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WATER CORPORATION

NOWERGUP SITE

STABLE FLY BREEDING IN BIOSOLIDS
Trial 1: Cover Effectiveness
Trial 2: Impact of Rainfall Events

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STABLE FLY BREEDING IN BIOSOLIDS

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December 2001

Cover Photo
Calliphora dubia
Calliphora albifrontalis

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1. SUMMARY

Fly breeding in stored manure has become one of the most contentious issues along the Swan Coastal Plain. A two-part investigation was undertaken to establish a 'best practice' fly management procedure for application to stored biosolid stockpiles prior to use as a low grade fertiliser and soil amender in agriculture. Trial 1 was designed to establish if an effective reduction in fly breeding could be achieved by the use of covers placed over large quantities of biosolid material. Covers were fabricated from either plastic (impermeable geomembrane) or open weave shade cloth and designed to exclude adult flies from ovipositing onto the biosolids. The biosolids were placed into three walled bunds with the covers secured to the external walls, allowing a secure and complete fit. The results of this trial demonstrated that both types of covers significantly reduced fly breeding and that there is no difference between the plastic and shade cloth covers in restricting fly breeding. Other factors to consider when assessing the cover types include manageability and cost. Assessment of all the criteria demonstrates shade cloth to be the most suitable choice for covering large biosolid stockpiles.

The second trial was designed to determine if fly breeding occurs in aged biosolid cake following a rainfall event. The results of this study demonstrated that rainfall events that may occur during summer do not appear to rehydrate aged biosolid cake and facilitate fly breeding. The trial showed that seasonal conditions associated with winter rainfall events do not initiate fly breeding in biosolid cake and during the winter months (July, August, and September) there is a reduction in adult fly numbers. Therefore, the storage of aged (older than 6 months), uncovered biosolid cake throughout the winter season may be an acceptable practice.

2. ISSUE

The Water Corporation produces approximately 40,000 wet tonnes of biosolid cake annually. Biosolids are stabilised, organic solids produced by waste water treatment processes which, in most cases, can be beneficially reused (ARMCANZ, 1995). It is used as a low-grade fertilizer and soil amender in broadacre agriculture, forestry plantations and composting products. Fly breeding in manures is of overriding concern throughout areas experiencing excessive fly problems, such as the Swan Coastal Plain. A preliminary study conducted by Paulin *et al.* (1998) demonstrated that when 1 litre pads of biosolid cake were exposed in areas of high stable fly density the cake dried out rapidly and did not support fly breeding. However, later in 1998 stable fly breeding was observed and recorded in considerably larger quantities of biosolid cake temporarily stored on a farm in the Gingin Shire.

A recent investigation demonstrated that reducing biosolid moisture content (> 40% moisture) and the placement of covers over small quantities of stockpiled biosolid cake reduces fly breeding (Nowergup Report, 2000a). However, covers may prove unmanageable when biosolid cake is stored in larger quantities and expensive in terms of the material used to make the covers. The alternative may be to produce a drier product.

Stored biosolids that have gradually dried out over time have an extremely low moisture content (Nowergup Report, 2000a). 'Aged' biosolids are not an attractive fly breeding resource and can be stored without associated fly problems. However, following a rainfall event the moisture content of uncovered biosolid material may increase along with the recurrence of fly breeding. Aged biosolids may provide an insight into the effectiveness of reducing the biosolid moisture content during production. The application and effectiveness of such management strategies to realistic quantities of stored biosolid cake requires additional development and investigation.

3. OBJECTIVES

Trial 1:

1. To determine if an effective reduction in fly breeding can be achieved by the placement of covers over large stockpiles of biosolid cake.

2. To determine what type of cover (complete or partial) provides an optimal reduction in fly breeding in stockpiles of biosolid cake.

Trial 2:

1. To determine if long term storage of biosolid cake (aged) facilitates fly breeding following a rainfall event.

4. INTRODUCTION

Over the last nine years the fly problem on the Swan Coastal Plain has reached epidemic proportions, especially in relation to the stable fly, *Stomoxys calcitrans* (Linnaeus) and the house fly, *Musca domestica* (Linnaeus). At present the stable fly is occurring in pest proportions and has become a major issue affecting human and livestock health. Surveys have shown that stable fly numbers have reached epidemic levels throughout the Shires of Gingin, Wanneroo and Kwinana. In some affected areas, livestock have been agisted elsewhere to avoid being attacked and outside workers have been impeded by excessive fly bites. Investigative research has identified poultry manure (broiler) in crop production (vegetable, turf and strawberry) as a major source of stable fly breeding on the Swan Coastal Plain. When used as either a pre-plant or sideband/top-dressing, raw poultry manure is capable of producing in excess of 10,000 stable flies per hectare.

