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WATER-TABLE MANAGEMENT FOR THE CONTROL OF TERMITES IN PEAT

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Termites can be a serious threat to oil palm grown on peat, particularly during the early development of the crop. Surveys on termites in peat soil recorded more than 20 termite species using a transect-belt method (Faszly *et al.*, 2003), and seven termite species using rubberwood stakes (Zulkefli *et al.*, 2006a). The species include the pest and non-pest termites of oil palm. One of the common economically important subterranean termites is from the *Coptotermes* genus which infests immature, young and mature palms in deep peat (Zulkefli *et al.*, 2006b).

The common control method against termites is by the use of chemicals. Chlorpyrifos and fipronil are the most widely used insecticides for termite management (Zulkefli, 2007). Chemical spraying onto palm trunks up to the shoots and soil drenching are the standard operating procedures in termite control. Repeated treatments are often required to control the pest population which comes back from adjacent area after several months of treatment (Lim and Silek, 2001). This is because only a small area can be controlled at any one time, based on the symptom of fresh mud trails on the infested palms.

The recommended water-table management for high fresh fruit bunch (FFB) yields on peat is 50-70 cm from the soil surface (Hasnol *et al.*, 2010). However, at this depth, termites can still forage for food on the remaining timber buried in the soil (Zulkefli and Norman, 2011). Treatment by chemical drenching at the palm base may not reach the termite population located deep in the peat soil, especially during the dry season (Zulkefli, 2007). Raising the water-table in peat is a simple method which can force the termite colony to move up to the soil surface where they can be more easily controlled. The water-table can be raised for a short period without affecting palm growth.

METHODOLOGY

A study on the effects of different water-tables on a *Coptotermes curvignathus* population was conducted in lysimeters filled with peat soil and rubberwood blocks as food source at the MPOB Research Station in Sessang, Sarawak (*Figure 1*). A total of 600 termites (workers+ soldiers) were used in each lysimeter. The termites were introduced into the lysimeter after the peat soil had stabilised at the standard water-table of 70 cm from the soil surface. Four water-tables [15, 30, 50 and 70 cm (control) from the soil surface] were tested over one week, with four replications.

Figure 1. Lysimeters made from high-density polyethylene (HDPE) tanks filled with peat soil to which were introduced the pest termite species, Coptotermes curvignathus, *for the water-table study at 15, 30, 50 and 70 cm from the soil surface.*

The survival of termites in the lysimeters was divided into two categories. The first category consisted of the termite population detected on the soil surface and from a termite detector station within the first three days after treatment. The second category comprised the population revealed from excavation of the peat soil above the water-table at seven days after treatment.

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Field observations were also carried out in Lawas, Sarawak. The study was conducted on two belt-transects (100 m length, 2 m width, 30 cm depth each) over three months at Ladang Trusan, Lawas, Sarawak. The aim of the study was to compare the effect of high and normal water-tables on the termite populations in an oil palm plantation.

RESULTS

Laboratory Study

Immediately after the water-tables reached their required levels (15, 30, 50 and 70 cm), a large number of termites were seen in the termite detector stations and on the soil surface. Within three days, the water-table at 15 cm from the soil surface had the fastest displacement effect on the termite population (*Table 1*). The second highest number of termites was recorded in the lysimeter with the 30 cm water-table, while the lysimeters with the remaining two water-tables recorded less than five termites over the same period of time.

TABLE 2. MEAN NUMBER OF LIVE TERMITES AND PERCENTAGE OF SURVIVAL AT DIFFERENT WATER-TABLES AT SEVEN DAYS AFTER TREATMENT

Water-table from soil surface (cm)	No. of live termites (Mean ± SE)	% survival
15	86.75 ± 9.69 d	14
30	179.25 ± 8.73 c	29
50	255.25 ± 6.80 b	42
70 (control)	362.50± 9.64 a	60

Note: Means ± SE in the same column with different letters are significantly different at P<0.05 according to Duncan's Multiple Range Test.

A second inspection during the dry months (> 70 cm water-table) recorded 14 and 7 termites, including those from the *Marcotermitinae* and *Termitinae* subfamilies. The last inspection recorded 10 and 13 termites (at 40 cm water-table).

