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# Arboriculture Research Note 44

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**THE EFFECTS OF TREE SPECIES ON VEGETATION AND NUTRIENT SUPPLY IN LOWLAND BRITAIN, by M.A. Anderson**

**Summary**

Forests modify soils and vegetation as they grow but at the end of an average woodland rotation in the lowlands there is generally less difference in the soil properties and plant communities under different tree species that there is at a point mid-way through. Little adverse cumulative effect of individual tree species on soil nutrient supply has yet been observed. By the end of a rotation plantations of most exotic trees tend to develop plant communities generally similar to those in oak plantations.

## Introduction

1. In Britain exotic tree crops, especially conifers have a reputation for impoverishing soils and degrading herbaceous vegetation. This view developed early in this century largely from theoretical predictions and casual observations. Only now is a body of systematic data beginning to emerge, which can substantiate or challenge these claims. Research on this subject is necessarily long-term and ideally undertaken on second or subsequent rotation sites. Britain has only a few forests, which are carrying such crops and we cannot yet generalize, but some pointers are beginning to emerge. The following should therefore be regarded as tentative; the current ideas will almost certainly be modified and new ones emerge as plantations mature and subsequent rotations become established. It should be emphasised that the observations made refer to lowland site conditions, i.e. below about 300m and away from the maritime west. In due course comparable observations will be available for upland regions of Britain.

## Features of Soil Development

2. Acidification
   Afforestation with both conifers and broadleaves is accompanied by acidification of the surface soil. Under conifers the pH of the surface mineral soil may be depressed by as much as one unit in the 25 years following planting. The same temporary change under broadleaves generally takes 40-60 years, although alders (*Alnus* spp) tend to depress the pH by at least one unit more, often within 20 years from planting.

3. Leaching
   Long-term leaching and re-deposition of mineral salts at depth take place under both conifers and broadleaves. There is no evidence yet in Britain of widespread nutrient deficiencies resulting from this. Very intensive leaching and podzolization is essentially a phenomenon occurring under heath land vegetation [particularly heather (*Calluna* spp)], the processes being less active under trees due to interception, which can be up to 40%, and transpiration; it is also less rapid on fine-textured soils. Plantation forests can therefore be expected to reduce surface nutrient losses, which would previously have occurred on non-woodland sites.

4. Surface accumulation
   Afforestation is nearly always followed by rapid litter accumulation. Where there was previously little litter, e.g. on agricultural land, this build up, as a first approximation, may be regarded as a bank of nutrients locked out of their natural cycles. On poor soils the result might be nutrient deficiencies. However, there is little evidence that litter build-up causes widespread nutrient deficiencies or that it persists late into the rotation.

5. Temporary problems of nutrient supply
   Soil pH, nitrogen, phosphorus and calcium tend to reach either maxima or minima at some point during tree rotation and then revert to a value close to the initial one; there is little cumulative effect for the rotation as a whole. Recent evidence suggests that the major nutrients tend to peak and trough at different times; the timing varies with tree species and site conditions, but no consistent patterns have yet emerged. Potassium responds rather differently from the other major nutrients, progressively accumulating at the bottom of the rooting zone under some productive deep rooters, [e.g Corsican pine (*Pinus nigra*)]. Sweet chestnut (*Castanea sativa*) and larch (*Larix* spp) growing on acid or very well-drained soils, tend to form very thick litter accumulations early in the rotation, while Grand fir (*Abies grandis*) and Douglas fir (*Pseudotsuga menziesii*) growing on good-quality brown earths accumulate very little litter, keeping an efficient cycle going.

6. Taken together, these features result in a general pattern of small nett changes in soil properties developing after a whole rotation, with marked peaks or troughs in nutrient supply occurring part-way through. Past indications of the influence of trees on soil nutrients may have picked up these marked temporary changes but not given emphasis to the longer-term effect.

