112 | 93 | ARB

Arboriculture Research Note

Issued by the D O E Arboricultural Advisory & Information Service

Nutrient injection into trees

S J Hodge
DoE Arboriculture Research Contract, Forestry Authority

Summary

The effects of injecting nutrients into the trunks of mature trees growing in urban areas were examined in four experiments. Nutrient injection into Red oak, sycamore, birch and Sweet chestnut had no consistent effect on shoot extension, leaf are, leaf colour, crown density or foliar macronutrient concentrations.

Introduction

1. conditions in which a tree is growing, for example in areas of hard paving, may prevent the application of fertilizers on to or into the soil. Competing vegetation may prevent the uptake of surface applied fertilizer by the tree. There may also be circumstances where a rapid response to nutrients is required. Introduction of macronutrients (NPK) directly into the sap stream of the tree is one option.

The "Mauget" system

2. Equipment designed to inject liquids into trees has been available for many years. The "Mauget" system, which has long been used by Arborists in USA, uses a feeder tube inserted into a small diameter (3/16") hole drilled through the bark into the xylem. A capsule containing a solution of the desired chemical under about one atmosphere is attached to the feeder tube through which the solution enters the tree (Costonis 1981).

"Stemix Hi Volume"

3. The technique has more recently been promoted in Britain as a method for injecting a liquid fertilizer; "Stemix Hi Volume"; in the spring or autumn. It is claimed that " Stemix Hi Volume" will provide the stimulation necessary for the proper acceptance of soil applied fertilizers and will enhance growth and vigour of treated trees from one to five years after treatment. "Stemix Hi Volume" is a 0.5% N; 0.7% P; 0.5% K liquid fertilizer. The number of 6 ml capsules required per tree is recommended as half the diameter at breast height in inches. So, if tree diameter is ten inches, five capsules will be required.

The experiments

4. In four experiments a standardized set of annual assessments of tree performance were undertaken involving measurement of stem diameter, shoot extension, leaf colour, leaf area, foliar macronutrient content and crown density.

5. 60 year old Red oaks (Quercus rubra) were injected with "Stemix Hi Volume" or deionised water in late May 1990, or not injected at all. The trees were located in a 7m wide strip of land between the pavement and road in a housing estate on the outskirts of Norwich. This land had a sparse grass cover in places, but much of the area was compacted bare earth (dry bulk densities up to 1.9/cm^3) resulting from the intensity of vehicular and pedestrian traffic. The soil had a high sand and gravel content.

6. In the first summer after treatment, macronutrient injection increased foliar N concentration compared with the water injection treatment, but not compared with the control. In the second year, macronutrient injected trees had increased leaf size, but sharply reduced crown density.

7. Semi-mature Sycamores (*Acer pseudoplatanus*) in Swindon were injected as the Norwich trees but in late September. The trees were located in weed free gaps in the pavement of a south facing road on a housing estate. The soil was derived from Kimmeridge clay. After two growing seasons no significant response had been detected.

8. 50 year old Birch (*Betula* spp) in Bromley were injected with "Stemix Hi Volume" in October. The trees were located within a 2m wide grass strip between the pavement and road on a housing estate. The soil was s sandy loan with a mean dry bulk density of 1.7 g/cm^3.

9. In the first summer after treatment foliar Mg concentration was increased by "Stemix Hi Volume", although the fertilizer contains no Mg. No effect was detected on tree condition or growth. In the second and third years, treated trees showed no improvement over the control.

10. 50 year old Sweet chestnut (*Castanea sativa*) in Colchester were injected with "Stemix Hi Volume". The trees were located on wide grass verges either side of a major road. The experiment site was in a shallow cutting to the west and on shallow fill to the east. A major telephone service duct installed two years earlier, ran down one of the verges very close to the trees. Many of the trees were dying back and showing evidence of fungal infection, especially with *Phytophthora* spp and *Ganoderma resinaceum*. The dieback was not clearly related to the service duct, and Forestry Authority pathologists indicated the most likely reason as root wrenching and branch damage in the 1977 and 1990 storms and the drought summers of 1989 an 1991. The soil was a clay loam with an average bulk density of 1.7 g/cm^3.

11. Nutrient injection had no significant effect on tree performance in the first summer after treatment. In the second year leaf size was higher in the treated trees, but foliar N concentration was significantly lower.

The effect of nutrient injection

12. Both the Norwich and Colchester experiments detected an increase in mean leaf size in response to stem injection in the second season after application; 21% and 15% respectively. However, in the Norwich experiment second season crown density was 44% lower in nutrient injected trees compared to the control. On balance, therefore, second season leaf biomass was reduced by the treatment of the Norwich Red oak.