Predictably, fly breeding in stored manure has become one of the most contentious issues along the Swan Coastal Plain. Recent studies have demonstrated that biosolid cake is a fly breeding resource. The Water Corporation produces and stores approximately 40,000 tonnes per annum of biosolid cake. It has been identified for use as a low-grade fertilizer in industries such as land rehabilitation, forestry stands and crop production. Composted biosolid cake may also play a role in horticulture and the landscaping industry. The potential use of biosolid cake in future industries depends heavily on the development of a storage procedure that reduces fly breeding and eliminates public concern.

Previous research has identified that both the moisture content and the size of the biosolid clumps influence both stable fly and house fly oviposition and larval development. Reducing the moisture content of stored biosolid cake (> 40% moisture) results in a sharp decrease in fly breeding success (Paulin *et al*., 1998). The production of a drier biosolid product prior to storage would clearly resolve the fly breeding problem. Unfortunately, dry biosolid cake that is stored without cover is exposed to periods of rainfall that may increase the moisture content of the biosolid material resulting in an increase in fly breeding.

Rainfall clearly presents a problem in relation to the storage of 'dry' biosolid cake. However, the winter rainfall period (June through September) may have little impact on fly breeding regardless of changes in the moisture content of biosolid cake. Studies investigating the ecology of the stable fly have indicated that during the winter period stable fly numbers are reduced. Colder temperatures have been noted to reduce fly activity and result in high mortality rates among many fly populations (Paulin *et al.*, 1998). It is also assumed that only limited fly breeding occurs during the winter period. This assumption is based on trials using poultry manure as no such studies have been conducted using biosolid cake. An investigation of fly breeding in biosolid cake during the early rainfall season will resolve this uncertainty.

Biosolid cake gradually dries out over time to the extent that it no longer facilitates fly breeding, presumably due to low moisture content. Observations of $4m^3$ uncovered biosolid cake have noted that aged biosolid material appears to be hydrophobic (Nowergup Report, 2000b). The dry external crust of the cake acts as a water barrier and rainfall runs off the surface of the biosolid cake to the ground. However, larger piles may not offer the same resistance to rainfall events and heavy rainfall may result in a higher biosolid moisture content and contribute to fly breeding success in the stored material. An investigation of the impact of rainfall events on large quantities of aged biosolid material will assess the value of producing and storing a dry biosolid product while contributing to the establishment of a 'best practice' storage procedure.

The use of protective covers has been suggested in response to the potential problems associated with the storage of exposed biosolid material (Nowergup Report, 2000b). Large quantities of stored biosolid cake shifts over time, spreading outwards. This gradual movement breaks the dried external crust and results in deep fissures that provide increased access for flies to the exposed resource. Preliminary research has demonstrated that full plastic covers reduce fly breeding when used over the surface of small quantities of biosolid material (Nowergup Report, 2000b). Plastic covers act as a barrier to fly entrance and oviposition, protect against rainfall events and hinder the potential dispersal of newly emerged flies. However, placing a full plastic cover over the biosolid material may result in condensation and the absorption of additional moisture. Dependant on the extent of the condensation, the moisture content of the biosolid cake may increase to a level that facilitates fly breeding.

A partial cover material, such as shade cloth, may be a valid alternative to a full plastic covering. The partial, fine mesh covering of shade cloth material would nullify the anticipated problem of year round condensation and allow the biosolid cake to desiccate. As with full plastic covers, shade cloth material restricts fly access to the biosolid resource and if adult flies oviposit through the shade cloth then it prevents newly emerged flies escaping from under the cover canopy. However, the partial cover offered by the material will allow rain onto the biosolid cake.

The effectiveness of either cover type over larger and more realistic quantities of stored biosolid cake has yet to be demonstrated. Large covers may prove unmanageable and inefficient cover handling could result in the incomplete covering of biosolid stockpiles allowing flies access to the resource. Determining the effectiveness of covers over larger biosolid stockpiles and the most suitable cost-effective cover will contribute to the establishment of a 'best practice' storage procedure for biosolid material.

