Mushrooms : Re-use of compost,

Project M / 5,

Interim report

December 1991.

On behalf of
The Horticultural Development Council,

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Appendices

1. SUMMARY AND CONCLUSIONS

This report covers the initial stages of an ongoing project sponsored by the Horticultural Development Council (HDC project M/5).

A series of trials in which spent mushroom compost was re-composted to formulate material suitable for casing of mushroom beds is described.

Aerated composting was successful and resulted in material with suitable physical and water holding properties.

Re-composting generally achieved adequate temperatures to ensure pasteurisation of recycled material.

Re-composting was completed successfully in-bulk and in enclosed chambers.

Rapidly composted-casing (RCC) had a lower proportion of disease than equivalent peat-cased plots.

Late termination of composting carried a risk of poor aeration and development of anaerobic conditions at casing, unless particular attention was paid to ruffling.

Premature termination of composting resulted in significant straw residue with an associated high risk of weed mould development.

Rapid A.bisporus colonisation of composted-casing, when compared to peat-based casing, resulted in crops benefiting from reduced time to airing.

Formulation of parent compost is likely to influence suitability for re-composting.

Further developments with regard to cropping trials, compost termination/microbial populations and parent composts are outlined.

Current compost formulations benefited from earlier airing than is typically the case. There appears to be an interaction between time to airing and casing conductivity which requires further study.

The benefit of leaching and/or the use of absorbent additives is currently under consideration.

2. INTRODUCTION AND REMIT

The mushroom industry produces substantial quantities of bio-degradable materials which are often dumped or used as low-value bulk, e.g. for mulching. Fresh waste compost is not generally rapidly re-used because of unsuitable physical structure, conductivity and pH.

In 1990 The Horticultural Development Council (HDC) received proposals from SAC to study re-composting of spent mushroom compost, (SMC). The principal objectives were as follows:

i) To provide an alternative casing material from within the industry.

ii) To add value to compost for sale.

iii) To reduce the disease risk from stockpiled material

The most significant objective was to consider re-use of compost as casing. This was because of the recurrent cost of peat for casing. Consequently, any reduction in costs would be of benefit. Furthermore, Bragg (1990) identified that the U.K. mushroom industry is the second largest consumer of commercial peat. This accounts for between 250,000 and 290,000 cubic metres per annum, 10 - 11.6% of commercial and domestic consumption. As such, the industry is in a potentially vulnerable position with regard to pressure by environmental groups demanding a reduction in peat consumption.

A two year project was commissioned by HDC from a start date of February 1991. This report covers progress made during the initial project phases.

Previous work has been carried out to assess the value of spent mushroom compost as casing. In particular, work in the U.S.A. has been concerned with some of these aspects. Nonetheless, published work is exclusively concerned with the use of stored, i.e. not re-composted, material. Many such commodities, reported by previous workers, have been stored for more than three years. Such stored material may be referred to as SMC, even when substantially altered by natural degeneration.

Within the context of this project, material derived from fresh SMC and which has subsequently been actively composted to produce material for casing is referred to as Rapidly Composted-Casing (RCC).

Uniquely, the current project is designed to study ways of rapidly re-composting material, and demonstrate manipulation during processing to alter both the physico-chemical and biological nature of end-products.

The full remit of the project is shown in Appendix I

3. FACILITIES

The project was carried out at Horticulture Department, SAC Auchincruive. The programme of work involved use of a range of on-site composting and cropping facilities.

3.1 Composting

Composting was carried out both in bulk and in small-scale insulated compost chambers.

Bulk composting was of fresh SMC of at least 3 tonnes per batch. SMC was obtained from SAC Auchincruive or was donated by Garnock Valley Mushrooms Ltd. Composting was carried out on a concrete 'apron' under ambient conditions. Bulk loads were sheeted during composting.

Compost temperature was monitored by direct recording and by logging of data for computer analysis using remote sensors, (Logit, DCP Micro-developments Ltd.). Gas detection was by spot-check analysis (Gastec Ltd) from void chambers placed within stacks at turning.

Small-scale composting was carried out in purpose-built insulated chambers of nominal 0.6 cubic metre capacity. Chambers were designed to allow monitoring of gas and temperature within composts while providing replicated environments similar to those within bulk compost stacks.

Small-scale chambers incorporated fan-ventilation and heater-cooler provision to further study re-composting under totally controlled environments.

Physical and chemical tests were carried out by SAC Biochemical Sciences - Analytical Service Unit, using normal laboratory sampling techniques, including Inductively-Coupled Spectrography.

Turning of compost was carried out in bulk using a tractor mounted fore-end loader, feeding to a conveyor lifter-spinner (Chatsworth Ltd). When necessary, compost from chambers was also turned, by hand, and via a powered shredded / mixer.

3.2 Cropping

Cropping was carried out in controlled environment chambers. Crops were cultivated using standard commercial composts produced at SAC Auchincruive (straw-horse manure) or donated by Garnock Valley Mushrooms Ltd, (straw-poultry manure).

Crops were grown in wooden trays (mean surface area : 0.5 sq.m) or in standard plastic cropping bags.

Fill rate was typically 1 tonne per trial @ 20-22 lb sq.ft. (83-92 kg/sq. m.)..

4. SCHEDULE

Because one of the primary project objectives was to introduce an element of recycling of material into mushroom schedules the history of each batch of material was recorded.

Batches of compost delivered to site were each allocated a code letter, supplemented with a parent source code for any constituent recycled material.

Compost history for those batches used in the course of this study are shown in Table 4.1.

Table 4.1. Compost and casing coding* for re-composting and subsequent cropping trials.

Compost A

Source: Garnock Valley Mushrooms Ltd.

Type: Fresh SMC

Objective: To provide bulk re-composted material (RCC)

Treatments: Re-composted

Compost B

Source: Garnock Valley Mushrooms Ltd.

Type: Weathered SMC > 3 years old.

Objective: To provide comparison to freshly prepared material

*** First letter refers to either cropped compost or fresh SMC delivered to site for re-composting / subsequent letters refer to casing material and their parent composts:-**

e.g. E / D2.A4. refers to a crop produced on spawned compost E and cased with re-composted D replicate number 2 which had been cased during cropping with re-composted A replicate number 4.

Table 4.1 continued, *

Compost C

Source: Garnock Valley Mushrooms Ltd..

Type: Bulk Spawn-run, Strain 501.

Objective: To test performance of RCC as casing and to determine potential benefits of pasteurising and leaching material.

Compost / Casing:
C / Pe (Peat casing)
C / B
C / A1
C / A2 (Leached casing)
C / A3 (Steamed + leached casing)
C / Cp (Cocopeat casing)

Compost D

Source: Garnock Valley Mushrooms Ltd..

Type: Bulk Spawn-run, Strain 501.

Objective: To test performance of RCC as casing and to determine potential benefits of pasteurising and leaching material.

Compost / Casing:
D / Pe
D / A1
D / A4 (Steamed casing)
D / A5 (Leached casing)
D / A6 (Steamed + leached casing)

Compost E

Source: Garnock Valley Mushrooms Ltd..

Type: Bulk Spawn-run, Strain 501

Objective: To test viability of reducing time to airing when casing with RCC.

Compost / Casing:
E / Pe
E / D1,D3:A1,A4,A5,A6:Pe

*** First letter refers to either cropped compost or fresh SMC delivered to site for re-composting / subsequent letters refer to casing material and their parent composts:-**

e.g. E / D2.A4. refers to a crop produced on spawned compost E and cased with re-composted D replicate number 2 which had been cased during cropping with re-composted A replicate number 4.

Table 4.1 continued, *

Compost F

Source: SAC Auchincruive

Type: Fresh SMC

Objective: To provide bulk re-composted material (RCC)

Treatments: Re-composted

Compost G

Source: Garnock Valley Mushrooms Ltd..

Type: Fresh SMC

Objective: To provide bulk and small-scale re-composted material (RCC)

Treatments: Bulk re-composting
Closed composting
Ventilated composting
Determination of rate of leaching

Compost H

Source: Mossgiel Mushrooms Ltd.

Type: Bulk peak-heated, Strain AX20.

Objective: To assess cropping potential and viability of reducing time to airing when using RCC as casing.

Compost / Casing H / Pe
H / G

*** First letter refers to either cropped compost or fresh SMC delivered to site for re-composting / subsequent letters refer to casing material and their parent composts:-**

e.g. E / D2.A4. refers to a crop produced on spawned compost E and cased with re-composted D replicate number 2 which had been cased during cropping with re-composted A replicate number 4.

5. PHYSICAL AND CHEMICAL ANALYSIS

Compost A

Pre-treatment: Cooked out

Quantity: 5 Tonnes

Turning: Three times per week (Monday/Wednesday/Friday)

Temperature profile:

Internal stack temperature climbed rapidly from delivery. Temperature reached 50 C on day 5 and continued to climb to a peak of 55 C on day 8. Duration in excess of 50 C indicated that adequate pasteurisation of material was achieved although this was not proven.

Temperature typically fell following turning although this effect was compensated for, for approximately 15 days, by increased activity of compost as a result of aeration. Subsequent turning did not appear to increase activity, but ensured continued aerobic composting.

Temperature profile of Compost A is shown in Figure 5.1.

Nutritional analysis:

Samples were withdrawn at intervals during re-composting and subjected to analysis (Table 5.1). Of particular significance is the high conductivity, which climbed markedly in the initial stages of re-composting. This coincided with the period of greatest activity, reflected in stack temperature. Conductivity was predominantly due to high levels of residual potassium. All elements were effectively concentrated during re-composting, as volume of the stack declined.

Nitrogen levels increased during the initial stages of the process. This was apparently due to the conversion of microbial /protein nitrogen to inorganic forms. Subsequent utilisation by microflora reduced levels by evolution of gaseous nitrogen.

The degree of aeration/water holding potential of the compost was determined as Air-filled porosity (AFP) (Figure 5.2). At week 5 RCC had an AFP of <1. This represents a high water holding capacity, but with a poor level of air porosity. Consequently, there was a high risk of material turning anaerobic.

Final appearance of Compost A after 5 weeks treatment was uniformly clay-like with no visible straw residue.

