MANAGEMENT OF SPENT TIMBER RESIDUE FROM OUT-WINTERING PADS

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1 INTRODUCTION

Out-wintering Pads (OWPs) offer a reduced cost alternative system to housing or concrete yards for out-wintering cattle. These are open enclosures filled with woodchip and with an artificial drainage system (Smith et al., 2006) above a plastic lined or compacted clay base. As well as bringing reduced risk of pasture damage during the winter period, OWPs have been shown to bring animal health and production benefits (Hickey et al., 2002). However, poor management may impact negatively on the environment. The top layer of Spent Timber Residue (STR) – woodchip mixed with slurry solids - is scraped after the winter period, removing large amounts of a nutrient-rich material. Land application of STR can be a practical management strategy, but its high C:N ratio could make it resistant to breakdown, suggesting that storage and/or active composting is necessary (Bernal et al., 2009; French & Hickey, 2003). This study comprised two main objectives. The first was to evaluate the impact on grass growth and nitrogen utilisation efficiency of three different types of STR after spreading to grassland. The second objective was to evaluate composting practices of STR by comparing two factors: chip size and heap composting-system (actively-turned v/s static).

2 MATERIALS AND METHODS

The experiments described below were carried out at North Wyke Research, SW England, starting on July 24th 2009, using STR collected fresh from the experimental OWPs at North Wyke used for beef steers (Fig. 1a).

Land application of fresh STR: A field experiment was carried out on a permanent pasture on a silty clay loam (Harrod, 1981). Three STRs were used and applied at different rates; G50 (2-4cm chip size), G30 (1-2cm chip size); and sawdust (supplying 60, 125, 250 and 500 kg N/ha), which were compared with different rates of ammonium-nitrate fertiliser. An area of 23m x 15.5m was marked out and the grass was cut to approximately 2cm and the cut herbage removed. The area was divided into three equal-size blocks (randomised block design). Each block comprised 18 treatment-plots of 2m x 2m separated from each other by a 0.5m race - in total, 54 plots (Fig. 1b). Fertiliser response plots were included in order to assess the N uptake efficiency of grass. The length of this field trial was 15 months. Soil samples from each block were analysed for major nutrients and each plot received a base treatment of P, K and S. The central area (1.1m x 1.1m) of each plot was selected for cutting/harvesting. The fresh weight of cut grass was recorded and sub-samples analysed for DM and N content. Data were processed using the statistical programme Genstat (GenStat, 2007).

FIGURE 1 **Out-wintering pads at North Wyke (a), land application (b) and storage (c) of STR.**

Storage and active composting of fresh STR: Twelve concrete bunkers built in 2001 were used for this experiment. The STRs used on this experiment were G30 and sawdust. Each STR was piled up and split into 6 heaps, 3 of which were actively composted (AC) and 3 remained static (SC), for 8 months (Fig. 1c) (a total of 12 heaps). Temperature was recorded from the centre of each heap at intervals of 15 minutes. Leachate volumes and composition, from each heap, were monitored. Leachate samples were analysed for total N, P and solids; ammonium-N; nitrate-N and C:N ratio, on a once per week basis. Ambient temperature and rainfall were also measured. Data analysis was again undertaken using the statistical programme Genstat (GenStat, 2007).

3 RESULTS AND DISCUSSION

3.1 Land application of STR.

Only one cut (first cut - 3 months from July 2009) has been taken, to date. A good dry matter crop-yield response curve was obtained to the chemical fertiliser (Fig. 2).