5. FLY SPECIES

S. calcitrans is abundant throughout the temperate and tropical world and has spread through human activities into the Australasian region. It was first recorded in Australia in 1881 but not in Western Australia until 1912 (Cleland, 1912). The adult stable fly is a biting fly and its main hosts are cattle and horses (Seddon, 1951). Lesser hosts include man (11% of all bites in USA), dogs, pigs and camels. Bites to domestic stock occur mostly on the limbs and belly. The adults feed several times per day, generally in the early morning and late afternoon, and blood meals are obligatory for females before oviposition. Larvae commonly breed in moist and rotting straw (stable litter) especially when mixed with urine or dung (Seddon, 1951). Stable fly larvae have also been recorded in grass clippings (Bull, 1919), rotting vegetation (Roberts, 1952), drifts at the edge of swamps, poultry manure (Dadour, 1994) and associated with horse, kangaroo, wallaby and rabbit dropping (Place, 1915). Scant evidence in the literature exists on the stable fly reaching pest proportions (Roberts, 1952).

M. domestica is cosmopolitan, and is associated with man wherever any settlement is made. It was first recorded in Australia in 1849 (Walker, 1849). There are numerous accounts of the house flys' relationship to public health (West, 1951) and it is best known as a vector of bacteria and protozoa that cause enteric disease (Greenberg, 1971). It is found indoors, and although not attracted to man *per se*, alights on food and food preparation areas. It breeds in human, horse, cattle, pig, poultry, sheep and kangaroo dung, rotting vegetable matter, kitchen refuse, lawn clippings and carrion (see Pont, 1973 for review). The housefly breeds throughout the year in warmer parts of Australia (Johnston, 1922).

Adult flies of both species are strong fliers, and the recorded flight range of 20 miles (Bishopp and Laake 1921) is probably far short of the house flys' ability. The flight range of the stable fly is at least 135 miles (Hogsette and Ruff 1985). With these capabilities, it is not surprising that both species can locate desirable breeding sites and develop large populations in a relatively short period

6. CONSULTATION

Water Corporation	V. Metham (Environmental Project Officer) N. Penney (Project Officer – Biosolids Management)

7. STUDY SITE

Approval was sought from the Department of Environmental Protection and the Health Department of Western Australia to conduct trials involving the covering of biosolid cake trials at the Nowergup Biosolids Facility.

The site used in this study was situated along Wesco Road, 36 km NNW of Perth in Nowergup. Nowergup is a leased site (by the Water Corporation) and both the compost site and the temporary storage site were used for this trial.

TRIAL 1: COVER EFFECTIVENESS

8. METHODS AND MATERIALS

Design

Biosolid storage bunkers and covers were supplied by the Water Corporation. A total of eight bunds were constructed for this trial at the Nowergup Biosolids Facility. With one exception, each bund consisted of three walls containing between 38 and 95 wet tonnes of biosolid cake with an open side for biosolid delivery. Figure 1 depicts the positioning of each of the bunds throughout the duration of the study. The orientation of the open side (front) of each bund is also indicated.

Biosolid cake was sourced from both Woodman Point and Beenyup Wastewater Treatment Plants (WWTP). The two sources of biosolid cake had different moisture contents and a half-and-half mixture was used in each bund. Biosolid cake produced at the Beenyup WWTP has an 84% water content, while biosolid cake from Woodman Point WWTP has a lower water content of only 72%. Biosolid cake from Beenyup was delivered to each bund first followed by the drier biosolid cake from Woodman Point Treatment Plant. The positioning of this drier material acted to hold the mixture within the surrounds of the bund throughout the trial duration. Biosolid cake was placed in the bunds at the Nowergup facility between the 24.11.00 and 1.12.00.

Two cover types were investigated. An impermeable geomembrane cover (Full Cover) was compared to an open weave shadecloth fabric (Partial Cover). The Water Corporation chose "Millennium Fabric ™" as the impermeable geomembrane but it should be noted that there are a large variety of geomembranes available. Covers were positioned over each bund containing the biosolid cake and extended approximately 1m over the sides of the bund walls. Covers were pegged to the ground on all three walled sides of the bunds. At the access side of the bunds the covers were secured to the ground by concrete filled buckets. This created an almost fly proof environment.

The eight bunds were randomly assigned into the following three treatment groups:

i. 6 bunds with Partial Covers (Shadecloth Fabric)
ii. 1 bund with Full Cover (Impermeable geomembrane)
iii. 1 bund with No Cover (Control)

One of the bunds from the partial cover treatment group was originally designed to be covered with calcite pellets. However, due to the density of the product the biosolid cake broke the back wall of the bund (Bund 6 see Figure 1). This bund was covered with shadecloth but had 2 non-fixed ends.

Five biosolid cake samples (2 litres each) were collected at random from the more moist areas of each of the bunds. Sampling was conducted every seven days over a period of 6 months. Sampling commenced on the 24.11.01 and concluded on the 18.04.01. Each sample was placed into a 6 litre container filled with 2 litres of dry sand and then covered with a mesh cloth lid. The presence of sand in the containers facilitated pupation. The samples were watered daily for three days after collection and then left for four weeks to allow for fly emergence. Once adult fly emergence ceased the flies were extracted, identified and counted.

