Inter-site and species specific differences in photosynthetic properties of C₃ plants growing in an African savanna/wetland mosaic

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We measured leaf-level gas exchange, relationships between area and mass based light saturated net photosynthetic rates (A sat and A mass) and leaf nitrogen and leaf phosphorus contents for dominant tropical grass and sedge species occurring in three different ecosystems, viz. rain-fed grassland, seasonal floodplain and permanent swamp, all located within the Okavango Delta, Botswana. Measurements were made during the wet season, when site-specific differences in growth conditions between the sites were minimal. Plants growing in the permanent swamp had the widest range of both area-based leaf nitrogen contents, 20–140 mmol m⁻², and nitrogen use efficiencies (NUE), 0.1–1.6 mmol C mol⁻¹ N s⁻¹. Species from the rain-fed grassland had highest leaf N and leaf phosphorus content (leaf P) (per dry mass), high specific leaf area (SLA), lower intercellular to ambient CO₂ concentration, C i/C a ratio, highest carboxylation efficiency (α) and, on average, higher light and CO₂ saturated photosynthetic rates (A sat). The benefit of the trends at the rain-fed grassland is interpreted as part of a rapid growth strategy during the relatively brief period of water availability. When compared to previously published “scaling relationships” developed for C₃ plants, significant differences were observed, especially in terms of relationships between A sat and either foliar N or foliar P concentration (whether expressed on a dry weight or a leaf area basis) and also in the SLA versus N and SLA versus P relationships. Overall foliar P (dry weight or area basis) provide a much better predictor of within and across species variation in both A sat and SLA than did foliar N concentrations. We interpret this as indicating that, as opposed to nitrogen, phosphorus availability may exert the more critical control on the functioning of herbaceous vegetation in this relatively oligotrophic ecosystem.

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Pollinator driven variation of Oxalis hirta (Oxalidaceae)

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The Cape is characterized by an immensely rich flora that is thought to have radiated relatively recently and very rapidly. As a result, scientists often use the Cape as a natural laboratory for studying speciation in plants. Several competing theories vie for importance in explaining the floral diversity of the Cape, with the most widely accepted being that plants have adapted and speciated along sharp soil boundaries which form intricate habitat mosaics. More recently the importance of pollinators has started to take an important position in explaining the adaptive radiations of plants in the Cape. The ranges of pollinators are often smaller than those of the plants that they pollinate so that different plant populations often have different suites of pollinators. As a result, adaptations to the different pollinators across the range may result in divergent floral forms, reproductive isolation and speciation. This honours project will explore the possibility of adaptive divergence in the floral form of Oxalis hirta being a result of pollinator selection. Oxalis hirta has a highly variable corolla tube length with long and short tubed varieties sometimes growing in different populations which are fairly close together. We expect that the tube length of the flowers should be closely correlated to the tongue lengths of the dominant pollinators at each population.

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The ecophysiology and value of Acacia karroo in the urban environment

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Urban open spaces are of strategic importance for quality of life of our increasingly urbanized society. Trees in towns and cities form an important part of complex urban ecosystems and provide significant ecosystem services and benefits for urban dwellers, for example; reducing particulate pollution, carbon sequestration, decrease air temperature, decrease water runoff, and increase in human health. Trees are also regarded as a solar-powered technology that can help restore balance to dysfunctional urban ecosystems. The urban environment put, however, a tremendous strain on trees by trenching, limited root growth and emission of pollutants into the atmosphere, water and soil. The problem is we do not always know what the impact of the urban environment is on the trees within our community. The aim

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of this investigation was to assess the overall anthropogenic and environmental impacts on urban trees by measuring the tree vitality of *Acacia karroo* using chlorophyll fluorescence kinetics (JIP-test) and leaf water potential using a pressure chamber. A comparative study following an urbanization gradient approach in Potchefstroom is used. The association between tree vitality measurements in the form of Performance Index values (PI) and soil physical and chemical data, leaf water potential and other vegetation components was determined using RDA-ordinations. Additionally, a model (SATAM) was used to determine the monetary value of trees in urban environments. All this information will eventually contribute to develop an urban tree management program for Potchefstroom. It was evident from this study that urbanization has a negative impact on tree vitality but the water potential of trees was not necessarily negatively impacted upon. Although trees in urban environments do not always have high performance values they still play a major role in urban environments. According to the tree appraisal method (SATAM) some of these trees have a value of over R60,000.

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**Abstracts**

**Dark chilling lowers the content and catabolism of ureides in soybean leaves: Long-term effects on nitrogen status and vegetative growth**

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Bacterial nitrogenase activity in the root nodules of certain legumes such as soybean leads to the synthesis of organic N-compounds known as ureides. Before utilisation in the leaves, ureides must first be converted to urea through a catabolic pathway that involves the enzyme allantoinase. Environmental stress factors, such as chilling stress, could potentially cause reductions in leaf ureide content and/or lower rates of ureide catabolism. Although these aspects may be very important in the inherent chilling sensitivity of warm-climate legumes such as soybean, no information about the effects of chilling stress on these processes exists. The aim of this study was to characterise allantoinase activity in soybean leaves and to determine the relationship with ureide content under normal and chilling temperatures. Plants of a chilling sensitive soybean genotype, PAN809, were cultivated under optimal conditions in a growth chamber. After four weeks of growth, leaves were harvested from plants at two-hour intervals throughout a 24-hour cycle. Large diurnal changes in allantoinase activity, and an inverse relationship between allantoinase activity and leaf ureide content, was observed. Allantoinase activity was generally at its lowest during the night but showed large increases already prior to the start of the light period. Maximum allantoinase activity occurred approximately four hours into the light period. These diurnal changes were most pronounced in young developing leaves. Simultaneous exposure of the roots and shoots of plants to dark chilling led to large reductions in both ureide content and allantoinase activity, while chilling of only the shoots reduced allantoinase activity but not ureide content. We provide novel evidence showing how dark chilling leads to severe N-limitation in shoots through a combined lowering of leaf ureide content and ureide catabolism. These perturbations manifested itself in the form of reduced shoot growth and the widespread development of chlorosis.

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**Root physiology and anchorage efficiency of young *Eucalyptus* trees derived from micropropagation, cuttings and seedlings**

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Micropropagation has improved rooting rates of numerous cold-tolerant hybrid clones of *Eucalyptus* species. However, *ex vitro* growth and physiology as well as root properties of those plants have received very little attention. Using a clone of *E. grandis* × *E. nitens*, we found no significant differences between micro- and macropropagated saplings and trees with respect to photosynthesis and leaf hydraulic characteristics. However, differences in root structure and anchorage efficiency were significant. At least 50% of the uprooted macropropagated trees produced a root system similar and equivalent in resistance to the tap roots of seed propagated *E. grandis* and *E. nitens*. However, none of the micropropagated trees produced equivalents of tap roots. Root abnormalities such as spiralling, kinked roots forming a ‘ball-and-socket’ at the root–shoot junction were common, and in addition, some micropropagated trees produced horizontal and vertical stems. Vegetatively propagated trees generally produced a shallower root system compared with seed propagated trees, which reduced uprooting resistance and led to trees being toppled by wind loading. The former produced fewer and thicker I-beam shaped roots, whereas the later produced T-beam shaped roots. The number of roots as well as root cross sectional area had a significant effect on the maximum force required to vertically extract roots. We found that for micropropagated trees, roots more efficient in anchorage developed after nearly two years of field-growth, which might be too late if saplings are to be planted in areas with strong winds. We conclude therefore, that the