral toxicity of cyhalothrin on *A. cerana*.

Oral toxicity of cyhalothrin on *A. cerana* by feeding methods is shown in table 4.4. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 0.0018 % (0.00139-0.00234), and the LD_{50} value is 0.018 $\mu\text{g}/\text{bee}$.

1.2 Toxicity of Thai neem extract on *A. florea* and *A. cerana*.

The quantity of azadirachtin in various neem extracts was determined by High Performance Liquid Chromatography (HPLC) ; the results are shown in Table 4.5.

1.2(a) Toxicity of neem-seed crude extract on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of neem-seed crude extract on *A. florea*.

Contact toxicity of neem-seed crude extract on *A. florea* by topical application is shown in Table 4.6. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 131.84 % (74.74-522.84), and the LD_{50} value is 1318.4 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of neem-seed crude extract on *A.*

cerana.

Contact toxicity of neem-seed crude extract on *A. cerana* by topical application is shown in Table 4.7. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95% confidence interval (24 hours) is 37.60 % (22.31-70.16), and the LD_{50} value is 376.4 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of neem-seed crude extract on *A. florea*.

Oral toxicity of neem-seed crude extract on *A. florea* by feeding methods is shown in Table 4.8. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of neem-seed crude extract was fluctuating. The results showed that at high concentrations, the % mortality of adult bees is low. (Figure 4.1)

1.2.4 Oral toxicity of neem-seed crude extract on *A. cerana*.

Oral toxicity of neem-seed crude extract on *A. cerana* by feeding methods is shown in Table 4.9. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of neem-seed crude extract was fluctuating. The results showed that at high concentration, the % mortality of adult bees is low. (Figure 4.1)

Table 4.1 : Contact toxicity of cyhalothrin on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.00001	30	0	0	2	6.67
0.0001	30	5	16.67	9	30.00
0.001	30	8	26.67	17	56.67
0.01	30	14	46.67	25	83.33
LC ₅₀ (%) by probit program		0.01086 %		0.00039 %	
95% confidence interval		0.00330-0.12083		0.00020-0.00075	

Table 4.2 : Contact toxicity of cyhalothrin on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.000005	30	2	6.67	6	20.00
0.00001	30	4	13.33	9	30.00
0.00005	30	10	33.33	18	60.00
0.0001	30	14	46.67	24	80.00
LC ₅₀ (%) by probit program		0.00012		0.00002	
95% confidence interval		(0.00006-0.00057)		(0.00002-0.00004)	

Table 4.3 : Oral toxicity of cyhalothrin on *A. florea*

Concentration (\times)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.000001	30	0	0	3	10.00
0.000005	30	0	0	4	13.33
0.00001	30	5	16.67	8	26.67
0.00005	30	7	23.33	16	53.33
LC ₅₀ (\times) by probit program		0.00017		0.00005	
95% confidence interval				(0.00002-0.00033)	

Table 4.4 : Oral toxicity of cyhalothrin on *A. cerana*

Concentration (\times)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.0005	30	0	0	1	3.33
0.001	30	4	13.33	11	36.67
0.003	30	9	30.00	21	70.00
0.005	30	10	33.33	25	83.33
LC ₅₀ (\times) by probit program		0.0079		0.0016	
95% confidence interval		(0.00459-0.02492)		(0.00129-0.00234)	

Table 4.5 :

Azadirachtin determined by High-Performance Liquid Chromatography (HPLC) in various extracts.

Extract	Azadirachtin found
Neem-seed crude extract	0.13 % (w/w)
Neem-seed extract	0.09 % (w/w)
Neem-leaf extract	0
Neem oil	0.04 % (w/w)
Commercial neem extract	
- Margosan - 0 [®]	0.01 % (w/v)
- Neemix [®]	0.029 % (w/v)
- Advantage [®]	0.023 % (w/v)

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Table 4.6 : Contact toxicity of neem-seed crude extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	0	0
10	30	0	0	2	6.67
50	30	0	0	10	33.33
100	30	0	0	12	40.00
LC ₅₀ (%) by probit program		-		121.84	
95% confidence interval		-		(74.74-522.84)	

Table 4.7 : Contact toxicity of neem-seed crude extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	1	3.33
10	30	0	0	8	26.67
50	30	0	0	16	53.03
100	30	0	0	21	70.00
LC ₅₀ (%) by probit program		-		37.60	
95% confidence interval		-		(22.31-70.16)	

Table 4.8 : Oral toxicity of neem-seed crude extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	1	3.33
5	30	0	0	2	6.67
10	30	0	0	0	0
50	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		*	
95% confidence interval		-		*	

Table 4.9 : Oral toxicity of neem-seed crude extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	2	6.67	4	13.33
5	30	1	3.33	2	6.67
10	30	0	0	0	0
50	30	0	0	0	0
LC ₅₀ (%) by probit program		*		*	
95% confidence interval		*		*	

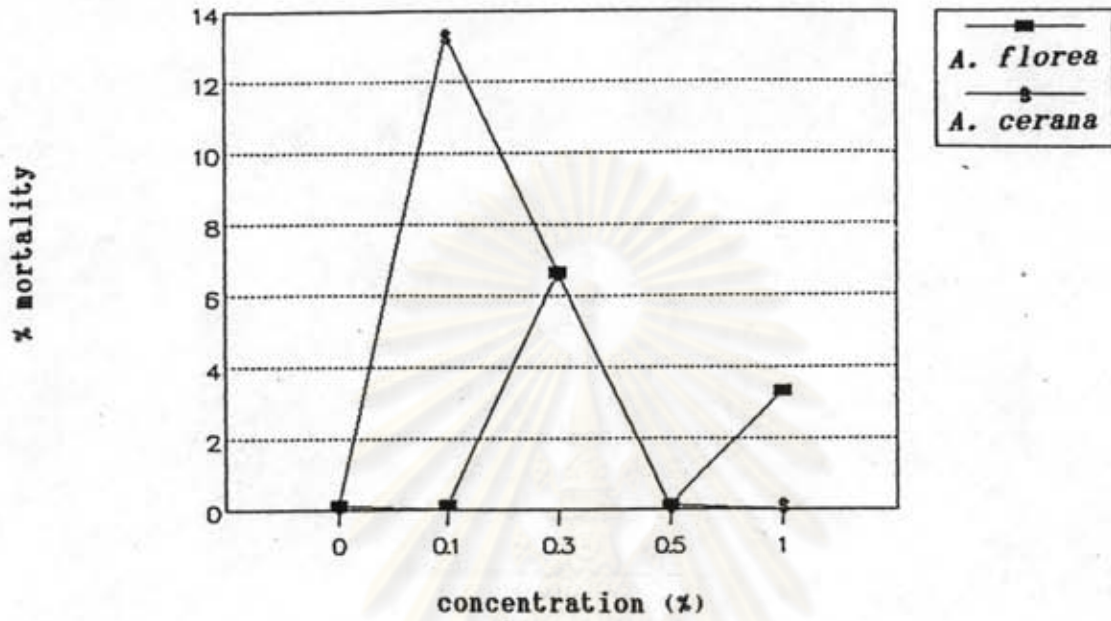


Figure 4.1 :

Oral toxicity of neem-seed crude extract on *A. florea* and *A. cerana*.

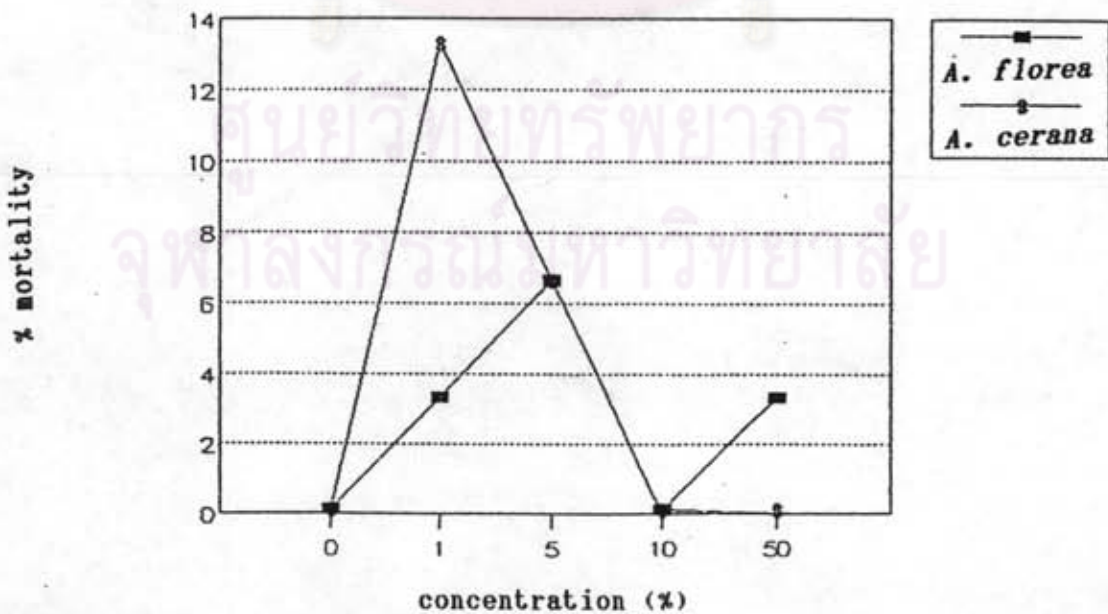


Figure 4.2:

Oral toxicity of neem-seed crude extract on *A. florea* and *A. cerana*.

1.2(b) Toxicity of neem-seed extract on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of neem-seed extract on *A. florea*.

Contact toxicity of neem-seed extract on *A. florea* by topical application is shown in Table 4.10. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 12.95 % (6.75-56.03), and the LD_{50} value is 129.5 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of neem-seed extract on *A. cerana*.

Contact toxicity of neem-seed extract on *A. cerana* by topical application is shown in Table 4.11. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 6.74 % (3.82-16.67), and the LD_{50} value is 67.4 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of neem-seed extract on *A. florea*.

Oral toxicity of neem-seed extract to *A. florea* by feeding methods is shown in Table 4.12. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of neem-seed extract was fluctuating. The results showed that at high concentration, the %mortality of adult bees is low. (Figure 4.2)

1.2.4 Oral toxicity of neem-seed extract on *A. cerana*.

Oral toxicity of neem-seed extract on *A. cerana*

by feeding methods is shown in Table 4.13. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of neem-seed extract was fluctuating. The results showed that at high concentration, the % mortality of adult bees is low. (Figure 4.2)

1.2(c) Toxicity of neem-leaf extract on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of neem-leaf extract on *A. florea*.

Contact toxicity of neem-leaf extract on *A. florea* by topical application is shown in Table 4.14. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 202.14 %, and the LD_{50} value is 2021.4 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of neem-leaf extract on *A. cerana*.

Contact toxicity of neem-leaf extract on *A. cerana* by topical application is shown in Table 4.15. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 377.96 %, and the LD_{50} value is 3779.6 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of neem-leaf extract on *A. florea*.

Oral toxicity of neem-leaf extract on *A. florea* by feeding methods is shown in Table 4.16. The results are presented as the

% mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 377.96 %, and the LD_{50} value is 3779.6 $\mu\text{g}/\text{bee}$.