Data Analysis

Data were analysed using Analysis of Variance. Differences between treatments were assessed using Fisher's Protected LSD at the 5% level of significance. All analyses were conducted using Genstat 5 1993.

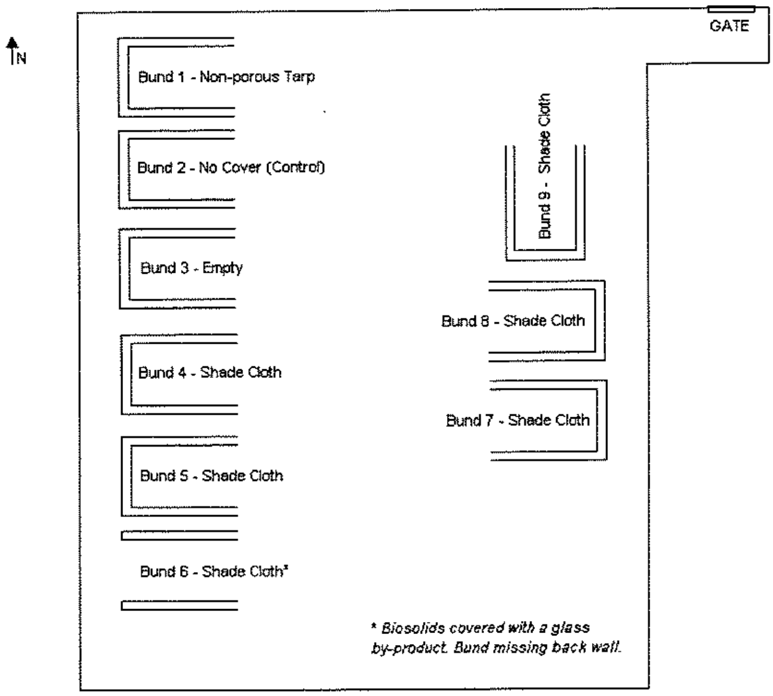

Figure 1: Orientation of the bunds throughout the duration of the trials at the Nowergup Biosolids Facility.

9. RESULTS AND DISCUSSION

Fly Species

Adult fly emergence results provide a useful indicator as to the presence and absence of fly species in the environment where sampling occurred. All trapped species are found along the Swan Coastal Plain and all have been associated with manures used in crop production. Four fly species were identified from flies that emerged from biosolid samples collected throughout the duration of the trial; *Musca domestica* (House Fly), *Stomoxys calcitrans* (Stable Fly), *Hydrotea rostrata* (Black Carrion Fly) and *Musa stabulans* (False Stable Fly). In addition, two representatives of the Family Anthomyidae (dung flies) emerged from biosolid samples collected from the control group. This Family consists of small, non-biting flies that in most cases feed on decaying vegetation/excrement

As expected, *M. domestica* and *S. calcitrans,* were the dominant species collected throughout the study duration. Figure 2 presents the species and the total number of flies that emerged from samples collected over the 6 month study period. The prolific breeding of these two species within stored biosolid material is clearly demonstrated by the number of flies collected from the control treatment throughout the study. Over the duration of the trial, a total of 1157 houseflies and 982 stable flies emerged from the control treatment samples. This figure represents only a fraction of total fly breeding within a single biosolid stockpile left exposed to fly activity. In comparison, total fly numbers observed from both the full and partial cover treatments are considerably lower. Figure 3 provides a visual indication of the extent of fly breeding with and without the presence of a cover.