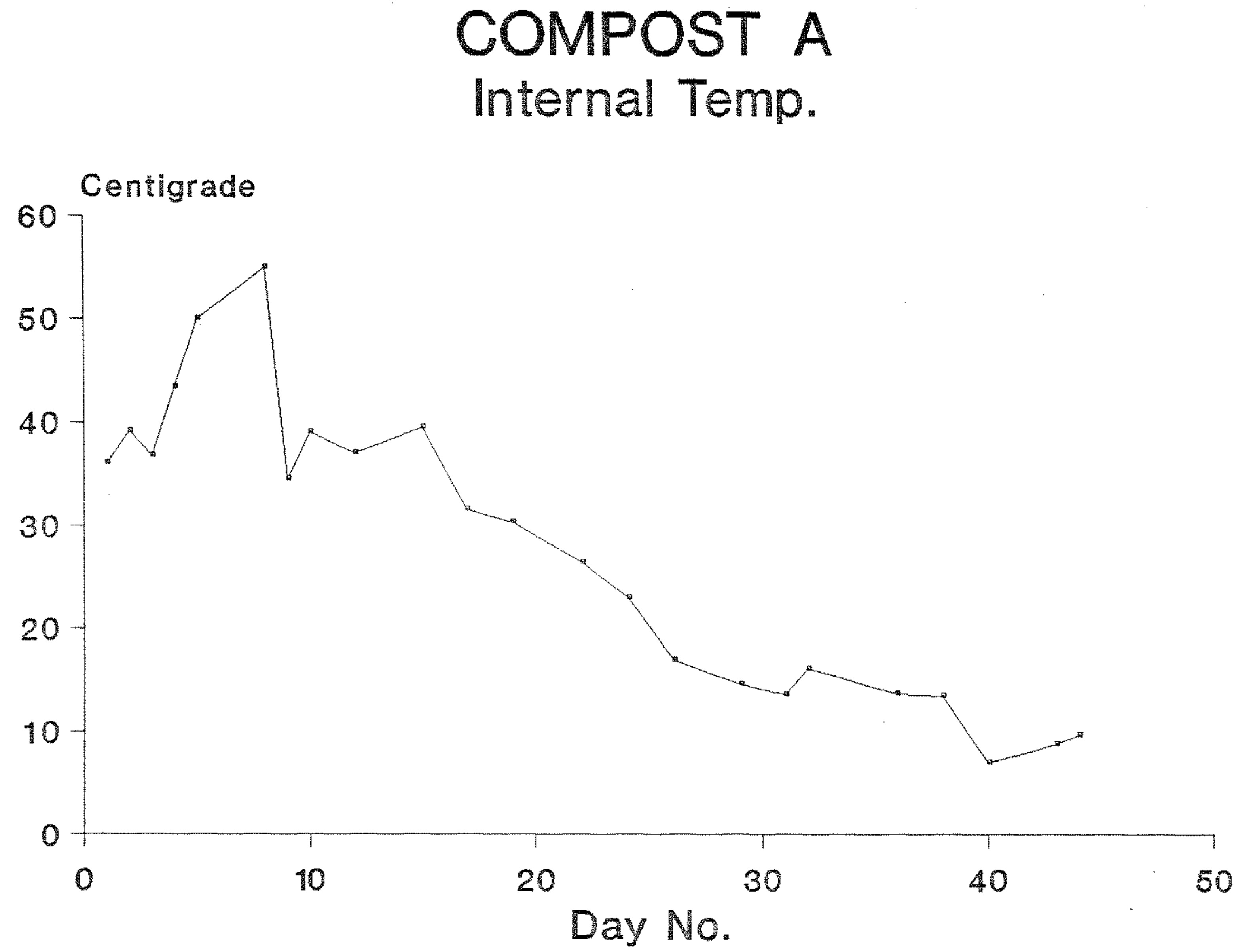

COMPOST A
Internal Temp.
Centigrade
60
50
40
30
20
10
0
0
10
20
30
40
50
Day No.

Fig. 5.1

Typical Analysis of Composted SMC with Time

Factor	Week 1	Week 2	Week 3
pH	7.7	7.2	7.3
Conductivity (uS/cm)	3480	3360	3700
Nutrients (mg/l)			
Ammonium-N	221	8	8
Nitrate-N	<1	56	7
Total N	221	64	15
Phosphorus	24	34	30
Potassium	2700	2760	3348
Magnesium	324	348	396
Calcium	2100	2280	2520
Manganese	24	25	28

Table 5.1

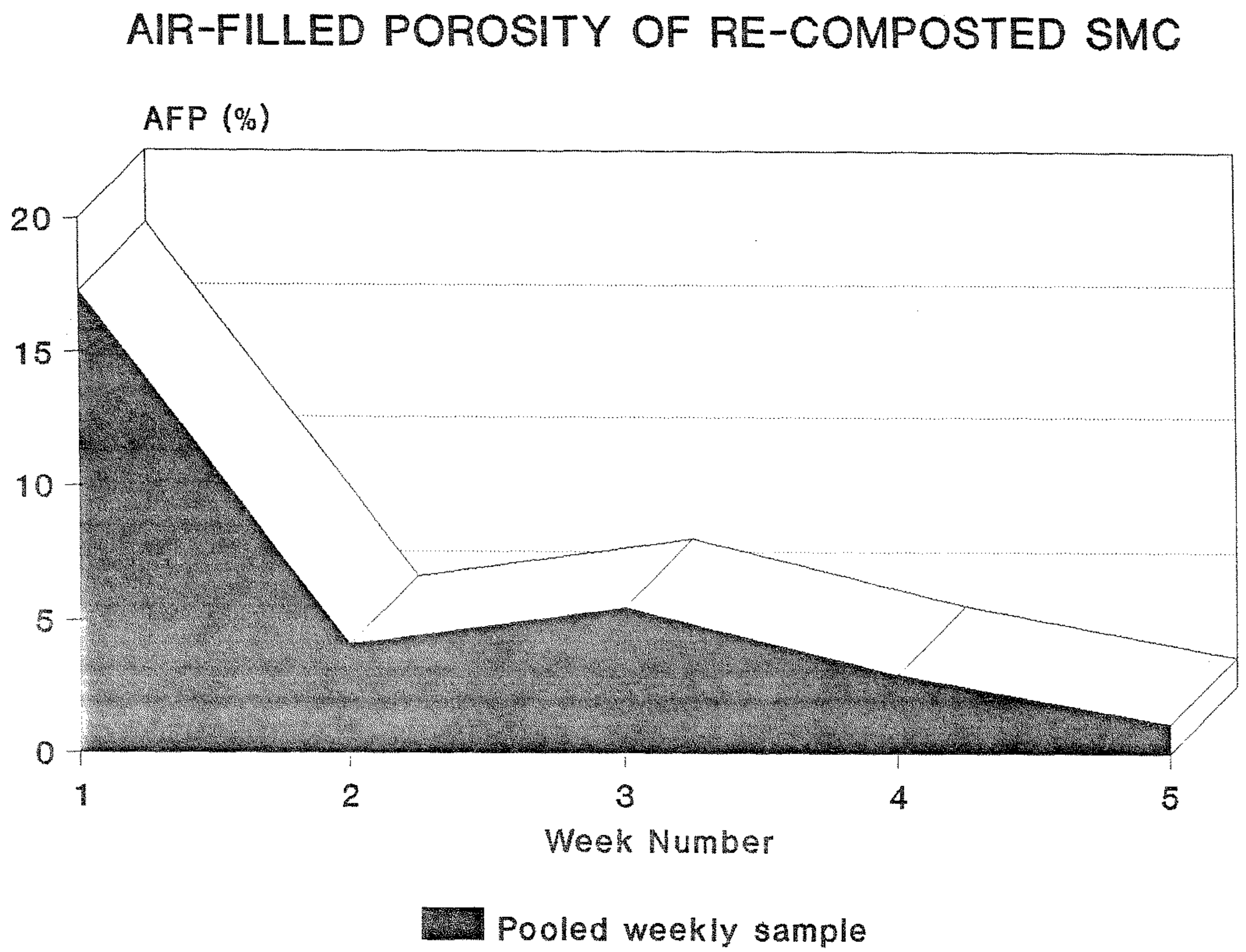

AIR-FILLED POROSITY OF RE-COMPOSTED SMC
AFP (%)
20
15
10
5
0
1
2
3
4
5
Week Number
Pooled weekly sample

Fig. 5.2

COMPOST B
Chemical Analysis

Factor	Compost B
pH	7.5
Conductivity (uS/cm)	1410
Nutrients (mg/l)	
Ammonium-N	<1
Nitrate-N	79
Total N	79
Phosphorus	30
Potassium	900
Magnesium	180
Calcium	948
Manganese	20

Table 5.2

Compost B

Pre-treatment:

Bulk material was stacked sequentially on land adjoining the source farm. Storage was to an approximate depth of 2 metres at dumping. Material was approximately 3 - 4 years old at analysis.

Quantity: Pooled samples were used as required from an undetermined supply, in excess of 1,000 tonnes at stacking.

Turning: Stacked material had not been turned.

Nutritional analysis:

Analysis of residual nutrients in stacked, weathered SMC is shown in Table 5.2. Conductivity remained fairly high, at 1410 microsiemens, although this is considerably lower than for rapidly composted material, (Compost A). Potassium remained a major contributor to conductivity despite weathering and natural leaching. Calcium level also remained high, with a corresponding pH of 7.5.

When compared to Compost A after 5 weeks, naturally weathered material was significantly coarser. A proportion of straw matter remained visible. Appearance was similar to Compost A at approximately 3 - 4 weeks and this was reflected in measured AFP of 4.1.

Compost D

Pre-treatment: Cooked-out prior to re-composting compared with none prior to re-composting.

Quantity: Approximately 1 tonne.

Turning: Routine twice weekly or continuous ventilation only.

Temperature profile:

Differences between re-composting of material which had been previously cooked-out post cropping and material which had not were small. The rapid rise in temperature due to the onset of re-composting indicated that steam did not completely kill the existing microflora present at the termination of cropping.

In all cases, SMC was cooled approximately to ambient temperature prior to aerating and stacking in chambers. Compost was subsequently either turned manually and shredded periodically or left in-situ and aerated by fresh-air ventilation.

All batches rapidly increased in temperature, although ventilated material peaked at approximately 55 C after 5 days. Non-ventilated material followed a pattern similar to that observed for bulk material. In this case, peak temperature was 71.5 C at day 8. Temperatures in excess of 55 C were for a greater period, up to day 13, than for ventilated material. This indicated that aeration of the latter was offset by the cooling effect of ambient air, (Figure 5.3).

Turning, which was on a routine basis, resulted in an immediate temperature reduction which was generally made-good within 24 hours. Early stages of re-composting were unaffected by turning.

Temperature of both ventilated and unventilated RCC declined to ambient after approximately 20 days, indicating a slowing of metabolic activity. Nonetheless, physical appearance was not adequate at this stage and conditioning was continued to day 29.