1.2.4 Oral toxicity of neem-leaf extract on *A. cerana*.

Oral toxicity of neem-leaf extract on *A. cerana* by feeding methods is shown in Table 4.17. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 202.14 %, and the LD_{50} value is 2021.4 $\mu\text{g}/\text{bee}$.

1.2(d) Toxicity of neem oil on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of neem oil on *A. florea*.

Contact toxicity of neem oil on *A. florea* by topical application is shown in Table 4.18. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 32.57 % (20.75-67.59), and the LD_{50} value is 325.7 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of neem oil on *A. cerana*.

Contact toxicity of neem oil on *A. cerana* by topical application is shown in Table 4.19. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 38.03 % (25.56-71.44), and the LD_{50} value is 380.30 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of neem oil on *A. florea*.

Oral toxicity of neem oil on *A. florea* by feeding methods is shown in Table 4.20. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 211.04 % (65.22-11502.84), and the LD_{50} is 2110.4 $\mu\text{g}/\text{bee}$.

1.2.4 Oral toxicity of neem oil on *A. cerana*.

Oral toxicity of neem oil on *A. cerana* by feeding methods is shown in Table 4.21. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 442.05 % (82.40-453164.55), and the LD_{50} value is 4420.5 $\mu\text{g}/\text{bee}$.

1.2(e) Toxicity of Margosan-0[®] on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of Margosan-0[®] on *A. florea*.

Contact toxicity of Margosan-0[®] on *A. florea* by topical application is shown in Table 4.22. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 453.99 % (144.82-1830522.46), and the LD_{50} value is 4539.90 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of Margosan-0[®] on *A. cerana*.

Contact toxicity of Margosan-0[®] on *A. cerana* by topical application is shown in Table 4.23. The results are presented

as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 178.84 % (90.76-1373.29), and the LD_{50} value is 1788.4 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of Margosan-0[®] on *A. florea*.

Oral toxicity of Margosan-0[®] on *A. florea* by feeding methods is shown in Table 4.24. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 1743.59% (209.74- 4.6×10^{87}), and the LD_{50} value is 17435.9 $\mu\text{g}/\text{bee}$.

1.2.4 Oral toxicity of Margosan-0[®] on *A. cerana*.

Oral toxicity of Margosan-0[®] on *A. cerana* by feeding methods is shown in Table 4.25. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 41.52 % (24.98-92.59), and the LD_{50} value is 415.2 $\mu\text{g}/\text{bee}$.

1.2(f) Toxicity of Neemix[®] on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of Neemix[®] on *A. florea*.

Contact toxicity of Neemix[®] on *A. florea* by topical application is shown in Table 4.26. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24



hours) is 209.90 % (118.3-3687.1), and the LD_{50} value is 2099.0 $\mu\text{g}/\text{bee}$.

1.2.2 Contact toxicity of Neemix[®] on *A. cerana*.

Contact toxicity of Neemix[®] on *A. cerana* by topical application is shown in Table 4.27. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) is 78.90 % (65.60-103.80), and the LD_{50} value is 789.0 $\mu\text{g}/\text{bee}$.

1.2.3 Oral toxicity of Neemix[®] on *A. florea*.

Oral toxicity of Neemix[®] on *A. florea* by feeding methods is shown in Table 4.28. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of Neemix[®] was fluctuating. (Figure 4.3)

1.1.4 Oral toxicity of Neemix[®] on *A. cerana*.

Oral toxicity of Neemix[®] on *A. cerana* by feeding methods is shown in Table 4.29. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of Neemix[®] was fluctuating. (Figure 4.3)

1.2(g) Toxicity of Advantage[®] on *A. florea* and *A. cerana*

1.2.1 Contact toxicity of Advantage[®] on *A. florea*.

Contact toxicity of Advantage[®] on *A. florea* by topical application is shown in Table 4.30. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC₅₀ value at 95 % confidence interval (24 hours) is 1289.9 %, and the LD₅₀ value is 12899.0 µg/bee.

1.2.2 Contact toxicity of Advantage[®] on *A. cerana*.

Contact toxicity of Advantage[®] on *A. cerana* by topical application is shown in Table 4.31. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC₅₀ value at 95 % confidence interval (24 hours) is 162.1 % (97.30-840.70), and the LD₅₀ value is 1621.0 µg/bee.

1.2.3 Oral toxicity of Advantage[®] on *A. florea*.

Oral toxicity of Advantage[®] on *A. florea* by feeding methods is shown in Table 4.32. The results are presented as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC₅₀ value at 95 % confidence interval (24 hours) was unable to calculate because the response of adult bees to toxicity of Advantage[®] was fluctuating. (Figure 4.4)

1.1.4 Oral toxicity of Advantage[®] on *A. cerana*.

Oral toxicity of Advantage[®] on *A. cerana* by feeding methods is shown in Table 4.33. The results are presented

as the % mortality of adult bees to various concentrations at 3 and 24 hours after treatment. The LC_{50} value at 95 % confidence interval (24 hour) was unable to calculate because the response of adult bees to toxicity of Advantage[®] was fluctuating. (Figure 4.4)

The comparative toxicity (based on LC_{50} value) of various Thai neem extracts and cyhalothrin on *A. florea* and *A. cerana* are shown in Table 4.34 and 4.35, respectively. The comparative toxicity (based on LD_{50} value) of various Thai neem extracts and cyhalothrin on *A. florea* and *A. cerana* are shown in Table 4.36 and 4.37, respectively.

The comparative toxicity (based on LD_{50} (azadirachtin) value) of various Thai neem extracts on *A. florea* and *A. cerana* are shown in Table 4.38 and 4.39, respectively.



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Table 4.10 : Contact toxicity of neem-seed extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	20	0	0	0	0
0.1	20	0	0	0	0
1	20	0	0	5	16.67
5	20	0	0	7	23.33
10	20	0	0	15	50.00
LC ₅₀ (%) by probit program		-		12.95	
95% confidence interval		-		(6.75-56.03)	

Table 4.11: Contact toxicity of neem-seed extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.1	30	0	0	0	0
1	30	0	0	6	26.67
5	30	0	0	12	40.00
10	30	0	0	17	56.67
LC ₅₀ (%) by probit program		-		6.74	
95% confidence interval		-		(3.82-16.67)	

Table 4.12 : Oral toxicity of neem-seed extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.1	30	0	0	1	0
0.3	30	0	0	2	6.67
0.5	30	0	0	0	0
1.0	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		*	
95% confidence interval		-		*	

Table 4.13 : Oral toxicity of neem-seed extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.1	30	2	6.67	4	13.33
0.3	30	1	3.33	2	6.67
0.5	30	0	0	0	0
1.0	30	0	0	0	0
LC ₅₀ (%) by probit program		*		*	
95% confidence interval		*		*	

Table 4.14 : Contact toxicity of neem-leaf extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
25	30	0	0	0	0
50	30	0	0	0	0
75	30	0	0	0	0
100	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		202.14	
95% confidence interval		-		-	

Table 4.15 : Contact toxicity of neem-leaf extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	20	0	0	0	0
25	20	0	0	0	0
50	20	0	0	0	0
75	20	0	0	1	3.33
100	20	0	0	1	3.33
LC ₅₀ (%) by probit program		-		377.96	
95% confidence interval		-		-	

Table 4.16 : Oral toxicity of neem-leaf extract on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
25	30	0	0	0	0
50	30	0	0	0	0
75	30	0	0	1	3.33
100	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		377.96	
95% confidence interval		-		-	

Table 4.17 : Oral toxicity of neem-leaf extract on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
25	30	0	0	0	0
50	30	0	0	0	0
75	30	0	0	0	0
100	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		202.14	
95% confidence interval		-		-	

Table 4.18 : Contact toxicity of neem oil on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	1	3.33
5	30	1	3.33	3	10.00
10	30	1	3.33	4	13.33
50	30	5	16.67	20	66.67
LC ₅₀ (%) by probit program		406.04		32.57	
95% confidence interval		(92.77-5683925.43)		(20.75-67.59)	

Table 4.19 : Contact toxicity of neem oil on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	0	0
5	30	0	0	2	6.67
10	30	2	6.67	3	10.00
50	30	12	40.00	18	60.00
LC ₅₀ (%) by probit program		64.62		38.03	
95% confidence interval		(41.06-170.54)		(25.56-71.44)	

Table 4.20 : Oral toxicity of neem oil on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.5	30	0	0	0	0.00
1.0	30	0	0	1	3.33
10.0	30	0	0	2	6.67
50.0	30	0	0	9	30.00
LC_{50} (%) by probit program		-		211.04	
95% confidence interval		-		(65.22-11502.84)	

Table 4.21 : Oral toxicity of neem oil on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulation % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
0.5	30	0	0	0	0.00
1.0	30	0	0	2	6.67
10.0	30	1	3.33	3	10.00
50.0	30	3	10.00	8	26.67
LC_{50} (%) by probit program		886.03		442.05	
95% confidence interval				(62.40-453164.55)	

Table 4.22 : Contact toxicity of Margosan-O[®] on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
5	30	0	0	0	0
10	30	0	0	1	3.33
50	30	0	0	4	13.33
80	30	0	0	5	16.67
LC ₅₀ (%) by probit program		-		453.99	
95% confidence interval		-		(144.82-1830522.46)	

Table 4.23 : Contact toxicity of Margosan-O[®] on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
5	30	0	0	0	0
10	30	0	0	2	6.67
50	30	0	0	7	23.33
80	30	0	0	9	30.00
LC ₅₀ (%) by probit program		-		178.84	
95% confidence interval		-		(90.76-1373.29)	

Table 4.24 : Oral toxicity of Margosan-0[®] on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
5	30	0	0	1	3.33
10	30	0	0	2	6.67
50	30	0	0	3	10.00
80	30	0	0	6	20.00
LC ₅₀ (%) by probit program		-		1773.59	
95% confidence interval		-		(209.74-4.6x10 ⁴⁷)	

Table 4.25 : Oral toxicity of Margosan-0[®] on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
5	30	0	0	5	25.00
10	30	0	0	7	35.00
50	30	0	0	17	85.00
80	30	0	0	18	90.00
LC ₅₀ (%) by probit program		-		41.52	
95% confidence interval		-		(24.96-91.59)	

Table 4.26 : Contact toxicity of Neemix[®] on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulation x mortality			
		3 h		24 h	
		number	mortality	number	mortality
0	30	0	0	0	0
10	30	0	0	0	0
30	30	0	0	1	3.33
50	30	0	0	3	10
100	30	0	0	7	23.33
LC ₅₀ (%) by probit program		-		209.90	
95% confidence interval		-		(116.3-3687.1)	

Table 4.27 : Contact toxicity of Neemix[®] on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated x mortality			
		3 h		24 h	
		number	mortality	number	mortality
0	30	0	0	0	0
10	30	0	0	0	0
30	30	0	0	1	3.33
50	30	0	0	8	26.67
100	30	0	0	19	63.33
LC ₅₀ (%) by probit program		-		78.90	
95% confidence interval		-		(65.60-103.80)	

Table 4.28 : Oral toxicity of Neemix[®] on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
10	30	0	0	2	6.67
30	30	0	0	0	0
50	30	0	0	2	6.67
100	30	0	0	1	3.33
LC ₅₀ (%) by probit program		-		*	
95% confidence interval		-		*	