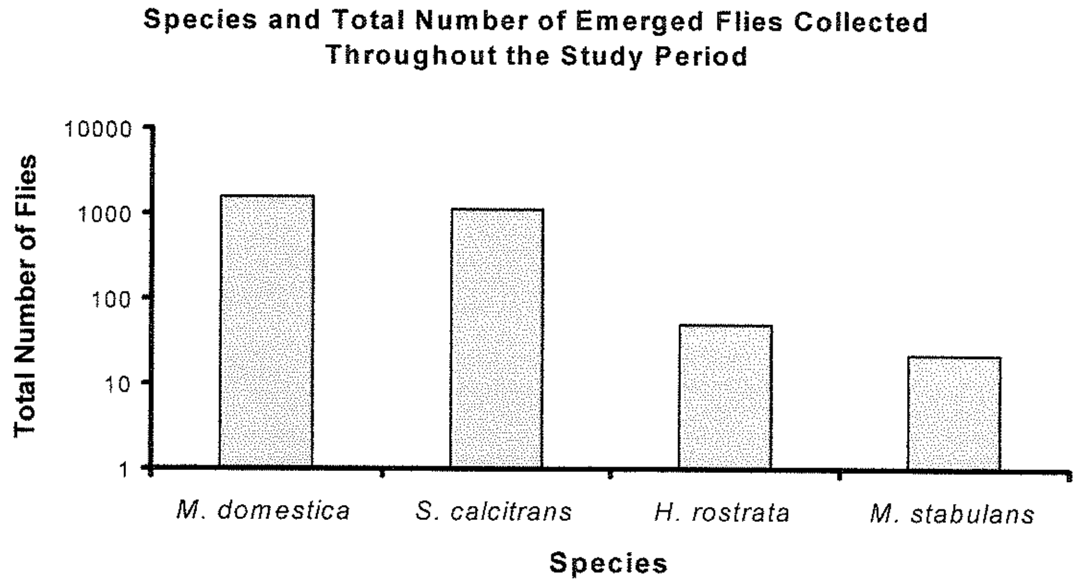

Figure 2: Species and total number of emerged flies collected throughout the six month study period (Logarithmic scale used). *M. domestic* (House Fly) and *S. calcitrans* (Stable Fly).

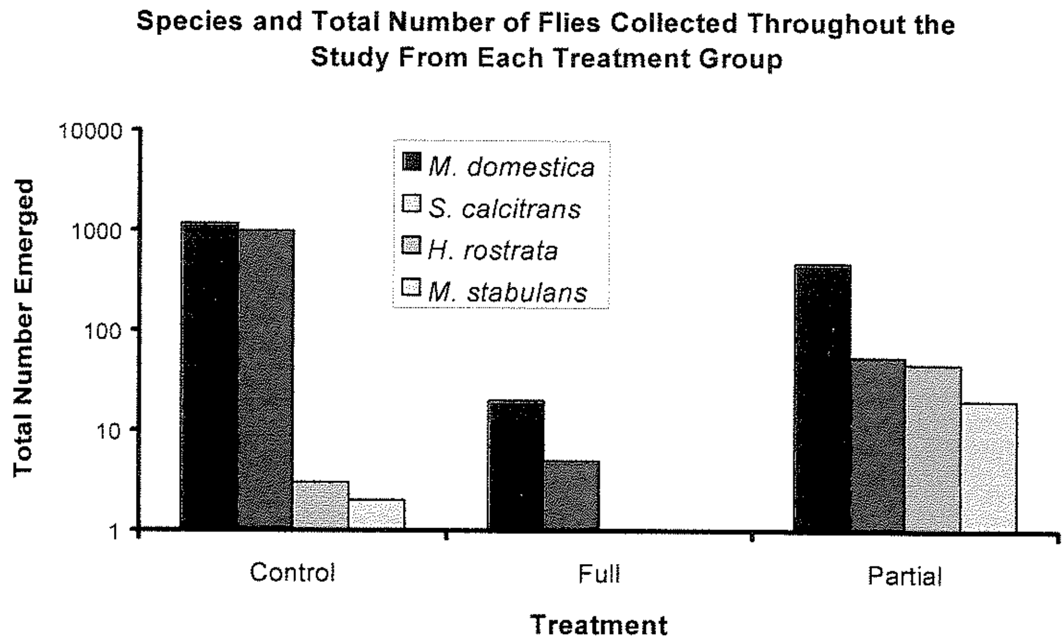

Figure 3: Species and total number of flies within each treatment group throughout the duration of the study period. Totals presented for the partial cover treatment represent the accumulated figure of sampling from all six replicas (Logarithmic scale used).

Cover Effectiveness

A comparative analysis of emerged fly numbers collected over the duration of the trial indicated a significant difference between the control treatment and the two cover treatments. Fly numbers within the control treatment were significantly higher than those within either cover treatments (t = 0.3, df = 160, P<0.001). The presence of either cover type appears to effectively reduce fly breeding success within stored biosolid cake as seen in Figure 4. Both cover types act as a barrier to fly activity and successfully limit oviposition upon biosolid material. Based on the low fly numbers observed in the impermeable geomembrane treatment, potential condensation problems do not appear to substantially enhance fly breeding. Similarly, covers made of shade cloth material were effective at reducing fly breeding. Shade cloth material acts as a fly barrier and the fine mesh openings are small enough to limit oviposition and reduce fly access.

Interestingly, while this study demonstrates that covers reduces fly breeding to an acceptable level, the monitoring method employed was unable to record the number of flies emerging from the biosolid cake under partial covers. To address this problem a number of emergence traps would need to be placed over the biosolid cake in each bund.

