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NUTRITION OF BROADLEAVED AMENITY TREES
I. FOLIAR SAMPLING AND ANALYSIS FOR DETERMINING NUTRIENT STATUS

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Summary

Most soils supply enough nutrients for healthy growth, provided weeds are controlled, but good responses to nitrogen are found from the second year onwards, with responses to phosphorus and potassium less common. A deficiency must be correctly identified before the right nutrient can be supplied and, for trees, leaf analysis is more informative than soil analysis. Mature leaves from the outside of the crown should be sampled in late July and August. Both the concentrations of the major nutrients and the balance between them are important in diagnosing deficiencies.

Introduction

1. Broadleaved trees are planted on a wide variety of sites and, in the absence of any clear indicators, arboriculturists tent to apply fertilisers as and insurance. Such fertilisers may be wasted or, more seriously, may damage newly planted trees if carelessly applied. This note sets out guidelines on determining the nutrient status and needs of broadleaved trees by analysing their leaves. Use of fertilisers is covered by Patch *et al*. (1984).

Likelihood of nutrient deficiencies

2. Most soils in which amenity trees are planted supply sufficient nutrients for healthy growth. Some sites, however, especially those disturbed during building and landscaping, lack topsoil or else the topsoil has been degraded through poor storage and handling and has lost its nitrogen. Thus on disturbed sites nitrogen is the element most likely to be deficient.

3. Phosphorus deficiency is only likely on the least fertile soils, such as freely drained sands and peats, or some restored mineral workings.

4. Potassium deficiency is uncommon in amenity trees except on leached sands, peats and on soils over chalk or limestone.

5. Balance between these three nutrients is as important as the level of supply and of uptake.

6. Magnesium deficiency is very uncommon. It is however, sometimes found in young trees growing on soils where the structure has been lost due to water-logging. It usually cures itself as the tree roots dry the soil and improve the structure; addition of magnesium fertiliser will have no effect.

7. Deficiencies of micronutrients (trace elements) are unlikely, but iron and manganese may become deficient on soils over chalk or limestone if disturbance has made them alkaline to the surface, especially if the site is nitrogen-rich; free lime at the surface is easily detected with dilute hydrochloric acid, which produces effervescence.

8. Copper deficiency has only been seen in trees growing on impoverished heathlands, where added major nutrients produce vigorous growth, an on some acid peats.

Deficiency symptoms

9. The descriptions below refer to fully developed leaves, exposed to sunlight, before autumn colours have developed (see Wallace, 1956).

10. Nitrogen deficient trees are yellow over the whole crown. Leaf size is reduced. There is seldom any zonation of the discoloration, e.g. between leaf veins.

11. Phosphorus deficiency produces stunted, dull leaves. In severe deficiency purple or red tints may appear, particularly at leaf margins.

12. Potassium deficient leaves are yellowish, sometimes between the veins, with <u>marginal</u> scorch in severe cases; bluish or purplish tints may appear. Protected leaves inside the crown may be less affected that exposed leaves.

13. Magnesium deficiency shows as a slight yellowing of the leaves, with marked yellowing and dead patches <u>between</u> the veins in severe cases.

Sampling Techniques

14. Only fully expanded undamaged leaves from the outside of the crown, exposed to full light, should be sampled, from late July to the end of August, when concentrations of the nutrients are steady. Leaves soiled by birds must be avoided but dust has little effect on the concentrations of major nutrients, so dusty leaves are usually acceptable.

15. Nutrient concentrations vary less with aspect and height than between healthy and deficient trees; in contrast, nutrient, concentrations in basal suckers and pollard shoots may be high and misleading. Leaves should therefore be collected from a convenient position on the outside of the true crown.

16. About <u>600 cm^2</u> of leaves (<u>enough to cover an A4 sheet of paper</u>), but excluding the petioles, should be collected from large or well-established trees. Recently planted trees rarely have enough foliage for this size of sample, so a composite sample from 5-10 trees of each species should be taken.

17. There is little point in sampling trees until at least two growing seasons after planting since before then they will not be in equilibrium with the site and nutrient concentrations may still reflect the nursery nutrient regimes.

18. If there is sufficient variation in vigour and <u>current</u> shoot growth to distinguish good and poor trees, separate samples should be made up from each category. If many trees are involved, replicate samples from each category will aid interpretation. Markedly different vegetation types should be sampled separately.

19. Leaf samples, fully labelled, should be packed in polythene and despatched as soon as possible to an analytical laboratory. If delay in despatch is likely the packed samples should be stored in a cool place.

