Chapter 9

Paclobutrazol Residues in Soil

9.1 Abstract

The SPME technique was used coupling with simple extraction and analysed by gas chromatography-mass spectrometry (GC-MS) to determine paclobutrazol residues in soil corresponding with soil depth at mango orchard which applied by soil drench. The results were observed high volume of paclobutrazol residue in upper soil layer (0-5 cm) after application in range of 1030-1300 milligrams per kilogram of dry soil. The low amount of residue was obtained in lower soil layer (10-20 cm) in range of 10-40 milligrams per kilogram of dry soil. Moreover, the persistence of paclobutrazol residue was evaluated about 3-5 months for only the first application.

9.2 Introduction

In order to the paclobutrazol is broad spectrum fungicide or plant growth regulator of triazole group, with is being widely used for induction of flowering, reduction of pruning and tillage in mango including decreased shoot elongation and root growth in cranberry (Mcarthur and Eaton, 1989). Paclobutrazol was taken up through the root and was transported primarily in the xylem through stem and accumulated in the leaves and fruit (Wang *et al*., 1986). The residue of paclobutrazol depends on the methods of application, dosed and crop species. It was found to persist 2-5 years in apple and 1-3 years in peach (Singh and Ram, 2000). Soil application of paclobutrazol has been found to be more effect responsive in regard to suppressing the vegetative growth and enhancing the reproductive growth in mango than foliar application (Burondkar and Gunjate, 1991; Tongumpai *et al.*, 1997; Singh, 2000). It may remain active for many years, and can severely affect the growth and development of subsequent crops or even interact (Jackson *et al*., 1996; Silva *et al*., 2003). Persistence of paclobutrazol in soil further complicates agricultural environment by affecting non-target succeeding crop (Bhattacherjee and Singh, 2002). Paclobutrazol residue in soil may result contamination of nearby water bodies, which in turn may also be a hazard to human and animal health and may influence the soil microbial activity (Sharma and Awasthi, 2005). Soil microbial counted in a mango orchard soil where paclobutrazol was frequently applied showed 58 % reduction of soil microorganism and it may be recommended for use in short rotation cropping systems (Jackson *et al*., 1996; Silva *et al*., 2003).

This chapter is conducted to apply the performance of the valid method for analysis of paclobutrazol residues in mango orchard soil using a sample preparation step by conventional extraction coupling with SPME extraction and analysis by GC-MS.

9.3 Materials and Methods

GC-MS Conditions

The GC-MS conditions was followed in Chapter 5

SPME procedure

The SPME conditions and processes were followed in Chapter 5

The extraction procedure of paclobutrazol from soil samples

The extraction procedure of paclobutrazol residue was followed in Chapter 7

Paclobutrazol application and collection of soil samples

The application of paclobutrazol was soil drench technique. The plot at Mae Jo University orchard was divided into two groups as blue and yellow and 5 trees were studied in each group (Figure 9.1). The two litres of paclobutrazol solution, concentration calculated depending on canopy diameter but in this case, was treated paclobutrazol at 1.0 gram active ingredient per square meter. It was equally spreaded within the application ring around each tree at a distance of 20 cm from the trunk. The ring was divided into 12 equal segments for each tree. The application of the volume per segment was 2/12 litres (Figure 9.2 and 9.3).

Soil samples have been collected at three depth levels from the ring segments used for PBZ application around each tree, selecting one segment per sampling date. The cylinders of soil samples (Figure 9.4) were frozen. It was cut into 3 segments according to the corresponding depth of the soil layer on the field. Stones of the dried soil were removed by sieving at a mesh size of 3.35 millimetres. For the transportation to University of Hohenheim, the sieved soil was sterilised at 121 ˚C for 20 minutes. Within each group (Blue and Yellow), samples were pooled for each soil layer and sampling date from the soil of 2 or 3 trees by grinding the dry soil in a ball mill for 5 minutes. The pooled samples were extracted and analysed as the same process used with GC-MS.