The stable fly season incorporates October through to April and sometimes May (Paulin *et al.*, 1998). The change in fly numbers detected within the control treatment over the duration of the study accurately reflects the expected trends in house and stable fly breeding that occurs in poultry manure. The highest incidence of emerged house flies occurred in the initial weeks followed by an increase in stable fly breeding (Figure 5). Both fly species then declined in numbers.

Comparison of Cover Types

Analysis of the two cover treatments indicated that there were no overall significant differences between the partial and full cover treatments. Either cover type is equally effective at reducing fly breeding success. However, fly numbers from bund 6 (partial cover treatment) were significantly lower compared with bund 2 (control), and significantly higher than bunds 1 (full cover treatment) and 9 (partial cover treatment) (t = 0.3, df = 160, P<0.05). Fly numbers from bund 6 were not significantly different from the fly numbers emerging from bunds 4, 5, 7 and 8. The higher fly numbers appear to be the result of the two non-fixed ends of the bund allowing greater adult fly access.

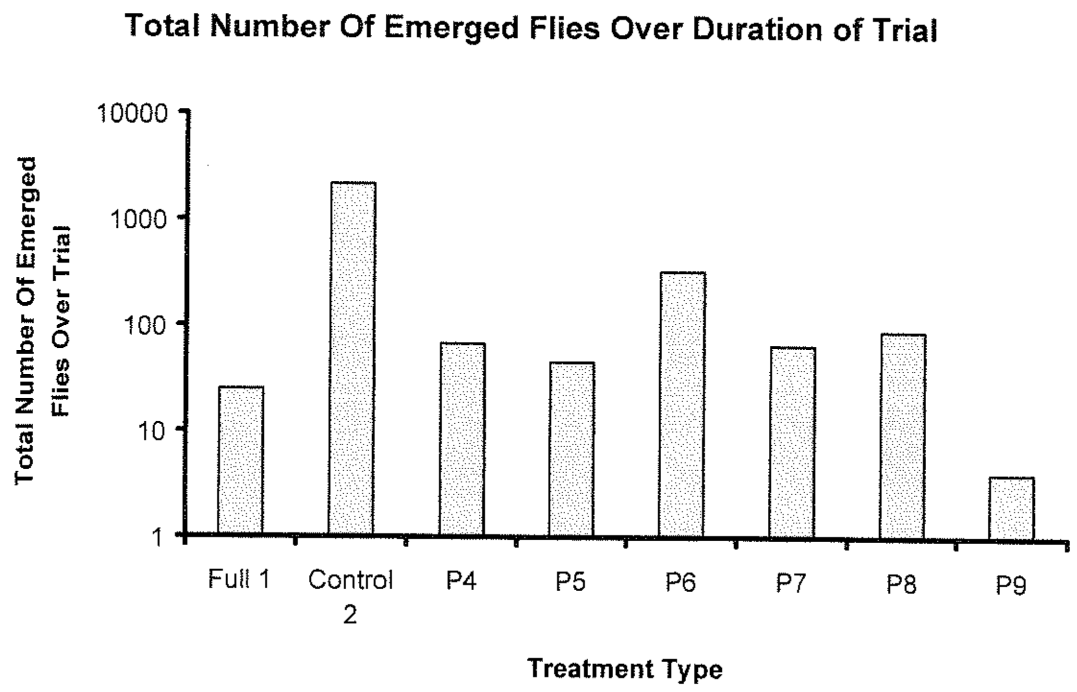

Figure 4: The total number of emerged flies over duration of trial. Full = Full Cover Treatment, Control = Control Treatment, P = Partial Cover Treatment, 1 - 9 = Bund Number (Corresponds To Figure 1; Logarithmic scale used).

