

USEFULNESS OF THIN CELL LAYERS IN PLANT TRANSFORMATION

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REFERENCES

- Attree S. M., Fowke L. C. (1993). Embryogeny of gymnosperms: advances in synthetic seed technology of conifers. *Plant Cell Tissue and Organ Culture*, 35: 1-35.
- Bilkey P. C., Cocking E. C. (1981). Increased plant vigor by *in vitro* propagation of *Saintpaulia ionantha* Wendl. from sub-epidermal tissue. *Horticultural Science*, 16: 643-644.
- Bozhkov P. V., Park Y. G. (1996). Conifer somatic embryogenesis: new knowledge in plant biology and breakthrough in tree biotechnology. *Journal of the Korean Forestry Society*, 85: 667-679.
- Bui V. L., Nhut D. T. (2001). Thin Cell Layer Morphogenesis in Ornamental Plant. *In: Chadha K. L., Ravindran P. N. and Leela Sahijram (Eds.), Biotechnology in Horticultural and Plantation Crops*. Malhotra Publishing House, New Delhi, India: 678-703.
- Bui V. L., Nghieng Thao D. M., Gendy C., Vidal J., Tran Thanh Van K. (1997). Somatic embryogenesis on thin cell layers of a C₄ species, *Digitaria sanguinalis* (L.) Scop. *Plant Cell Tissue and Organ Culture*, 49: 201-208.
- Bui V. L., Nghieng Thao D. M., Gendy C., Vidal J., Tran Thanh Van K. (1998). Transformation of a C₄ monocot, the *Digitaria sanguinalis* (Large grabgrass) using somatic embryogenesis induced on Thin Cell Layers. Abst P191, 9th International Congress on Plant Tissue and Cell Culture, Jerusalem, Israel, 14-19 June.
- Bui V. L., Nhut D. T., Tran Thanh Van K. (1999). Plant production via shoot regeneration from thin cell layer pseudo-bulb explants of *Lilium longiflorum in vitro*. *Compte Rendu de l' Académie de la Science, Paris*, 322: 303-310.
- Carimi F., De Pasquale F., Crescimanno F. G. (1999). Somatic embryogenesis and plant regeneration from pistil thin cell layers of Citrus. *Plant Cell Reports*, 18: 935-940.
- Charest P. J., Holbrook L. A., Gabrad J., Iyer V. N., Miki B. I. (1988). *Agrobacterium*-mediated transformation of thin cell layer explants from *Brassica napus*. L. *Theoretical and Applied Genetics*, 75: 438-445.
- Chen L., Zhang S., Beachy R. N., Fauquet C. M. (1998). A protocol for consistent, large-scale production of fertile transgenic rice plants. *Plant Cell Reports*, 18: 25-31.
- Cheng M., Fry J. E., Pang S., Zhou H., Hironaka C. M., Duncan D. R., Conner T. W., Wan Y. (1997). Genetic transformation of wheat mediated by *Agrobacterium tumefaciens*. *Plant Physiology*, 115: 971-980.
- Chlyah A., Tran Thanh Van K. (1974). Histological changes in epidermal and subepidermal cell layers of *Begonia rex* induced to form de novo unicellular hairs, buds and roots. *Botanical Gazette*, 145: 55-59.
- Chlyah A., Tran Thanh Van M. (1975). Differential reactivity in epidermal cells of *Begonia rex* excised and grown *in vitro*. *Physiologia Plantarum*, 35: 16-20.
- Compton M. E., Veuilleux R. E. (1992). Thin Cell Layer morphogenesis. *Horticultural Review*, 14: 239-264.
- Cruz-Hernandez A. W., Litz R. E., Lim M. G. (1998). *Agrobacterium tumefaciens*-mediated transformation of embryogenic avocado cultures and regeneration of somatic embryos. *Plant Cell Reports*, 17: 497-503.
- da Silva J. A. T. (2001). TCL technology for manipulating chrysanthemum organogenesis. Abstract of the 17th International Congress for Plant Growth Substances. Brno, Czech Republic: 115.
- da Silva J. A. T., Nhut D. T. (2002). Control of plant organogenesis: genetic and biochemical signals in plant organ form and development. *In: Nhut D. T., Bui V. L., Tran Thanh Van K., Thorpe T. (Eds.). Plant Thin Cell Layer Culture System: Regeneration and Transformation Application*. Kluwer Academic Publishers, The Netherlands: 122-176.

