What is the function of leaf succulence in the Aizoaceae?

B.S. Ripleya, C. Klakb, T. Abrahama, M.D. Cramerb

aDepartment of Botany, Rhodes University, South Africa
bDepartment of Botany, University of Cape Town, South Africa

d Leaf succulence has been proposed as a mechanism of water, nutrient and CAM acid storage, and as a cheap method of leaf construction. Increasing leaf succulence has been associated with a greater reliance on CAM physiology as the efficiency of PEPcase helps overcome increasing mesophyll conductance. These proposed mechanisms were explored in a range of Aizoaceae species with varying degrees of leaf succulence. Specific leaf area was not increased by succulence and average values do not indicate cheap leaf construction costs. Stored water did little to prolong leaf gas exchange and positive carbon assimilation during periods of dehydration but did maintain the integrity of the photosynthetic apparatus during prolonged periods of stomatal closure. Increasing succulence was not associated with an increasing dependence on CAM, nor on decreasing mesophyll conductance. This is explained by the distribution of photosynthetic tissue around leaf periphery, leaving the non-photosynthetic leaf interior as a potential nutrient and water store. In these species, succulence appears to be associated with allowing plants to survive long periods of dehydration without the necessity of being obligate CAM plants.

doi:10.1016/j.sajb.2013.02.066

Stress metabolic alterations in in vitro Cyrtanthus regenerants

B. Ncube, J.F. Finnie, J. Van Staden

Research Centre for Plant Growth and Development, School of Life Sciences, University of KwaZulu-Natal Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa

Cyrtanthus (Amaryllidaceae) is an important genus of monocotyledonous plants whose bulbs and flowers are highly sought after for both medicinal and ornamental purposes. Due to their valuable use in traditional medicine and potential for the production of novel compounds, understanding their metabolic response to various environmental factors is a crucial aspect. Plant species vary in their sensitivity and response to abiotic stress factors but it may be assumed that all plants have encoded capability for stress perception, signalling, and response. The metabolic alterations of stress-mediated adjustments in plants are elicited through several cross-linked pathways with responses ranging from synthesis of limited quantities of specialized metabolites to large shifts in primary metabolite composition. In an attempt to further our understanding of these species, in vitro-derived C. contractus and C. guthrieae plantlets were used for the model study of their metabolic response to salt and osmotic stresses. The plantlets were cultured on solid Murashige and Skoog (MS) media with three different PEG-induced osmotic potentials and four NaCl stress levels at 25 °C. The levels of proline and phenolic compounds measured at intervals of 3, 4 and 5 weeks from initial plantlet culture were found to increase in a stress-dependent pattern. The levels of these metabolites also showed a significant increase with an increase in the duration of plantlets under stress conditions. The highest proline concentration (9.98 μmol g DW) was recorded in C. contractus at 300 mM NaCl after 5 weeks. A corresponding high level of total phenolic compounds (147 mg GAE/g DW) was also recorded in the same treatment for the same species. The activity of proline dehydrogenase (PDH) was shown to decrease with an increase in proline levels from week 3 to week 5 in almost all the stress factor conditions. The

doi:10.1016/j.sajb.2013.02.066
high levels, particularly of phenolic compounds obtained under water and salt stress conditions in this study present a promising potential of manipulating culture and/or growing conditions for the production of desired metabolites with medicinal benefits.

doi:10.1016/j.sajb.2013.02.067

Transcriptional profiling of nodule development in soybean

S.G. Van Wyk, K.J. Kunert, B.J. Vorster

Department of Plant Sciences, University of Pretoria, Pretoria 0002, South Africa

Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa

Soybean is one of the most important sources of vegetable protein used for both food and animal feed worldwide. The symbiotic interaction between soybean (Glycine max cv. Williams) and nitrogen fixing bacteria (Bradyrhizobium japonicum) provides fixed nitrogen for plant growth, seed production and ultimately crop yield. The bacteria are located in specialized structures, the nodules, on the roots of the soybean plants, which maintain a favourable environment for bacterial nitrogen fixation. However, the nodules have a short lifespan and they often senesce and die before the seeds have been filled. Moreover, the nodules are highly sensitive to environmental stress, particularly drought and temperature extremes, which trigger premature senescence and early death. However, little is known about the molecular processes that underpin stress-induced nodule senescence and mechanisms that enable plants such as soybean to tolerate drought and other stresses. The study has therefore been designed to address these issues directly and to gain new knowledge that will assist to produce soybean varieties with improved stress tolerance. The aim of the research is to enhance the understanding of the specific functions of the soybean cysteine protease - cysteine protease inhibitor system in natural and stress-induced premature nodule senescence. Progress to date includes the identification of all the cysteine proteases and cysteine protease inhibitors present in soybean, as well as characterization of their expression and change in expression from development and onset of natural senescence. Further characterization of the individual components of the protease-protease inhibitor system, might make it possible to silence a particular cysteine protease or recombinantly express a specific natural or engineered cystatin in soybean nodules that could possibly delay either natural or stress-induced nodule senescence.