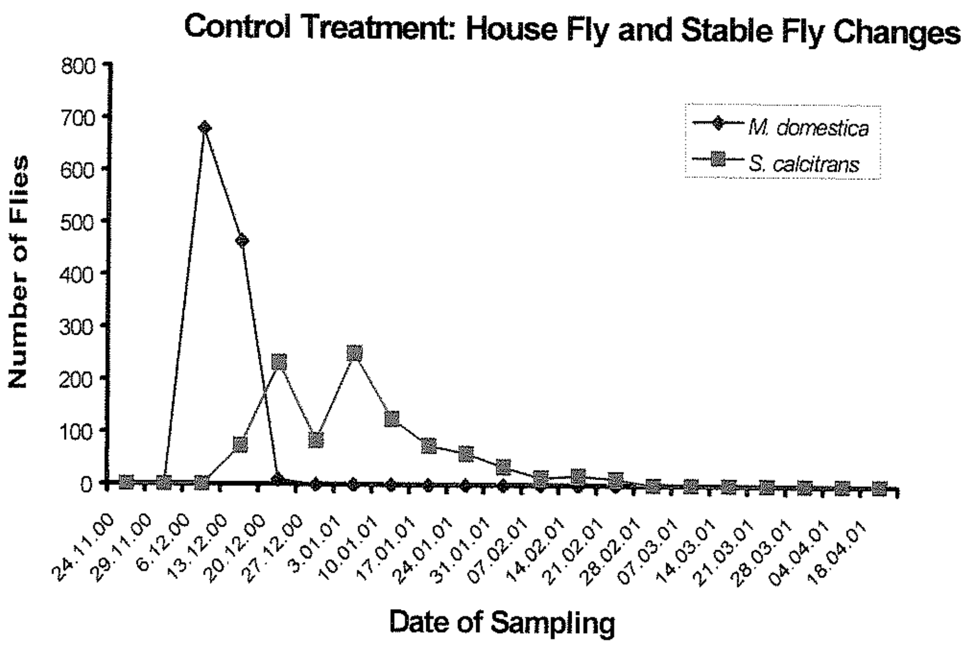

Figure 5: Number of house flies (*M. domestica*) and stable flies (*S. calcitrans*) within the control treatment. Indicates changes in species dominance.

Cover Manageability

The bund size used at Nowergup Biosolids Facility are similar to the type of bunds that are constructed on farms to house biosolid cake prior to use in agriculture. Both cover types were manageable but an individual can more easily manipulate the shade cloth on and off the bunds. The impermeable geomembrane was more cumbersome and generally required 2 people to manipulate it especially in a high wind. However, if a careful checking procedure is employed when removing and replacing the cover to ensure that the biosolid stockpile is tightly and completely covered by the material then fly breeding will be reduced. The fly breeding levels observed within bund six emphasize the importance of complete coverage. The two non-fixed ends of bund six allowed greater fly access to the resource and consequentially a significantly higher level of fly breeding than that observed in the other bunds covered by shade cloth.

Fly Activity

Interestingly, over the first two weeks of the trial no flies were detected within the control treatment samples. Previous studies have noted a similar absence of fly activity during the initial stages following the dumping of biosolid cake in the open. Possibly, at this early stage the low number of eggs within the total biosolid stockpile are difficult to detect by the extraction of small, random samples. Alternatively, changes in biosolid composition over the first few days may result in a more attractive resource for fly breeding. The deep fissures that occur over time as the resource hardens may prove attractive for oviposition, as the eggs are sheltered and protected. Further investigation into the early absence of fly activity may resolve such questions and facilitate a greater understanding of the timing of fly breeding in biosolid cake.

10. RECOMMENDATIONS

General

Fly breeding in large quantities of biosolid cake can be effectively reduced by the placement of covers over the entire exposed surface of the biosolid stockpile. During biosolid cake storage the presence of either a full plastic or shade cloth cover acts as an effective adult fly barrier limiting fly oviposition and emergence. Although both cover types are equally effective at reducing fly breeding, shade cloth covers appear to be the easiest to handle and the most cost-effective material.

Data relating to the control bund indicates that fly numbers approached zero following a period of three months and low fly breeding occurred in subsequent months (see Figure 5). Based on the data gathered in this study, it is recommended that covers remain in place over freshly dumped biosolids in the Wanneroo Shire for a minimum of three months during the stable fly season (October to May).

It is also recommended that a careful checking procedure be set in place when removing and replacing covers over biosolid cake. The procedure should limit the time of exposure and incorporate a checking system to ensure that complete coverage is achieved when the cover is replaced over the biosolid cake surface.

Specific

1) Covers fitted tightly over the surface of the biosolid heap reduce fly breeding by limiting fly access and oviposition.
2) Full plastic and shade cloth covers are equally efficient at reducing fly breeding in stored biosolid cake.
3) Covers should remain in place for at least three months.
4) Large covers are manageable, but a checking procedure should be enforced to ensure complete coverage is maintained at all times

Future R & D

- An extension of this trial over a two year period would be beneficial in establishing the annual fluctuations in stable fly and house fly abundance. This would entail using traps (protein and sticky) to estimate adult fly populations in the Nowergup area
- A study of the changes in biosolid cake composition when stored under cover over time. Biosolid cake may take longer to dry out and age when placed under cover. This will provide a suitable time schedule for covers to be removed from remaining stockpiles that no longer support fly breeding

TRIAL 2: IMPACT OF RAINFALL EVENTS

11. METHODS AND MATERIALS

A total of three bunds were utilised at the Nowergup Biosolids Facility. Each bund consisted of three walls containing 76 wet tonnes of biosolid cake with an open side for biosolid delivery. The biosolid cake was sourced as described previously in Trial 1 and stored at the Nowergup facility 6 months prior to the start of this investigation.