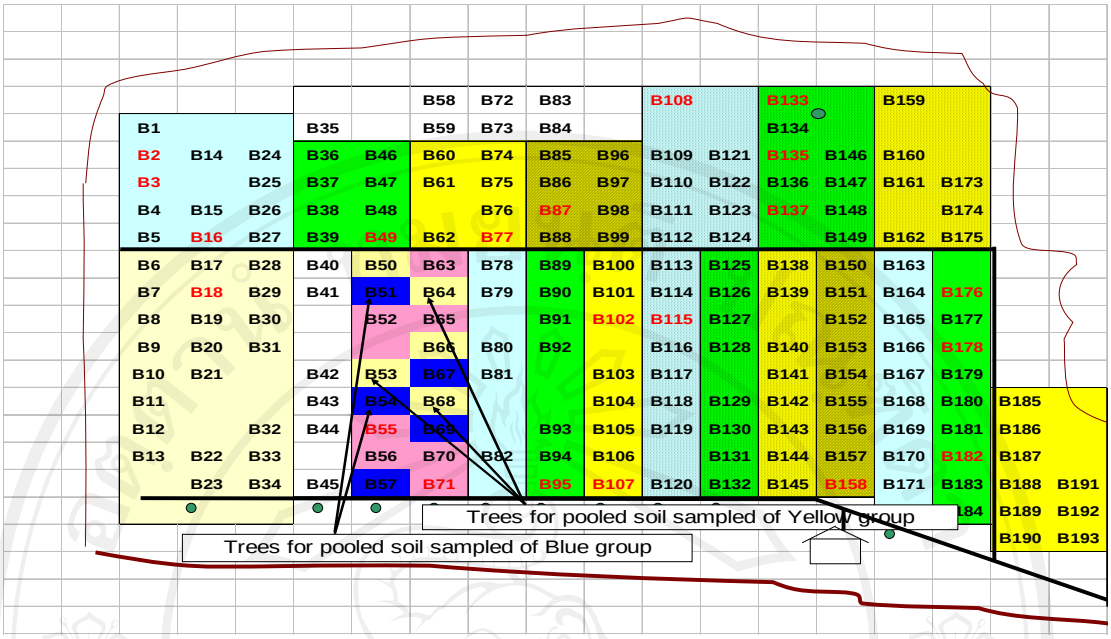

Figure 9.1 Tree treatments of the map were applied by paclobutrazol (soil drench technique) for studied the residues in soils (B plot). The location was at Mea Jo University farm, Baan Pong.

