Dry Weights

No significant treatment effects ($P \leq 0.05$) were found in dry weights of shoots, roots or whole plants at harvest. Mean dry weights of whole plants are shown in Fig. 3.

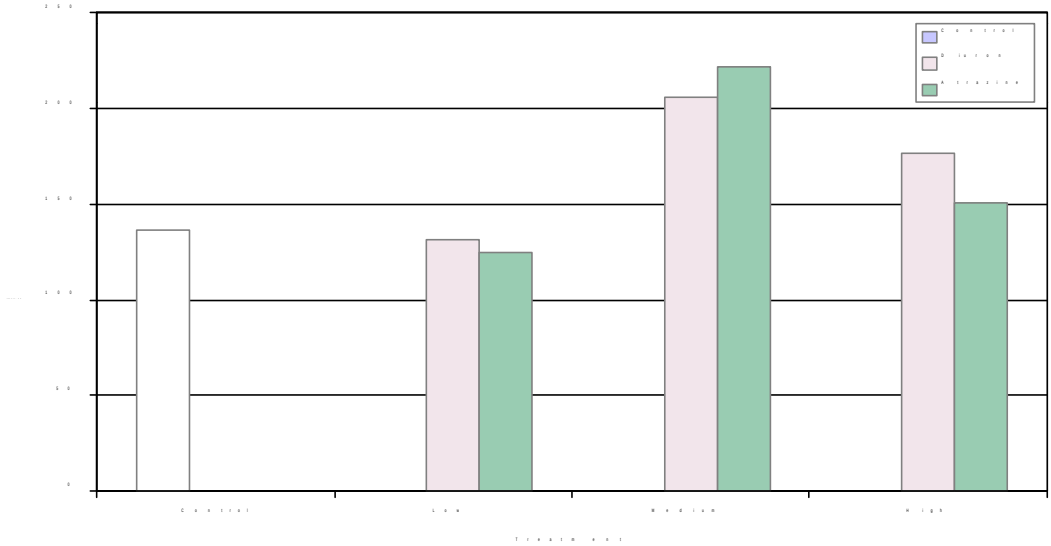

Fig. 3. Mean effect of 3 levels of atrazine and diuron on the whole plant dry weight of vetiver at harvest, NS ($P \leq 0.05$).

Mean Quantum Yield

The F_v/F_m ratio of vetiver grass was not affected by application of either herbicide at concentrations up to 2000 µg L^{-1} (Fig. 4). The average F_v/F_m ratio produced by vetiver grass for all treatments was 0.77.

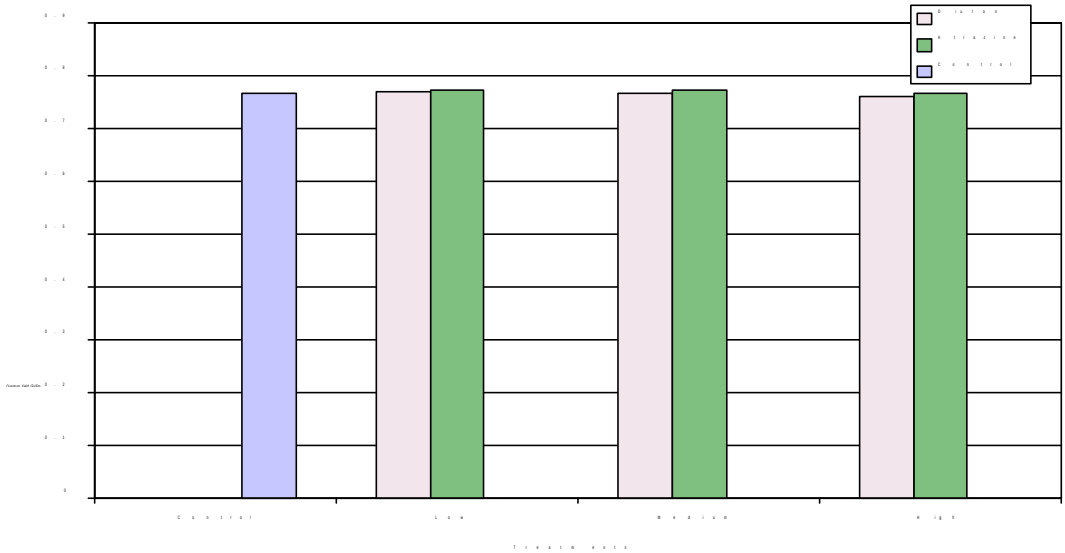

Fig. 4. Mean herbicide effects on F_v/F_m ratio of selected vetiver stool leaves 26-27 days after atrazine and diuron application, NS ($P \leq 0.05$).

