UNIVERSITI PUTRA MALAYSIA

IN VITRO AND IN VIVO REGENERATION OF ORYZA SATIVA L. cv. MR219 AND ZEA MAYS L. var. RUGOSA BY APICAL MERISTEM TISSUES

LAVANYA SILVARAJAN

FS 2013 36

IN VITRO AND *IN VIVO* REGENERATION OF *ORYZA SATIVA* L. cv. MR219 AND *ZEA MAYS* L. var. *RUGOSA* BY APICAL MERISTEM TISSUES

By

LAVANYA SILVARAJAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Master of Science

January 2013

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

IN VITRO REGENERATION OF _ORYZA SATIVA_ L. cv. MR219 AND _ZEA MAYS_ L. var. _RUGOSA_ BY APICAL MERISTEM TISSUES

By

Lavanya Silvarajan

Chairman : DR. Rosimah Nulit, PhD

Faculty : Science

Conventional propagation of important cereal crops such as corn and rice are vulnerable to unpredictable climatic changes. To ensure the constant availability of these crops, it is important to look towards alternative propagation methods such as *in vitro* regeneration. To date, there are limited reports of an ideal *in vitro* regeneration protocol of both rice and corn from shoot apical meristem (SAM) and no reports on root apical meristem (RAM) as explant. Thus, the objective of the present study is to establish an ideal *in vitro* regeneration system for Malaysian *indica* rice MR219 and Thai Super Sweet corn. Regeneration was successfully achieved by means of shoot and root apical meristem (SAM and RAM) obtained from 4-day old germinating seedlings through tissue culture. The study found that primary shoot was successfully induced from SAM and RAM of MR219 rice on liquid MS medium supplemented with 0.1 mg L^{-1} KIN (kinetin) and 0.2 mg L^{-1} KIN respectively. Vigorous primary shoots were induced from SAM and RAM of Thai Super Sweet corn on liquid MS medium supplemented with 0.15 mg L^{-1} KIN and only liquid MS medium respectively. Following this, shoot multiplication from SAM of MR219 rice was highest on solid MS medium supplemented with a combination of 1.5 mg L^{-1} KIN and 0.05 mg L^{-1} IAA (indole-3-acetic-acid) with an average of 8.8 ± 0.22 shoots. RAM of

MR219 rice required solid MS medium supplemented with a combination of 2.0 mg L^{-1} KIN and 0.05 mg L^{-1} IAA with an average of 5.7± 0.17 shoots. Shoot multiplication of Thai Super Sweet corn was highest for SAM and RAM on solid MS medium supplemented with a combination of 3.0 mg L^{-1} KIN and 0.01 mg L^{-1} IAA and solid MS medium supplemented with a combination of 3.0 mg L^{-1} KIN and 0.15 mg L^{-1} IAA with an average of 13.1 ± 0.16 and 6.3 ± 0.19 shoots. In both species, shoot multiplication was in concomitant with root formation for both explants on ideal treatments. Regenerated plantlets survived greenhouse conditions upon acclimatization with a satisfying survival rate of more than 80% and 60% for plantlets produced from SAM and RAM of both species respectively. In conclusion, the highly efficient and economic protocol suggested in this study can be applied as an alternative to conventional propagation method for the large-scale production of MR219 rice and Thai Super Sweet corn throughout the year.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

