92 | 90 | ARB

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THE USE OF WATER RETENTIVE MATERIALS IN TREE PITS

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Summary
The potential benefits of using water retentive polymers at planting has been demonstrated in lab tests and container trials carried out by the Forestry Commission (FC) and Liverpool University. However, of the five products tested in field experiments, only Aquastore significantly improved the growth of newly planted trees. Water retentive polymers may be of benefit in situations where irrigation can be assured and may allow and extension of the interval between irrigation treatments. These products are unlikely to yield benefits to newly planted trees in terms of survival or sustained growth improvement during long periods of drought.

Background

1. Manufactured products that are claimed to improve tree survival and growth by holding soil moisture against gravity and evaporation whilst releasing it to the tree, have been extensively advertised and are now being widely specified. This Note reviews results from the use of five products, Agrigel, Growsoak 400, Broadleaf P4 (BP4), Aquastore (all water retaining cross linked polyacrylamide polymers) and Alginure Soil Conditioner (a seaweed based product) in eight experiments.

Forestry Commission research: Broadleaf P4 (BP4)

2. The first experiments were established on a heavy clay using *Tilia platyphyllos* and *Fraxinus excelsior* transplants, and on a light sandy soil using *Acer pseudoplatanus* transplants and Japanese Paper Pot *Pinus nigra* var *maritime*. No significant survival or growth response was detected from the use of BP4 in any of five growing seasons on either soil.

3. Another experiment on light sandy soil examined in more detail the performance of newly planted Quercus petraea and Alnus glutinosa transplants with BP4 applied at the manufacturers recommended rate into backfill. Half of the trees in each plot were kept weed free to examine the interaction between weed growth and the use of this product. After two growing seasons, no significant responses to BP4 had been detected. However, in line with earlier results (Davies and Gardiner, 1987), weed growth had a significant (p,0.001) adverse effect on tree survival (figure 1).

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4. To examine more closely manufacturers' claims regarding water retentive products a mobile rainshelter was sued to simulate drought conditions. The first rainshelter experiment examined the effect of BP4 incorporated at the manufacturers recommended rate into the planting pit backfill of *Tilia platyphyllos* whips. The site was kept weed free throughout the year. All trees were watered to field capacity at planting and, subsequently, two levels of irrigation were applied; regular irrigation to field capacity and no irrigation. Gypsum blocks at 25cm below the soil surface were used to monitor soil moisture in each treatment.

5. Despite BP4 increasing levels of available soil moisture in laboratory trials, this was not reflected in the soil moisture tension and growth assessments made during the life of this rainshelter experiment. From 25

days into the experiment the unirrigated BP4 pots displayed markedly higher soil moisture tensions (i.e., lower moisture availability) than the unirrigated control treatment (figure 2, lower graph). This was totally contrary to expectation. Conversely, soil moisture tensions under the irrigated BP4 treatment tended to be lower (i.e. Higher moisture availability) than under the irrigated control.

6. Tree height and diameter increments and total and mean shoot extension showed no significant response to the use of Broadleaf P4 under either irrigation regime.

7. The second rainshelter experiment examined the effect of BP4 and Alginure Soil Conditioner incorporated at the manufacturers' recommended rated into planting pit backfill of *Acer platanoides* transplants. A basal treatment of fertilizer was incorporated into each planting pit to isolate the water supply effect of these products from any fertilizer effect. In addition, grass turf was laid over the site at experiment establishment in order to intensify competition for moisture, and to examine the value of these two widely used products in what is an all too commonly encountered situation.

8. The need to irrigate was determined by gypsum block readings taken twice weekly, and trees were trickle irrigated until all gypsum clocks showed the soil to be as near o field capacity as possible. The other half of the trees received an initial trickle irrigation to ensure the soil and BP4 were as near field capacity as possible. From this time trees received no additional water.

9. In the unirrigated plots the foliage of the trees eventually browned and the trees died. Fig.2 (upper graph) shows the incidence of trees with totally browned foliage in relation to increasing soil moisture tension (lower graph). Soil Moisture tensions in the BP4 plots reached wilting point one week before that in the control. As a result, the onset of the total browning of foliage occurred a week earlier that the control.

10. Irrigation significantly increased tree height growth but there was no significant growth difference between amelioration treatments.

Liverpool University research: Broadleaf P4

11. Container trials, carried out at Liverpool University (Woodhouse, 1989) showed significant growth benefits to two year old Acer pseudoplatanus and one year old rooted cuttings of Salix viminalis from the use of BP4 incorporated into coarse sand at the manufacturers' recommended rate whether irrigated every three days or every six days.