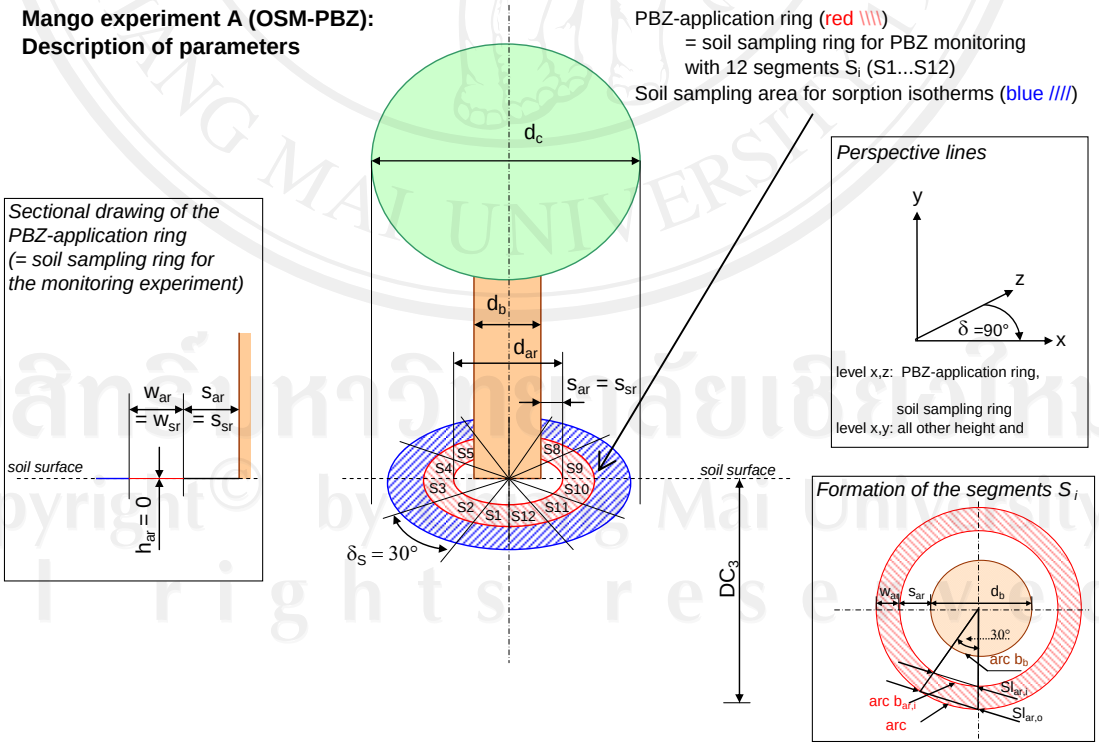

Figure 9.2 Diagrammatic of paclobutrazol application for residues analysis in soil and mango.

Figure 9.3 The application ring around the tree (red arrows are widen 15 cm).

Figure 9.4 The soil samples in B plot are collected by cylindrical-drilling machine.

9.4 Results

The results obtained showed that the residues of paclobutrazol in top layer (0-5 cm), were present in high amount after application in both groups. In contrary, the middle layer (5-10 cm) and bottom layer (10-20 cm) also decreased in both cases. Then they decreased gradually with time for both groups and in each layer. The paclobutrazol at an initial study was observed from 0.013- 0.380 milligrams per kilogram of dry soil samples. Paclobutrazol in only the top layer decreased after first application from 1,030–1300 milligrams per kilogram of dry soil samples to 18–25 milligrams per kilogram of dry soil samples. This fall was caused by leaching to lower layers with water. In the bottom layer in both groups, the paclobutrazol content remained nearly constant at 10 – 40 milligrams per kilogram of dry soil samples. As shown in Table 9.1 and Figure 9.5, showed that the dislocation of paclobutrazol for blue group from top to bottom layer (Figure 9.5(A)), also the same in yellow group (Figure 9.5(B)). All of data obtained gave the coefficient of variance (CV) below 18 %, also with the lowest of standard deviation (S.D.). In addition, the persistence of paclobutrazol residue in soil was evaluated to be about 93-154 days (~3-5 months).