Table 4.29 : Oral toxicity of Neemix[®] on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
10	30	0	0	0	0
30	30	0	0	2	6.67
50	30	0	0	1	3.33
100	30	0	0	3	10
LC ₅₀ (%) by probit program		-		*	
95% confidence interval		-		*	

Table 4.30 : Contact toxicity of Advantage[®] on *A. florea*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
10	30	0	0	1	3.33
30	30	0	0	2	6.67
50	30	0	0	4	13.33
100	30	0	0	12	40
LC ₅₀ (%) by probit program		-		162.10	
95% confidence interval		-		(97.30-840.70)	

Table 4.31 : Contact toxicity of Advantage[®] on *A. cerana*

Concentration (%)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
10	30	0	0	1	3.33
30	30	0	0	2	6.67
50	30	0	0	3	10
100	30	0	0	5	17
LC ₅₀ (%) by probit program		-		1269.9	
95% confidence interval		-		-	

Table 4.32 : Oral toxicity of Advantage[®] on *A. florea*

Concentration (μ)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	2	6.67
10	30	0	0	0	0
20	30	0	0	2	6.67
30	30	0	0	1	3.33
LC ₅₀ (μ) by probit program		-		*	
95% confidence interval		-		*	

Table 4.33 : Oral toxicity of Advantage[®] on *A. cerana*

Concentration (μ)	Number of adult bees	Number and accumulated % mortality			
		3 h		24 h	
		number	%mortality	number	%mortality
0	30	0	0	0	0
1	30	0	0	0	0
10	30	0	0	2	6.67
20	30	0	0	1	3.33
30	30	0	0	3	10
LC ₅₀ (μ) by probit program		-		*	
95% confidence interval		-		*	

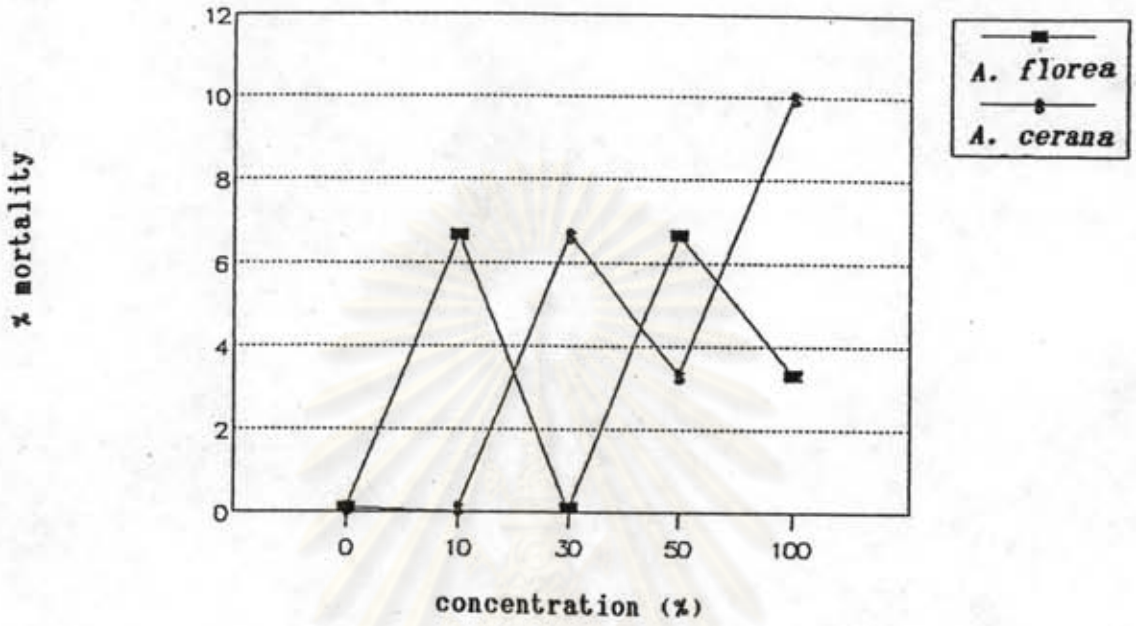


Figure 4.3 :

Oral toxicity of Neemix[®] on *A. florea* and *A. cerana*.

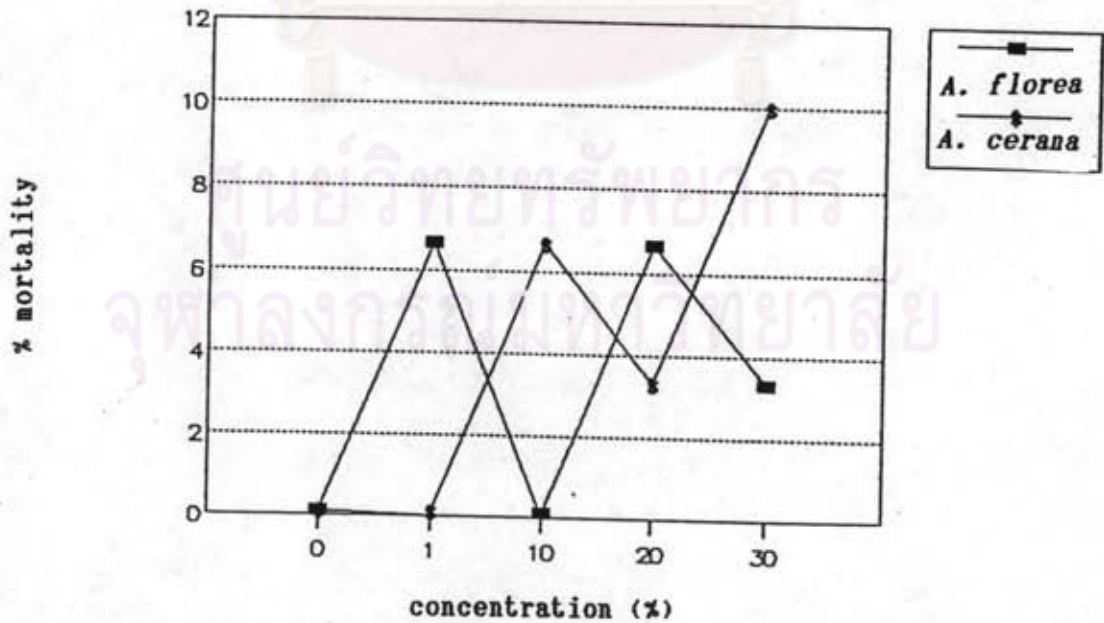


Figure 4.4 :

Oral toxicity of Advantage[®] on *A. florea* and *A. cerana*.

Table 4.34 :

The comparative toxicity of cyhalothrin and various neem extracts on *A. florea* by topical application and feeding methods. (LC₅₀ at 24h)

extract	LC ₅₀ (%) at 95 % confidence interval	
	topical application	feeding methods
Cyhalothrin	0.00003 (0.00002-0.00004)	0.00005 (0.00002-0.00033)
Neem-seed crude extract	131.84 (74.74-522.84)	*
Neem-seed extract	12.95 (6.75-56.03)	*
Neem-leaf extract	202.14	377.96
Neem oil	32.57 (20.75-67.59)	211.04 (65.22-11502.84)

Table 4.34 (cont.) :

The comparative toxicity of cyhalothrin and various neem extracts on *A. florea* by topical application and feeding methods. (LC₅₀ at 24 h)

Extract	LC ₅₀ (%) at 95 % confidence interval	
	topical application	feeding methods
Margosan-0 [®]	453.99 (144.82-1830522.46)	1773.59 (209.74-4.6x10 ⁸⁷)
Neemix [®]	209.90 (118.3-3687.1)	*
Advantage [®]	1289.90	*

Note : * = Unable calculated.



Table 4.35 :

The comparative toxicity of cyhalothrin and various neem extracts on *A. cerana* by topical application and feeding methods. (LC_{50} at 24 h)

Extract	LC_{50} (%) at 95 % confidence interval	
	topical application	feeding methods
Cyhalothrin	0.00039 (0.0002-0.00075)	0.0018 (0.00139-0.00234)
Neem-seed crude extract	37.60 (22.31-70.16)	*
Neem-seed extract	6.74 (3.82-16.67)	*
Neem-leaf extract	377.96	202.14
Neem oil	38.03 (25.56-71.44)	442.05 (82.40-453164.55)

Table 4.35 (cont.) :

The comparative toxicity of cyhalothrin and various neem extracts on *A. cerana* by topical application and feeding methods. (LC_{50} at 24 h)

Extract	LC_{50} (%) at 95 % confidence interval	
	topical application	feeding methods
Margosan-0 [®]	178.84 (90.76-1373.29)	41.52 (24.98-92.59)
Neemix [®]	78.90 (65.60-103.80)	*
Advantage [®]	162.10 (97.30-840.70)	*

Note : * = Unable calculated.

Table 4.36 :

The comparative toxicity of cyhalothrin and various neem extracts on *A. florea* by topical application and feeding methods. (LD₅₀ at 24 h)

Extract	LD ₅₀ (µg/bee)	
	topical application	feeding methods
Cyhalothrin	0.0003 (0.0002-0.0004)	0.0005 (0.0002-0.0033)
Neem-seed crude extract	1318.4 (747.4-5228.4)	*
Neem-seed extract	129.5 (67.5-560.3)	*
Neem-leaf extract	2021.4	3779.6
Neem oil	325.7 (207.5-675.9)	2110.4

Table 4.36 (cont.) :

The comparative toxicity of cyhalothrin and various neem extracts on *A. florea* by topical application and feeding methods. (LD₅₀ at 24 h)

Extract	LD ₅₀ (µg/bee)	
	topical application	feeding methods
Margosan-0 [®]	4539.9 (1448.2-18305224.6)	17435.9 (2097.4-4.6x10 ⁸)
Neemix [®]	2099.0 (1183.0-36871.0)	*
Advantage [®]	12899.0	*

Note : * = Unable calculated.

Table 4.37 :

The comparative toxicity of cyhalothrin and various neem extracts on *A. cerana* by topical application and feeding methods. (LD_{50} at 24 h)

Extract	LD_{50} ($\mu\text{g}/\text{bee}$)	
	topical application	feeding methods
Cyhalothrin	0.0039 (0.002-0.0075)	0.018 (0.0139-0.0234)
Neem-seed crude extract	376.4 (223.1-701.6)	*
Neem-seed extract	67.4 (38.2-166.7)	*
Neem-leaf extract	3779.6	2021.4
Neem oil	380.3 (255.6-714.4)	4420.5 (824.0-4531645.5)

Table 4.37 (cont.) :

The comparative toxicity of cyhalothrin and various neem extracts on *A. cerana* by topical application and feeding methods. (LD₅₀ at 24 h)

Extract	LD ₅₀ (µg/bee)	
	topical application	feeding methods
Margosan-0 [®]	1788.4 (907.6-13732.9)	415.2 (249.8-925.9)
Neemix [®]	789.0 (656.0-1038.0)	*
Advantage [®]	1621.0 (973.0-8407.0)	*

Note : * = Unable calculated.