REGENERASI *IN VITRO ORYZA SATIVA* L. cv. MR219 DAN *ZEA MAYS* L. var. *RUGOSA* MELALUI TISU EPIKAL MERISTEM

Pembiakan konvensional padi dan jagung menghadapi pelbagai kekangan seperti kekangan biotik dan abiotik. Untuk memastikan ketersediaan bekalan bijirin-bijirin ini bagi memenuhi permintaan pengguna, kaedah pembiakan alternatif seperti regenerasi *in vitro* adalah penting. Laporan regenerasi *in vitro* padi dan jagung melalui kaedah tisu kultur menggunakan tisu meristem (SAM dan RAM) adalah terhad. Oleh itu, objektif kajian ini adalah untuk menghasilkan sistem regenerasi *in vitro* untuk padi Malaysia MR219 dan jagung "Thai Super Sweet" melalui kultur tisu menggunakan tisu SAM dan RAM yang telah diperoleh daripada plumul dan radikel anak benih yang bercambah sebagai eksplan. Pucuk utama berjaya dihasilkan daripada SAM dan RAM padi MR219 dalam media cecair MS yang ditambah 0.1 mg L^{-1} KIN and 0.2 mg L^{-1} KIN masing-masing. Manakala, bagi jagung "Thai Super Sweet", pucuk utama telah berjaya dihasilkan daripada SAM and RAM dalam media cecair MS yang ditambah 0.15 mg L^{-1} KIN dan media tanpa zat pengatur tumbuhan. Pertumbuhan dan pemanjangan pucuk daripada SAM padi MR219 paling optimum (8.8 ± 0.22 pucuk/daun) dalam media pepejal MS media yang ditambah kombinasi 1.5 mg L^{-1} KIN dan 0.05 mg L^{-1} IAA. Manakala, RAM padi MR219 memerlukan media pepejal MS yang ditambah kombinasi 2.0 mg L^{-1} KIN dan 0.05 mg L^{-1} IAA dengan purata 5.7 ± 0.17 pucuk/daun. Pertumbuhan pucuk daripada SAM jagung "Thai Super Sweet" paling optimum dalam media pepejal MS yang ditambah kombinasi 3.0 mg L^{-1} KIN dan 0.01 mg L^{-1} IAA, Manakala, RAM memerlukan media pepejal MS ditambah kombinasi 3.0 mg L^{-1} KIN dan 0.15 mg L^{-1} IAA. Pertumbuhan pucuk daripada eksplan kedua-dua spesies berlaku seiring formasi dan pertumbuhan akar. Anak

pokok yang berjaya diregenerasi menunjukkan pertumbuhan normal setelah diaklimatisasi. Purata kadar mandiri anak pokok yang dihasilkan daripada SAM melebihi 80%, manakala anak pokok yang dihasilkan daripada RAM melebihi 60% bagi kedua-dua spesies. Maka, secara keseluruhan, SAM merupakan eksplan yang lebih efisen berbanding RAM. Sebagai kesimpulan, protocol regnerasi *in vitro* yang telah dihasilkan dalam kajian ini boleh digunapakai sebagai alternatif kepada pembiakan konvensional untuk meningkatkan pengeluaran padi MR219 dan jagung "Thai Super Sweet" bagi memenuhi permintaan pengguna sepanjang tahun.

ACKNOWLEDGEMENTS

First and foremost, I am grateful to God for His blessing that has enabled me to successfully complete my thesis. I would like to take this opportunity to express my utmost and sincere appreciation to my supervisor, Dr. Rosimah Nulit for her patience, continuous guidance, knowledge, experience, dedication and most of all, for believing in me and this research. Her sincere supervision, confidence and advice have guided me to complete my thesis successfully. In addition to this, I would like to extend my utmost appreciation to Associate Professor Dr. Faridah Qamaruz Zaman, my co-supervisor for all the advice and supervision given throughout my research.

I would also like to thank my friends and my lab partners for their sharing knowledge and companionship whilst conducting experiments in our lab. Additionally, my appreciation is extended to the staffs of the Biology Department for their assistance for the usage of laboratory equipments. I am grateful to MARDI Tanjung Karang and MARDI Serdang for providing me with MR219 rice and Thai Super Sweet corn seedlings for this research.

Besides the above appreciation, this is definitely a great opportunity to express my honest gratitude to Research University Grant Scheme (RUGS) for funding my research. Last but not least, my heartiest appreciation is extended to my family, my father Silvarajan Perumal, my mother Sushila Kannian and sister Ratheega for their constant moral support, encouragements, and also for their believe in me throughout my life.

The word Thank you will not be able to express my gratefulness to all of you and only God can repay all of your kindness.

DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been dully acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

_____

LAVANYA SILVARAJAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

2,4-D	2,4-Dichlorophenoxyacetic acid
2ip	6-(gamma,gamma-Dimethylallylamino) purine
ANOVA	Analysis of Variance
BAP	6-Benzylaminopurine
BERNAS	Padiberas Nasional Berhad
CPA	Cyproterone acetate
cv.	Cultivar
cm	Centimeter
DOA	Department of Agriculture
FAO	Food and Agriculture Organization
g	grams
$g\ L^{-1}$	grams per liter
ha	Hectare
IAA	Indole-3- acetic acid
IBA	Indole-3- butyric acid
KIN	Kinetin
L	Liter
LAF	Laminar Air Flow
MADA	MUDA Agricultural Development Authority
MARDI	Malaysian Agricultural Research and Development Institute

mg L^{-1}	Miligrams per liter
Min	Minutes
mm	Milimeter
mL	Mililiter
MT	Metric Ton
NAA	1-naphthaleneacetic-acid
PGR	Plant Growth Regulators
ppm	Parts per million
RAM	Root Apical Meristem
SAM	Shoot Apical Meristem
SE	Standard Error
SPSS	Statistical Package for the Social Sciences
USDA	United States Department of Agriculture
var.	Variety
^{o}C	Degree celcius
(v/v)	Volume over volume
%	Percent

CHAPTER 1

INTRODUCTION

Cereal crops are important worldwide as a major food source for human and their domesticated animals. Among these, rice serves as a staple food in many countries throughout the world, whereas corn is one of the most important cereal crops in the world. In Malaysia, MR219 is currently the most popular rice variety grown since its release in 2001 while Thai Super Sweet corn is increasing in popularity due to its delicious taste, high sugar content and long shelf life.

Presently, Malaysia's rice self-sufficiency stands at 72% while domestic corn production is insignificant. Hence, Malaysia still depends on imports to meet any further increase in consumer demand. In addition to this, conventional propagation of these crops is vulnerable to climatic uncertainties. Moreover, rice and corn are subjected to diseases especially in temperate and tropical regions such as Asia. This poses a major biological restriction on production of these important cereal crops. Due to this, the current rice self-sufficiency rate is expected to decline and dependency on corn imports is expected to increase in Malaysia.

With the increasing population, it is vital to improve the production of local crop varieties, as loss in production may lead to hunger and famine, especially in developing countries such as Malaysia. As such, it is imperative for Malaysia to look towards alternative methods of propagation to achieve rice self-sufficiency and decrease dependency on corn imports. The alternative method proposed should overcome disadvantages faced by conventional propagation methods, hence, should be independent of limitations such as environmental factors, availability of land,

disease and seasonal constraints. The high potential alternative method proposed in this study is *in vitro* plant regeneration.

Generally, *in vitro* regeneration has superiority over conventional propagation methods due to production of disease free plants at high multiplication rate and plantlets produced establish faster, healthier, and stronger, have shorter production cycle and higher yields (Darvari *et al.,* 2010). However, the establishment of a highly ideal protocol depends on suitable explants, plant growth regulators (PGRs), media composition as well as appropriate physical and chemical environments.

Preceding studies available on the *in vitro* regeneration of rice and corn involved laborious and time-consuming methods due to the long intermediate callus phase, which required sub-culturing. Moreover, there are no reports of an ideal regenerative protocol for rice and corn that bypasses the intervening callus phase. A protocol such as this could minimize somaclonal variation.

Using meristem tissue as an explant and modifying PGRs within the culture medium are two most effective ways to establish an ideal *in vitro* regeneration protocol (George *et al.,* 2008) that not only avoids intermediate callus formation but is also efficient, economic and time saving. Organogenesis (shoot induction) can be achieved directly from meristem tissue (Alam *et al.,* 2010) due to its high sustainability, totipotency and plasticity.

Two important meristematic regions of a plant are the shoot apical meristem (SAM) and root apical meristem (RAM). Although many tissue culture studies thus far have

utilized SAM as an explant, RAM is a less popular choice of explant in comparison. However, RAM is a potentially efficient source of explant for regeneration if shoot can be regenerated from root meristem. This can be achieved through the modification of PGRs within growth medium.

To date, there are limited reports of an ideal *in vitro* regeneration protocol of both rice and corn from SAM and no reports on RAM as explant. Therefore, the present study was undertaken to research avenues based on the following objectives.