Nutritional analysis

Analysis of pooled samples revealed changes during processing, in line with previous observations. After re-composting, pH had risen slightly to 8.1 and 7.3 for unventilated and ventilated RCC respectively. Ammonium-nitrogen remained relatively high at 0.293% (Total N 2.69%) and 0.127% (Total N 2.54%) respectively. This reflected earlier termination of composting when compared to previous batches.

Evolution of ammonia followed the pattern of previous analysis. Peak production was at day 10 at up to 90 ppm in unventilated chambers. This coincided with peak temperature. Similarly, CO_2 evolution peaked at this time with up to 2.4% concentration within RCC.

Similarly, AFP remained relatively high, at 14.1 for unventilated and 12.0 for ventilated material. Moisture capacity was in the range 54.7% - 56.9%.

Physical appearance was finally similar to that of Compost B, naturally weathered material, with a small percentage of straw-residue apparent.

Volume reduction over the re-composting period was 28.1%.

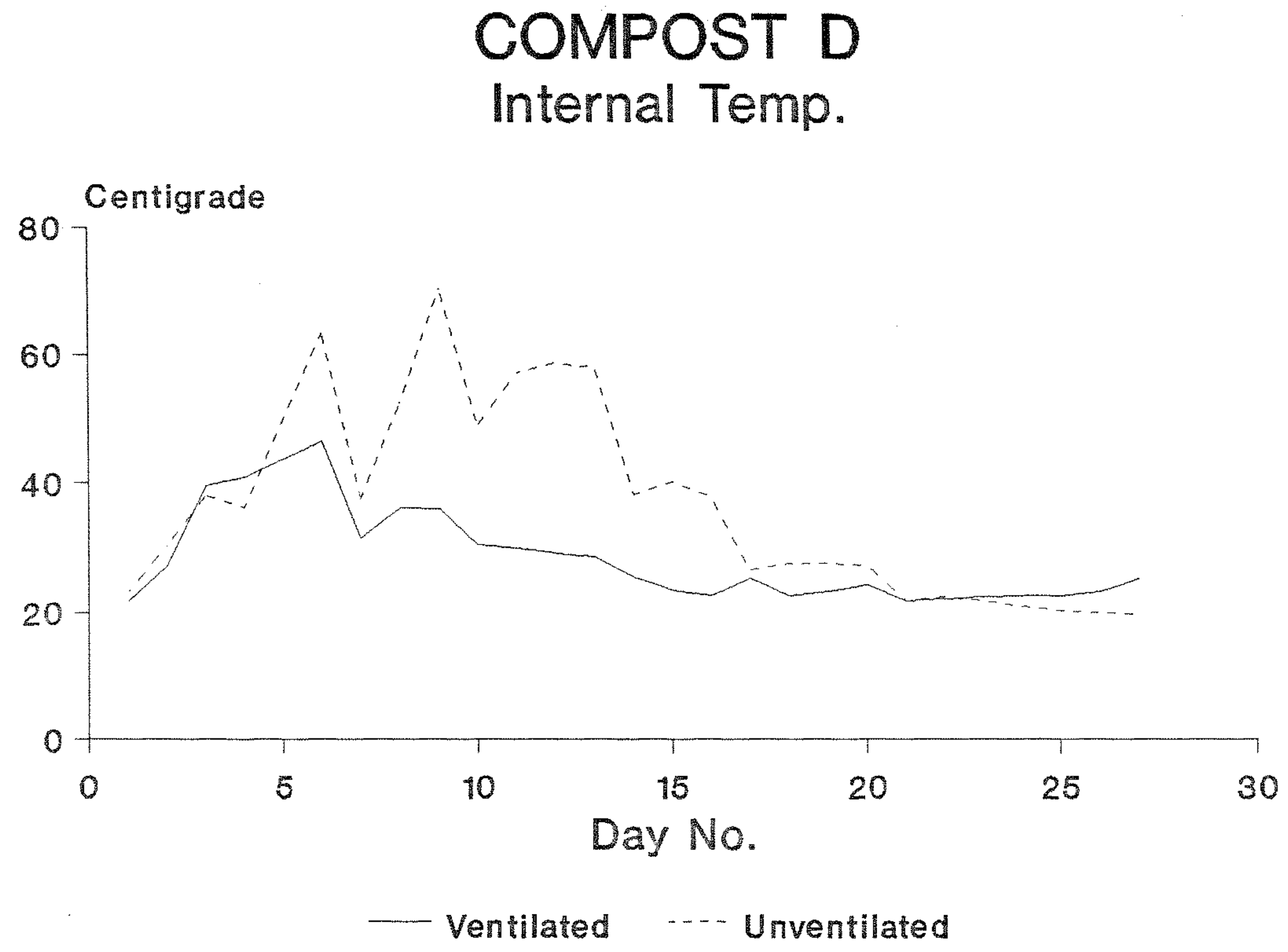

COMPOST D
Internal Temp.
Centigrade
80
60
40
20
0
0
5
10
15
20
25
30
Day No.
Ventilated
Unventilated

Fig. 5.3

Compost F

Pre-treatment: Cooked-out after cropping.

Quantity: Approximately 3 Tonnes bulk plus chambers.

Turning: At twice weeky intervals. Turning was initially by paddle-mixing, subsequently by conveyor-lifter /spinner.

Temperature profile:

Profiles of temperature are shown in Figure 5.4. Bulk compost failed to re-compost satisfactorily. Core temperature climbed rapidly to a maximum of 41.7 C on day 6. However, it failed to reach pasteurisation temperatures in excess of 55 C, as was the case for previous batches.

At day 9 a distinct sulphurous smell was evident. On inspection of the compost core a dull, greyish, anaerobic area was apparent. This batch was consequently aborted.

Material handled within chambers was more successful, although direct comparison with material produced in bulk was not possible. As with bulk material peak temperature was unsatisfactory, reaching only 46.0 C on day 7. Material remained aerobic during the course of re-composting, which continued to day 25. At that time, all material had a friable consistency with a low proportion of straw residue apparent.

Turning was prompted by a levelling-off or a fall in temperature. This tended to reduce the number of turns required and minimised the loss of metabolic heat generally associated with routine turning.

Because of poor pasteurisation, this material was abandoned as casing.

Compost G

Pre-treatment: Cooked-out post-cropping.

Quantity: Greater than 5 Tonnes

Turning: On levelling-off or reduction in temperature. Small-scale composting was either turned manually or fresh-air was introduced for 24 hours without movement of material.

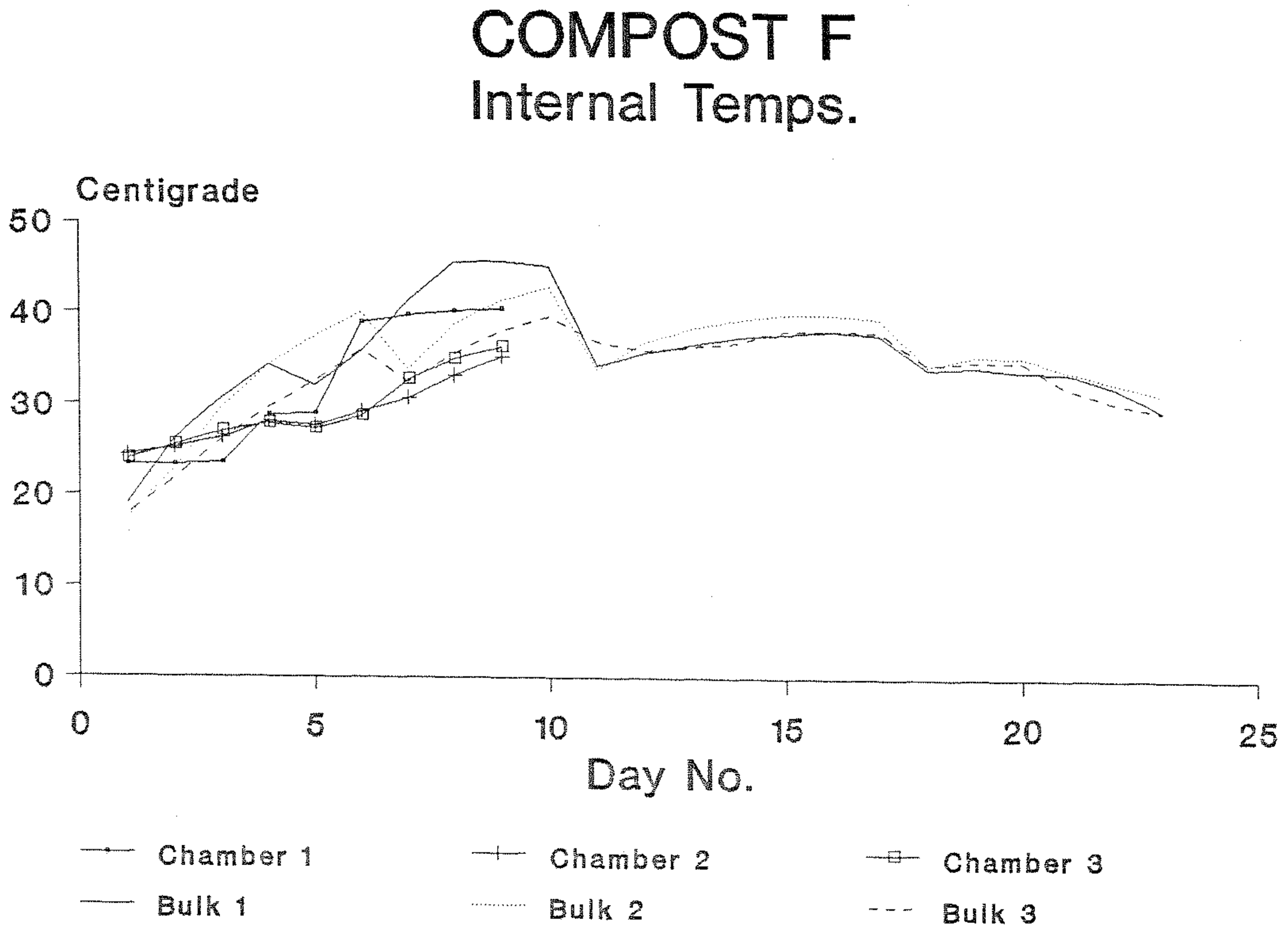

COMPOST F
Internal Temps.
Centigrade
50
40
30
20
10
0
0
5
10
15
20
25
Day No.
Chamber 1
Chamber 2
Chamber 3
Bulk 1
Bulk 2
Bulk 3

Fig. 5.4

Temperature profile:

Composting of material was satisfactory both for bulk and and for small-scale material.

