The Forestry Authority
A part of the Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT
http://www.forestry.gov.uk

# Bracken as a Peat Alternative

INFORMATION NOTE

ISSUED BY FORESTRY PRACTICE FEBRUARY 1998

PREPARED BY RONA PITMAN[1] AND JOAN WEBBER[2] OF FOREST RESEARCH

## ABSTRACT

**Trials using bracken harvested mainly in the autumn from the New Forest have shown that this material can be successfully composted and used as a potting medium for hardy ornamental nursery stock. The high temperatures that are attained during composting break down ptaquiloside, the carcinogen that bracken contains, and the end result is a material with a high content of fine fibres. On its own bracken compost can be used for mulching, or in combination with peat it can provide a low pH mulch or potting medium, suitable for growing calcifuge plants.**

## INTRODUCTION

1. In the past bracken (*Pteridium aquilinum*) was gathered regularly in the autumn for animal bedding, fertilizer (in ashed form) and horticultural use. Generations of gardeners and nurserymen used bracken as a surface mulch to retain moisture and suppress weed growth; it was also incorporated into potting mixtures with other materials such as pine needles, hop waste and peat, making it particularly suitable for acid loving plants (Benzian, 1965; Rymer, 1976). However, with increasing labour costs and alternative products, bracken use declined and nowadays it is only used in horticulture if there is a local supply and a family tradition of use.

2. Partly as a consequence of the decline in these traditional uses, the area cover of bracken has increased at an estimated rate of 1-3% p.a. since 1950 (Taylor, 1986). Both the bracken ferns and the spores they produce contain the carcinogen, ptaquiloside (Hirono *et al.*, 1984), and it is well known that the green foliage is toxic to grazing animals (Evans and Mason, 1965; Fenwick, 1988). Recently, small scale efforts within south-east England have attempted to conserve and reclaim small areas of lowland heath against the encroachment of bracken (Rose, 1994; Timms, 1989). This has involved clearance by swiping, chemical spraying, chisel ploughing and cutting, often resulting in the production of 'waste' material. Cutting while green can be very effective at reducing ground cover and vigour, eventually leading to the eradication of bracken (Brown and Robinson, 1997).

3. However, although bracken control is best achieved by early cutting, this may not be appropriate in some conservation areas. In the New Forest, Hampshire, the Forestry Commission has a duty to control bracken in areas of grazing, but conservation restrictions delay the bracken cut until September or even later. At this time of year the plant is fully lignified and beginning to dry out and senesce. Within the New Forest, there are over 800 ha of bracken growing on low gradient sand and gravel terrain well suited to mechanised harvesting by tractor and forage harvester. During both 1992 and 1993 about 65 ha were cut yielding over 1500 $m^3$ of material, with a fresh weight of approx. 4 tonnes per hectare.

4. The cut bracken is usually left in large dumps or heaps which, more by accident than design, encourages composting and gradual breakdown through the action of heat tolerant micro-organisms. Preliminary trials with some of the material from one of these 'waste dumps' suggested it could be a good container mix for growing some perennial plant species. To explore the potential of using bracken from the New Forest as a horticultural medium, both for mulching and potting, a series of trials were set up to assess the most effective way of composting bracken. The presence of the carcinogen, ptaquiloside, both before and after composting was also assessed in a limited number of samples. Finally, the performance of the composted material was tested by Horticulture Research International, Efford, as a partial or complete substitute for peat in a range of container grown nursery stock.

[1] Forestry Consultant
[2] Forest Research, Alice Holt Lodge, Farnham, Surrey

## COMPOSTING BRACKEN

5. The objectives of composting bracken are threefold:

   - to break down the physical structure of the material;
   - to produce a consistent material, with stable physical and chemical properties;
   - to produce a safe product for handling.

   Composting increases the proportion of 'fines' (particles less than 6 mm in length) so giving better water holding capacity. Shorter fibres also make handling easier when potting or mixing with other media. The initial sizes of fibres in the cut bracken depends on the method and time of harvesting. Double chopping rather than single chopping with a forage (silage) harvester produces more finely divided material, while green bracken composts to give a larger proportion of 'fines' compared with older September cut bracken (see Table 1).