1) To establish an efficient *in vitro* regeneration protocol for *indica* rice (*Oryza sativa* L. cv. MR219) and Thai Super Sweet Corn (*Zea mays* L. var. *rugosa*) by shoot and root apical meristem tissue.

2) To study the effects of plant growth regulators towards the *in vitro* regeneration of *indica* rice (*Oryza sativa* L. cv. MR219) and Thai Super Sweet corn (*Zea mays* L. var. *rugosa*) by shoot and root apical meristem tissue.

REFERENCES

Aamir Ali., Naz, S., Siddiqui, F.A., & Iqbal, J. (2008). An efficient protocol for large-scale production of sugarcane through micropropagation. *Pak. J. Bot.*, 40(1): 139-149.

Adeniyi, O. J., Adetimirin, V.O., Ingelbrecht, I & Asiedu, R. (2008). Shoot and plantlet regeneration from meristems of *Dioscorea rotundata* Poir and *Dioscorea alata* L. *AJB*- Vol. 7(8): 1003-1008.

Agriculture and Agro-based Industries Ministry. (2012). Available online: - http://www.malaysia.gov.my/agricultureandagrobasedindustry.

Ahmad, S & Ismail, M.R. (2009). Deterministic model approaches in identifying and quantifying technological challenges in rice production and research and in predicting population, rice production and consumption in Malaysia. *Pertanika J. Trop. Agric. Sci*. Vol. 32 (2): 1511-3701

Ahmad, A., Zhong, H., Wang, W., Sticklen, M.B. (2002). Shoot apical meristem: *In vitro* regeneration and morphogenesis in wheat (*Triticuma estivum* L.). *In Vitro Cell. Dev. Biol*. Plant -38:163-167.

Ahmadabadi, M., Ruf, S., Bock, R. (2007). A leaf based regeneration and transformation system for maize (*Zea mays* L.). *Transgenic Res*. 16: 437-448.

Akbar, M.A., Roy, S.K. (2006). Effects of Liquid Medium on Rooting and Acclimation of Regenerated Microshoots of Banana (*Musa sapientum* L.) cv. Sagar. *Plant Tiss. Cult. Biotechnol*. 16(1): 11-18.

Ali, A., Sajid, A., Naveed, N.H., Majid, A., Saleem, A., Khan, U.A. (2011). Initiation, proliferation and development of micro-propagation system for mass scale production of banana through meristem culture. *African Journal of Biotech:* 1684-5315.

Al-Khayri, J.M. & Al-Bahrany. A.M. (2002). Callus growth and proline accumulation in response to sorbitol and sucrose induced osmotic stressing rice. *Biol. Plant.*, 45: 609-611.

Alam I., Sharmin S.A, Naher M.K., Alam M.J., Anisuzzaman M & Alam M.F.(2010). Effect of growth regulators on meristem culture and plantlet establishment in sweet potato. *Plant Omics Journal*. 3:1836-3644.

Alam MF., Banu MLA., Swaraz AM., Parvez S., Hossain M., Khalekuzzaman M., Ahsan N. (2004). Production of virus free seeds using meristem culture in tomato plant under tropical conditions. *J Plant Biotechnol* 6:221-227.

Altman, A & Hasegawa, P.M. (2012). Plant Biotechnology and Agriculture: Prospects for the 21st Century. *Chicago Journals*: 87:3 268-270.

Armiyanti, Kadir, M.A., Kadzimin, S & Panjaitan, S.B. (2010). Plant regeneration of *Michelia champaca* L., through somatic embryogenesis. *African Journal of Biotechnology*. 7: 1684-5315.

Ammirato, P.V. (1983). Embryogenesis. In: Handbook of Plant Cell Culture, Vol 1 (Eds.): D.A Evans, W.R. Sharp, P.V. Ammirato & Y. Yamada. (pp 74-123) *Macmillan*, New York.

Atak, C & Celik, O. (2009). Micropropagation on *Anthurium andraeanum* from leaf explants. Pakistan Journal of Bot. 41(3), 1155-1161.

Arinaitwe, G., Rubaihayo, P.R., Magambo, M.J.S. (2000). Proliferation rate effects of cytokinins on banana (*Musa* spp.) cultivars. *Sci. Hortic*. 86:13-21.