Bulk core temperature rapidly climbed to in excess of 55 C by day 3, and by day 7 for chambers (Figure 5.5). Peak temperature of bulk material was 62.0 C, 66.4 C for turned chambers and 64.1 C with aeration. Bulk material maintained high temperatures for longer than did chambers although all treatments stayed in excess of 55 C for more than 24 hours.

By day 36 all turned treatments had reduced in temperature to approximately ambient, although composting was allowed to continue up to day 65. Material which was not physically turned but which was aerated, when 'turning' was required, responded for the duration of the experiment. This indicated that mixing of material accelerated the process in the other treatments.

Nutritional analysis

Analysis of material at day 42 followed trends previously demonstrated for earlier batches. All samples retained a high level of conductivity which was primarily due to potassium. Nitrogen levels remained higher than for previous batches, despite longer re-composting (Table 5.3).

Evolution of carbon dioxide peaked at turn 2 (day 6) and reflected the high level of metabolic activity and temperature of the stack. This subsequently reduced, with corresponding detection of hydrogen sulphide, indicating too high a stack temperature and creation of anaerobic conditions. This was corrected at turn 3. Ammonia production peaked subsequently as CO_2 evolution became re-established and aerobic activity stabilised (figure 5.6).

Volume of RCC reduced during the course of re-composting. This is shown in Figure 5.7. Ventilated material lost least, reflecting the less active composting process. Turned material reduced to approximately 62% of original volume. The greatest reduction took place within the first ten days of composting.

Bulk material was subjected to leaching by sprayline in order to determine the potential for reducing conductivity. Leaching took place rapidly, with significant reduction in conducvtivity occurring approximately ten hours from start (Figure 5.8).

In all cases appearance of RCC was uniform and similar to peat-like compost. Some straw residue was apparent although this was less than 1%.

Water holding capacity of bulk RCC was in the range 68% - 73%.

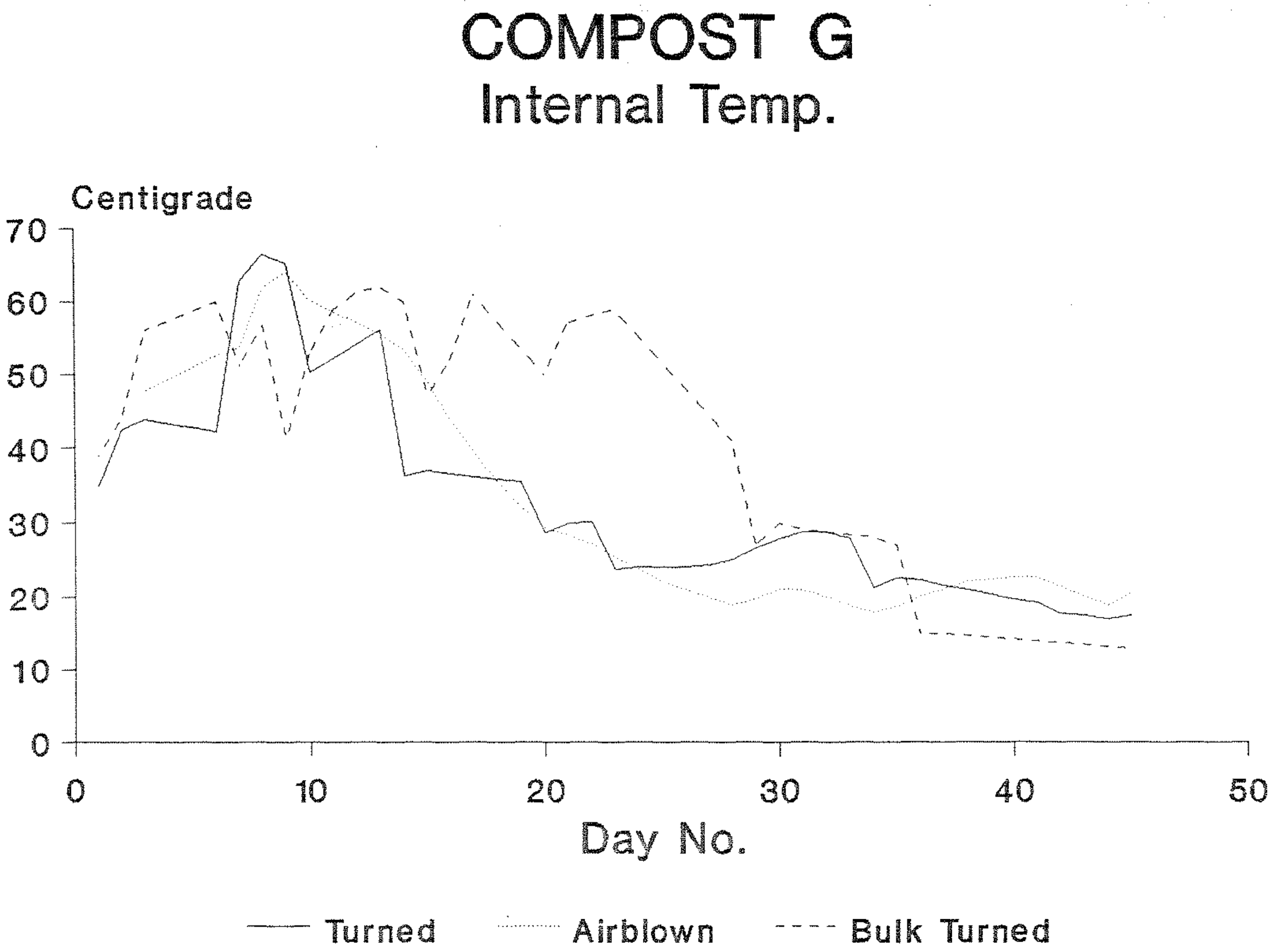
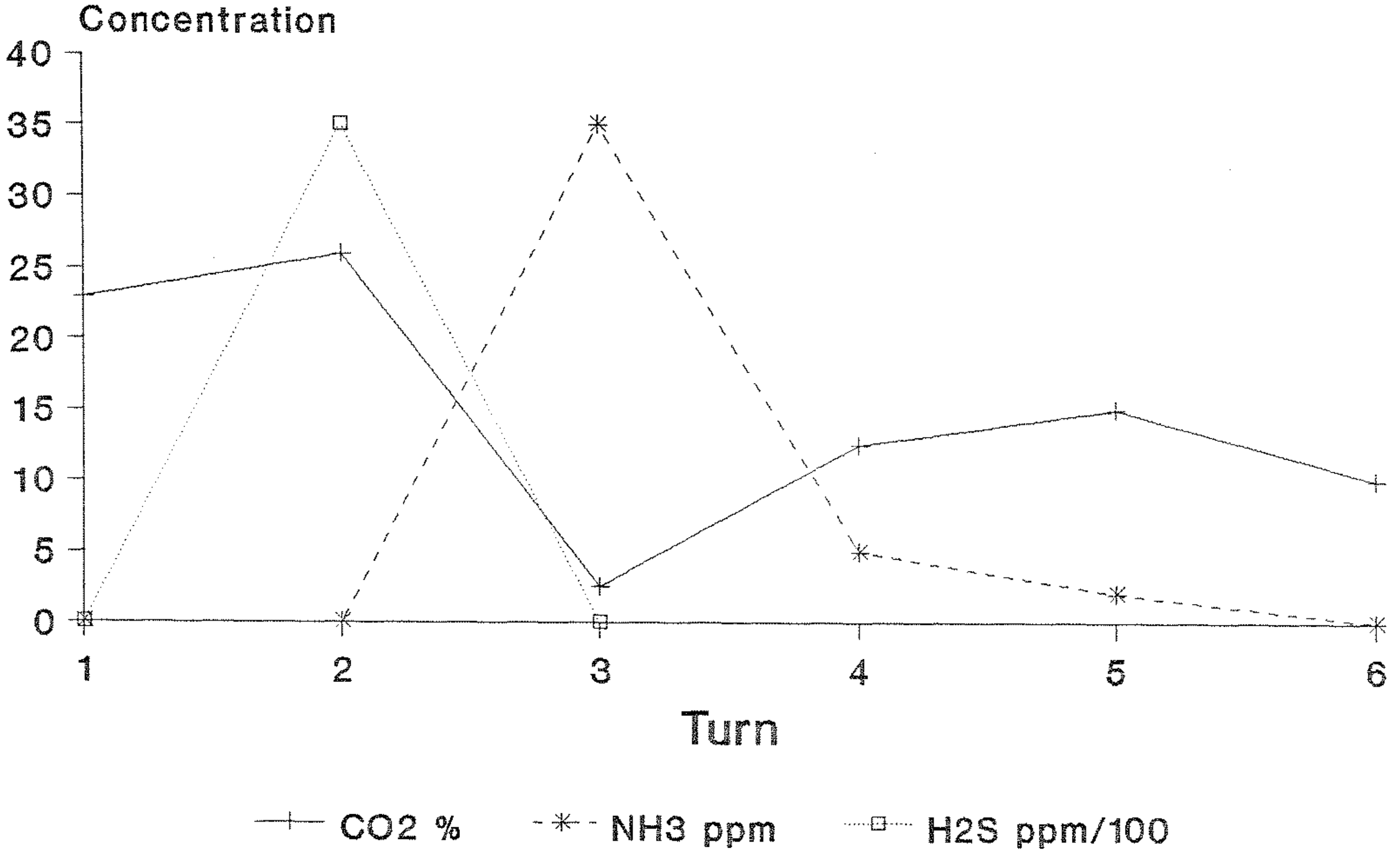

COMPOST G
Internal Temp.
Centigrade
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Day No.
Turned
Airblown
Bulk Turned

Fig. 5.5

COMPOST G
Post-Composting Analysis

Factor	Turned	Airblown	Bulk Turned
pH	7.3	7.0	7.0
Conductivity (uS/cm)	3030	3780	3960
Air-filled Porosity (%)	22.6	13.6	3.2
Nutrients (mg/l)			
Ammonium-N	242	7	14
Nitrate-N	<1	119	243
Total N	242	126	257
Phosphorus	24	28	30
Potassium	2490	3384	3600
Magnesium	216	276	276