6. During 1992 and 1993, autumn cuts of New Forest bracken were made in September - October; in both those years the bracken failed to spore so harvesting was straightforward. A small summer cut of green bracken taken in July was also added into the trial for comparison. All the material was composted using methods originally described for wood chips (Webber and Gee, 1996). To ensure active decomposition, water was added to the bracken to give a minimum moisture content of 70% (fresh weight) - this was tested gravimetrically as the material came on site. Heaps of bracken 1.5-2 m high were then loaded into storage bays, 10 m long, which held up to 40 $m^3$ and allowed easy access for turning by tractors.

7. Regular turning prevented compaction and encouraged decomposition by aerobic sugar fungi (Frankland, 1966). It also prevented the composting heaps from overheating, maintaining temperatures of 55-60°C or slightly hotter (see Figure 1). Raising the temperature in this way had the advantage not only of promoting the rapid breakdown of long fibres but also eliminated the carcinogen, ptaquiloside (Table 1). No noticeable improvement in the rate of decomposition was achieved with the addition of nitrogenous compounds such as urea, ammonium nitrate or ammonium sulphate although higher temperatures were achieved during composting with this addition of N. Macronutrients, including P, K, Cl and Na, were lost through leachate drainage declining to about half their initial concentration after three months of composting, although large amounts of water soluble K still remained at the end of nine months composting (Pitman, 1995).

8. As composting progressed, the pH of the unfertilized bracken increased from acid (pH 5.5-5.8) to neutral (pH 6.5-7.0). This gradual increase in pH did not occur if fertilizers such ammonium sulphate were added prior to composting. Moreover, if untreated heaps of bracken were left for long periods (two years or more) there was also some degree of reacidification. The heaps became naturally thatched as rainwater carried finer particles inside leaving behind the long fibres. Conditions within these insulated heaps, when aerobic activity had ceased encouraged slow re-acidification. After 15-18 months the pH had often returned to around 5.5 or less. The end result was a neutral-acid potting medium with a high proportion of 'fines'.

**Table 1 Changes in bracken during composting**

| | Ptaquiloside & analogues | % 'fines' of various lengths <6 mm | 6-12 mm |
|---|---|---|---|
| **Summer cut bracken** | | | |
| Freshly cut (5/7/93) (West Heath) | present | 45.5 | 25.4 |
| Composted for 3 weeks | none | - | - |
| Composted for 16 weeks | none | 56.9 | 32.4 |
| **Autumn cut bracken[a]** | | | |
| Freshly cut (27/9/93) (New Forest) | trace | 23.4 | 28.6 |
| Composted for 12 weeks | none | 40.9 | 30.0 |
| Composted for 45 weeks | none | 45.6 | 28.0 |
| **Dead bracken (8/11/93) (West Heath)** | none | - | - |

[a] Non-sporing bracken

## GROWING TRIALS

9. A sample of composted bracken, with low pH (4.8-5.0) and a high proportion of fines (>45%), was used in a series of pot trials which compared the growth of a range of hardy ornamentals. The aim of the trial (1993-94) was to assess the potential of composted bracken as a partial or complete replacement for peat in routine nursery stock production.

10. A number of varieties were grown on from rooted cuttings in 2 litre pots, using peat and composted bracken mixed together in different proportions with the addition of slow release fertilizer (Osmocote 12-14 month, spring: 15 - 9 - 11). The main plant varieties that were tested were: *Azalea* 'Rosebud', *Chamaecyparis pisifera* 'Boulevard', *Erica carnea* 'Ann Sparks', *Viburnum x burkwoodii* and *Weigela* 'Bristol Ruby'. However, within the design of the replicated experiment, blocks of the primary species were enclosed by guard plants of *Calluna vulgaris* 'Firefly', *Elaeagnus x ebbingei*, *Chamaecyparis lawsoniana* 'Ellwood's Gold', *Cotoneaster* 'Cornubia' and *Hypericum* 'Hidcote' which had also been planted in peat:bracken mixtures, so the composts were tested over a wide variety of species. The pots were maintained on outdoor sandbeds with a regular daily overhead watering regime. The size, colour and root growth of the test plants were assessed twice over an entire year of growth.