Arulselvi, P ., Krishnaveni S. (2009). Effect of hormones, explants and genotypes in *in vitro* culturing of sorghum. *Journal of Biochemical Technology*: 1(4):96-103.

Badoni, A. and J. S. Chauhan. (2009). Effect of growth regulators on meristem-tip development and *in-vitro* multiplication of potato cultivar 'Kufri Himalini'. *Nature and Sci*.7 (9): 31-34.

Ball, E. (1953). Hydrolysis of sucrose by autoclaving media, a neglected aspect in the culture of plant tissues. *B. Torrey Bot. Club* 80: 409-411.

Bano S., Jabeen M., Rahim F., Ilahi I. (2005). Callus induction and regeneration in seed explants of Rice (*Oryza sativa* cv. Swat-II). *Pak. J. Bot*. 37: 829-836.

Baruah, W. J., Harwood, W. A., Lonsdale, D. A., Harvey, A., Hull, R., Snape, J. W. (1999). Luciferase as a reporter gene for transformation studies in rice (*Oryza sativa* L.). *Plant Cell Rep*. 18:715-720.

Bermejo, C., Espósito, M.A., Cravero, V. (2011). *In vitro* plant regeneration from cotyledonary nodes of recombinant inbred lines of lentil. *Scientia Horticulturae* :134 (2012) 13–19

BERNAS.(2012). Shrinking land spells trouble for rice production in Malaysia. Retrieved 30th March 2012 from http://www.bernas.com.gov.

Beckingham, C. (2007). Commodity growing guides- Sweet corn.*NSW Department of Primary Industries*. Available online. http://www.dpi.nsw.gov.au/agriculture/horticulture/ vegetables/commodity/sweet-corn. NSW, Australia.

Bhojwani, S.S Rajdhan MK (1996). Plant Tissue Culture: Theory and Practice. (pp 483-586). Revised: *Elsevier,* Amstredam.

Bhojwani, S.S & Rajdhan MK (2004). Plant Tissue Culture and Practice, a revised edition, Panima Publishing Corp New Delhi.

Biswas, M.K., Hossain, M., Islam, R. (2007). Virus free plantlet production of strawberry through meristem culture. *World Journal of Agricultural Science*: 757-763.

Boudolf, V., Vlieghe, K., Beemster, G.T.S., Magyar, Z., Torres Acosta, J.A., Maes, S., Van Der Schueren, E., Inze,´ D., De Veylder, L. (2004). The plant-specific cyclin dependent kinase CDKB1;1 and transcription factor E2Fa-DPa control the balance of mitotically dividing and endoreduplicating cells in *Arabidopsis*. *Plant Cell* 16: 2683–2692

Boudaoud A. (2010). An introduction to the mechanics of morphogenesis for plant biologists. *Trends in plant science* 15:353-360.

Bonga, J.M. & Von Aderkas,P. (1992). *In vitro* culture of trees. *Kluwer Academic Publishers*, Dordrecht, 2: 236.

Brown DC., Thorpe TA. (1986). Plant regeneration by organogenesis. In: Vasil IK (ed) Cell Culture and Somatic Cell Genetics of Plants .*Academic Press*, New York. 7: 36-45

Burstrom, H. (1957). Root surface development, sucrose inversion and free space. *Physiol. Plant.* 10, 741-751.

Calamar, A & De Klerk, G. J. M. (2002). Effect of sucrose on adventitious root regeneration in apple. *Plant Cell Tiss. Org. Cult*. 70:207-212.

Chandra, R. and R. K. Birhman .(1994). *In vitro* micro propagation in relation to pedigree in potato. *Journal of Indian Potato Association.* 21:87.

Cha-um, S., Thi-Thanh Hien, N & Kirdmanee, C. (2006). Disease-free Production of Sugarcane Varieties (*Saccharum officinarum* L.) Using *in vitro* Meristem Culture. *Biotechnology*,5:443-448.