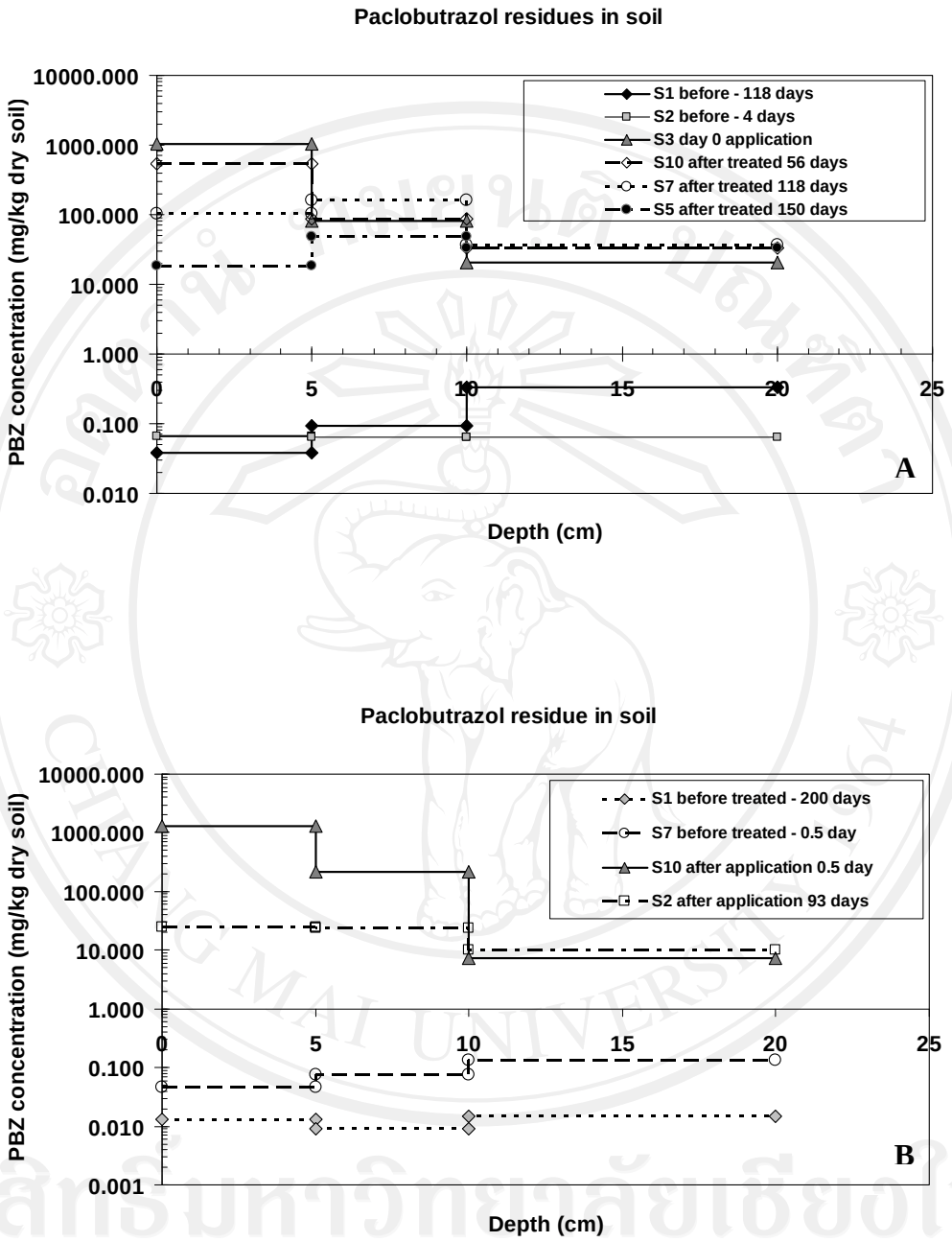

Figure 9.5 The dislocation of paclobutrazol within the soil layer in Blue (*A*) and Yellow (*B*) group (adapted from Reintjes, 2005; Niedhart *et al*., 2006)

Table 9.1 Summary of paclobutrazol residues in soil at different soil depths following its treatment at 1.0 g *a.i.*/m^2 (adapted form Reintjes, 2005).

Plots and Segments	Duration (days)	Paclobutrazol residues (mg/kg of dry soil samples)								
		Top layer (0-5 cm)	S.D.	CV (%)	Middle layer (5-10 cm)	S.D.	CV (%)	Bottom layer (10-20 cm)	S.D.	CV (%)
Group Blue										
S1	0	0.038	0.03	0.99	0.094	0.12	4.96	0.328	0.07	6.05
S2*	114	0.066	0.39	14.31	0.063	0.06	2.06	0.099	0.10	4.30
S3**	118	1,030.530	0.03	0.42	80.077	0.05	1.13	20.271	0.06	1.99
S10	174	541.687	0.04	0.68	85.699	0.13	3.02	33.719	0.03	0.96
S7	236	102.653	0.23	4.92	160.215	0.08	1.53	37.008	0.03	0.81
S5	268	18.732	0.03	0.91	48.919	0.10	2.76	33.444	0.15	4.38
Group Yellow										
S1	0	0.013	0.15	3.35	0.009	0.21	4.58	0.015	0.21	5.06
S7*	200	0.047	0.26	8.63	0.077	0.11	4.36	0.136	0.35	17.52
S10**	200	1,299.790	0.14	1.90	213.425	0.16	2.91	7.238	0.06	3.20
S2	293	25.040	0.28	8.68	23.5560	0.09	2.76	10.160	0.25	10.68