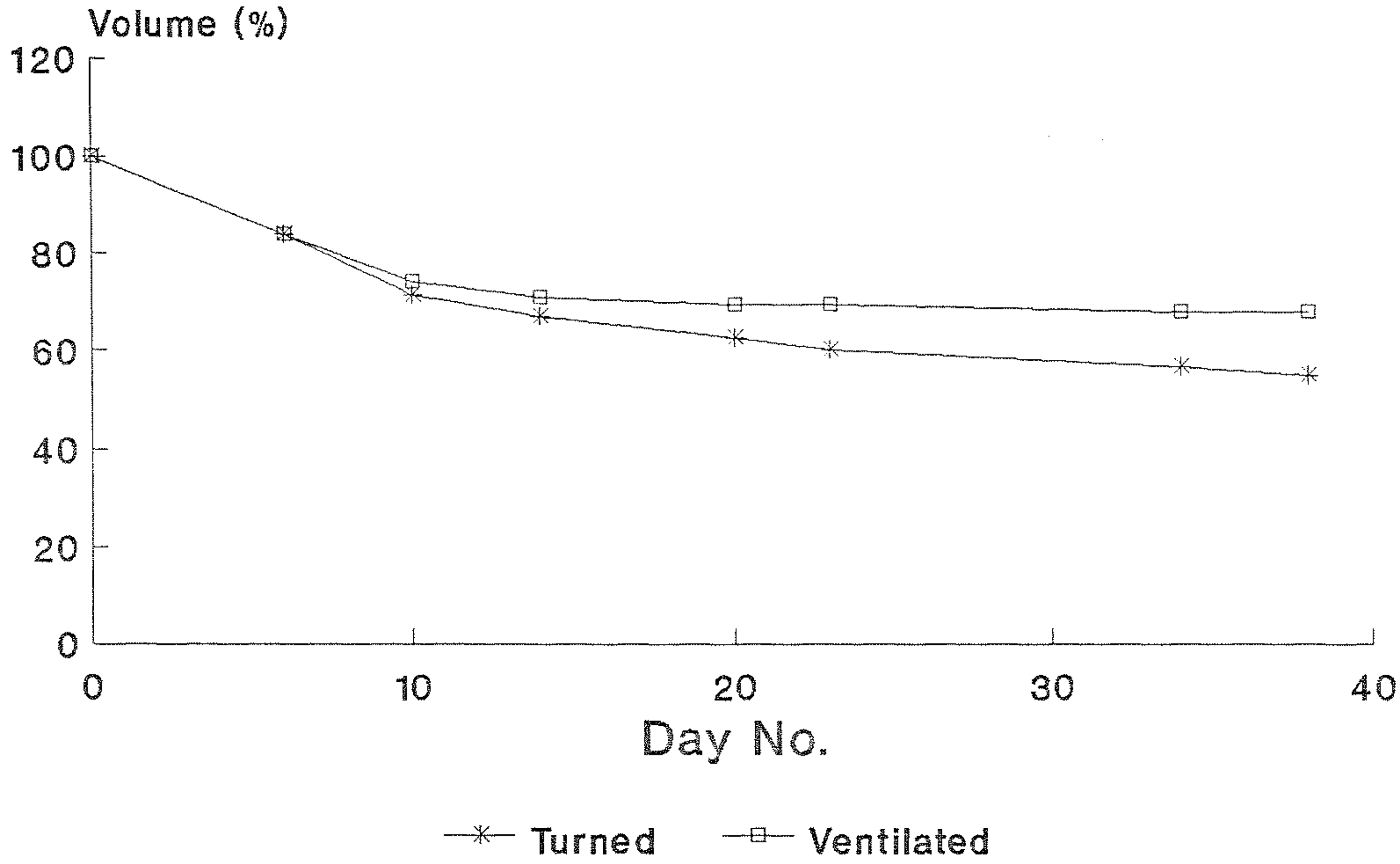
Table 5.3



COMPOST G

Gas Concentration in Bulk Turned Compost

Fig. 5.6



COMPOST G

Residual Volume (%) of Chamber Compost

Fig. 5.7

LEACHING OF RECOMPOSTED SMC

Conductivity vs Time

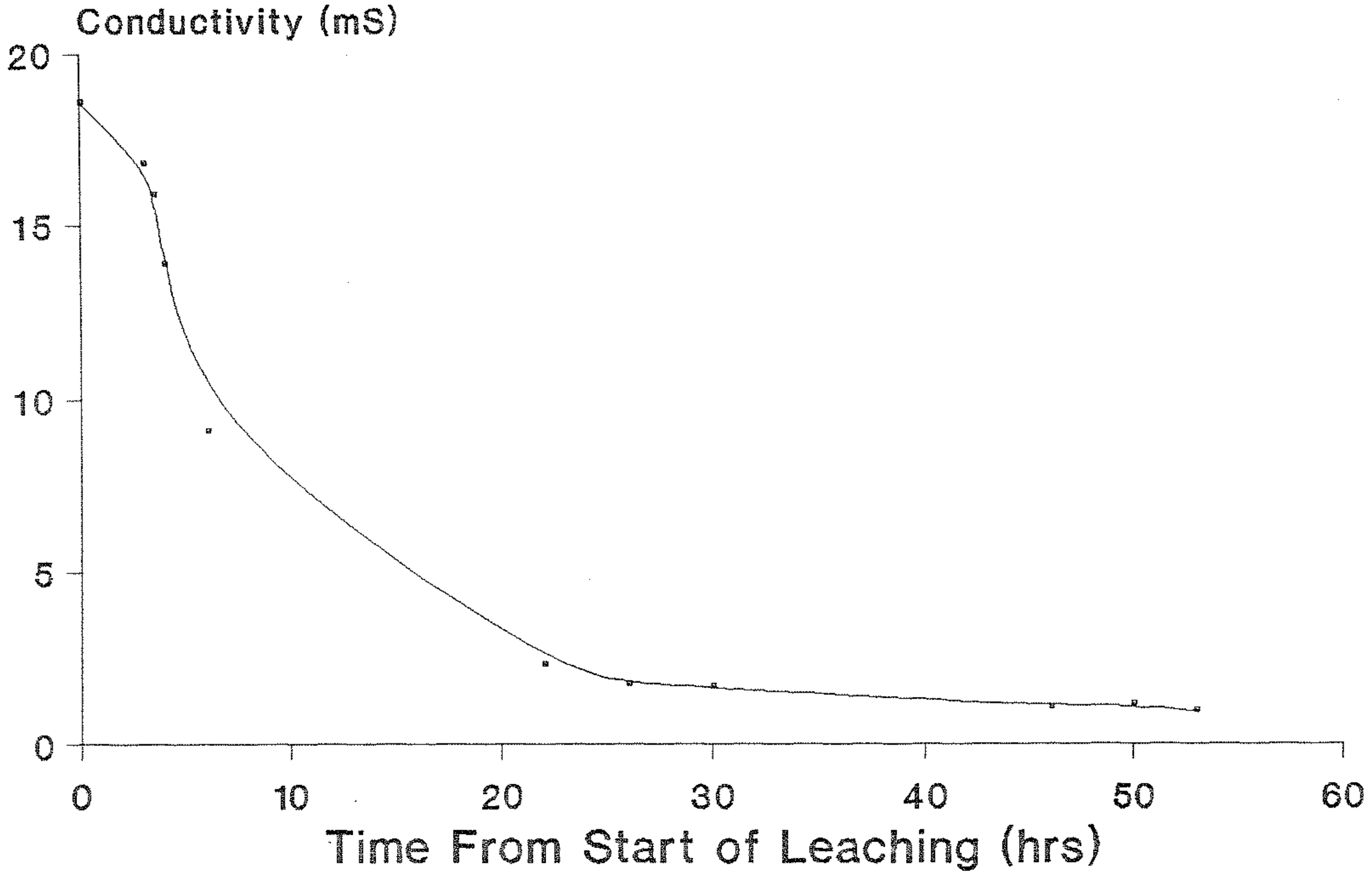


Fig. 5.8

6. CROPPING TRIALS

Yield data is based on crops grown on wooden trays within environment-controlled cabinets.

A number of features have been apparent in each crop. In particular, growth rate of Agaricus bisporus was generally faster than in conventional peat casing. This may be due to the relatively high levels of nutrients remaining in batches of RCC. The exact relationship between growth of the fungus and casing conductivity is not clear for RCC.

The physical nature of RCC also was significant in determining the success of cropping trials. Early material had a clay-like nature which had a high water holding capacity. Similar in appearance to continental casing formulations it did suffer from 'caking' when used as casing. Consequently there was a high risk of the casing layer becoming anaerobic. This was avoided by 'ruffling', although unreplicated material used as casing on a commercial shelf-operation suffered because of insufficient attention to this aspect.

Compost batches which were stopped composting at less than 5 weeks and which retained a proportion of straw residue were better aerated. However, other problems of continued degradation and pest and disease development were noted.

Two main approaches have been adopted.

i) To determine yield potential for RCC in comparison to peat casing.

ii) To assess RCC microflora and identify pest and disease risk associated with RCC.

6.1 Yield

Yield of mushrooms from crops cased both with peat and with RCC (A - C) shows that, to date, peat out-performs the new material (Table 6.1, Figure 6.1). Nonetheless, this was associated with problems of too-rapid growth and lack of aeration, discussed above. Leaching and sterilisation by steam were employed to determine treatment effect on yield.

For trays handled using a normal schedule of airing, leaching provided the greatest benefit, resulting in a yield of 174.0 Kg / Tonne. Sterilisation increased this to 177.7 Kg / Tonne. These near-commercial yields indicate that RCC has potential as a commercially viable casing alternative.

MARKETABLE MUSHROOM YIELD

Overall Total Weeks 1-6

CASING MATERIAL	Kg/sq.m.	lb/sq.ft.	Kg/tonne
PEAT and CHALK	22.66	4.64	256.9
RCC	7.31	1.50	82.9
LEACHED RCC	15.34	3.14	174.0
STERILE RCC	7.09	1.45	80.4
STERILE LEACHED RCC	15.67	3.21	177.7

Compost Fill Rate = 88.2 Kg/sq.m. 18.06 lb/sq.ft.