doi:10.1016/j.sajb.2013.02.068

Ecological implications of smoke-derived compounds in grassland soils following fire: Germination activity of smoke residues in soil and quantification of two active compounds

M.E. Light, H.M. Ghebrehiwot, M.G. Kulkarni, G. Szalai, V. Soós, E. Balázs, J. Van Staden

Research Centre for Plant Growth and Development, School of Life Sciences, University of KwaZulu-Natal Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa

Department of Plant Physiology, Agricultural Institute, Centre for Agricultural Research, Hungarian Academy of Sciences(ARI-HAS) Brunszvik u, 2462 Martonvásár, Hungary

Department of Genomics, Agricultural Institute of the Hungarian Academy of Sciences (ARI-HAS), Brunszvik u2, 2462 Martonvásár, Hungary

Smoke from burning vegetation contains many highly active chemicals that may play a role in promoting seed germination and enhancing post-germination processes. The butenolide compound in smoke responsible for enhancing germination in many species has been identified as 3-methyl-2H-furo[2,3-c]pyran-2-one (karrikinolide, KAR1). A structurally-related butenolide, 3,4,5-trimethylfuran-2(5H)-one (trimethylbutenolide, TMB), which inhibits germination and reduces the effect of KAR1, was also identified recently. The mechanisms of action and interaction of these compounds is not yet fully understood. Furthermore, the ecological implications of these compounds remaining in the soil following a fire and the spatial influence of smoke drift on burnt sites and neighbouring areas has not been explored. This study assessed the germination activity of extracts from burnt soil samples and quantified the amount of KAR1 and TMB present in the soil following a grassland fire. Extracts of the soil samples, taken at depths of 0–2, 2–4, 4–6 and 6–8 cm, were prepared using dichloromethane and tested for germination activity using achenes (seeds) of Grand Rapids lettuce (Lactuca sativa Lcv. ‘Grand Rapids’), which are known to respond to smoke extracts and these chemicals. At all soil depths, the Grand Rapids lettuce seeds exhibited significantly higher germination when treated with burnt soil extracts compared to the no-burn soil (control). The Grand Rapids lettuce seeds also showed significantly higher germination when treated with soil extracts from the adjacent plots. Compared to the no-burn soil, a higher concentration of KAR1 and TMB were detected in the top layers (0–2 and 2–4 cm) of the burnt soils. Findings of this study indicate that smoke increases the levels of KAR1 and TMB in the soil which may influence germination of seeds of certain smoke-responsive plant species in the soil seed bank.

doi:10.1016/j.sajb.2013.02.069

The role of different explants on the transformation efficiency in Dierama erectum Hilliard

M.J. Koetle, P. Baskaran, J.F. Finnie, J. Van Staden

Research Centre for Plant Growth and Development, School of Life Sciences, University of KwaZulu-Natal Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa

Dierama erectum is a member of the Iridaceae and is regarded as an important horticultural plant due to its high ornamental value. The species has an erect inflorescence with about 10 flowers on each inflorescence. The high economic potential of D. erectum is attributed to its large size and production of erect flowers. Tissue culture methods for improvement of ornamental plants are vital for their regeneration and development. A quick and effective method is needed to facilitate selection of putative transformants during genetic manipulation of D. erectum. The aim of this study is to use different explant sources: hypocotyls, shoots, and embryogenic calli for developing a transformation procedure for early flower induction in D. erectum. An effective micropropagation protocol was thus developed and results showed that maximum shoot production (12 shoots per explant) can be achieved with hypocotyl explants cultured on Murashige and Skoog medium supplemented with 1.0 μM benzyladenine (BA) under a 16 h photoperiod at 100 μmol m⁻² s⁻¹. One-month-old regenerated shoots were used to induceembrogenic calli with various concentrations and combinations of BA, 2,4-dichlorophenoxyacetic acid (2,4-D) and 4-amino-3,5,6-trichloropicolinic acid (picloram). Further experiments including the characterization of the resultant calli are on-going.

doi:10.1016/j.sajb.2013.02.070