Analysis

20. Standard analysis, which can be done by any laboratory handling plant material, determines the concentrations of nitrogen, phosphorus, potassium and magnesium, as elements, expressed as a percentage of the oven-dry weight of leaves.

21. There is extraordinarily little date derived from fertiliser trials and associated with observed responses to particular nutrients. However, analysis of nearly 4,000 samples of a wide range of broadleaves from a number of sites between 1975 and 1982 has shown some consistent differences between genera. Table 1, derived form these analyses, shows the concentrations found to be associated with healthy growth and, more tentatively, concentrations below which trees might be regarded as deficient in particular nutrients.

Table 1.

Tentative indicator concentrations of foliar nutrients, as % OD weight, for 15 species and genera of broadleaved trees.

Nutrient	Tree species	Probably adequate if more than:	Possibly deficient if less than:
Nitrogen	Alder [1], Birch, Lime [2], Robinia, Walnut ,Willow [3]	2.8	2.5
	Ash, Beech, Norway maple, Oak, Sweet chestnut	2.3	2.0
	Apple [4], Hawthorn [5], Sorbus [6], London plane	2.0	1.7
Phosphorus	Ash, Birch, Lime, Robinia, Norway maple, Walnut, Willow	0.22	0.19
	Alder, Hawthorn, Sorbus	0.18	0.16
	Apple, Beech, London plane, Oak, Sweet chestnut	0.16	0.14
Potassium	Robinia, Walnut, Willow	1.2	1.0
	Other species (as above)	0.9	0.7

[1]. *A. glutinosa*. [2]. Mainly *T. x europaea, T. platyphyllos* and *T. cordata*. [3]. *S. alba* and *S. caprea*. [4]. Ten ornamental varieties. [5]. *C. monogyna, oxycantha,* and *C. prunifolia*. [6]. Mainly *S. aucuparia* and *S. aria*.

22. The values in Table 1 do not take account of age (or size) of trees. Miller *et al*. (1981) have provided convincing evidence of a marked fall in the optimum nitrogen concentration in the needles of Corsican pine with increasing tree size and it is likely that this principle holds true for

all trees. Thus one would expect a 1m sapling in good health to have higher concentrations of major nutrients than a 20m tall tree of the same species.

23. Concentrations can also vary considerably between individual trees on one site. Taking these two uncertainties into consideration it becomes essential to look at the balance between the major nutrients as well. Work on conifers has established general ratios between the three most important nutrients and the analyses referred to above have largely confirmed this. Table 2 shows idealised concentrations of major nutrients and the ratios between them. Large departures of these ratios, e.g. a doubling or halving, may be taken as indicating imbalance and therefore a probable deficiency of the nutrient with the reduced ratio.

Table 2.

Examples of a Nutirent Balance

	N	P	K
"Demanding " species %	2.4	0.24	1.2
"Undemanding" species%	1.8		
Ratios	10:	1:	5

Interpretation

24. Deficiency or imbalance as shown by foliar analysis can be corrected with an appropriate fertliliser. If, however, analysis reveals a serious deficiency of two or more nutrients, the cause may lie in the failure of the root system following water logging or fungal attack, rather than a lack of nutrients in the soil; it is always worth examining the roots of sickly trees. Weed competition can also affect nutrient uptake, particularly of nitrogen, by young trees. In all such instances fertilisers could make things worse rather then better.
25. Analysis of soils to assess the fertiliser needs of trees has so far proved disappointing and cannot be recommended. It is, however, always worth checking the soil ph before a site is planted, since alkaline or very acid soils will rule out some tree species. The physical state of the soil, especially after disturbance, is also very important; principles of land-forming, cultivation and drainage on disturbed sites are covered in Arboriculture Research Note 37/84/SSS. Good soil drainage is just as important for the single tree as for a plantation.

Fertilisers and Weed Control

26. Fertiliser nitrogen is quick acting and poorly held by most soils, so nitrogen added to the backfill is unlikely to benefit newly planted trees. If fertilisers are used at planting they should, therefore, be low in nitrogen and high in phosphorus and potassium- or even contain no nitrogen at all. Weeds exploit a site more rapidly than trees do, and also respond more vigorously to nitrogen; it follows that weed control is an essential part of the aftercare of amenity trees, and in general fertilisers should not be used without effective weed control (see McCavish and Insley, 1983).

Conclusions

27. Analysis of leaves from the exposed crown, sampled in late summer, will give an indication of the major nutrient status and fertiliser needs of established broadleaved trees and provide a better guide than soil analysis.

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