Table 6.1

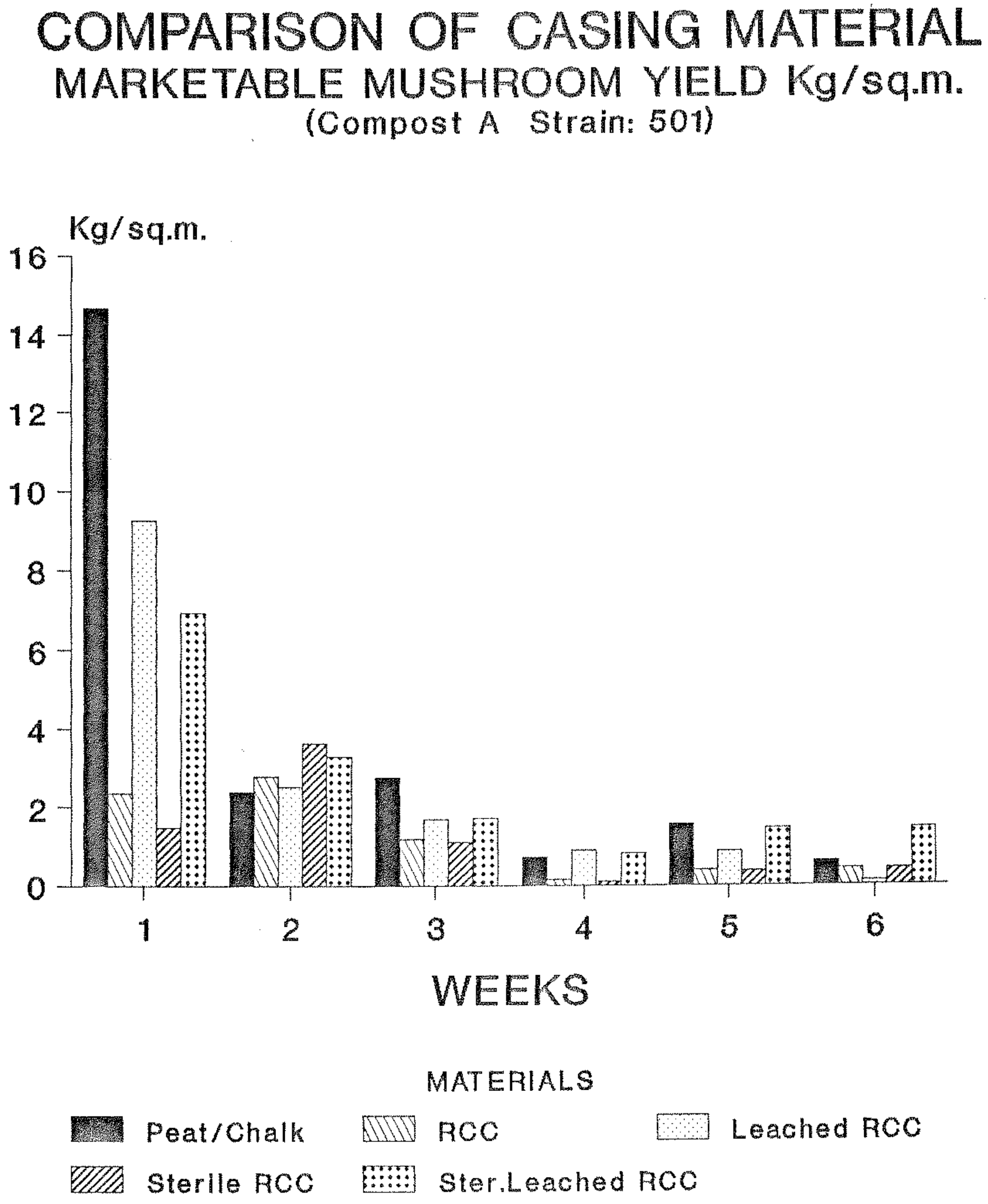

COMPARISON OF CASING MATERIAL
MARKETABLE MUSHROOM YIELD Kg/sq.m.
(Compost A Strain: 501)
Kg/sq.m.
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
WEEKS
MATERIALS
Peat/Chalk
RCC
Leached RCC
Sterile RCC
Ster.Leached RCC

Fig. 6.1

The rapid rate of A. bisporus growth observed for RCC under normal growth conditions resulted in excess overlay of casing prior to airing. A trial to determine the viability of reducing time to airing showed that this may be the case. A.bisporus was grown under normal commercial conditions until shortly after casing. In comparison to normally treated peat-cased trays, those cased with RCC were aired prematurely.

Trays were incubated normally until initiation had taken place and, prior to cropping, trays were destructively assessed.

Initiation in peat cased trays was at a normal commercial level. Similarly treated RCC cased trays had a reduced level of initiation. This supports results from earlier cropping trials. However, where airing was carried out earlier than normal, initiation was similar in RCC when aired at day 4, and significantly greater than in peat when aired at day 2,($p>0.05$) (Figure 6.2).

Trials to test this observation and to grow crops to maturity under reduced time to airing are in progress at the time of reporting.

6.2 Pest and disease

Pasteurisation temperatures reached during re-composting imply that RCC is free of pests and disease organisms at the time of production. However, subsequent handling and storage may greatly influence the development and expression of problems if they are subsequently introduced to the material.

Occurrence of pathological problems was recorded for all cropping trials. In order to more clearly identify potential problems no pesticides were used during cropping.

The only pests identified during the course of cropping experiments were red pepper mite, Pygmephorus c.f. tarsalis. Typical food source for this species is thermophilic fungi, including Chaetomium spp. RCC/F in which this species was found had a relatively high proportion of straw residue, supporting the view that this particular batch was under-composted.

In those trays cased with RCC/A the major disease problem was Blotch, Pseudomonas tolaasii. However, incidence of blotch was typically greatest in those trays cased with peat. Although yield was greatest from such plots the true level of disease, when expressed as a proportion of yield showing symptoms, was higher than for RCC casing ($p = 0.01$) (Figures 6.3 - 6.5).

Other moulds were also recorded, but these, including Cephalosporium spp. tended to be end of crop problems. All RCC had a lower proportion of waste when compared to a normal peat mix.

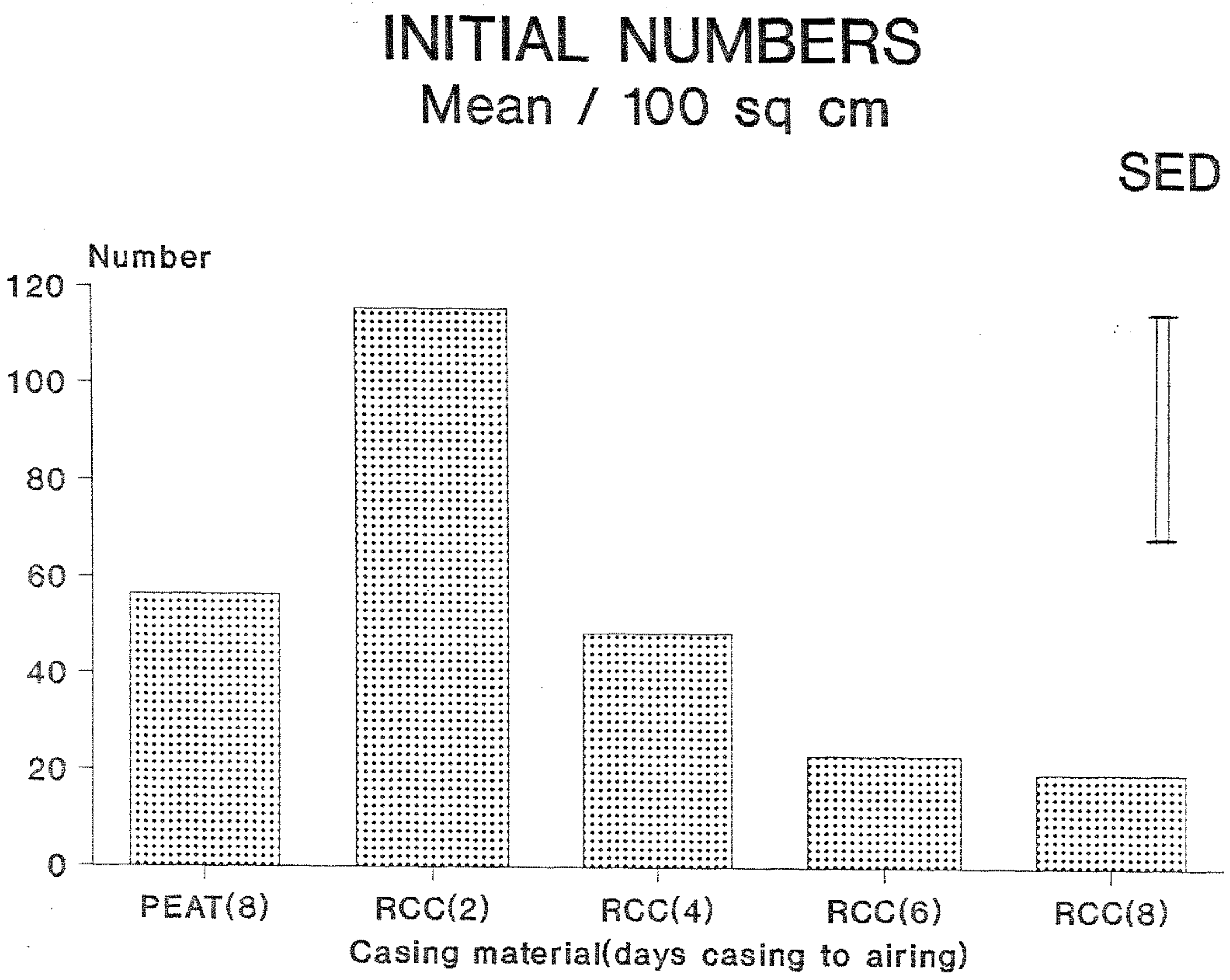

INITIAL NUMBERS
Mean / 100 sq cm
SED
Number
120
100
80
60
40
20
0
PEAT(8)
RCC(2)
RCC(4)
RCC(6)
RCC(8)
Casing material(days casing to airing)