TABLE 1. MEAN NUMBER OF *Coptotermes curvignathus* DETECTED IN THE TERMITE DETECTOR STATIONS AND ON THE SOIL SURFACE AT VARYING WATER-TABLES

Water-table in lysimeter (cm from soil surface)	Mean± SE No. of live termites in detector stations (workers+soldiers)		
	DAY 1	DAY 2	DAY 3
15	13.7 ± 0.48 a	11.75 ± 0.48 a	11.75 ± 0.25 a
30	6.00 ± 0.41 b	5.25 ± 0.25 b	7.50 ± 0.29 b
50	3.50 ± 0.29 c	3.50 ± 0.29 c	4.25 ± 0.25 c
70 (control)	2.75 ± 0.25c	3.50 ± 0.48 c	4.25 ± 0.48 c

Note: Means ± SE in the same column with different letters are significantly different at P<0.05 according to Duncan's Multiple Range Test.

The higher water-tables of 15 cm and 30 cm from the soil surface recorded termite survival of 14% and 29%, respectively (*Table 2*). The highest survival rate (60%) was recorded for the water-table at 70 cm from the soil surface (control). Most of the live termites were detected on the rubberwood blocks above the water-table inside the lysimeter.

Field Study

In the field study, the first inspection which was carried out during the rainy period (when the water-table was at 15 cm from the soil surface) recorded 23 and 18 termites from three subfamilies, namely, *Coptotermitinae*, *Rhinotermitinae* and *Nasutitermes*, in the two transects.

These observations indicate that termites will move up to the soil surface during periods of high water-table (*i.e.* 15 cm from the soil surface).

FIELD WATER-TABLE MANAGEMENT FOR TERMITE CONTROL USING SANDBAG WEIRS

Termites infest and kill immature and mature palms in the field. The loss in returns arise from the costs of chemical control and supplying new palms, and from the lower yield due to the reduced number of standing palms at maturity. Termite infestations may reach 8%-9% of the palms ha^{-1}, with 3% killed at an early stage. At a palm density of 160 palms ha^{-1}, the loss of FFB yield from the 3% palms killed has an estimated value of RM 327.00 ha^{-1} yr^{-1}.

The estimated cost of termite control with chemicals (*i.e.* chlorpyrifos) is RM 187.00 (at four rounds year^{-1}) which includes labour cost and the treatment of six adjacent palms to prevent new infestations. The use of fipronil is cheaper at RM 82.00 (two rounds year^{-1}); thus, this chemical is more frequently used.

For field water-table management, the estimated cost of preparing adjustable sandbag weirs (*Figure 2*) is about RM 2700.00 per location. It is suggested that one weir is required for every 20 ha of peatland depending on the topography. It has been estimated that the small investment incurred for constructing weirs followed by chemical treatment (at RM 217.00 ha^{-1}) is lower than the loss in monetary terms from the annual direct yield loss due to palms killed by termites (RM 327.00 ha^{-1}) (*Table 3*).

Figure 2. Adjustable weirs made from sandbags.

TABLE 3. COST COMPARISON BETWEEN CHEMICAL TREATMENT AND WEIR CONSTRUCTION

Direct yield loss (FFB) (RM ha^{-1})	Cost of treatment (with fipronil) (RM ha^{-1} yr^{-1})	Cost of weir (1 for 20 ha) (RM ha^{-1} yr^{-1})
327.00	82.00	135.00

Based on these results, the current standard practice in water-table management in peat soil (maintained at 50-70 cm from the soil surface) does not significantly affect the termite population in the field. This is indicated by the fewer termites detected on the palms or on the soil surface during the dry periods. During these times, the termites were far below the soil surface, especially inside the remaining timber buried in the peat.

The field results indicate that the above-ground foraging activities of subterranean termites during the rainy season (when the water-table was at 15 cm from the soil surface) were at their highest, and these slightly decreased towards the end of the rainy season, while the lowest activities were observed during the dry months (70 cm water-table). It can therefore be inferred that climatic factors, especially rainfall, which cause high water-tables, reduce the soil temperature and also increase the moisture content of the peat, hence influencing the foraging pattern and activity of the subterranean termites.

BENEFITS

- The technology reduces the cost of control operations by minimising the infested areas and chemical applications.
- Treatments can be targeted to control only the subterranean pest termites.

CONCLUSION AND RECOMMENDATIONS

The area covered by pest termite foraging activities can be reduced by raising and maintaining the field water-table. This can be achieved by maintaining a high water-table within a termite-infested block. Adjustable sandbag weirs or wooden planks can be used to raise the water levels in the collection drains.

The time and duration for raising the water-table should not coincide with the rainy seasons to avoid chemical wash-out after soil drenching. Seven days is sufficient to force the termites to the soil surface and to conduct chemical control activities.

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