MASS PROPAGATION OF BAMBOO, AND ITS ADAPTABILITY TO WASTE WATER GARDENS

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ABSTRACT

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Unregulated and inappropriate disposal of wastewater poses serious pollution problems in many parts of the developing World. However, reuse of wastewater may help to meliorate global water shortages, especially in developing nations where facilities for safe disposal of wastewater do not exist.

Some bamboo species grow more rapidly than timber species and have numerous actual and potential applications for environmental conservation and income generation. In view of these attributes, bamboo was chosen for use in the present study of the potential utilisation of wastewater to improve water and nutrient supplies, while providing an environmentally compatible method for wastewater disposal and a fast-growing, non-timber source of woody material for subsistence farmers.

As the extremely long vegetative period before flowering occurs in many species limits seed supplies, it is vital to develop effective methods for mass propagation of bamboo to enable its widespread adoption by subsistence farmers in East Africa. Seven potentially important species were used in studies intended to develop suitable micropropagation procedures: these were *Dendrocalamus membranaceus*, *Dendrocalamus yunnanicus*, *Dendrocalamus strictus*, *Phyllostachys heteroclada*, *Oxytenanthera abyssinica*, *Phyllostachys pubescene* and *Dendrocalamus giganteus*. Multiplication rates differed between species ($P<0.001$) and these difference became apparent within five months of establishing the cultures. *D. yunnanicus* was the most promising in terms of ultiplication rate, easily outperforming all other species ($P<0.001$), by increasing to 3,500 plantlets within eight months.

Three species (*Dendrocalamus giganteus*, *Bambusa vulgaris* and *B. nutans*) were grown in 100 litre tanks in a factorial experiment under field conditions. Sewage effluent or clean water was applied daily according to the treatment involved. A second experiment contained 339 younger plants irrigated with three sources of water, including industrial wastewater. Subsequent analysis revealed that the wastewater did not contain toxic concentrations of nutrients or trace metals.

Weekly and diurnal measurements of net photosynthesis, transpiration rate and stomatal conductance were made over a nine month period, while non-destructive measurements of plant height, collar diameter, number of leaves and leaf area were made over a 15 month period.

Destructive harvests after 0, 9 and 15 months of treatment were used to determine leaf and stem fresh and dry weights.

When averaged over all species, irrigation with wastewater increased stem fresh and dry weight plant-1 by 30-40 % relative to plants receiving clean water ($P<0.05$), with *B. vulgaris* and *B. nutans* performing better than *D. giganteus*. A significant water*time interaction was apparent for plant height, branch number, leaf area plant-1 and biomass production for all species; values were greater for plants irrigated with wastewater than in those receiving clean water. Volumetric soil moisture content did not differ significantly between the clean and wastewater treatments between March and November 2006, but differed between the two measurement depths (20 and 60 cm; $P<0.001$).

The gas exchange and SPAD values (an indirect measure of chlorophyll concentration) revealed several significant effects. SPAD values varied with time ($P<0.001$), but not

between species, and were greater in plants irrigated with wastewater than in those receiving clean water ($P<0.001$).

Stomatal conductance, transpiration and net photosynthesis all showed significant effects of species, irrigation treatment, time and leaf position in the canopy ($P<0.05$). Instantaneous transpiration efficiency (ITE) was greater in plants irrigated with wastewater than in those receiving clean water ($P<0.05$).

Elemental analysis showed that the concentrations of trace metal nutrients in the wastewater supplies used in both experiments were not sufficiently high to elicit toxic responses, although Cu, Ni, Zn, K, N and total organic carbon concentration were all higher in wastewater than in clean water ($P<0.05$). Na concentration was sufficiently high to induce a 10 % reduction in plant growth. The uptake of specific elements (e.g. K, Ca, Mg, Fe, Zn, Ni, Mo, As and Al) varied between species and with time ($P<0.05$), suggesting possible genotype preferences and environmental influences. The concentration of individual elements within leaves was influenced by their position in the canopy ($P<0.05$).

The large size, rapid growth and water pumping properties of many bamboo species make them suitable candidates for phytoremediation, although selection of appropriate species for specific applications is important. The multiple and diverse uses of bamboos makes them an attractive proposition for environmental restoration and poverty alleviation in subsistence communities in developing nations. Future research should focus on uptake of nutrients and pollutants by roots, the suitability of agroforestry for wastewater treatment, and long term studies of wastewater uptake by bamboo with regard to potential environment benefits and biomass production by bamboo.