13. The general lack of response to nutrient injection is consistent with the findings of Smiley et al (1991) (the only other published work on using the "Mauget" system to inject macronutrients) who reported the response of Willow oak (*Quercus phellos*) to two injections of "Stemix Hi Volume", in mid July 1989 and late April 1990. The treatment had no effect on foliar nutrient concentrations, and improved the leaf colour of two of nine trees in 1989 and one in 1990. Soil applied fertilizer improved leaf colour of six of nine trees in 1989 and four in 1990 in the same experiment, and resulted in an increase in foliar N concentration ($P<0.10$) two months after application.

14. Stem injection of micronutrients with the "Mauget" system has been practised widely and with some success (Kielbaso & Ottman 1976, Neely 1980), although the effectiveness of the system has not been consistent (Funk & Peterson 1980). Smiley *et a*l (1991) reason that poor results from macronutrient compared to micronutrient injection is due to the quantity of nutrients injected relative to the amounts required by the tree. They calculated that to raise foliar N concentration of a tree with a 10 kg dry weight of leaves from 1.4% to 2.0% would take 60g of N, requiring 2500 capsules of "Stemix High Volume".

The effect of tree wounding

15. Shigo et al (1977) studied the reaction of trees to "Mauget" stem injection. They reported that little wood discoloration or cambial dieback was associated with wounding when no chemicals were added. Injection with Stemix was associated with some wood discoloration but very little cambial dieback. Observations at the Norwich experiment reflect this finding; the injection of "Stemix Hi Volume" caused weeping and bark discoloration around the wound for a year after treatment whilst the injection of deionised water had no effect. No weeping was noted around the injection wounds in sycamore, birch or Sweet chestnut. Arron et al (1992) noted weeping of, and bark cracking around, injection holes in Norway maple (Acer platanoides) but not in Green ash (*Fraxinus pennsylvanica*). Perry *et a*l (1991) evaluated the literature on injection

wounds. They noted that wounds on any type serve as potential invasion sites for pathogens and concluded that 'in view of the damage associated with injection wounds, the injection of substances into trees should be an act only of desperation or last resort'.

Conclusion

16. Under the conditions of the four experiment sites, mature and semi-mature amenity trees of four species wed a lack of any clear positive growth or condition response to injection of "Stemix Hi Volume" using the "Mauget" system. Where it is practical to do so, enhancing macronutrient supply to amenity trees is best achieved by fertilizer application to the soil using a formulation indicated by the results of foliar analysis (Hodge 1991). In areas if hard paving, injection of "Semi Hi Volume" appears not to be an effective means of improving the macronutrient status and growth of amenity trees.

17. This work is fully reported in Hodge (in press).

Acknowledgements

18. These experiments were part funded by the UK Department of the Environment, Arbor Products International Ltd, Colin Pryce Terralift, Bromley Metropolitan Borough Council and Dolwin and Gray Ltd. Thanks are due to Bromley Metropolitan Borough Council, Colchester Borough Council, Norwich City Council and Thamesdown Borough Council for their cooperation. The assistance of K Knott, B Collins, D Hendrie, D Patch and T Houston is gratefully acknowledged.

References

Arron GP, Bremner LA & Cormack W B (1992) Effect of trunk injection of Uniconazole on the growth of Norway maple and Green ash over four years. *J.Arb.* 18(6) 302-306.

Costonis A A (1981) Tree injection: perspective macroinjection/ microinjection of Uniconazole on the growth of Norway maple and Green ash over four years. *J. Arb* 7(10) 275-277

Funk R & Petersen W (1980) Nutrient treatments for sugar maple decline. *J Arb* 6(5) 124-129

Hodge S J (1991) Improving the growth of established amenity trees: fertilizer and weed control. *Arboriculture Research Note 103/91/Arb*. Arboricultural Advisory and Information Service, Farnham

Hodge S J (in press) The effect of stem nutrient injection and compressed air soil injection on the performance of established trees. *J Arb.*

Kielbaso J J & Ottman K (1976) Maganese deficiency contributing to maple decline. *J Arb*. 1(1) 27-32,

Neely D (1980) Pin oak chlorosis: trunk implantations correct iron deficiency. *J. For*. 71 340-342.

Perry T O, Santamour F S Jr, Stipes R J, Shear T & Shigo A L (1991) Exploring alternatives to tree injection. *J Arb.* 17(8) 217-226.

Shigo A L , Money W E & Dodds D I (1977) Some internal effects of "Mauget" tree injections. *J. Arb*. 3(11) 213-220.

Smiley E T, Fraedrich B R & Booth D C (1991) Comparison of trunk injected and soil applied macronutrients. *J. Arb.* 17(12) 322-324.

Published by: February 1993

Arboricultural Advisory and Information Officer
Alice Holt Lodge
Wrecclesham
Farnham
Surrey

GU10 4LH

The Arboricultural Advisory and Information Service provides advice and information about trees based on research results and experience, both national and international, to arboriculturists, landscape architects, the construction industry and other professionals, also to private individuals. The service is funded by the Department of the Environment.
The Arboricultural Research Note series is supported by the Forestry Commission.