Chang TT., Pan Y., Chu Q., Peiris R., Loresto GC. (1991). Cytogenetic, electrophoretic and root studies of javanica rices. In: Rice Genetics II. Proceedings of the Second International Rice Genetics Symposium (pp. 21-32). *International Rice Research Institute (IRRI), Manila, Philippines.*

Chang, C., Moll, B.A., Evenson, K.B., Guiltinan, M.J. (1996). *In vitro* plantlet regeneration from cotyledon, hypocotyl and root explants of hybrid seed geranium. *Plant Cell Tissue Organ Cult*. 45, 61–66.

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 Rep. 18:25-31.

Choi, P. S.; Soh, W. Y.; Liu, J. R. (1996). Somatic embryogenesis and plant regeneration in cotyledonary explant cultures of Chinese cabbage. *Plant Cell Tiss. Organ Cult.* 44:253–256.

Chowdhury, C. N., Tyagi, A. K., Maheswari, N., and Maheswari, S.C. (1993). Effect of L-proline and L-tryptophan on somatic embryogenesis and plant regeneration of rice (*Oryza sativa* L. cv. Pusha 169). *Plant Cell Tissue Org. Cult.* 32: 357-361.

Cleland RE. (1995) Auxin and cell elongation. In Plant hormones: Physiology, biochemistry and molecular biology. *Kluwer Academic Publishers*. 6:.214-227

Cosgrove DJ. (2000). Loosening of plant cell wall. *Nat Rev Mol Cell Biol.* 6:850-861.

Crisp P.; Walkey D. G. A.; Bellman E.; Roberts E. (1975). A mutation affecting curd colour in cauliflower (*Brassica oleracea* L. var. *botrytis* DC). *Euphytica* 24: 173–176.

Cuenca, B. & Vieitez, A.M. (2000). Influence of carbon source on shoot multiplication and adventitious bud regeneration in *in vitro* beech cultures. *Plant Growth Regul*. 32: 1–12.

Darvari FM., Sariah M., Puad MP., Maziah M. (2010). Micropropagation of some Malaysian banana and plantain (*Musa* sp.) cultivars using male flowers. *Afr. J. Biotechnol.* 9(16): 2360-2366.

Datta, S.K., Datta,K and Potrykus, I. (1990). Embryogenesis and plant regeneration from microspores of both indica and japonica rice (*Oryza sativa*). *Plant Sci.* 67(1): 83-88.

Datta SK. (2004). Rice Biotechnology—a need for developing countries. *AgBio Forum.* 7:31

Danckwardt-Lilliestrom C. (1957) Kinetin induced shoot formation from isolated roots of *Isatis tinctoria*. *Physiol Plantarum* 10: 794-7.

Danson, J.W.,Lagat, M., Mbogori, M. (2006). Screening tropical maize lines for the production and regeneration of friable and embryogenic Type II callus. *Afr. J. Biotechnol*. 5(23): 2367-2370.

Dello ioio R., Nakamura K., Moubayidin L., Perilli S., Taniguchi M., Morita MT., Aoyama T., Costantino P., Sabatini S. (2008). A genetic framework for the control of cell division and differentiation in the root meristem. *Science.* 322:1380-1384.

Devi, P., Zhong, H., Sticklen, M. B. (2000). *In vitro* morphogenesis of pearl millet (*Pennisetum glaucum*. L.): Efficient production of multiple shoots and inflorescences from shoot apices. *Plant Cell Rep*. 56:546-550.

Dewitte W & Murray JA. (2003). The plant cell cycle. *Annu Rev Plant Biol* 54:235-264.

Department of Agriculture (DOA). (2003). Available online :- http://www.doa.gov.my/infostat.

Dixon, R.A., Gonzales, R.A. (eds) (1985). Plant cell culture: a practical approach. Oxford University Press, New York Published by British Library Cataloguing in Publication Data.

Dobranszki, J & Teixeira da Silva, J.A. (2010). Micropropagation of apple: A review. *Biotechnology Advances*, 28,462-488.

Doerner P & Celenza J. (2000). How plant growth regulator is involved in cell control: In plant hormone research. *Springer* pp.1-27.

Edelman, J & Hanson, A.D. (1972). Photosynthesis by carrot tissue cultures. Planta 102: 11-25.