Comparison with Other Species

To demonstrate vetiver's herbicide tolerance a comparison was made with the performance of *Phragmites australis*, another wetland grass species, grown under the same conditions. For each species, whole plant dry weights at the high rate of both herbicides were expressed as a percentage of respective dry weights of the control (Fig. 5). While growth of vetiver was unaffected by either atrazine or diuron at 2000 $\mu g\ L^{-1}$, both herbicides reduced growth of *Phragmites australis* to less than 40% of the control.

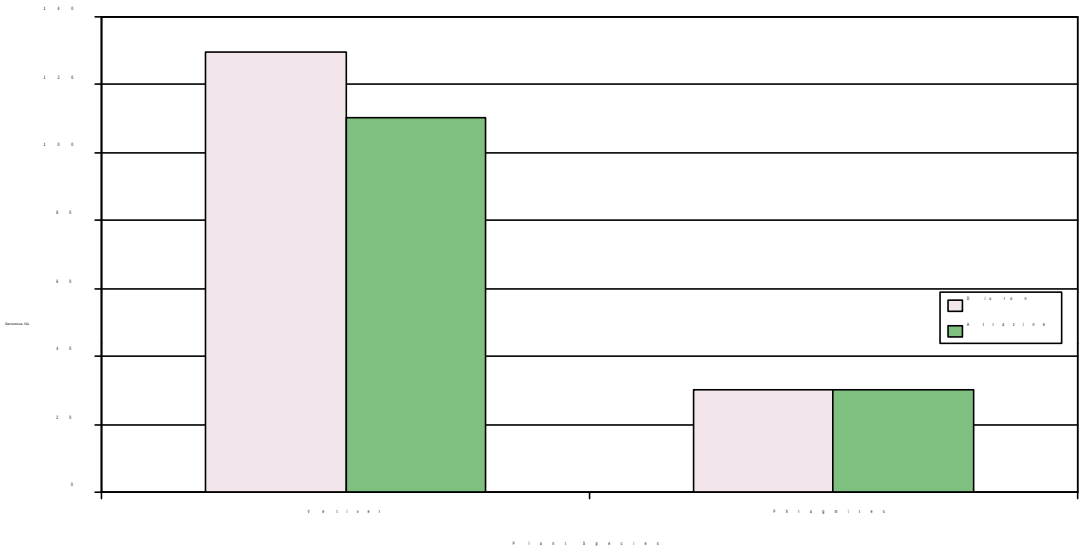

Fig. 5. Comparison of mean whole plant dry weights of vetiver and phragmites at the high rates of herbicide application, when expressed as a percentage of dry weights of respective controls.

Discussion

Results of this experiment confirmed the ability of vetiver to establish and grow well in a shallow wetland environment. Importantly, the results also clearly demonstrated that growth and performance of vetiver were not affected by exposure to the herbicides, atrazine and diuron, at concentrations likely to be found in agricultural runoff or water bodies downstream. Indeed, vetiver was shown to be unaffected by either herbicide at concentrations as high as 2,000 $\mu g\ L^{-1}$; levels which are likely to be encountered in the environment only in situations of accidental spillage, or direct application to waterways. Vetiver's tolerance towards the two herbicides was demonstrated in terms of both growth (water use, cumulative leaf area and dry weight) and photosynthetic activity (PAM fluorometry).

Vetiver displays several morphological and physiological characteristics that make it eminently suitable for use as a vegetative buffer or wetland plant species (Truong 1999). Its potential for application as a vegetative buffer has already been well demonstrated (for example, Truong et al. 1996).

The use of wetlands for the removal of pollutants involves a complex variety of biological processes, involving microbiological transformations and physio-chemical processes such as adsorption, precipitation or sedimentation (Dunabin and Bowmer 1992; Ansola et al. 1995, Brown et al. 1998; McKinlay and Kasperek 1999). The ability of vetiver to tolerate flooded soil conditions makes it very suitable for use in ephemeral or permanent wetlands. Its dense stands of stiff, erect stems can reduce flow velocity, increase detention time and enhance deposition of sediment and sediment-bound contaminants (e.g. heavy metals and some pesticide residues). Furthermore, vetiver's dense, finely structured root system can improve bed stability and nutrient uptake, and provide an environment that stimulates microbiological processes in the rhizosphere. Use of the sterile or low fertility genotype of *V. zizanioides* (Truong 1999) should minimise its potential for becoming an aquatic weed.

Conclusion

Results of this study indicate that vetiver is unlikely to be adversely affected by runoff containing residues of atrazine or diuron.

Further research is needed to determine the mechanism underlying vetiver's tolerance to these herbicides, and indicate the extent to which residues are: (i) absorbed by the roots, and (ii) translocated to the shoots. Further research is also required to evaluate the effects of longer-term (chronic) exposure of vetiver to atrazine and diuron.

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