The aged biosolid cake of each of the three bunds were then exposed to 31mm of natural rainfall between 5th –7th of May 2001. On the 8th of May an artificial rainfall event was simulated by the application of 2kl (2000 litres) of water to the three bunds. 2kl of 'watering' is equivalent to 20mm of natural rainfall in each bund. An identical artificial rainfall event was applied on 9th and 10th of May with the addition of 7.5mm of natural rainfall on the 10th of May. Throughout the duration of the study the three bunds received an additional 51.6mm of natural rain during the remainder of May and another 73.5mm throughout June.

Biosolid cake sampling was conducted every seven days throughout May and then every fourteen days during June. Sampling commenced on the 09.05.01 and continued for a further six sample periods on the following dates: 16.05.01, 23.05.01, 30.05.01, 06.06.01 and 27.06.01. The timing of the trial was planned to survey fly breeding throughout the pre-winter and early winter rainfall season prior to the expected decline in fly activity. Five, 2 litre, biosolid cake samples were collected at random from the moister areas of each of the three bunds. Samples were set up and maintained as described in Trial 1. Once adult fly emergence ceased the flies were extracted, identified and counted.

12. RESULTS AND DISCUSSION

Fly Activity

No flies emerged from any of the samples collected throughout the duration of the entire study period (9th May – 27th June 2001).

The stable fly season incorporates October through to April and sometimes May (Paulin *et al.*, 1998). The timing of the trial incorporated both the tail end of the stable fly season (May) and the early rainfall season (June). This allowed a survey of fly breeding following an early season rainfall event occurring prior to the expected winter decline in fly activity. The absence of fly breeding observed provides strong evidence that rainfall events do not enhance fly breeding in aged biosolid cake. The dried outer layer of the aged biosolid material may have acted as a barrier to water absorption and prevented any increase in overall moisture content. The aged biosolid cake was clearly not an attractive fly breeding resource despite the rainfall events potential to rehydrate the cake.

Additionally, the absence of fly breeding activity in the aged biosolid cake throughout the latter part of the trial lends support to the observations of previous ecological studies. Other studies have found that stable fly numbers and activity decline during the winter period due to unfavorable seasonal conditions (Paulin *et al.*, 1998). Fly breeding has also been noted to wane throughout the winter months in poultry manure. Based on the results of this study a similar seasonal decline in fly breeding appears to occur in aged biosolid cake.

13. RECOMMENDATIONS

General

Aged biosolid cake stockpiled throughout the rainfall season can be left uncovered, as fly breeding appears limited by the nature of the aged cake and seasonal changes in fly activity. The aged biosolid material has an extremely low moisture content and presents an unattractive resource for fly breeding. Rainfall events do not appear to rehydrate the aged biosolid cake to the extent that the cake facilitates fly breeding success. The production of dry biosolid products, such as pellets which have a low moisture content, would similarly provide a successful means of reducing fly breeding success during storage.

Further, the seasonal conditions associated with rainfall events and the early winter period are linked in the literature to a decline in fly activity and breeding. The results of this study suggest a similar trend in the case of fly breeding in biosolid cake. Moreover, observations of fly breeding in stockpiles of biosolid cake in both the Gillingarra and Yerecoin regions during the winter period fly breeding has never been recorded.

Following an early winter rainfall event, aged biosolid cakes appears to remain an unattractive fly breeding resource. However, this may not be the case following a summer rainfall event given the more favorable seasonal conditions and the higher fly activity associated with this period. A similar trial conducted through summer simulating a mid-summer rainfall event is recommended. This would be more indicative of the impact of rainfall events on house fly and stable fly breeding in aged biosolid cake.

Specific

1. Aged biosolid cake remains an unattractive resource for fly breeding following an early winter rainfall event. Rainfall events do not appear to rehydrate the aged biosolid cake and facilitate fly breeding.
2. Results reinforce previous studies indicating that during winter the adult fly population decreases along with a corresponding decline in fly breeding.
3. Covers over aged biosolid cake appear unnecessary during the winter rainfall season although an extended survey throughout the duration of winter would be prudent.

Future R&D

- A study simulating a mid-summer rainfall event would provide a comprehensive evaluation of fly breeding activity in aged biosolid cake
- An extension of this trial throughout the duration of the winter period using fresh biosolid cake would firmly establish the patterns of seasonal decline in fly breeding in biosolid cake.

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