Fig. 6.2

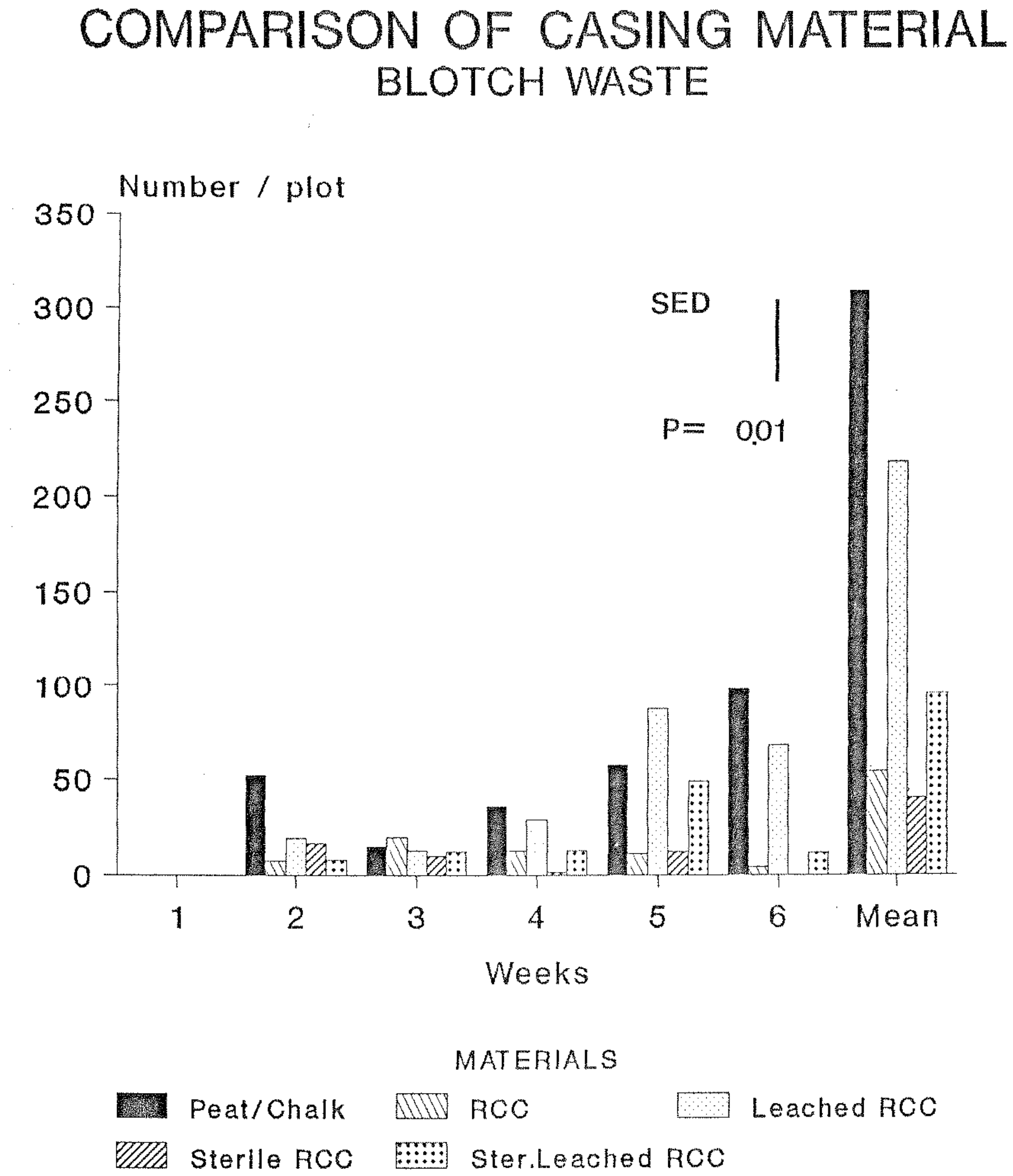

COMPARISON OF CASING MATERIAL
BLOTCH WASTE
Number / plot
350
300
250
200
150
100
50
0
SED
P= 0.01
1
2
3
4
5
6
Mean
Weeks
MATERIALS
Peat/Chalk
RCC
Leached RCC
Sterile RCC
Ster.Leached RCC

Fig. 6.3

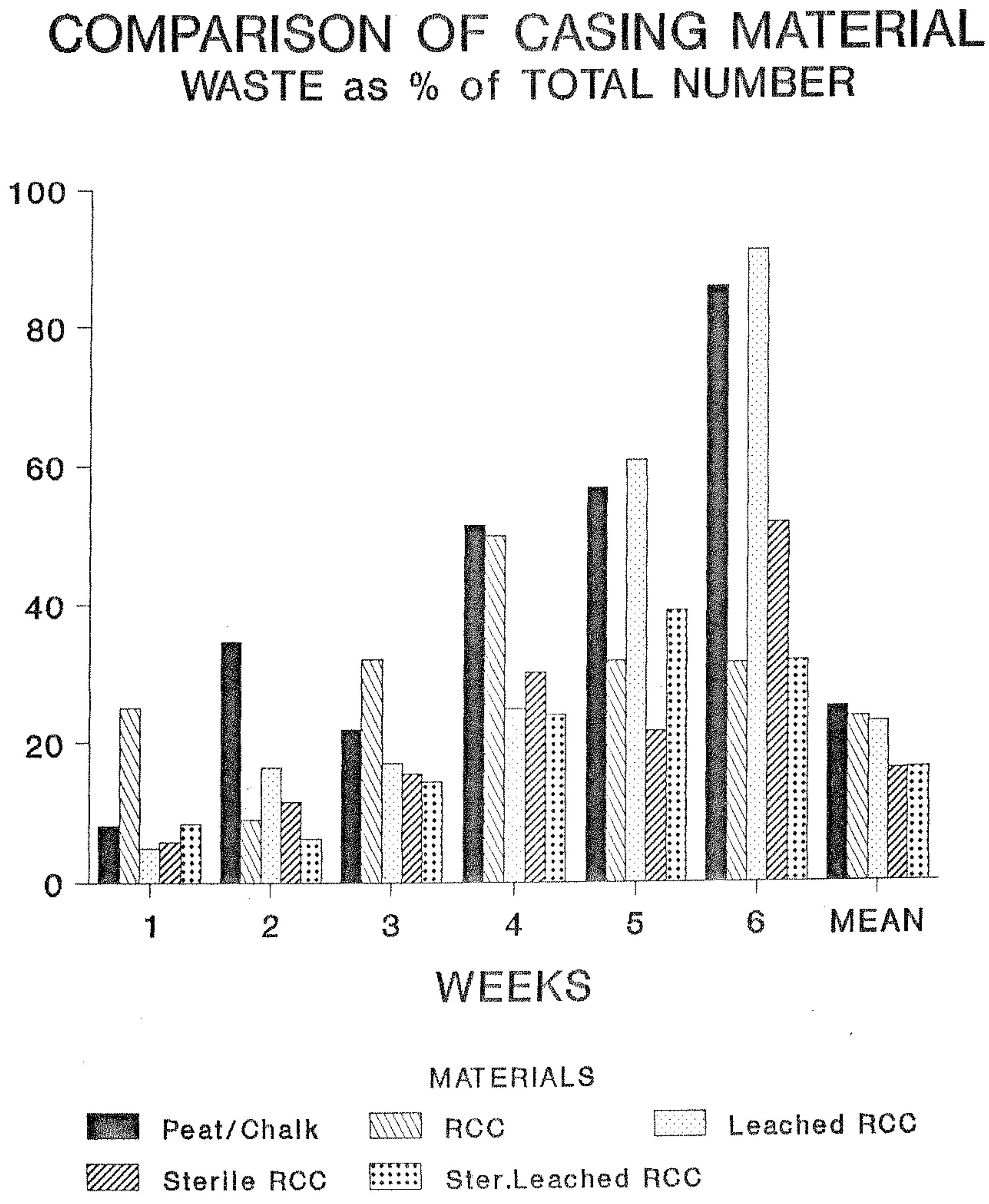

COMPARISON OF CASING MATERIAL
WASTE as % of TOTAL NUMBER
100
80
60
40
20
0
1
2
3
4
5
6
MEAN
WEEKS
MATERIALS
Peat/Chalk
RCC
Leached RCC
Sterile RCC
Ster.Leached RCC

Fig. 6.4

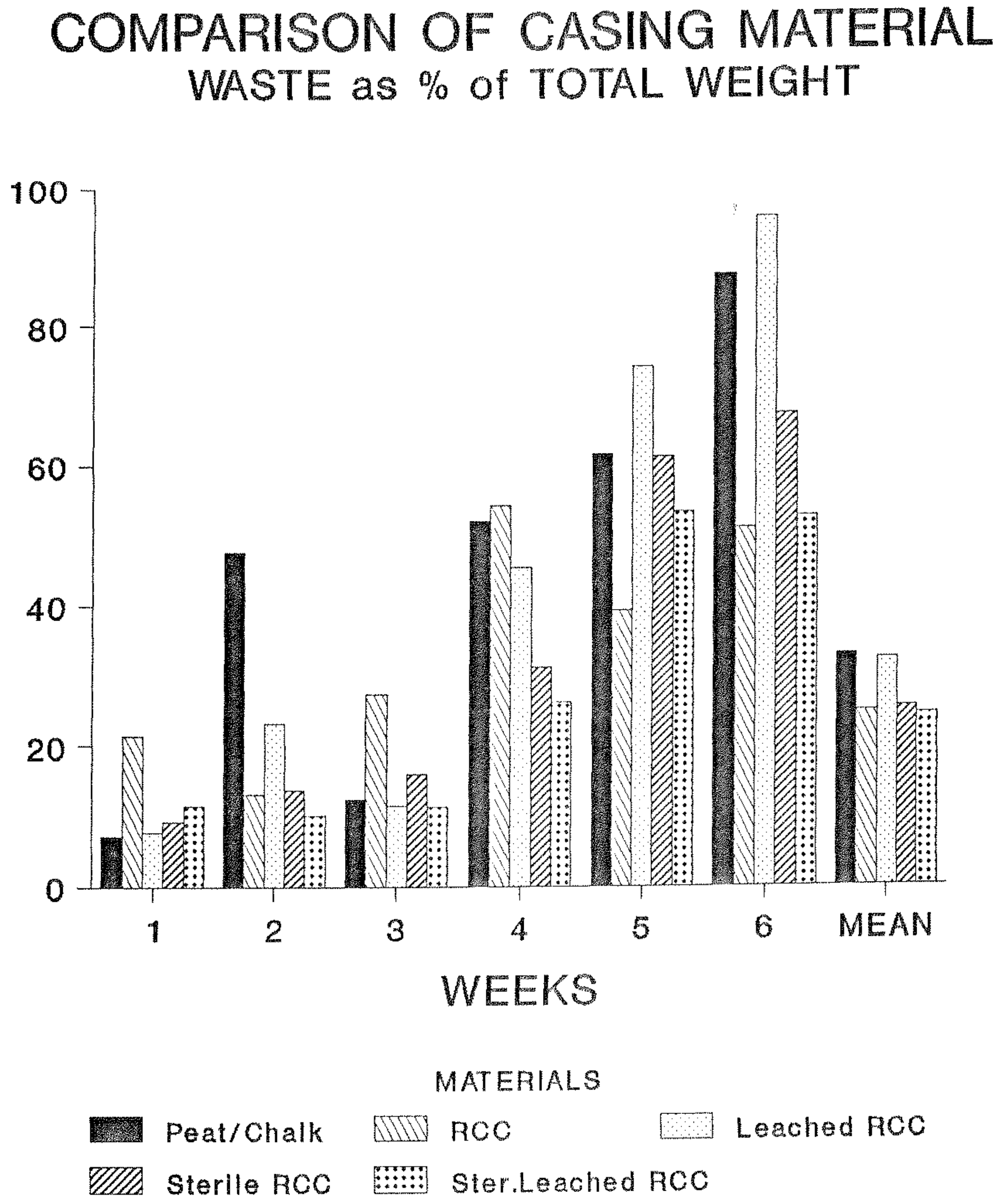

COMPARISON OF CASING MATERIAL
WASTE as % of TOTAL WEIGHT
100
80
60
40
20
0
1
2
3
4
5
6
MEAN
WEEKS
MATERIALS
Peat/Chalk
RCC
Leached RCC
Sterile RCC
Ster.Leached RCC

Fig. 6.5

Compost which had been re-composted for less than 5 weeks prior to use as RCC tended to have relatively high colonisation by weed moulds. Chaetomium spp. was noted and this supports the view that composting was not complete for such batches.