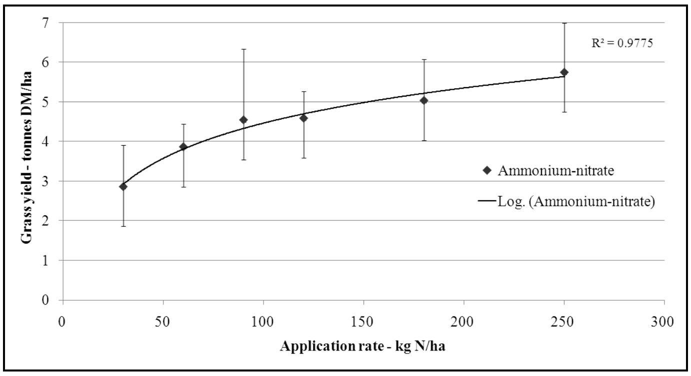

FIGURE 2 **Response curve for the chemical fertiliser (ammonium-nitrate).**

Some treatments of STR gave positive yield responses and nitrogen off-take (Fig. 3). By multiple comparison, a 20 kg N/ha application rate of G30 STR produced a higher yield than a 60 kg N/ha application rate of fertiliser N (n.s, $P>0.05$). The highest ($P<0.05$) yield was obtained by the highest fertiliser N rate of 250 kg/ha with 5.7 t DM/ha; the lowest ($P<0.05$) yield was observed from the 20 kg N/ha of sawdust STR (2.6 t DM/ha), though not significantly different to the control ($P>0.05$) (Fig. 3).

Augustenborg (2008) found no significant silage yield and DM response ($p<0.01$) from N in STR for first and residual cuts, with yields being similar to control plots. Mackay et al. (1989) reported an increase in soil organic matter after land application of manures mixed with wood shavings.

An application rate of 160 kg N/ha of G30 had similar effect ($P>0.05$) to a 20 kg N/ha application rate of the same chip size (Fig. 3).

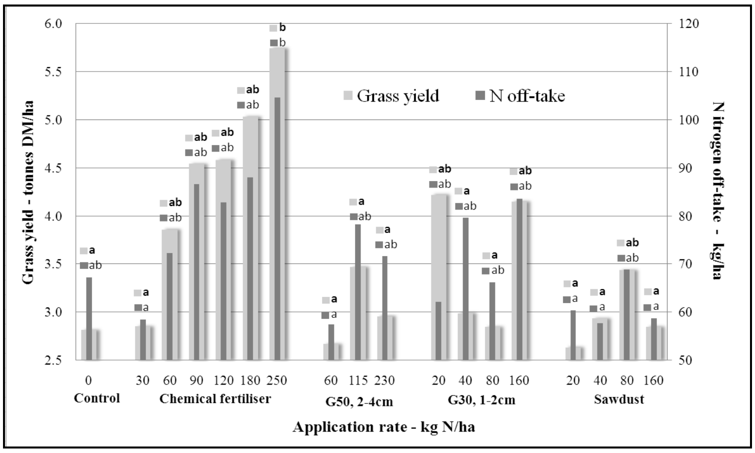

FIGURE 3 **Grass yield and N off-take of STR and chemical fertiliser for the first cut. Letters “a” and “b” are significantly different, P<0.05.**

Where nitrogen off-take was below that of the control, it can be inferred that nitrogen immobilisation has occurred, though there were few significant treatment differences ($P>0.05$). The lower nitrogen off-take from the

STR treatments can be partially explained by the low available N (ammonium-N) in this organic residue (35 and 38 mg/kg DM basis, for sawdust and G30, respectively) (Table 1) compared to that of beef cattle slurry 10% DM (20000 mg/l DM basis) (Chambers & Nicholson, 2004), FYM 25% DM (1600 mg/kg DM basis) (Chambers & Nicholson, 2004) or dirty water 0.5% DM (60000 mg/l DM basis) (Chambers & Nicholson, 2004). It is also possible that some N immobilisation may have occurred due to the ready availability of carbon in STR, especially in the case of the finely divided sawdust; however, it is noteworthy that N off-take from the 30 kg N/ha fertiliser treatment was also lower than that of the control (n.s. $P>0.05$).

3.2 Storage and active composting of STR

Nutrient composition of STR: The initial total N content of the G30 STR (12000 mg/kg, DM basis) was lower than the average typical cattle FYM (25% DM) of 24000 mg/kg DM basis (MAFF, 2000), but higher in sawdust STR with 25000 mg/kg DM basis - a mix of shredded wood-based residues such as compressed boards and other wood sources. The Phosphorus content was lower to cattle FYM (25% DM) of 14000 mg/kg DM basis (MAFF, 2000); the initial sawdust STR had a total P content (DM basis) of 3200 mg/kg and initial G30 3000 mg/kg (Table 1).