Table 4.38:

The comparative toxicity of various neem extracts on *A. florea* by topical application and feeding methods. (LD_{50} of azadirachtin at 24 h)

Extract	LD_{50} (μg azadirachtin/bee)	
	topical application	feeding methods
Neem-seed crude extract	1.71 (0.97-6.80)	*
Neem-seed extract	0.12 (0.06-0.50)	*
Neem-leaf extract	no azadirachtin	no azadirachtin
Neem oil	0.13 (0.08-0.27)	0.84 (0.26-46.01)

Table 4.38 (cont.) :

The comparative toxicity various neem extracts on *A. florea* by topical application and feeding methods. (LD₅₀ of azadirachtin at 24 h)

Extract	LD ₅₀ (µg azadirachtin/bee)	
	topical application	feeding methods
Margosan-0 [®]	0.45 (0.14-1830.50)	1.74 (0.20-4.6x10 ⁸⁴)
Neemix [®]	0.61 (0.34-10.69)	*
Advantage [®]	2.97	*

Note : * = Unable calculated.

Table 4.39 :

The comparative toxicity of various neem extracts on *A. cerana* by topical application and feeding methods. (LD_{50} of azadirachtin at 24 h)

Extract	LD_{50} (μ g azadirachtin/bee)	
	topical application	feeding methods
Neem-seed crude extract	0.05 (0.29-0.91)	*
Neem-seed extract	0.06 (0.03-0.15)	*
Neem-leaf extract	no azadirachtin	no azadirachtin
Neem oil	0.15 (0.10-0.28)	1.77 (0.33-1812.65)



Table 4.39 (cont.) :

The comparative toxicity of various neem extracts on *A. cerana* by topical application and feeding methods. (LD_{50} of azadirachtin at 24 h)

Extract	LD_{50} (μg azadirachtin/bee)	
	topical application	feeding methods
Margosan-0 [®]	0.18 (0.09-1.37)	0.04 (0.33-1812.65)
Neemix [®]	0.23 (0.19-0.30)	*
Advantage [®]	0.37 (0.22-1.93)	*

Note : * = Unable calculated.

2. Residual toxicity of Thai neem extract and cyhalothrin on *A. florea* and *A. cerana*.

2.1 Residual toxicity of Thai neem extract on *A. florea*.

Residual toxicity of Thai neem-seed extract on *A. florea* by topical application and feeding methods are shown in Table 4.40. The results showed that three hours after spraying with the neem-seed extract (1%, 1000 ml/area), no residual effect was found on *A. florea*. (Figure 4.5)

2.2 Residual toxicity of Thai neem extract on *A. cerana*.

Residual toxicity of Thai neem-seed extract on *A. cerana* by topical application and feeding methods are shown in Table 4.41. The results showed that six hours after spraying with the neem-seed extract (1%, 1000 ml/area), no residual effect was found on *A. cerana*. (Figure 4.5)

2.3 Residual toxicity of cyhalothrin on *A. florea*.

Residual toxicity of cyhalothrin on *A. florea* by topical application and feeding methods are shown in Table 4.42. The results showed that 48 hours after spraying with cyhalothrin (0.002 %, 1000 ml/area), no residual effect was found on *A. florea*. (Figure 4.6)

2.4 Residual toxicity of cyhalothrin on *A. cerana*

Residual toxicity of cyhalothrin on *A. cerana* by topical application and feeding methods are shown in Table 4.43. The results showed that six hours after spraying with cyhalothrin (0.002 %, 1000 ml/area), no residual effect on *A. cerana*. (Figure 4.6)

Table 4.40 :

Residual effect of neem extract on *Antigonon leptopus* to *A. florea*

Time after spraying (h)	% mortality ($\bar{X} \pm SD$)	
	Topical application	Feeding methods
0	4.44 \pm 1.93	2.22 \pm 1.93
1	2.22 \pm 1.93	0.00 \pm 0.00
3	0.00 \pm 0.00	0.00 \pm 0.00
6	0.00 \pm 0.00	0.00 \pm 0.00
12	0.00 \pm 0.00	0.00 \pm 0.00
24	0.00 \pm 0.00	0.00 \pm 0.00
48	0.00 \pm 0.00	0.00 \pm 0.00
60	0.00 \pm 0.00	0.00 \pm 0.00

Table 4.41 :

Residual effect of neem extract on *Antigonon leptopus* to *A. cerana*

Time after spraying (h)	% mortality ($\bar{X} \pm SD$)	
	Topical application	Feeding methods
0	5.56 \pm 1.93	2.22 \pm 1.93
1	4.44 \pm 1.93	0.00 \pm 0.00
3	2.22 \pm 1.93	0.00 \pm 0.00
6	0.00 \pm 0.00	0.00 \pm 0.00
12	0.00 \pm 0.00	0.00 \pm 0.00
24	0.00 \pm 0.00	0.00 \pm 0.00
48	0.00 \pm 0.00	0.00 \pm 0.00
60	0.00 \pm 0.00	0.00 \pm 0.00

Table 4.42 :

Residual effect of cyhalothrin on *Antigonon leptopus* to *A. florea*

Time after spraying (h)	% mortality ($\bar{X} \pm SD$)	
	Topical application	Feeding methods
0	83.33 \pm 3.33	37.78 \pm 5.09
1	75.56 \pm 1.93	13.33 \pm 3.34
3	55.54 \pm 6.94	6.67 \pm 3.34
6	26.67 \pm 6.67	2.22 \pm 1.92
12	7.78 \pm 1.92	0.00 \pm 0.00
24	2.22 \pm 1.92	0.00 \pm 0.00
48	0.00 \pm 0.00	0.00 \pm 0.00
60	0.00 \pm 0.00	0.00 \pm 0.00

Table 4.43 :

Residual effect of cyhalothrin on *Antigonon leptopus* to *A. cerana*

Time after spraying (h)	% mortality ($\bar{X} \pm SD$)	
	Topical application	Feeding methods
0	10.00 \pm 3.33	1.11 \pm 1.93
1	4.44 \pm 1.93	0.00 \pm 0.00
3	1.11 \pm 1.93	0.00 \pm 0.00
6	0.00 \pm 0.00	0.00 \pm 0.00
12	0.00 \pm 0.00	0.00 \pm 0.00
24	0.00 \pm 0.00	0.00 \pm 0.00
48	0.00 \pm 0.00	0.00 \pm 0.00
60	0.00 \pm 0.00	0.00 \pm 0.00

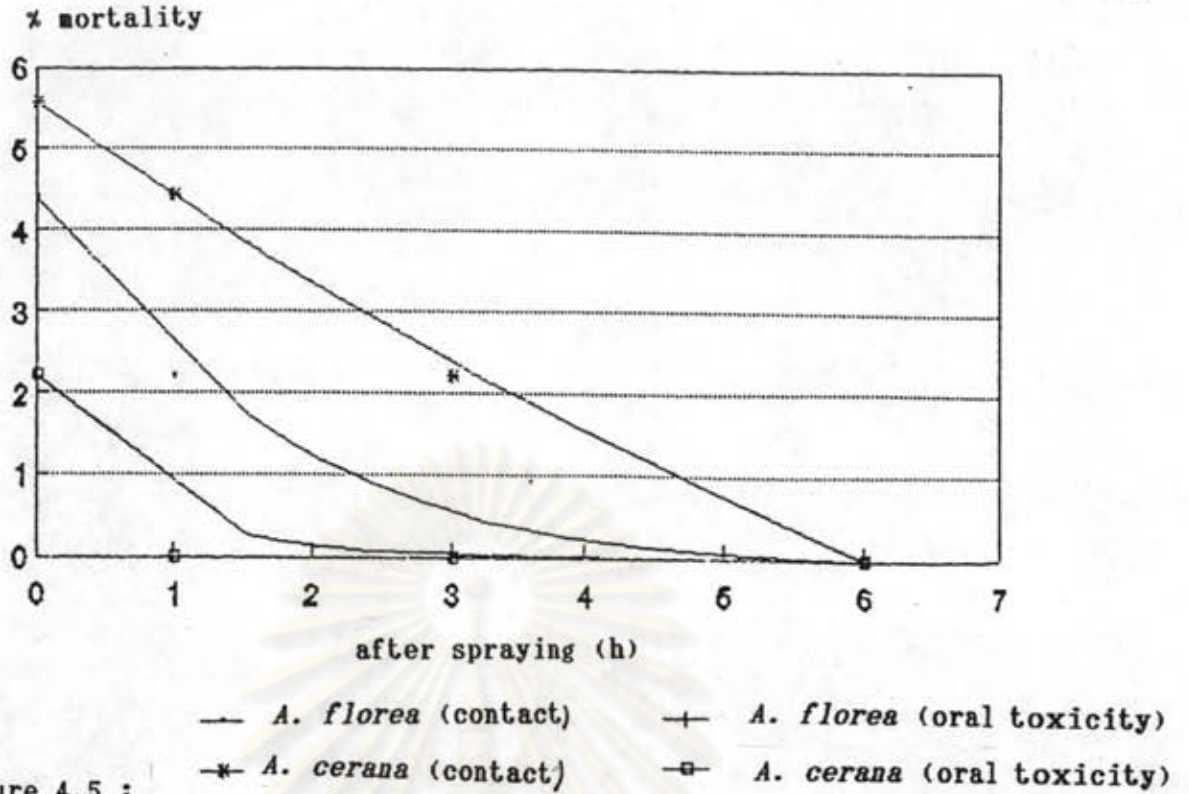


Figure 4.5 :

Residual effect of neem extract on *Antogonon leptopus* to *A. florea* and *A. cerana*.

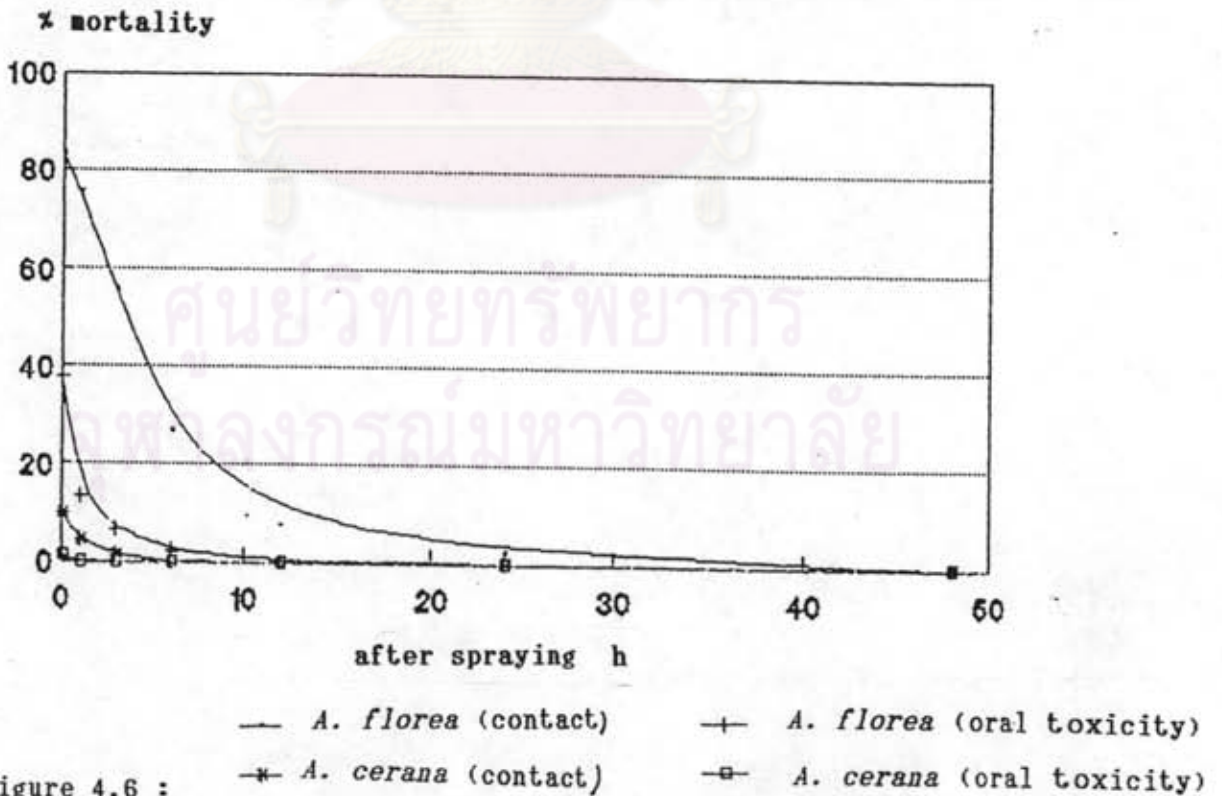


Figure 4.6 :

Residual effect of cyhalothrin on *Antogonon leptopus* to *A. florea* and *A. cerana*.