11. Overall, plants growing in a 50:50% mix of peat and bracken had good growth and showed no deterioration in foliage colour; results for the main plant varieties are shown in Figure 2. Statistical analysis (ANOVA) indicated that growth of *Viburnum* was even significantly improved in the 50:50 peat/bracken mix compared with growth in peat alone. Mixes with 75% or more bracken, produced good specimens of *Azalea* and *Viburnum*, but all the other species had significantly poorer growth compared with the 100% peat control. This applied both to the main species and the guard plants.

12. The 'open' nature of the bracken compost was effective in reducing the incidence of liverwort on the surface of the pots, but the water retention even of finely chopped bracken was always about 20-25% less than comparable samples of peat. This reduced water retention probably accounted for the poorer growth of the experimental plants growing in compost of 75% or 100% bracken. It is likely, therefore, that irrigation methods would have to be adjusted from the typical techniques applied to peat if 'bracken only' compost was used with a wide range of plants. Recently, however, specialised nurseries within Hampshire have successfully used mixes of composted bracken for growing a variety of acid loving plants including *Acer*, *Azalea*, *Camellia*, *Rhododendron* and *Erica* species.

## CONCLUSIONS

13. Bracken can be successfully composted to produce a mulching or growing material, using either summer cut or autumn cut material, although the less lignified summer cut material composts much more quickly taking only about 4-5 months. Freshly cut heaps should be turned frequently to encourage the aerobic microbial activity which is required for composting and consequently the breakdown of ptaquiloside.

14. It is not necessary to add fertilizer to achieve successful composting, but a low pH material can be produced more quickly this way. The material is then probably best used mixed with peat (or other composts such as loam or coir) to enhance its water holding capacity when used as a growing medium. It is suitable without any further treatment for use as a mulch.

15. To ensure that any carcinogens within the bracken have had time to break down, the material should only be used in the year following harvest, after composting. Properly composted bracken was found to be completely free of ptaquiloside and its analogues (Potter and Pitman, 1995). However, physical contact with bracken during harvesting, heaping and turning should be minimised, particularly in late August if spores have developed on the fronds.

16. Cutting and harvesting bracken in July or early August can be an effective control measure, because it reduces the vigour and spreading ability of the plant (Brown and Robinson, 1997) and could be a useful alternative to the use of the herbicide Asulam. Cutting bracken from late August onwards is less effective as a control measure because starch is then being translocated into the storage rhizome underground (Williams and Foley, 1976).

17. Harvesting bracken as a long term resource for composting can be achieved from one area under a rotational regime of biennial cutting allowing the plant to recover biomass in the rest year (Callaghan *et al.*, 1984; Lowday and Marrs, 1992).

