

APPLIED PHYSIOLOGY AND PRACTICAL BIOREACTORS FOR PLANT PROPAGATION

Jeffrey Adelberg^{1*} and Miklós G. Fári²

¹Department of Horticulture, Clemson University, 247 Poole Ag Center, Clemson SC 29634, USA,

*Fax: + 1864 656 4960, *E-mail: jadlbrg@clemson.edu

²Ottó Orsós Laboratory, Department of Plant Biotechnology, University of Debrecen, Hungary

REFERENCES

- ADELBERG J. (2005). Efficiency in thin-film liquid system for *Hosta* micropropagation. *Plant Cell Tissue and Organ Culture*, 81: 359-368.
- ADELBERG J. (2006). Agitated, thin-films of liquid media for efficient micropropagation. *In: Dutta Gupta S., Ibaraki Y. (Eds). Engineering for Plant Tissue Culture, Frontiers of Biotechnology Vol. 6, Springer-Verlag, Heidelberg, Germany: 101-117.*
- ADELBERG J., KROGGEL M., TOLER J. (2000). Greenhouse and nursery growth of micropropagated *Hostas* from liquid culture. *Hort-Tech*, 10: 754-757.
- ADELBERG J., TOLER J. (2004). Comparison of agar and an agitated, thin-film liquid system for micropropagation of ornamental elephant ears. *HortScience*, 39: 1088-1092.
- ADELBERG J., DELGADO M. P., TOMKINS J. P. (2005). Ancymidol and liquid media improved micropropagation of *Hemerocallis* cv. Todd Monroe on the rocker thin film bioreactor. *Journal of Horticultural Biotechnology*, 80: 774-778.
- ADELBERG J., COUSINS M. (2006). Thin films of liquid media for heterotrophic growth and storage organ development: Turmeric as a model plant. *HortScience*, 41: 539-542.
- ADELBERG J., DELGADO M. P., TOMKINS J. P. (2007). *In vitro* sugar and water use in diploid and tetraploid genotypes of Daylily (*Hemerocallis* spp.) in liquid medium as affected by density and plant growth regulators. *HortScience*, 42: 325-328.
- ADELBERG J. (2010). Sucrose, water and nutrient use during stage II multiplication of two turmeric clones (*Curcuma longa* L.) in liquid medium. *Scientia Horticulturae*, 124: 262-267.
- ADELBERG J., DELGADO M. P., TOMKINS J. P. (2010). Spent medium analysis for liquid culture micropropagation of *Hemerocallis* on Musrashige and Skoog medium. *In Vitro Cellular & Developmental Biology-Plant*, 46: 95-107.
- AKITA M., OHTA Y. (2002). A simple bioreactor system for production of storage organs of Chinese Yam (*Dioscorea opposita* Thunb.). *Plant Biotechnology*, 19: 353-356.
- ALPER Y., YOUNG R., ADELBERG J., RHODES B. (1994). Mass handling of watermelon microcuttings. *Transactions of the American Society for Aricultural Engineering*, 37: 1337-1343.
- COUSINS M., ADELBERG J. (2008). Short-term and long-term time course studies of turmeric (*Curcuma longa* L.) microrhizome development *in vitro*. *Plant Cell Tissue and Organ Culture*, 93: 283-293.
- CHEN J., ZIV M. (2001). The effect of ancymidol on hyperhydricity, regeneration, starch and antioxidant enzymatic activities in liquid-cultured *Narcissus*. *Plant Cell Reports*, 20: 22-27.
- CHEN J., ZIV M. (2003). Carbohydrate, metabolic, and osmotic changes in scaled-up liquid cultures of *Narcissus* leaves. *In Vitro Cellular & Developmental Biology-Plant*, 39: 645-650.
- DEWIR Y. H., CHAKRABARTY D., HAHN E. J., DATTA S. K., PAK K. Y. (2008). Kinetics of nutrient utilization and photosynthetic enzyme activities during floral versus vegetative differentiation of *Spathiphyllum* in air-lift bioreactor cultures. *Plant Growth Regulation*, 54: 157-164.
- DEWIR Y. H., CHAKRABARTY D., ALI M. B., SINGH N., HAHN E. J., PAK K. Y. (2007). Influence of GA₃, sucrose and solid medium/bioreactor culture on *in vitro* flowering of *Spathiphyllum* and association of glutathione metabolism. *Plant Cell, Tissue and Organ Culture*, 90: 225-235.
- DUCOS J.-P., LAMBOT C., PÉTIARD V. (2007). Bioreactors for coffee mass propagation by somatic embryogenesis. *International Journal of Plant Developmental Biology*, 1: 1-12.
- EIBL R., EIBL R. (2006). Design and use of the wave bioreactor for plant cell cultures. *In: Dutta Gupta S., Ibaraki Y. (Eds). Engineering for Plant Tissue Culture, Frontiers of Biotechnology Vol. 6, Springer-Verlag, Heidelberg Germany: 203-229.*
- ESCALONA M., SAMSON G., BORROTO M., DESJARDINS Y. (2003). Physiology of effects of temporary immersion bioreactors on pineapple plantlets. *In Vitro Cellular & Developmental Biology-Plant*, 39: 651-656.
- ETIENNE E., BERTHOULY M. (2002). Temporary immersion systems in plant micropropagation. *Plant Cell Tissue and Organ Culture*, 69: 215-231.
- FÁRI M. G., KERTÉSZ T., LÁSZLÓ M., VARGA Z. (2006). Design of a revert rotary plant micropropagation bioreactor - '3R' system. Application for research, possibilities of scaling-up and limitations. *Acta Horticulturae*, 725: 561-570.
- FÁRI M., KERTÉSZ T., PALUSKA F. (2008). Berendezés és eljárás növények tömeges, programozható mikroszaporítására. Hungarian Patent Office, Budapest, Hungary, No. P 09 00018, 07. 10. 2008 (in Hungarian).
- FIROOZABADY E., GUTTERSON N. (2003). Cost-effective propagation methods in pineapple. *Plant Cell Reports*, 21: 844-850.
- GEORGE E., HALL M., DE KLERCK G. J. (2008). *Plant propagation by tissue culture*, Edition 3, vol. 1, Springer, Dordrecht, the Netherlands: 134.
- GOLLAGUNTA V., ADELBERG J., RAJAPAKSE N., RIECK J. (2004). Media composition affects carbohydrate status and quality of *Hosta toku-*