3. Repellant effects of Thai neem extract and cyhalothrin to honey bees

The results of the repellant effects of neem extract and cyhalothrin to honey bee were recorded by counting the number of bees foraging on the flowers. This is shown in Table 4.44. Cyhalothrin showed more repellant effect than neem extract. (Figure 4.7)

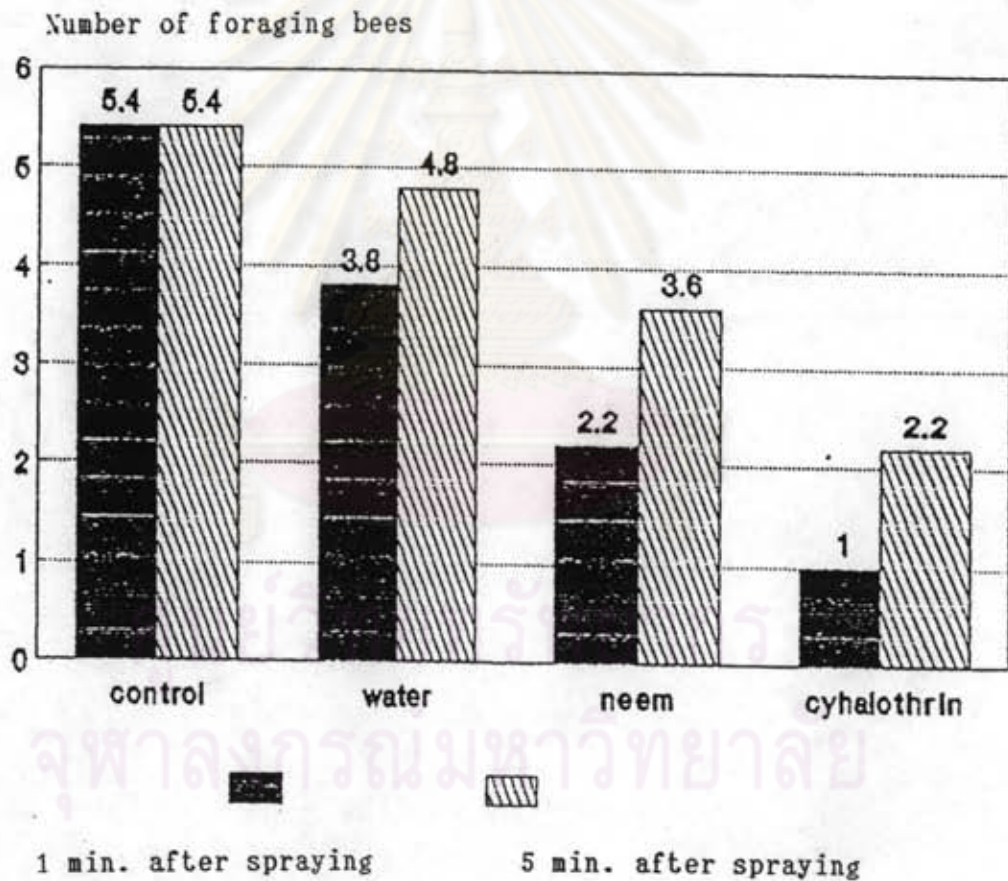


Figure 4.7 :

Repellant effects of neem extract and cyhalothrin to honey bees.

Table 4.44 :

The repellent effects of cyhalothrin and neem extract on *Antigonon leptopus* to *A. cerana* and *A. florea*.

	Number of bees foraging on the flower ($\bar{X} \pm SD$)		
	Before spray	One min. after spray	Five min. after spray
Normal	5.4 \pm 1.14 ^a		
Water		3.8 \pm 0.84 ^b	4.8 \pm 0.84 ^a
Neem extract		2.2 \pm 0.84 ^c	3.6 \pm 0.55 ^b
Cyhalothrin		1.0 \pm 0.71 ^d	2.2 \pm 0.45 ^c

Note : 1 = Average value from 5 replications.

2 = The same letter represents no statistical difference in Duncan's Multiple Range test ($p < 0.05$)

4. A field trial to assess the effects of neem extract on *A. cerana*.

4.1 Climatic conditions

The weather condition during the study is shown in Table 4.45. The experiment was set up in two replicates. Except for the rainfall, the weather condition was not different in the two replicates during the study.

4.2 Effects on foraging activity and bee behaviour.

The foraging activity of honey bees in both the treated and untreated plots were found to be lower when compared with the bees in natural setting. The bee behaviour appeared quite normal on both plots.

4.3 Condition of the experimental beehives.

4.3.1 Eggs

The variation in the number of eggs within the beehive in both the treated and untreated plots was found to decline with time, but no statistical difference was observed between the two plots at $p < 0.05$. The results are summarised in Table 4.46 and shown in Figure 4.8.

4.3.2 Larvae

The variation in the number of larvae within the beehive in both the treated and untreated plots was found to decline with time, but no statistical difference was observed between the two plots at $p < 0.05$. It was found that the variation of larvae within the beehive in the treated and untreated plots was statistically different in the ninth week. The results are summarised in Table 4.47 and shown in Figure 4.9.



4.3.3 Brood

The variation in the number of brood within the beehive in both the treated and untreated plots was found to decline with time, but no statistical difference was observed between the two plots at $p < 0.05$. The results are summarised in Table 4.48 and shown in Figure 4.10.

4.3.4 Adult

The variation in the number of adult within the beehive in both the treated and untreated plots was found to decline with time, but no statistical difference was observed between the two plots at $p < 0.05$. The results are summarised in Table 4.49 and shown in Figure 4.11.

4.3.5 Nectar and pollen collection

The variation of nectar collection within the beehive in both the treated and untreated plots was found to fluctuated with time, but no statistical difference was noted between the two plots at $p < 0.05$. The results are summarised in Table 4.50 and shown in Figure 4.12. However, the results clearly indicated a regular trend that more nectar collection was made in the untreated plots than the treated plots. Similarly, pollen collection within beehive in both the treated and untreated plots was found to fluctuated with time, but no statistical difference was noted between the two plots at $p < 0.05$. However, the results clearly suggest a regular trend that more pollen collection was made in the untreated plots than the treated plots. The results are summarised in Table 4.51 and shown in Figure 4.13.

Table 4.45 : Climatic condition during the study.

Recorded time	Temperature (°C)	Average Temp. (°C)	Humidity (% RH)	Rain (mm)
11/7/93	28.5	24.1 - 33.5	76	0
16/7/93	25.0	24.1 - 33.5	76	0
25/7/93	27.0	24.1 - 33.5	92	28
1/8/93	28.0	24.1 - 33.5	92	0
8/8/93	28.0	24.0 - 34.7	80	0
15/8/93	27.0	24.0 - 36.0	70	0
22/8/93	29.0	23.3 - 34.7	74	0
29/8/93	28.0	24.2 - 34.0	78	6
5/9/93	27.0	22.5 - 33.5	87	0
12/9/93	26.0	22.3 - 32.0	98	1
Recorded time	Temperature (°C)	Average Temp. (°C)	Humidity (% RH)	Rain (mm)
3/10/93	27.0	23.2 - 34.6	89	41.0
10/10/93	28.5	23.1 - 31.8	80	0.0
17/10/93	28.0	23.2 - 31.7	83	0.4
24/10/93	28.0	23.8 - 32.4	73	0.0
31/10/93	27.0	20.3 - 34.2	70	66.0
7/11/93	29.0	22.5 - 31.4	92	1.3
14/11/93	27.0	22.9 - 32.7	98	18.2
21/11/93	27.0	22.9 - 32.7	98	18.2

Table 4.46 :

Effects of neem extract on variation of egg within beehive.

Recorded time (week)	Number of egg ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	276.50 \pm 140.70	303.75 \pm 108.58
1	210.75 \pm 77.34	289.25 \pm 76.23
2	112.25 \pm 38.66	181.25 \pm 124.03
3	104.50 \pm 53.77	107.25 \pm 79.45
4	93.00 \pm 65.21	43.33 \pm 58.59
5	79.50 \pm 64.73	63.50 \pm 44.55
6	61.25 \pm 80.66	88.33 \pm 88.36
7	76.25 \pm 110.25	76.67 \pm 41.93
8	55.00 \pm 21.21	25.00 \pm 35.35
9	37.50 \pm 10.61	120.00 \pm 98.99

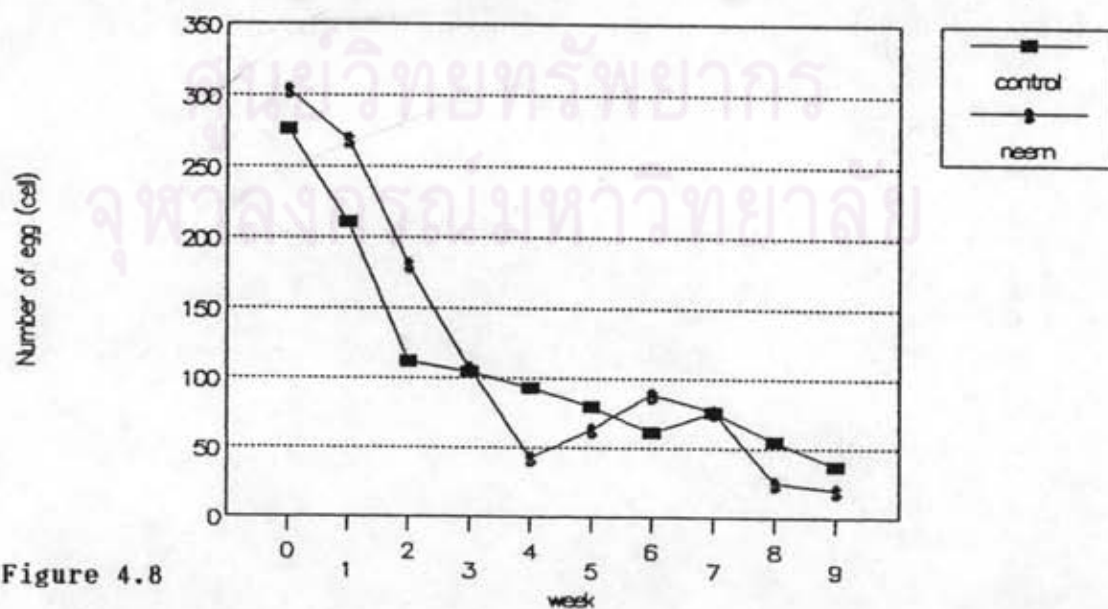
Note : No statistical difference ($p < 0.05$)

Figure 4.8

Effects of neem extract on variation of egg within beehive.