- de Vries S. C. (1998). Making embryos in plants. *Trends in Plant Science*, 3: 451-452.
- Gamborg O. L., Miller R. A., Ojima K. (1968). Nutrient requirements of suspension cultures of soybean root cells. *Experimental Cell Research*, 50: 151-158.
- Gendy C., Sene M., Bui V. L., Vidal J., Tran Thanh Van K. (1996). Somatic embryogenesis and plant regeneration in *Sorghum bicolor* (L.) Moench. *Plant Cell Reports*, 15: 900-904.
- Gill R., Gerrath J., Saxena P. K. (1992). High-frequency direct embryogenesis in thin layer cultures of hybrid seed geranium (*Pelargonium*). *Canadian Journal of Botany*, 71: 408-13
- Goh C. J., Nathan M. J., Kumar P. P. (1995). Direct organogenesis and induction of morphogenic callus through thin section culture of *Heliconia psittacorum*. *Scientia Horticulturae*, 62: 113-120.
- Hoshino Y., Zhu Y. M., Nakano M., Takahashi E., Mii M. (1998). Production of transgenic grapevine (*Vitis vinifera* L. cv. Koshusanjaku) plants by co-cultivation of embryogenic calli with *Agrobacterium tumefaciens* and selecting secondary embryos. *Plant Biotechnology*, 15: 29-33.
- Ibaraki Y., Kurata K. (2001). Automation of somatic embryo production. *Plant Cell Tissue and Organ Culture*, 65: 179-199.
- Jullien F. Tran Thanh Van K. (1994). Micropropagation and embryoid formation from young leaves of *Bambusa glaucescens* 'Golden Goddess'. *Plant Science*, 98: 199-207.
- Jungnickel F., Zaid S. (1992). Micropropagation of African Violets (*Saintpaulia* spp. and cvs.). In: Bajaj Y.P.S. (Ed.). *Biotechnology in Agriculture and Forestry, High-Tech. and Micropropagation IV*, Springer-Verlag Berlin, 20: 357-395.
- Krysiak C., Mazuś B., Buchowicz J. (1999). Generation of DNA double-stranded breaks and inhibition of somatic embryogenesis by tungsten microparticles in wheat. *Plant Cell Tissue and Organ Culture*, 58: 163-170.
- Lakshmanan P., Loh C. S., Goh C. J. (1995). An *in vitro* method for rapid regeneration of a monopodial orchid hybrid *Aranda* Deborah using thin section culture. *Plant Cell Reports*, 14: 510-514.
- Lakshmanan P., Taji A. (2000) Somatic embryogenesis in leguminous plants. *Plant Biology*, 2: 136-148.
- Lee-Stadlmann O. Y., Lee S., Hackett W. P., Read P. E. (1989). The formation of adventitious buds in vitro on micro-sections of hybrid *Populus* leaf mid veins. *Plant Science*, 61: 263-272.
- Luthra R., Dubey R. K., Srivastava A. K., Kumar S. (1997). Microprojectile mediated plant transformation: a bibliographic search. *Euphytica*, 95: 269-294.
- May R. A., Trigiano R. N. (1991). Somatic embryogenesis and plant regeneration from leaves of *Dendranthema grandiflora*. *Journal of the American Society for Horticultural Science*, 116: 366-371.
- Mulin M., Tran Thanh Van K. (1989). Obtention of *in vitro* flowers from thin epidermal cell layers of *Petunia hybrida* (Hort.) *Plant Science*, 62: 113-121.
- Murashige T., Skoog F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiologia Plantarum* 15: 473-496.
- Nhut D. T., Bui V. L., Tran Thanh Van K. (2000). Somatic embryogenesis and direct shoot regeneration of rice (*Oryza sativa* L.). *Journal of Plant Physiology*, 157: 559-565.
- Nhut D. T., Bui V. L., Tran Thanh Van K. (2001). Manipulation of the morphogenetic pathways of *Lilium longiflorum* transverse thin cell layer explants by auxin and cytokinin. *In Vitro Cellular and Developmental Biology – Plant*, 37: 44-49.
- Ninković S., Miljuš-Djukić J., Nešković M. (1995). Genetic transformation of alfalfa somatic embryos and their clonal propagation through repetitive somatic embryogenesis. *Plant Cell Tissue and Organ Culture*, 42: 255-260.
- Otani M., Shimada T., Kimura T., Saito A. (1998). Transgenic plant production from embryogenic callus of sweet potato (*Ipomoea batatas* (L.) Lam.) using *Agrobacterium tumefaciens*. *Plant Biotechnology*, 15: 11-16.
- Pelissier B., Boucheffa O., Pepin R., Freyssinet G. (1990). Production of isolated somatic embryos from sunflower thin cell layers. *Plant Cell Reports*, 9: 47-50.
- Raemakers C. J. J. M., Jacobsen E., Visser R. G. F. (1995). Secondary somatic embryogenesis and applications in plant breeding. *Euphytica*, 81: 93-107.
- Rajasekaran K., Hudspeth R. L., Cary J. W., Anderson D. M., Cleveland T. E. (2000). High-frequency stable transformation of cotton (*Gossypium hirsutum* L.) by particle bombardment of embryogenic cell suspension cultures. *Plant Cell Reports*, 19: 539-545.
- Rout G. R., Debata B. K., Das P. (1991). Somatic embryogenesis in callus culture of *Rosa hybrida* L. cv. Landora. *Plant Cell Tissue and Organ Culture*, 27:65-69.
- Rout G. R., Samantaray S., Das P. (1998). *In vitro* propagation of woody ornamentals: a review. *Proceedings of the National Academy of Science India Section Biological Sciences*, 68: 91-106.
- Rout G. R., Samantaray S., Das P. (2000). Biotechnology of the banana: a review of recent progress. *Plant Biol-*

