CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Differences in diuron degradation were found when comparing between three bioremediation treatments including natural attenuation, biostimulation (addition of Triton X-100, n-butanol or NH_4Cl) and bioaugmentation (addition of pure or mixed bacterial culture) as well as between two soil types. In loam soil condition A, natural attenuation was more effective in enhancing biodegradation of 20-ppm diuron by 17% than that bioaugmentation (addition of pure culture) and biostimulation (addition of Triton X-100 and *n*-butanol) within 8 weeks. Increasing concentration of Triton X-100 resulted in increasing of biodegradation by 9%, 14% and 15% for 20.6, 103 and 206 ppm Triton X-100, respectively. The addition of 100 ppm *n*-butanol also stimulated biodegradation by 9%. Otherwise, 100-ppm diuron had no changes in biodegradation among three types of treatment compare with control. Since the properties of silty clay soil were tightly absorbed, biodegradation was not observed.

In loam soil condition B, natural attenuation and bioaugmentation (addition of consortium) was higher ability to degrade 20-ppm diuron by 31% than that biostimulation (addition of 1,000 ppm NH_4Cl) by 26% within 15 days. By addition of 100-ppm diuron, microorganisms were less ability to degrade diuron than that of 20-ppm is that they were able to degrade diuron with 22%, 18% and 14% for bioaugmentation, biostimulation and natural attenuation, respectively. However, there was no change in diuron biodegradation in silty clay soil.

6.2 Recommendations

From the results, the suitable conditions for diuron degradation should be optimized to ensure the efficient bioremediation. The conditions such as expanding incubation time, aeration rate and optimal texture of soil may be improved the diuron degradation.

After natural attenuation, the diuron degradation in 4 weeks was not changed in silty clay soil samples. Thus, the sample should be incubated longer for diuron degradation. The extension time may increase the activity of diuron degradation.

The texture of soil affected diuron degradation in biostimulation treatment. Diuron was tightly absorbed in silty clay soil than loam soil. The numbers of indigenous bacteria were low in silty clay soil, thus it probably had low ability of the diuron degradation. Addition of sand should be carried out to change the texture of silty clay soil. This would also increase the aeration, provide optimum moisture for indigenous bacteria and decrease the amount of sorped diuron in soil. The extension time is also suggested to increase the activity of diuron degradation similarity to natural attenuation.

Bioaugmentation results showed that the exogenous bacteria were able to degrade diuron. The mixture of exogenous bacteria between A1 and R3 consortium bacteria may further increase diuron degradation because R3 consortium were isolated from the tested soil and may survive better in soil than A1 consortium.

Ammonium chloride could be used as an additional nitrogen source for biostimulation of indigenous bacteria as the results showed the increased in population

and microbial activity of soil bacteria. Consequently, ammonium chloride may be added along with the mixture of A1 and R3 consortium bacteria to increase diuron degradation rate of the added bacteria.

In addition, it is useful to study the behavior of microbial population responsible for diuron degradation. Change in populations of diuron degrading bacteria could be monitored by PCR-DGGE of 16S rRNA method instead of SSCP. It will help more understanding in the community change of diuron degrading bacteria during the bioremediation.