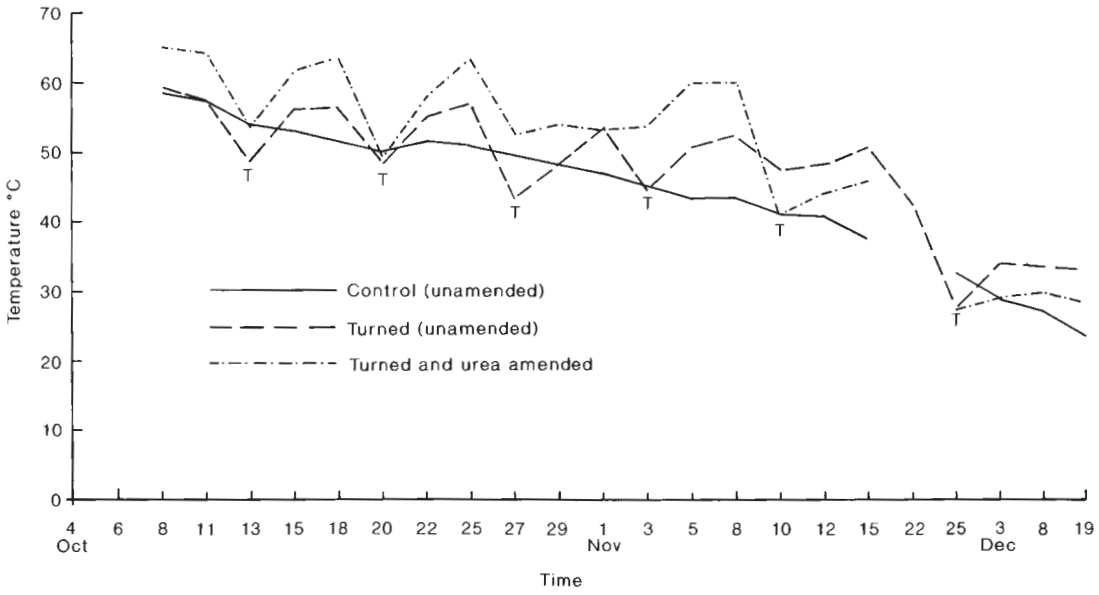


**Figure 1**

Temperature changes in piles of double-chopped bracken from the New Forest immediately after harvesting and over the following three months (1993). Replicated piles of bracken were given the following treatments: control, left undisturbed with no fertilizer; regularly turned (at time T) but no other treatment; regularly turned and urea added at the beginning of the composting period. Substitution of urea by ammonium sulphate and ammonium nitrate produced the same temperature profile.

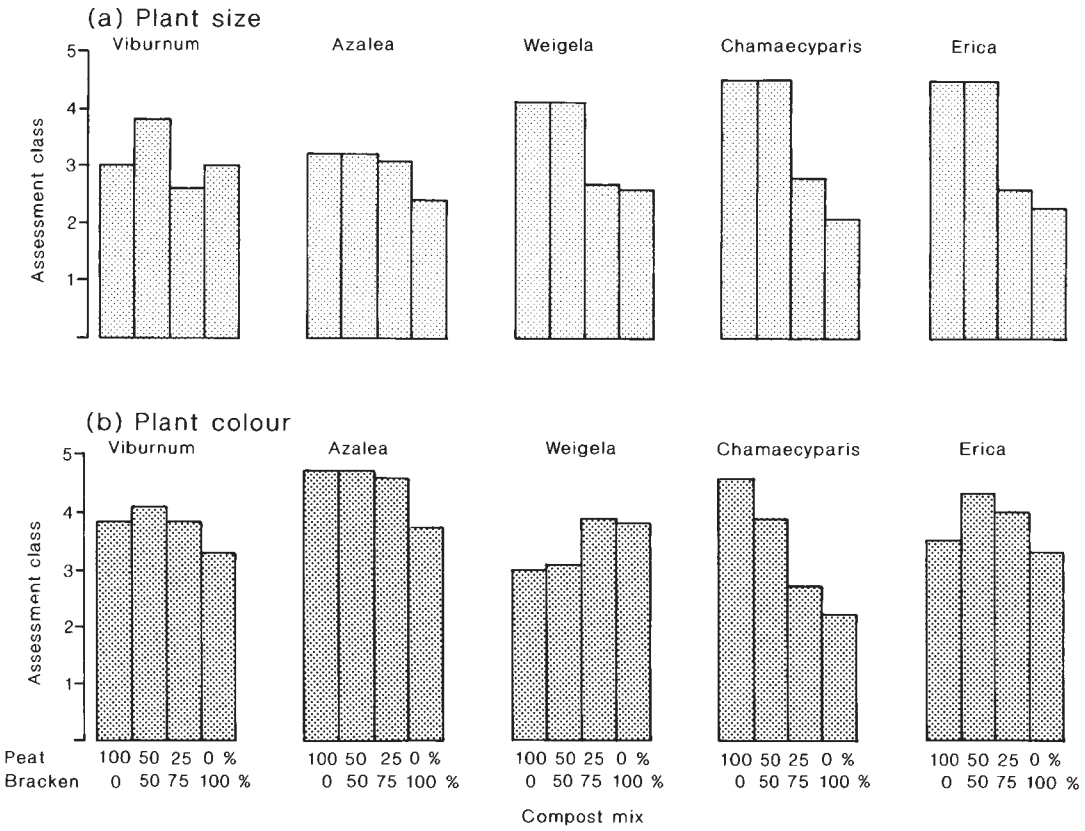


**Figure 2**

Comparative growth of a range of nursery stock species planted in 100% peat, 100% bracken and two peat:bracken mixes after 10 months. Plant size (a) and colour (b) were assessed on a 1-5 score, a score of 1 indicating poor growth or foliage colour while 5 indicated strong growth and excellent colour.