- ogy, 2: 512-524.
- Sarria R., Torres E., Angel F., Chavarriaga P., Roca W. M. (2000). Transgenic plants of cassava (*Manihot esculenta*) with resistance to Basta obtained by Agrobacterium-mediated transformation. *Plant Cell Reports*, 19: 339-344.
- Simmonds D. H., Donaldson P. A. (2000). Genotype screening for proliferative embryogenesis and biolistic transformation of short-season soybean genotypes. *Plant Cell Reports*, 19: 485-490.
- Snyder G. W., Ingersoll J. C., Smigocki A. C., Owens L. D. (1999). Introduction of pathogen defense genes and a cytokinin biosynthesis gene into sugarbeet (*Beta vulgaris* L.) by *Agrobacterium* or particle bombardment. *Plant Cell Reports*, 18: 829-834.
- Tanaka K., Kanno Y., Kudo S., Suzuki M. (2000). Somatic embryogenesis and plant regeneration in chrysanthemum [*Dendranthema grandiflorum* (Ramat.) Kitamura]. *Plant Cell Reports*, 19: 946-953.
- Tokuji Y., Fukuda H. (1999). A rapid method for transformation of carrot (*Daucus carota* L.) by using direct somatic embryogenesis. *Bioscience, Biotechnology and Biochemistry*, 63: 519-523.
- Tran Thanh Van K. (1980). Control of morphogenesis by inherent and exogenously applied factors in thin cell layers. *International Review of Cytology*, 32: 291-311.
- Tran Thanh Van K. (1981). Control of morphogenesis. *Annual Review of Plant Physiology*, 32: 291-311.
- Tran Thanh Van K. (1991). Molecular aspects of flowering. *In: Harding J., Singh F., Mol J. N. M. (Eds.) Genetic and Breeding of ornamental plants*. Springer-Verlag, Berlin, Heidelberg, New York: 367-385.
- Tran Thanh Van K., Richard L., Gendy C. A. (1990). An experimental model for the analysis of plant cell differentiation: thin cell layer. Concept, strategy, methods, records and potential. *In: Durzan D. and Rodriguez R. (Eds.) NATO Biotechnology series*, Plenum press, New York: 215-224.
- Tran Thanh Van K., Yilmaz A., Trinh T. H. (1985). Who to programme *in vitro* different morphogenetic expression in some conifers. *In: Bonga J. M., Durzan D. J. (Eds.) Cell and Tissue Culture in Forestry*. Martinus Nijhoff Publisher, Dordrecht: 168-182.
- Tran Thanh Van M. (1973a). *In vitro* control of de novo flower, bud, root and callus differentiation from excised epidermal tissues. *Nature*, 246: 44-45.
- Tran Thanh Van M. (1973b). Direct flower neoformation from superficial tissue of small explant of *Nicotiana tabacum*. *Planta*, 115: 87-92.
- Trinh T. H., Mante S., Pua E. C., Chua N. H. (1987). Rapid production of transgenic flowering shoots and F₁ progeny from *Nicotiana plumbaginifolia* epidermal peels. *Biotechnology*, 5: 1081-84.
- Urban L. A., Sherman J. M., Moyer J. W., Daub M. E. (1994). High frequency shoot regeneration and *Agrobacterium*-mediated transformation of chrysanthemum (*Dendranthema grandiflora*). *Plant Science*, 98: 69-79.
- Vivier M. A., Pretorius I. S. (2000). Genetic improvement of grapevine: tailoring grape varieties for the third millennium: a review. *South African Journal of Enology and Viticulture*, 21: 5-26.
- Walden R., Wingender R. (1995). Gene transfer and plant regeneration techniques. *TIBTECH*, 13: 324-331.
- Walter C., Grace L. J., Wagner A., White D. W. R., Walden A. R., Donaldson S. S., Hinton H., Gardner R. C., Smith D. R. (1998). Stable transformation and regeneration of transgenic plants of *Pinus radiata* D. Don. *Plant Cell Reports*, 17: 460-468.
- Wang M-B., Abbott D. C., Upadhyaya N. M., Jacobsen J. V., Waterhouse P. M. (2001) *Agrobacterium tumefaciens*-mediated transformation of an elite Australian barley cultivar with virus resistance and reporter genes. *Australian Journal of Plant Physiology*, 28: 149-156.