*before treated paclobutrazol **after treated paclobutrazol

9.5 Discussion

The paclobutrazol residue in soil was observed that after the first application. The persistence was also still seen in soil at 10-50 milligrams per kilogram of dry soil samples. In comparison to Sharma and Awasthi (2005), it has been reported that paclobutrazol was applied at the soil at tree basins in the month of September every year. The persistence of paclobutrazol residues in the soil was found to be a little over 8 months after application. It was seen that paclobutrazol residues accumulated in the surface soil (0-15 cm) at the tree basins and that the soil residue at season-1 were 0.065 and 0.302 µg/g from the lower (5 g *a.i.*) and higher (10 g *a.i.*) treatments, respectively. At the end of each season, there was a small increase in the amount of residues corresponding to the number of yearly application that had been made. Similarly, Mcarthur and Eaton (1989) found that paclobutrazol could still be detected in the soil 50 weeks after application at cherry orchard. Moreover, the persistence of paclobutrazol residues at different soil depths which was treated at 5 and 10 grams active ingredient per tree was found but only in laboratory condition. The present study was therefore carried out to determine the persistence and mobility of paclobutrazol residues in soil following its soil application in mango orchard from the point of environment significance of such residues. The residues of paclobutrazol in surface soil (0-15 cm) decreased gradually with time from 1.77 and 4.87 micrograms per gram at 0 day after treatment to 0.37 and 2.19 micrograms per gram at 60 days and just above the detectable level (0.01 microgram per gram) at 210 days at both the treatment concentrations (Shalini and Sharma, 2006). Subhadrabandhu *et al*. (1999) also studied the residues of paclobutrazol and reported to remain upto 11 months. In addition, a rate of 2 grams paclobutrazol per tree effectively controlled vegetative growth for 3 years in apricot. Bioassay with broad bean (*Vicia faba* L.) confirmed that paclobutrazol was still present in the treated soil for almost 3 years after application (Jacyna and Dodds, 1995).

The previous documents showed that the trunk-drench application contributed deeper penetration of paclobutrazol into the soil than other applications, such as foliar spray or trunk injection. Furthermore, paclobutrazol persists in the soil for a long time

it dose not suitable to apply PBZ in drenches, therefore it has high effected to induce mango off season flower, and only spray treatments can be recommended. Moreover, the advantages of paclobutrazol applications by the high-pressure injection technique are reduction of an excess chemical in soil along with promotion of an efficient use of paclobutrazol (TISTR, 1999). On the other hand, the movement of paclobutrazol from upper to lower soil layer occurred by leaching due to regular rainfalls during the beginning of rainy season, as revealed by the comparison of both groups and the climate data obtained for this period at Mae Jo University field. The irrigation was also another reason. Accumulation of high paclobutrazol levels in the top soil may be also ascribed to the limited water solubility of paclobutrazol (26-35 milligrams per litre). The persistence of paclobutrazol in the soil may result in contamination of nearby water bodies, thus presenting a possible hazard to human and animal health, and could also influence soil microbial activity with further effects on biodiversity. When paclobutrazol was applied to soil drench several times, an accumulation of residue could be increased. Soil microbial count of a mango orchard soil was reduced by up to 58 % (Jackson *et al*., 1996; Silva *et al*., 2003).

9.6 Conclusion

Even the results are based on a one-season experiment, it can be seen from the current trial that there was still paclobutrazol residues in soil. The persistency of paclobutrazol was 3-5 months.