Endo, S., Sugita, K., Sakai, M., Tanaka, H., Ebinuma, H. (2002). Single-step transformation for generating marker-free transgenic rice using the ipt-type MAT vector system. *Plant J.* 30:115-122.

El-Itriby, H.A., Assem , S.K., Hussein, E.H.A., Abdel-Galil, F.M., Madkour, M.A. (2003). Regeneration and transformation of Egyptian maize inbred lines via immature embryo culture and a Biolistic particle delivery system. *In Vitro Cell. Dev. Biol.-Plant* 39: 524-531.

Elliott, R.F. (1969) Growth of excised meristem tip of kumara, *Ipomoea batatas* (L.) *Poir*. in axenic culture. *New Zealand J Bot* 7:158-166.

Farnham D.E., Benson G.O., Pearce R.B. (2003). Corn perspective and culture. Chapter 1. In Pj White, LA Johnson (Eds). Corn chemistry and technology (pp 1-31). 2nd Edition. *American Association of Cerial Chemicals, Inc*.

Finch R.P., Baset A.,.Slamet IH., Cocking E.C. (1992). *In vitro* shoot culture of wild *Orygae* and other grass species. *Plant Cell, Tissue and Organ Culture* 30: 31-39.

Food and Agriculture Organization of the United Nations, Rome. (2005). Proceedings of the FAO Rice conference 2004. Rice in global markets FAO commodities and trade proceedings. Issn: 1816-5303.

Food and Fertilizer Technology Center (FFTC). (2002). Research Highlights- MR219, a new high yielding rice variety with yields of more than 10mt/ha. *RH.*2002-10

Food and Agricultural Organization (2011). FAOSTAT. Available online : http://faostat.fao.org.

Furguson, J.D. (1967). The Nutrition of Excised Wheat Roots. *Physiologia Plantarum*: 0.1111/j.1399-3054.1967.

Fujimura R., Mori T., Ito J., Fujimoto H. (1965). Studies on the malformed tomato fruits. IV. Effect of treating time of hormone and high temperature on the occurrence of puffy fruits. *Hyogo Pref. Agric. Stn. Res. Rep.,* 13 63–68 . (pp60-63).

Gamborg, O.L. and Phillips, (1995). Plant Cell Tissue Organ Culture. *Narosa Publishing House, New Delhi,* 978-81-7319-101-5, pp: 56-93.

Gamborg, O.L. (2002). Plant Tissue Culture. Biotechnology. Milestones. *In vitro Cellular and Developmental Biology-Plant*. 38:84-92.

Ganeshan, S., Baga, M., Harvey, B. L., Rossnagel, G. B., Scoles, G. L., Chibbar, R. N. (2003). Production of multiple shoots from the Thidiazuron treated mature embryos and leaf base/apical meristems of barley (*Hordeum vulgare* L.). *Plant Cell Tiss. Organ Cult.* 73:57-64.

Gauchan, D.P. (2012). Effect of different sugars on shoot regeneration of Maize (*Zea Mays* L.). *Journal of Science, Engineering and Technology:* pp 119-124.

George, E. F.& Sherrington, P. D.(1984). Plant propagation by tissue culture. *Eversley Publishing House, England.*.

George E.F., Hall M.A., Klerk G.-J.D. (2008): Plant Propagation by Tissue Culture. Volume 1. *The Background, Springer, Dordrecht*. (pp 1-28).

Gless, C., Lorz, H., Jahne-Gartner, A. (1998). Transgenic oat plants obtained at high efficiency by microprojectile bombartment of leaf base segments. Journal of Plant Physiology: Vol:152-151:157.

Global Agriculture Information Network (2012).GAIN. Available online : *http://* www.fas.usda.gov/info/factsheets/reports.asp.

Greco B., Lomonaco, A.A., Boggini, B., Tomassini, C., Tanzanella O.A. (1990). Clonal propagation of rice through proliferation of axillary shoots. *Euphytica* 48 (2): 123-127.

Green CE, Phillips RL. (1975). Plant regeneration from tissue cultures of maize. *Crop Science*15: 417-421.