Table 4.47 :

Effects of neem extract on variation of larvae within beehive.

Recorded time (week)	Number of larvae ($\bar{Y} \pm SD$)	
	Control plot	Neem plot
0	323.00 \pm 172.76	406.75 \pm 271.79
1	106.25 \pm 84.07	133.00 \pm 103.55
2	36.75 \pm 23.97	45.25 \pm 43.55
3	19.50 \pm 15.93	23.75 \pm 30.79
4	15.00 \pm 15.68	11.67 \pm 20.21
5	29.75 \pm 36.02	11.00 \pm 15.56
6	27.50 \pm 55.00	35.33 \pm 48.01
7	43.25 \pm 84.51	14.00 \pm 18.52
8	37.50 \pm 10.61	12.50 \pm 17.66
9 *	32.50 \pm 3.53 *	1.50 \pm 2.12 *

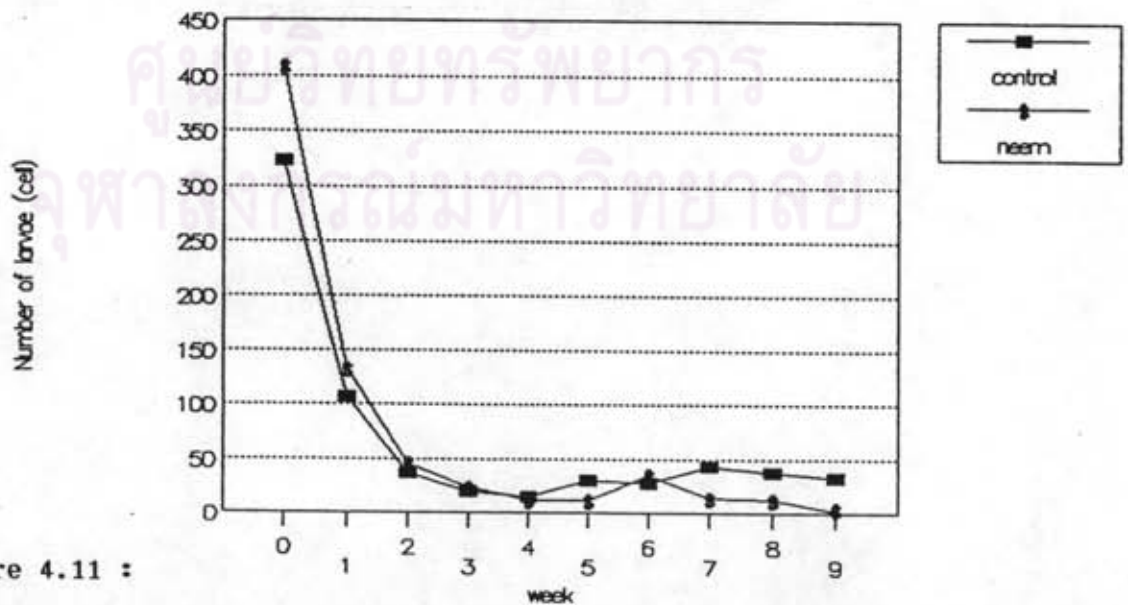
Note : No statistical difference ($p < 0.05$)* = In ninth week represented statistical difference between control plot and neem plot ($p < 0.05$).

Figure 4.11 :

Effects of neem extract on variation of larvae within beehive.

Table 4.48 :

Effects of neem extract on variation of brood within beehive.

Recorded time (week)	Number of brood ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	1507.25 \pm 525.58	1289.00 \pm 357.25
1	1200.00 \pm 347.65	950.50 \pm 583.12
2	577.50 \pm 309.48	481.50 \pm 461.78
3	168.75 \pm 160.28	79.75 \pm 134.17
4	36.25 \pm 72.50	49.33 \pm 85.45
5	14.25 \pm 28.50	0.50 \pm 0.71
6	12.25 \pm 24.50	18.33 \pm 31.75
7	36.25 \pm 70.51	30.00 \pm 51.96
8	80.00 \pm 66.47	1.00 \pm 1.41
9	20.00 \pm 28.28	4.00 \pm 5.66

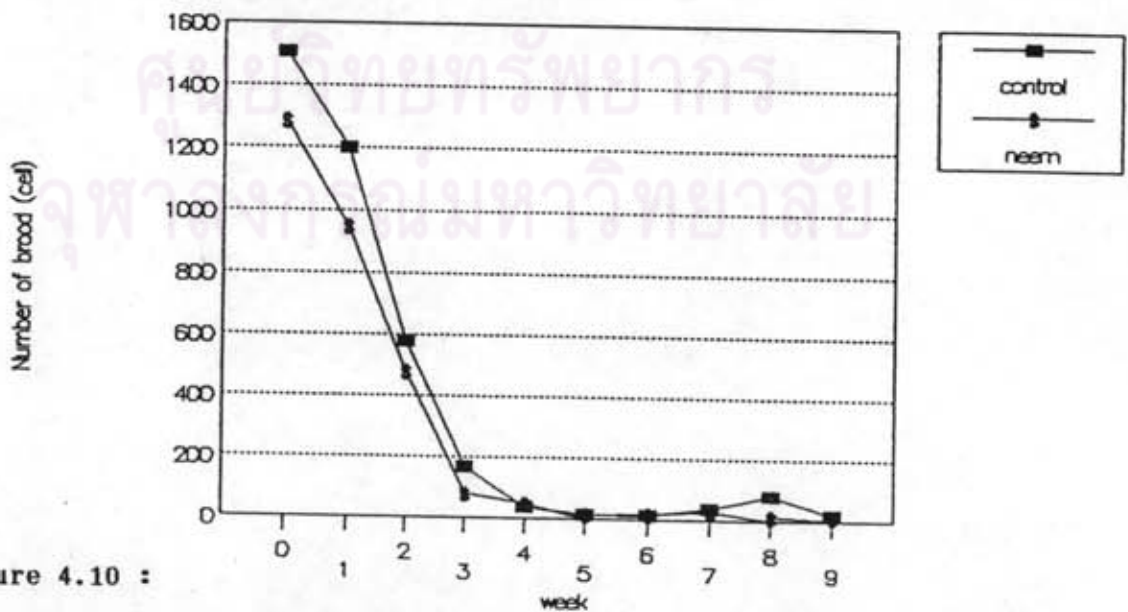
Note : No statistical difference ($p < 0.05$)

Figure 4.10 :

Effects of neem extract on variation of brood within beehive.

Table 4.49 :

Effects of neem extract on variation of adult within beehive.

Recorded time (week)	Number of adult ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	5875.00 \pm 5227.09	5295.00 \pm 4356.58
1	4857.50 \pm 4991.32	4137.50 \pm 3309.27
2	3116.25 \pm 1867.62	2886.25 \pm 2052.59
3	1937.50 \pm 1621.63	1701.25 \pm 922.17
4	1928.75 \pm 1687.52	1736.67 \pm 1121.70
5	1529.25 \pm 1161.34	720.00 \pm 339.41
6	1691.50 \pm 1404.65	1170.00 \pm 834.90
7	1506.00 \pm 1245.37	1547.33 \pm 1699.48
8	1024.00 \pm 852.70	1243.50 \pm 1211.27
9	1179.00 \pm 1196.42	669.00 \pm 468.10

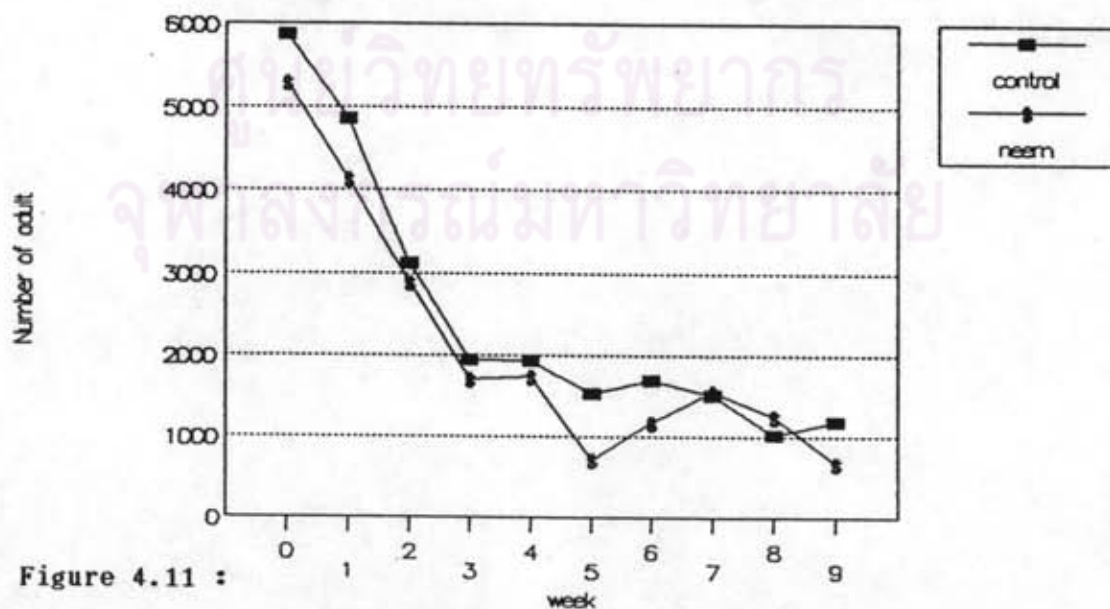
Note : No statistical difference ($p < 0.05$)

Figure 4.11 :

Effects of neem extract on variation of adult within beehive.