- dama Tratt. 'Newberry Gold' microporpagules during low temperature storage. *Plant Cell, Tissue and Organ Culture*, 77: 125-131.
- IBARAKI Y., KURATA K. (1993). Comparison of culture methods from the viewpoint of nutrient movement. ASAE paper no. 934049, Presented Spokane WA, June 1993.
- JO E. A., MURTHY H. N., HAHN E. J., PAEK K. Y. (2008). Micropropagation of *Alocasia amazonica* using semisolid and liquid cultures. *In Vitro Cellular & Developmental Biology-Plant*, 44: 26-32.
- LIAN M. L., CHAKRABARTY D., PAEK K. Y. (2003). Bulblet formation from bulb scale segments of *Lilium* using bioreactor system. *Biologia Plantarum*, 46: 199-203.
- KUMAR P., GEETHA S., SAVIRITHI P., JAGADEESWARAN R., MAHNENDRAN P. (2003). Diagnosis of nutrient imbalances and derivation of new RPZI (Reference population zero index) values using DRIS/MDRIS and CND in leaves of turmeric (*Curcuma longa* L.) *Journal of Applied Horticulture*, 5: 7-10.
- MAKI S., DELGADO M., ADELBERG J. (2005). Time course study of ancymidol for use in micropropagation of Hosta. *HortScience*, 40: 764-766.
- MURASHIGE T., SKOOG F. (1962). A revised medium for rapid growth and bio-assays with tobacco tissue cultures. *Physiologia Plantarum*, 15: 473-497.
- MURASHIGE T., SHABDE M., HASEGAWA P., TAKATORI F., JONES J. (1972). Propagation of asparagus through shoot apex culture I. Nutrient medium for formation of plantlets. *Journal of the American Society of Horticultural Science*, 97: 158-161.
- NIRMAL BABU K., MINNOO D., GEETHA S., SUMANTHI P., PARVEEN K. (2003). Biotechnology of turmeric and related species. *In: Ravindran P., Nirmal Babu K., Sivaraman K. (Eds). Turmeric, The Genus Curcuma. CRC Press, Boca Raton FL.: 107-123.*
- PAEK K. Y., CHAKRABARTY D., HAHN E. J. (2005). Application of bioreactor systems for large scale production of horticultural and medicinal plants. *Plant Cell, Tissue and Organ Culture*, 81: 287-300.
- PAEK K. Y., HAHN E. J., SON S. H. (2001). Application of bioreactor cultures for the large-scale micropropagation of plants. *In Vitro Cellular & Developmental Biology-Plant*, 37: 284-292.
- SIVAKUMAR G., KIM S. J., HAHN E. J., PAEK K. Y. (2005). Optimizing environmental factors for large-scale multiplication of chrysanthemum (*Chrysanthemum grandiflorum*) in balloon-type bioreactor culture. *In Vitro Cellular & Developmental Biology-Plant*, 41: 822-825.
- TAKAYAMA S., AKITA M. (2006). Bioengineering aspects of bioreactor application in plant propagation. *In: Dutta Gupta S., Ibaraki Y. (Eds). Engineering for Plant Tissue Culture, Frontiers of Biotechnology Vol. 6, Springer-Verlag, Heidelberg Germany: 81-98.*
- TOWLER M., KIM Y., WYZLOUZIL B., CORRELL M., WEATHERS P. (2006). Design development and applications of mist bioreactors for micropropagation and hairy root culture. *In: Dutta Gupta S., Ibaraki Y. (Eds). Engineering for Plant Tissue Culture, Frontiers of Biotechnology Vol. 6, Springer-Verlag, Heidelberg Germany: 119-131.*
- ZIV M. (1992). The use of growth retardants for the regulation and acclimatization of *in vitro* plants. *In: Karsen C., Van Loon L., Vregdenhil D. (Eds). Progress in plant growth and regulation. Kluwer Academic Publishers, Dordrecht, The Netherlands: 809-817.*
- ZIV M. (1999). Organogenic plant regeneration in bioreactors. *In: Altman A., Ziv M., Izhar S. (Eds). Plant Biotechnology and In Vitro Biology in the 21st Century. Kluwer Academic Publishers, Dordrecht, The Netherlands: 673-679.*
- ZIV M., SHEMESH D. (1996). Propagation and tuberization of potato bud clusters from bioreactor culture. *In Vitro Cellular & Developmental Biology-Plant*, 32: 31-36.