Liverpool University research: Aquastore

12. Acer pseudoplatanus transplants were planted into 15 litre polypots containing coarse sand or peat an coarse sand (2:1), and either 0.2%, 0.4%v/v or on dry Aquastore. All trees were given an equal quantity of water when any tree showed signs of wilting. Increasing tree growth and reducing shoot/root were associated with increasing level of polymer (table1).

Table 1: The response of container grown Acer pseudoplatanus to Aquastore and peat after one growing season.

Sand Substrate

Amendment (v/v)	Plant Total dry wt.(g)	Total shoot extension (cm)	Shoot:root ratio
No amedment	23	9	1.3
0.2%polymer	25	13	1.0
0.4% polymer	31	21	0.7

Peat:sand substrate

Amendment (v/v)	Plant Total dry wt.(g)	Total shoot extension (cm)	Shoot:root ratio
No amendment	31	37	2.5
0.2% polymer	36	57	1.9
0.4% polymer	51	69	1.2

13. Another container experiment was undertaken with *Acer pseudoplatanus* transplants in 15 litre polypots containing a 2:1 pear: coarse sand mix and either 0.2%, 04% v/v or no dry Aquastore. Trees were watered to field capacity and the droughted when fully in leaf, and posts were periodically weighed to assess evapotranspiration. Amendment with 0.4% Aquastore increased the water supply available to the tree from 16 to 31 days.

14. In a third experiment, *Acer pseudoplatanus* transplants were pit planted into a sandy loam soil with either 0.4% v/v Aquastore, 25% by volume peat or no ameliorant. Trees were watered to field capacity at planting but received only ambient (but relatively frequent) rainfall there after. After one growing season Aquastore had improved plant dry weight and shoot extension but had reduced shoot/root ration (table.

Table 2: The response of field grown *Acer pseudoplatanus* to Aquastore after one growing season.

Amendment (v/v)	Plant Total dry wt.(g)	Total shoot extension (cm)	Shoot:root ratio
No amendment	12	4	2.0
25.0% peat	15	5	1.8
0.4% polymer	20	7	1.1

Forestry Commission research: other polymers

15. Agrigel and Grow soak 400 (see figure 1) (cross linked polyacrylamide polymers) yielded no benefit in terms of tree survival and growth when tested in field experiments. In addition, any water retentive properties of the seaweed derived sodium alginate in Alginure Soil Conditioner had no beneficial effect on the survival of *Acer platanoides* transplants.

Other research

16. Hummel and Johnson (1985) tested water retentive product Terrasorb (a gelatinized starch-hydrolyzed polyacrylonitrile graft co-polymer) and found no significant benefit to its use on *Liquidambar styraciflua* planted in a find sandy soil.

Discussion

17. Container experiments at Liverpool University under controlled conditions have shown significant growth benefits from the use of BP4 under both three and six day irrigation regimes. No such benefit was detected in any of the FC experiments reported above. The reason for the major differences in results probably lies in the frequency of water supply. The three FC experiments conducted under ambient conditions did not receive regular rainfall and in rainshelter experiments the droughting treatment involved only one low volume irrigation in 130 days.

18. Aquastore was found to significantly improve the growth of newly planted transplants in their first growing season in both container and field experiments. Possible explanations for these results are that in lab tests, Aquastore was found to hold up to 383 times its weight of deionised water (BP4 held up to 304 times its weight), and that in experiments t was used at the manufactures recommended rate equivalent to four times the tare at which BP4 was used (although one of the FC trials rested BP4 at 0.2g/litre; double the manufacturers' recommended rate with no beneficial effect to the survival and growth of newly planted transplants).

19. It appears that, for the products tested to be of benefit to the survival and growth of newly planted trees, a regular input of water is required in order to 'recharge' the product. Continued hot dry weather causes dehydration of the product by transpiration. During a period of sustained drought the product becomes as dry as the surrounding soil, and hence is of no benefit to the tree. The difference in the effectiveness of Aquastore and the other products tested appears to be best explained in terms of the quantity of water they hold, and hence the period of dry weather over which they will release water to the tree (although the differences found could be partly due to the relatively high summer rainfall falling on the Liver experiment).

Conclusions

20. The potential benefits of using water retentive polymers at planting has been demonstrated in lab tests and container trials. However, in field experiments only Aquastore significantly improved the growth of newly planted trees. Water retentive polymers may be of benefit in situations where irrigation can be assured and may allow an extension of the interval between irrigation treatments. These products are unlikely to yield benefits to newly planted trees in terms of survival or sustained growth improvement during long periods of drought. Good weed control is generally the most effective way of minimising moisture stress of newly planted trees.

Acknowledgement

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