Table 4.50 :

Effects of neem extract on variation of nectar collection within beehive

Recorded time (week)	Number of honey cell ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	1772.25 \pm 426.03	1613.75 \pm 613.65
1	1524.25 \pm 443.12	1800.00 \pm 716.66
2	1971.75 \pm 954.62	1006.75 \pm 384.84
3	1113.25 \pm 858.10	1057.25 \pm 557.91
4	1531.75 \pm 910.28	1905.00 \pm 495.30
5	2455.25 \pm 947.60	1899.50 \pm 844.99
6	2466.00 \pm 802.99	1556.67 \pm 499.66
7	2473.50 \pm 493.44	1556.67 \pm 965.88
8	1365.50 \pm 436.28	740.00 \pm 841.46
9	1062.50 \pm 13.44	446.00 \pm 595.38

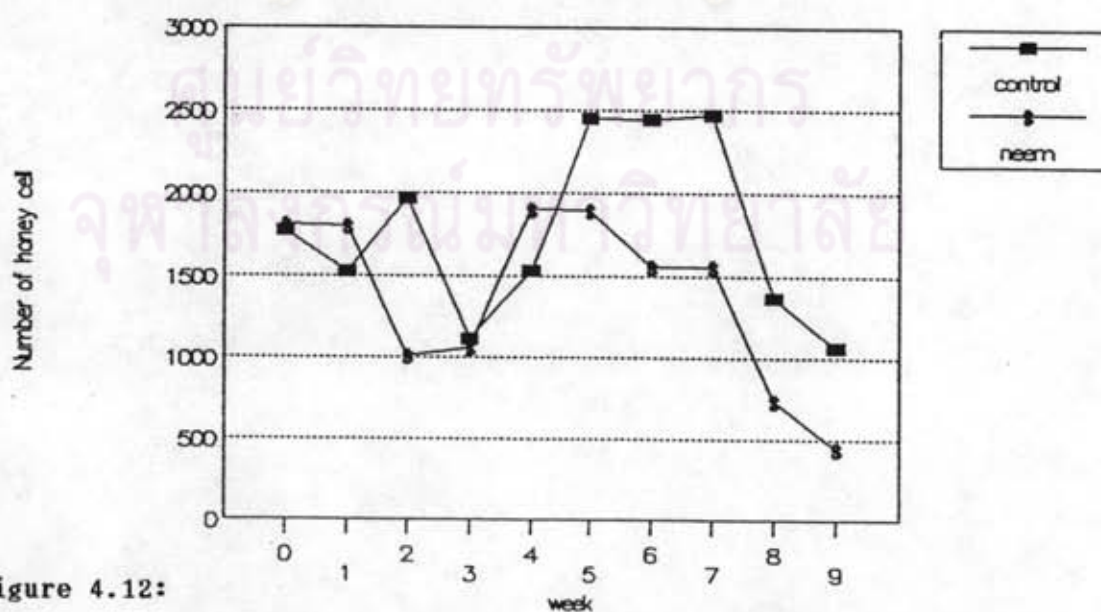
Note : No statistical difference ($p < 0.05$)

Figure 4.12:

Effects of neem extract on variation of nectar collection within beehive

Table 4.51 :

Effects of neem extract on variation of pollen collection within beehive

Recorded time (week)	Number of pollen cell ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	5.25 \pm 2.36	6.00 \pm 2.58
1	7.00 \pm 6.96	12.75 \pm 18.72
2	2.25 \pm 3.30	9.25 \pm 12.31
3	0.75 \pm 0.96	0.75 \pm 1.50
4	0.50 \pm 0.56	0.33 \pm 0.56
5	0.75 \pm 0.96	1.00 \pm 1.41
6	0.00 \pm 0.00	0.00 \pm 0.00
7	0.50 \pm 1.00	3.00 \pm 5.19
8	17.50 \pm 24.70	0.00 \pm 0.00
9	0.00 \pm 0.00	0.00 \pm 0.00

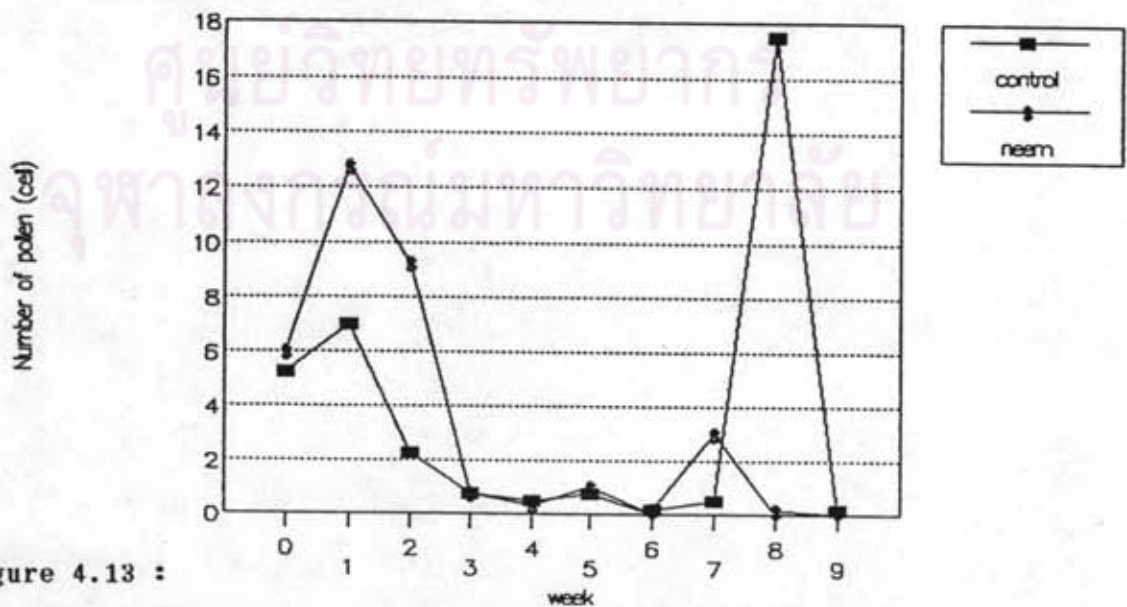
Note : No statistical difference ($p < 0.05$)

Figure 4.13 :

Effects of neem extract on variation of pollen collection within beehive

4.3.6 Weight

The variation of weight of the beehive in both the treated and untreated plots was found to decline slightly with time, but no statistical difference was observed between the two plots at $p < 0.05$. The results are summarised in Table 4.52 and shown in Figure 4.14.

4.3.7 Abnormal larvae and brood

The variation of abnormal larvae and brood within the beehive in both the treated and untreated plots was found to be not statistically different between the two plots at $p < 0.05$. The results are summarised in Table 4.53 and shown in Figure 4.15.

4.3.8 Absconding

Absconding of honey bees was found in the treated plot at the fifth week.

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Table 4.52 :

Effects of neem extract on variation of weight within beehive.

Recorded time (week)	Weight (in kg) of beehive ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	4.93 \pm 0.22	4.85 \pm 0.24
1	4.95 \pm 0.25	4.85 \pm 0.24
2	4.83 \pm 0.20	4.73 \pm 0.21
3	4.84 \pm 0.27	4.74 \pm 0.19
4	4.88 \pm 0.36	4.80 \pm 0.26
5	4.86 \pm 0.36	4.65 \pm 0.21
6	4.86 \pm 0.36	4.65 \pm 0.07
7	4.98 \pm 0.25	4.58 \pm 0.11

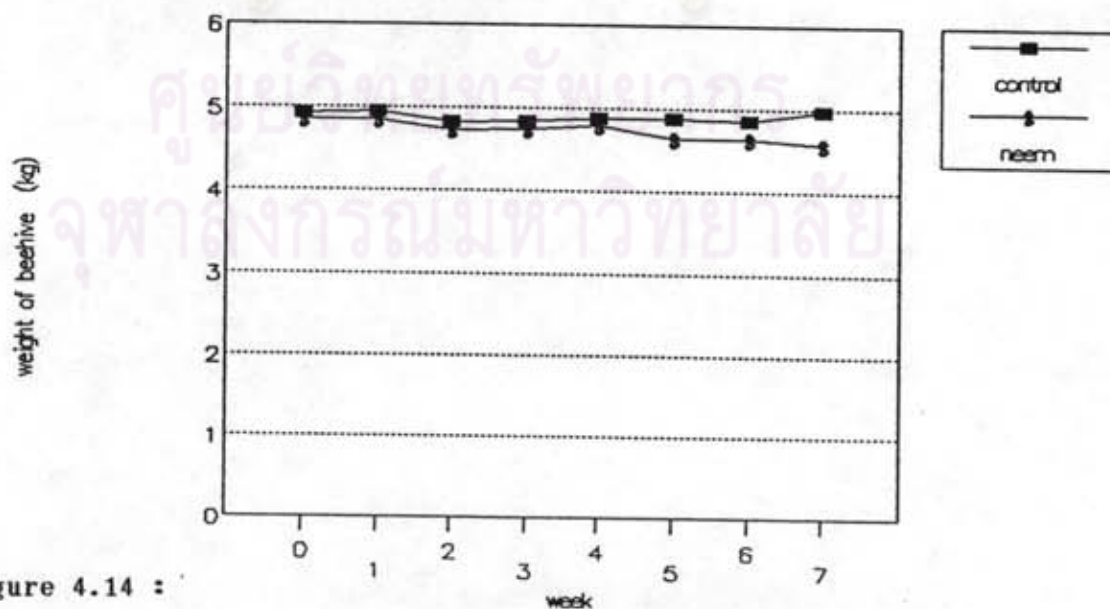
Note : No statistical difference ($p < 0.05$)

Figure 4.14 :

Effects of neem extract on variation of weight within beehive.

Table 4.53 : Effects of neem extract on variation of abnormal larvae and brood within beehive.

Recorded time (week)	Number of abnormal larvae/brood ($\bar{X} \pm SD$)	
	Control plot	Neem plot
0	0.00 \pm 0.00	0.00 \pm 0.00
1	2.25 \pm 2.87	7.75 \pm 8.92
2	4.25 \pm 6.55	9.75 \pm 15.06
3	0.50 \pm 0.58	0.50 \pm 0.58
4	0.00 \pm 0.00	0.33 \pm 0.58
5	0.00 \pm 0.00	0.00 \pm 0.00
6	0.00 \pm 0.00	0.00 \pm 0.00
7	0.00 \pm 0.00	1.67 \pm 2.89
8	0.00 \pm 0.00	0.00 \pm 0.00
9	0.00 \pm 0.00	0.00 \pm 0.00

Note : No statistical difference ($p < 0.05$)

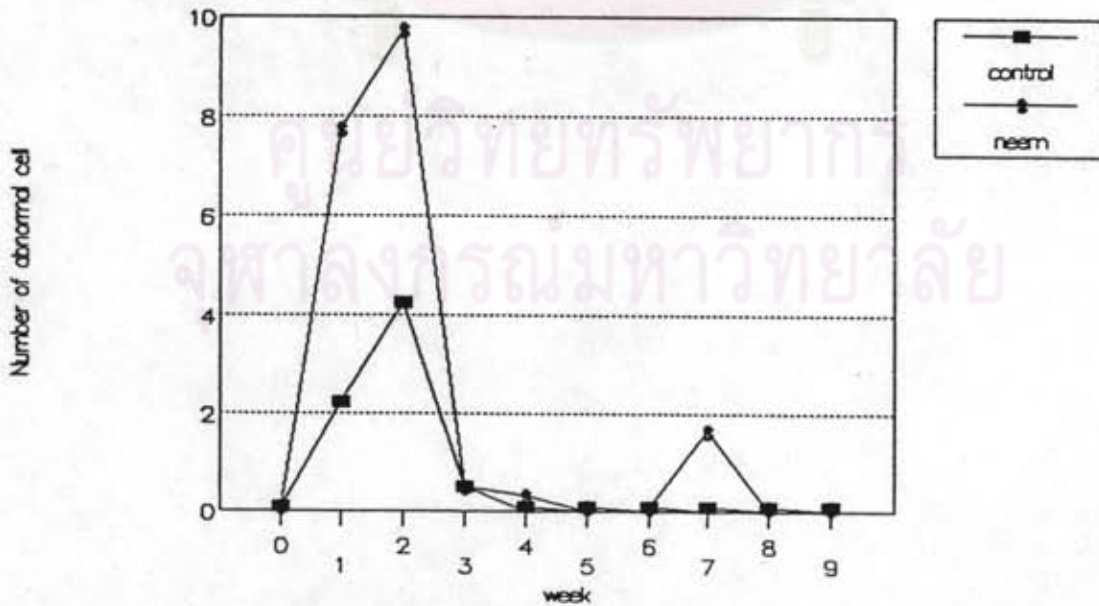


Figure 4.15: Effects of neem extract on variation of abnormal larvae and brood within beehive.