**Features of Plant Community Development**

7. Initial changes

   Fencing initially benefits heather and soft grasses, such as Yorkshire fog (*Holcus lanatus*), taller grasses and shrubs taking over later. From canopy closure to first or second thinning, herbaceous vegetation is largely excluded by shade. However, a bank of seed persists in the soil, particularly of ephemeral species such as foxglove (*Digitalis purpurea*); the larger seeds of trees and shrubs, however, do not persist. Scots (*Pinus sylvestris*) and Corsican pines rarely close canopy completely and under their cover remnant flora of ferns, brambles and plants with perennial underground organs usually survive in patches.

8. Thinning

   Following thinning, more light reaches the woodland floor and plant communities re-develop, initially in patches between trees. With normal management 15-20 acid oak-wood species generally appear after 50 years under most trees on lowland sites.

Plant Speices Found Under Most Lowland Tree Crops
50 years from Planting

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| Bracken | *Pteridium aquilinum* |
| Brambles | *Rubus fruticosus* ag. |
| Broad buckler fern | *Dryopteris dilatata* |
| Soft rush | *Juncus effusus* |
| Tufted hair-grass | *Deschampsia caespitosa* |
| Honeysuckle | *Lonicera periclymenum* |
| Field woodrush | *Luzula capestris* |
| Common bent | *Agrostis tenuis* |
| Oak saplings | *Quercus* spp. |

| | |
|---|---|
| Rowan | *Sorbus aucuparia* |
| Birch | *Betula* spp. |
| Willow-herb | *Chamaenerion* & *Epilobium* spp. |
| Wood sage | *Teucrium scorodonia* |
| Holly | *Ilex aquifolium* |
| Male fern | *Dryopteris filix-mas* |

9. Influence of litter

   Once a plant community has begun to develop following thinning, litter form exerts a strong influence on plant communities. Loosely packed litter, e.g. under Scots and Corsican pines and Sweet chestnut, encourages large populations of plant species with rhizomes or stolons such as bracken and bramble, which can penetrate the litter mat without risk of desiccation. The smaller herbs such as Wood sorrel (*Oxalis acetosella*) and Wood anemone (*Anemone nemorosa*) with roots more liable to desiccation are more abundant under spruce (*Picea* spp), larch and small leaved deciduous trees. The abundance of less-common plants depends largely on the length of the continuous woodland history of the site. There is evidence that less common species, e.g. Yellow archangel (*Galeobdolon luteum*), take centuries to reinvade in any significant quantity.

10. Browsing in older plantations

    By the time plantations are open to larger mammals browsing can strongly influence the type of plant community, which develops. Corsican pine plantations tend to develop either a bramble-rich or a bracken-rich type of vegetation, reflecting the local abundance of deer; roe, in particular, can virtually exclude bramble.

11. Minor species

    The "oak-wood" flora of about 20 species, noted in para 8, persists under a wide range of tree species until the tree cover is removed or degenerates naturally. The entry of other, rarer plants is strongly controlled by the depth of packed litter and by the bank of soil-seed or other perennating organs. Beyond one rotation trends cannot yet be predicted but will almost certainly depend on the abundance and longevity of reproductive material in the soil since few plan species can rapidly invade new woodland. It is now understood that some plant species, e.g. foxglove and heather, can persist for several decades as viable seed in the soil, germination in large quantities after clear-felling.

12. In the future it is likely that the abundance of small herbs may be encouraged by artificially reducing litter depth and that particular species will eventually begin to associate with particular crops (as the orchid *Goodyera repens* has done with Corsican pine in East England).

**General conclusion**

13. Both soil nutrient supply and plant communities vary most under different tree species 20-25 years after planting at about the first thinning stage. Thereafter, major nutrient concentrations and plant communities become progressively more similar under a variety of tree species. Potash may be an exception to this rule in accumulating under deep-rooted trees. The control of the timing of temporary peaks and troughs of nutrient supply under different species is not yet understood. In the long-term, the list of plant species, beyond a common invasive set of about 15, will depend largely on the soil bank of seeds and other perennating organs, the length of woodland history and the packing of litter.

**Reference**

Anderson, M.A. (1979). The development of plant habitat under exotic crops. In *Ecology and Design in Amenity Land Management*. Editors: Wright, S.E. and Buckley, G.P., Wye College, Kent.

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