In the case of trials to determine the effect of reducing time to airing a significant difference in disease status was noted, ($p = 0.01$) Growth of weed moulds was greatest in peat casing when compared to trays cased with RCC (Figure 6.6).

With regard to fungi and bacteria, RCC batches have routinely been assessed for population establishment.

Populations of bacteria within RCC were broadly similar although treatment significantly ($p>0.05$) affected establishment (Table 6.2).

Table 6.2

Bacterial population ranges within casing. (counts/g.dr.wt)

Peat casing	$3.19 \times 10^7 - 6.13 \times 10^7$
RCC (pre-cropping)	$1.06 \times 10^6 - 6.66 \times 10^8$
RCC (croppped)	$6.05 \times 10^7 - 7.75 \times 10^8$
Leached RCC	$5.06 \times 10^6 - 1.97 \times 10^9$
Sterilised RCC	$8.86 \times 10^5 - 3.14 \times 10^8$
RCC - aired day 2	$3.26 \pm 0.95 \times 10^7$
RCC - aired day 4	$8.04 \pm 3.91 \times 10^7$
RCC - aired day 6	$6.12 \pm 2.73 \times 10^7$
RCC - aired day 8	$1.08 \pm 0.43 \times 10^8$

For RCC that had been composted for more than 5 weeks fungal populations were all less than 1×10^5. Where straw residue was significant, populations tended to be higher, at up to 1.69×10^7.

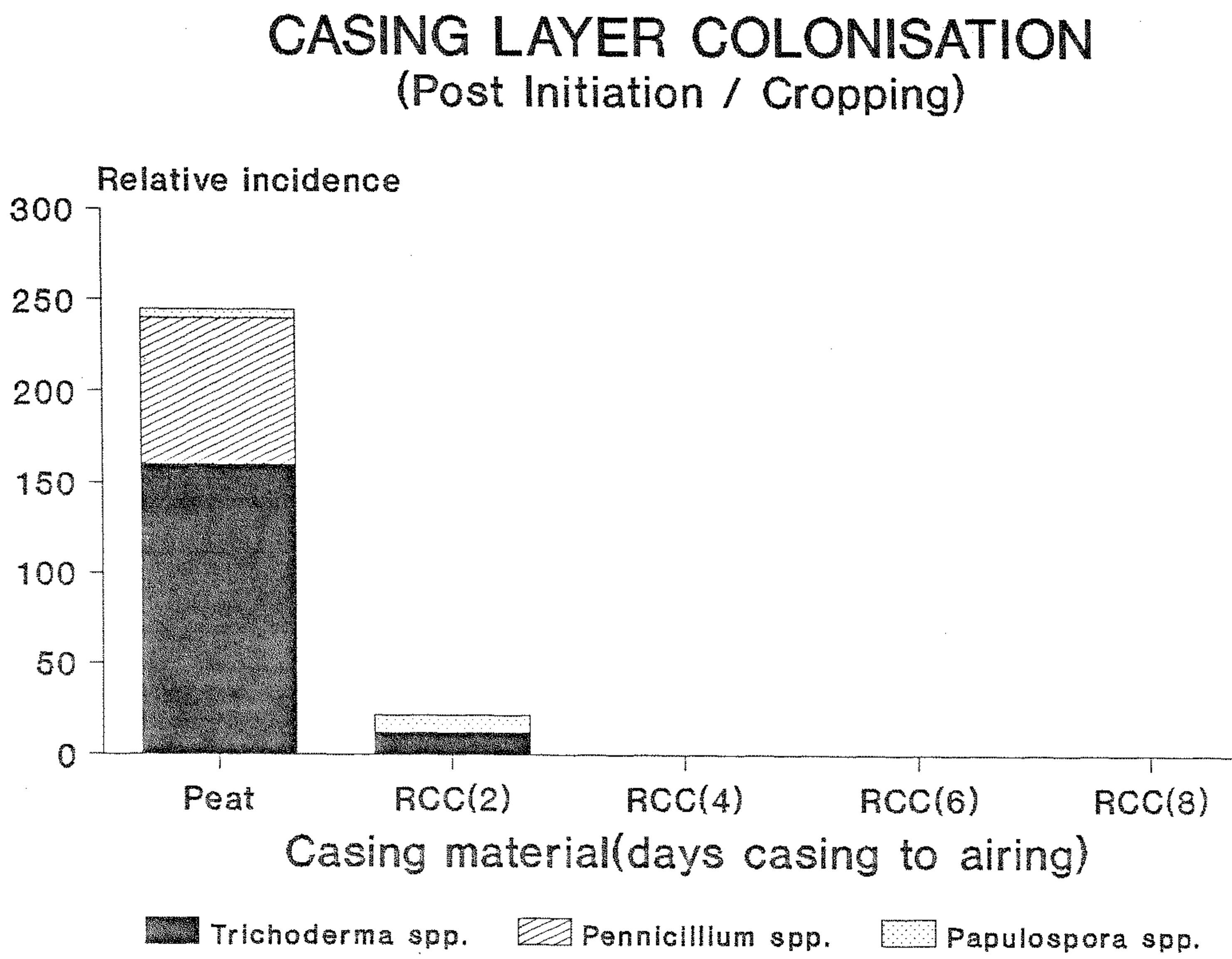

CASING LAYER COLONISATION
(Post Initiation / Cropping)
Relative incidence
300
250
200
150
100
50
0
Peat
RCC(2)
RCC(4)
RCC(6)
RCC(8)
Casing material(days casing to airing)
Trichoderma spp.
Pennicillium spp.
Papulospora spp.

Fig. 6.6

7. DISCUSSION AND FUTURE PROGRAMME.

The early phases of the project, reported here, indicate a good potential for production of friable material based on rapidly composted spent mushroom compost. When used as casing, yields have approached commercially acceptable levels, although further development work is required.

For early batches, termination of re-composting was too late, resulting in a high risk of anaerobic conditions when applied as casing. However, termination at 3-4 weeks resulted in too great a straw residue, which tended to encourage development of weed moulds. With the latter type of compost, water holding capacity was also insufficient.

RCC composted for 4-5 weeks, with little straw residue, had a water holding capacity in excess of 70%. In terms of appearance, porosity (AFP) and water holding capacity this material appeared highly suited to use as casing.

RCC may have a lower disease potential than comparable peat-based casing. This is likely to be dependent on satisfactory compost termination and the amount of straw residue. The reason for this is not clear, although it may be related to differences in bacterial populations between casing materials.

Assessment of microbial populations of RCC have indicated that such material may readily support a bacterial population of benefit to A.bisporus. Further modification of the composting process by microbial inoculation is likely to be most beneficial in this respect. **The next phase of compost development will include encouraging establishment of benign organisms towards compost termination.** This will primarily involve use of Pseudomonas spp. e.g. Ps. putida in conjunction with NCPPB, Harpenden.

Most of the cellulolytic fungi which may best accelerate compost degradation per se are themselves potential antagonists of A.bisporus. As such, populations existing in RCC after pasteurisation are likely to be harmful when used as casing. This does not hold true for material used as a plant substrate for which many cellulolytic fungi, e.g.Trichoderma spp. are well known as beneficial organisms.

Use of small-scale chambers for re-composting provides a model system for both composting in bulk and for future consideration of enclosed re-composting. However, re-composting, unless anaerobic, does not result in significant odour or effluent problems. As such, where composting for A.bisporus compost has been stopped because of odour problems, and transferred solely to controlled environments, facilities may be usefully employed for processing of SMC by the described techniques.

Growth of A.bisporus on RCC differs from patterns which normally occur in peat casing and this requires further investigation.

Changes in time to airing are a priority development and this work is being repeated at the time of reporting.

The inter- relationship between growth of A.bisporus and conductivity and casing physical properties of porosity / water holding capacity requires to be assessed for RCC.

The suitability of source material for re-composting requires further assessment. RCC derived from poultry manure - straw compost appears better than material based on horse manure-straw. This will be further considered over the duration of the project. Similarly, new compost formulations, such as controlled environment compost (HDC project M / 3) require consideration.

APPENDICES

I	Contract outline
II	Liaison and publicity
III	List of abbreviations

Appendix II

Liaison and publicity

The project is carried out at SAC Auchincruive under Mr. J. Rothwell as HDC Co-ordinator and Dr. R.A.K. Szmidt as Project Leader.

Comments have been welcomed from growers and those companies who have kindly supplied composts. In particular, thanks are due to Mr. M. Komatsu of Garnock Valley Mushrooms Ltd.

Information on the project was provided in a presentation to the U.K. Mushroom Growers Association annual conference, Glasgow: 13 September 1991.

A poster presentation of the subject has also been prepared and is available for meetings. This has been presented at the Institute of Horticulture conference - Biotechnology in Horticulture, Preston : 10 - 12 September 1991 and to the Scottish Mycology and Plant Pathology Group : 13 November 1991.

Interest in the project has been considerable, not least from the U.S.A., following the Glasgow meeting. Correspondence has been to Dr. Wuest at Pennsylvania State University where early work on naturally weathered material was done. They are aware of the HDC project remit but not of details of protocol or results.

Appendix III

List of abbreviations

AFP	Air-filled porosity
C	Degrees centigrade
Cp	Cocopeat
CO_2	Carbon dioxide
EC	Electrical conductivity
HDC	Horticultural Development Council
NCPPB	National collection of plant pathogenic bacteria
NH_3	Ammonia
Pe	Peat-based casing
%	Percentage
pH	Acidity level
ppm	Parts per million
RCC	Rapidly composted-casing
SMC	Spent mushroom compost
spp.	Species