5. Effects of neem extract on larvae of *A. cerana*.

The results of effects of neem extract on 1 day-, 2 day-, and 3 day-old larvae are summarised in Table 4.54 and presented graphically in Figure 4.16, 4.17, and 4.18.

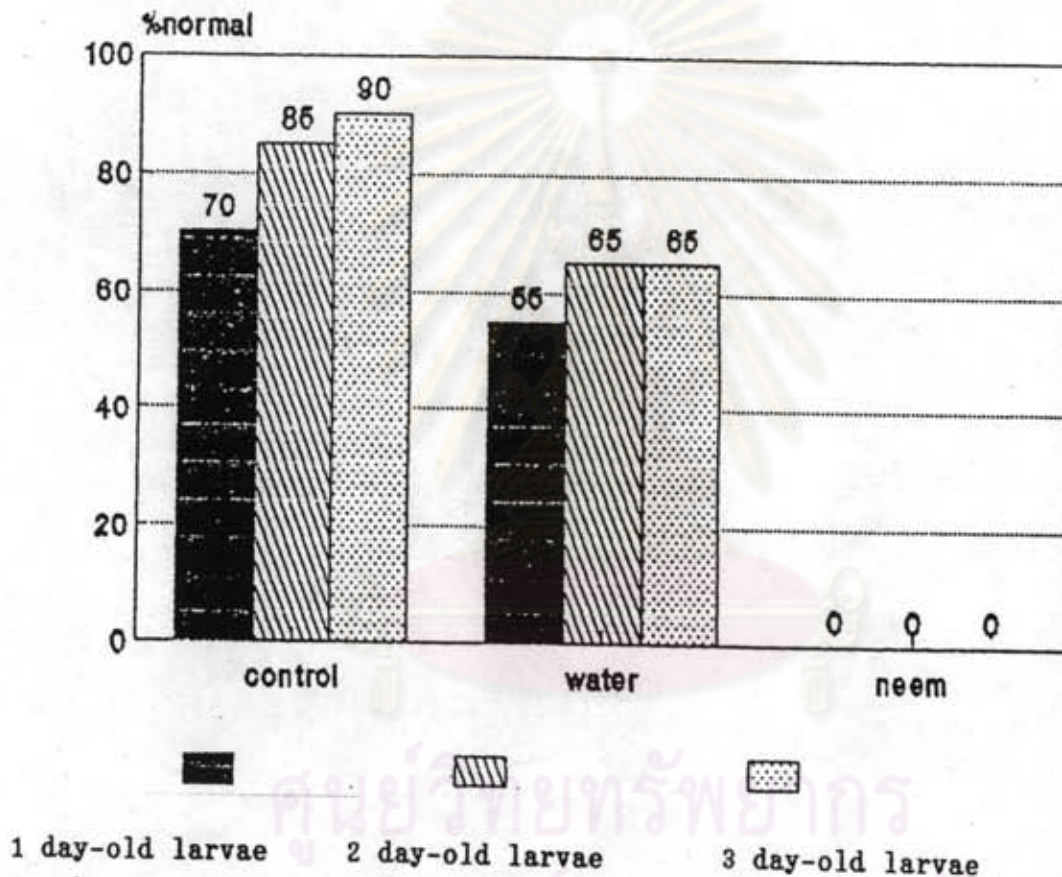


Figure 4.16 :

Effects of neem extract on normal cell of 1 day-, 2 day- and 3 day-old larvae.



Table 4.54 : Effect of neem extract on larvae of *A. cerana*

treated with Larvae	% normal			% abnormal			% disappear		
	1day	2 days	3days	1 day	2 days	3days	1 day	2 days	3days
Normal	^a 70 ±14	^a 85 ±7	^a 90 ±0	^a 0 ±0	^a 0 ±0	^a 0 ±0	^a 30 ±14	^a 15 ±7	^a 10 ±0
Water (control)	^a 55 ±7	^b 65 ±7	^a 65 ±21	^a 0 ±0	^a 0 ±0	^a 0 ±0	^a 45 ±7	^a 35 ±7	^b 35 ±21
Neem	^b 0 ±0	^a 0 ±0	^b 0 ±0	^a 0 ±0	^a 5 ±7	^b 35 ±7	^b 100 ±0	^b 95 ±7	^a 65 ±7

Note : 1 = Average value from 3 replications.

2 = The same letter on the left side represents no statistical difference in vertical in Duncan's Multiple Range test ($p \leq 0.05$).

3 = The same letter on the right side represents no statistical difference in horizontal in Duncan's Multiple Range test ($p \leq 0.05$).

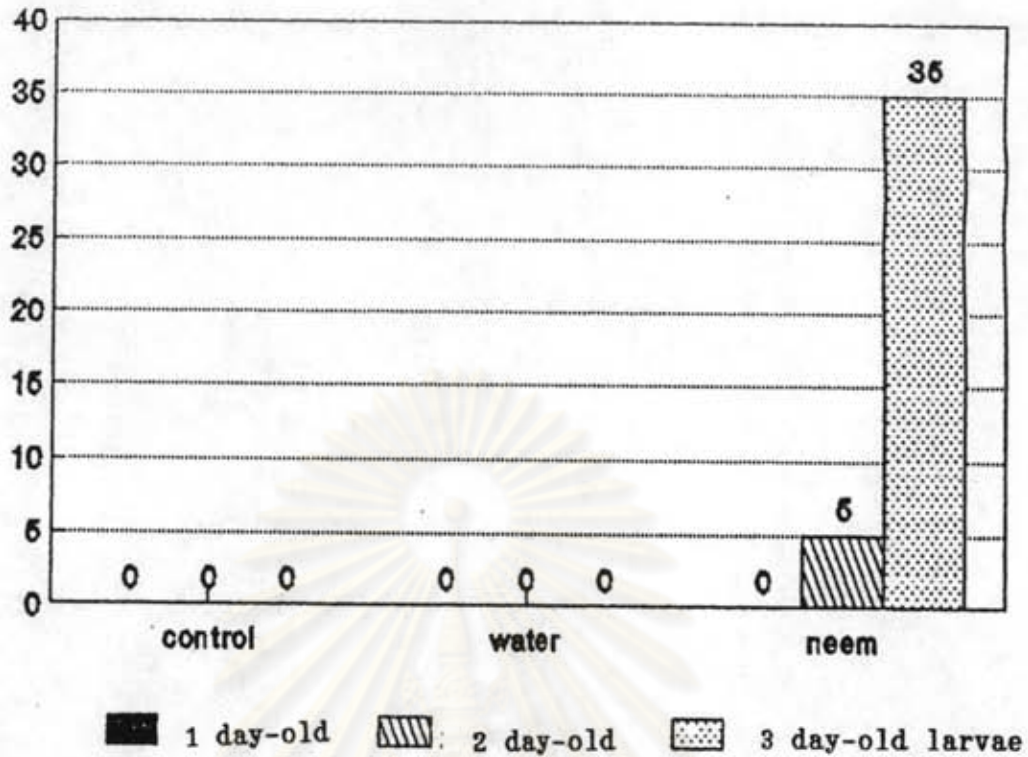


Figure 4.17 :

Effects of neem extract on abnormal cell of 1 day-, 2 day- and 3 day-old larvae.

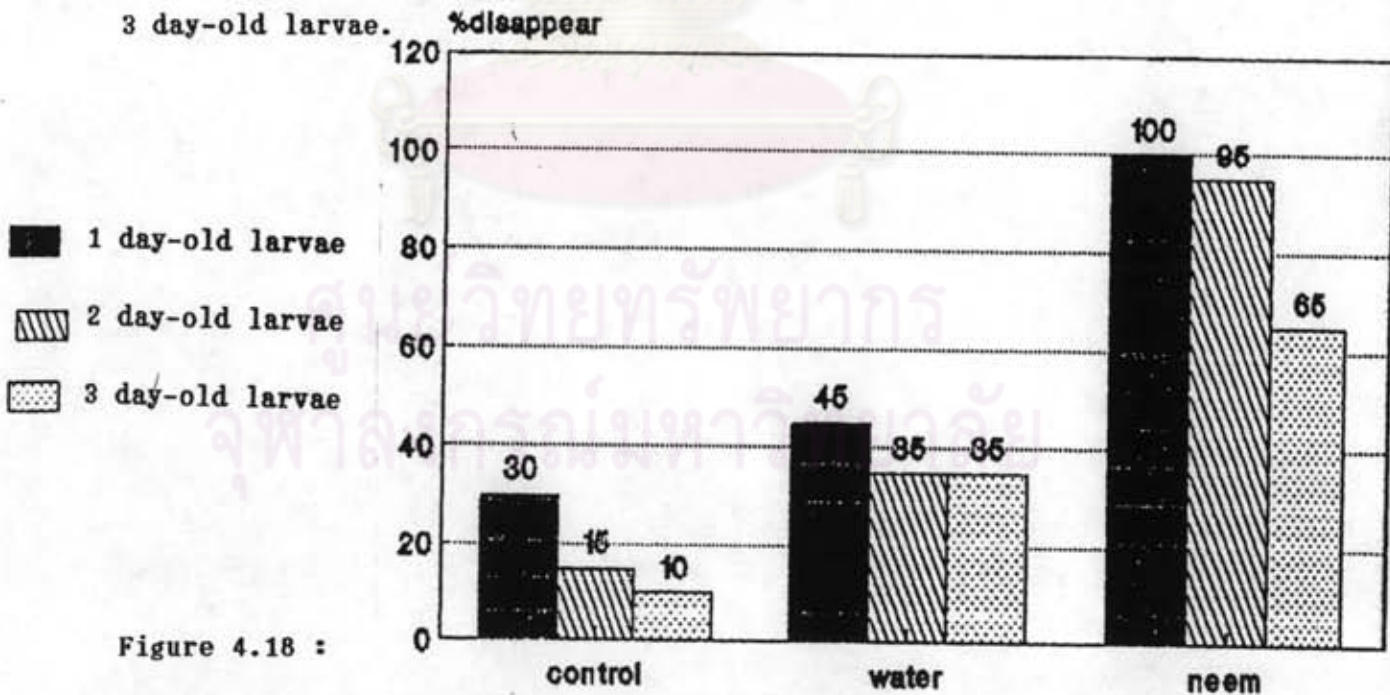


Figure 4.18 :

Effects of neem extract on disappear cell of 1 day-, 2 day- and 3 day-old larvae.