## REFERENCES


**BENZIAN, B. (1965).**
*Experiments on nutrition problems in forest nurseries*.
Forestry Commission Bulletin 37. HMSO, London.

**BROWN, R. and ROBINSON, R. (1997).**
*Bracken management handbook: a guide to best practice*.
Rhone- Poulenc, Ongar, Essex.

**CALLAGHAN, T. V., SCOTT, R., LAWSON, J. and MAINWARING, A. (1984).**
*An experimental assessment of native and naturalised species of plants as renewable sources of energy in Great Britain: Bracken - Pteridium aquilinum*.
Project 674. ITE Merlewood, Cumbria.

**EVANS, I. A. and MASON, J. (1965).**
Carcinogenic activity of bracken. *Nature* **26**, 913-919.

**FENWICK, G. R. (1988).**
Bracken (*Pteridium aquilinum*) toxic effects and toxic constituents.
*Journal of the Science of Food Agriculture* **46**, 147-175.

**FRANKLAND, J. (1966).**
Succession of fungi on decaying petioles of *Pteridium aquilinum*.
*Journal of Ecology* **54**, 41-63.

**HIRONO, I., YAMADA, K, NINA, N., SHIZURI, M., OJIKA, M., HASAKA, S., JAMAJI, T., WAKAMATSU, K., KIGASHI, H., NUYAMA, K. and UOSAKI, Y. (1984).**
Separation of carcinogenic fraction of bracken fern.
*Cancer Letters* **21**, 239-246.

**LOWDAY, J. E. and MARRS, R. H. (1992).**
Control of bracken and the restoration of heathlands. 1. Control of bracken.
*Journal of Applied Ecology* **29**, 195-203.

**PITMAN, R.M. (1995).**
Bracken compost: a substitute for peat? *In*: R.T. Smith and J. Taylor eds, *Bracken: an environmental issue*.
The University, Leeds, pp. 191-196.

**POTTER, D.M. and PITMAN, R.M. (1995).**
The extraction and characterisation of carcinogens from bracken and the effect of composting. *In*: R.T. Smith and J. Taylor eds, *Bracken: an environmental issue*.
The University, Leeds, pp. 110-115.

**ROSE, F. (1994).**
Report on the remaining heathlands of W. Sussex 1991-92. *In: West Sussex heathland forum*.
West Sussex County Council, Chichester. 54pp.

**RYMER, L. (1976).**
The history and ethnobotany of bracken.
*Botanic Journal of the Linnean Society* **73**, 151-176.

**TAYLOR, J. (1986).**
The bracken problem: a local hazard and global issue.
*In*: A. J. Thompson and R.T. Smith, eds. *Bracken biology and management*. Australian Institute of Agricultural Science Occasional Publication 40, pp. 241-246.

**TIMMS, M. (1989).**
*The future of Hampshire's heathland*. Winchester Planning Department Publication: Wheaton Press, Exeter.

**WEBBER, J.F. and GEE, C. (1996).**
*Compost from woody wastes*.
Arboricultural Practice Note 2. Arboricultural Advisory and Information Service, Farnham.

**WILLIAMS, G.H. and FOLEY, A. (1976).**
Seasonal variations in the carbohydrate content of bracken.
*Botanical Journal of the Linnean Society* **73**, 87-93.


## ACKNOWLEDGEMENTS


We thank the Forest Management team at The New Forest Office, Forest Enterprise, Lyndhurst, for their assistance in this work and particularly Harry Oram and Dave Morris. Financial Support from the Hampshire County Council Heathlands Project and from the West Sussex Downlands Committee is gratefully acknowledged. Our thanks also to John Williams for drawing the figures and Richard Jinks for helpful comment on the text.

Enquiries relating to this publication should be addressed to:

Dr Joan Webber
Forestry Research
Alice Holt Lodge
Wrecclesham
Farnham
Surrey
GU10 4LH

Tel: 01420 22255
Fax: 01420 23653

E-mail: j.webber@forestry.gov.uk

ISSN 1460 - 3802
ISBN 0 - 85538 - 367 - 4





FPD9/30-H(ECD)-NVSP7/1.5K-JAN98