TABLE 1 **Average nutrient composition of STR (before and after storage-first 4 months).**

	Units **mg/kg**, dry weight	**Total N** (Kjeldahl)	**Ammonium** (NH_4-N)	**Nitrate** (NO_3-N)	**Total P**	**C:N Ratio**
	Initial composition					
	Sawdust, 31% DM	25000	35	17	3200	21
	G30, 32% DM	12000	38	24	3000	30
	After composting					
Active (AC)	Sawdust 32% DM	25000	62	20	3200	20
	G30 29% DM	16000	52	50	3600	31
Static (SC)	Sawdust 40% DM	30000	88	15	3300	16
	G30 32% DM	14000	50	20	3400	37

Initial total N and ammonium-N composition of sawdust STR increased significantly on the static treatment ($P<0.05$) during the first 4 months of composting. Nitrate content was unaffected during composting for both chip sizes, with exception of active G30 were nitrate content increased significantly ($P<0.05$) to more than double the initial content.

Leachate composition from composting heaps: Differences in average leachate concentrations of total N, NH_4, and C:N ratio were not significant ($P>0.05$) between chip sizes within a composting system. Between composting systems, greater release ($P<0.05$) of total N and NH_4 in leachate was observed in static G30 than active G30. Leachate composition tended to show greater differences between sawdust and G30 chips in static systems than in active treatments. Total N leachate concentrations from static G30 (89 mg/l) were higher ($P<0.05$) than that from static sawdust heaps (58 mg/l). Nitrate leachate concentrations between active and static sawdust heaps were similar ($P>0.05$), while G30 heaps showed lower nitrate concentration ($P<0.05$) on SC, suggesting that less nitrification occurred during the first four months of composting than in active G30 heaps.

TABLE 2 **Average first 4-months leachate composition of compost heaps.**

Composting system	Units **mg/l**, fresh weight	**Total N** (Kjeldahl)	**Ammonium** (NH_4-N)	**Nitrate** (NO_3-N)	**Total P**	**C:N Ratio**
Active (AC)	Sawdust 1.5% DM	38	4	6	14	10
	G30 1.7% DM	52	9	16	46	13
Static (SC)	Sawdust 1.6% DM	58	7	6	11	9
	G30 3.1% DM	89	14	2	22	8

Temperature performance of active and static heaps: Adequate thermophilic conditions (40-65^{o}C) were obtained during the first month for both AC and SC (Fig. 4). The moisture content decreased in all heaps through evaporation, reducing microbial activity, and thus heap temperature, following the first month. The performance of average heap temperatures during composting were similar to that observed by Ahn et al (2007) where during the first 20 days of composting heap temperatures stayed above 40 ^{o}C, and gradually decreasing to ambient temperature, for wood shavings mixed with poultry manure.

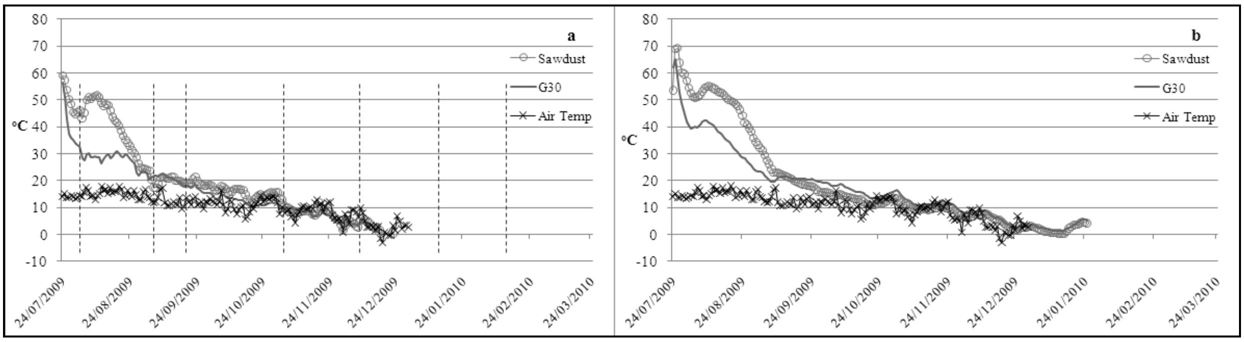

FIGURE 4 **Active (a) and static (b) composting. Dashed lines indicate heap-turning points.**

4 CONCLUSIONS

The management of STR is a key factor for the sustainable application of OWPs in livestock production systems. Application of STR to grassland can result in positive yield responses, but may result in N immobilisation within the plant-soil system. Composting of STR will assist the breakdown of organic fractions, though in this study it was observed that STR can be applied without being composted. A large heap (>2 tonnes) is important in composting for maintaining high temperatures; an adequate thermophilic period is essential for wood breakdown (40-65 ^{o}C).

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