Gutierrez, C., Ramirez-Parra, E., Castellano, M., Carlos del Pozo, J.C. (2002) G_1 to S transition: more than a cell cycle engine switch. *Curr Opin Plant Biol* 5**:** 480–486.

Gupta, S & Mahalaxmi. (2009). *In vitro* high frequency direct plant regeneration from whole leaves of blackberry. *Scientia Horticulturae* 120- 22–26.

Haque, M. S., Wada, T., & Hattori, K. (2003). Shoot Regeneration and Bulblet Formation from Shoot and Root Meristem of Garlic cv Bangladesh Local. *Asian J. Plant Sci.*, Vol. 2,(pp 23-27), ISSN 1682-3974.

Hansen, G., Shillito, R. D., Chilton, M. D.(1997). T-strand integration in maize protoplasts after a codelivery of a T-DNA substrate and virulence genes. *Proc. Natl Acad. Sci.* USA 94:11726-11730.

Hazarika, B.N. (2003). Acclimatization of tissue cultured plants. *Curr. Sci.*, 85: 1704-1711.

Heath, J. D., Boulton, M. I., Raineri, D. M., Doty, S. L., Mushegian, A. R., Charles, T. C., Davies, J. W., Nester, E. W. (1997). Discrete regions of the sensor protein VirA determine the strain-specific ability of Agrobacterium to agroinfect maize. *Mol. Plant Microbe Interact.* 10:221-227.

Hisajima S., Chongpraditnum P., Arai Y. (1987). Microplant propagation of rice plant *in vitro*. *Japan J. Trop. Agri*. 31 (1): 12-15.

Hobbie, L.J. (1998). Auxin: molecular genetic approaches in Arabidopsis. Plant *Physiol. Biochem*. 36: 91-102.

Honda, H., Liu, C., & Kobayashi, T. (2001). Large-Scale Plant Micropropagation. *Plant Cells Advances in Biochemical Engineering/Biotechnology*. 157-182.

Hopkins, W.G. & Hüner N.P.A. (2009). Introduction to Plant Physiology. 4th edition. *Wiley, John & Sons, Incorporated*. 9: 96-108.

Huang, X.Q., Wei, Z.M. (2004). High frequency plant regeneration through callus initiation from mature embryos of maize. *Plant Cell Rep*. 22: 793-800.

Huang, W. and Liu. L.F. (2002). Carbohydrate metabolism in rice during callus induction and shoot regeneration induced by osmotic stress. *Bot. Bull. Acad. Sci.*, 43: 107-113

Ilan, A. & Khayat, E. (1997). An overview of commercial and technological limitations to marketing of micropropagated plants. *Acta Hort*. 447: 642-648.

Inzé, D., & De Veylder, L. (2006). Cell cycle regulation in plant development. *Annu. Rev. Genet*. 40 77–105.

Ismail, H. (2000). Micropropagation of *Acacia Auriculiformis* A.CUNN ex.benth from different explant sources. Unpublished PhD Thesis .

Jain, R. K.(1997). Effects of some factors on plant regeneration from *indica* rice cells and protoplasts- A review. *Indian J. Exp.Biol.* 35:323-331.

Jardinaud,M . F., Souvre,A ., Beckert, M., Alibert, G. (1995). Optimizationo f DNA transfera nd transientb eta-glucuronidaseex pressioni n electroporated maize (*Zea mays* L.) microspores. *Plant Cell Rep.* 15:55-58.

Javed, F. & Ikram, S. (2008). Effect of sucrose induced osmotic stress on callus growth and biochemical aspects of two wheat genotypes. *Pak. J. Bot.*, 40: 1487-1495.

Jha TB, Ghosh B (2005). Plant Tissue Culture Basic And Applied, Universities Press New Delhi India. 7:21-25

Jones E., Chu W., Ayele M. (2009). Development of single nucleotide polymorphism (SNP) markers for use in commercial maize (*Zea mays* L.) germplasm. *Mol Breed*. 10.1007/s11032-009-9281-z.

Kawata, S.I and A. Ishihara. 1968. The regeneration of rice plant (*Oryza sativa* L.) in the callus derived from seminal root. *Proc. Jpn. Acad.*, 44: 549-553.

Kaur, K. & Kant,U. (2000). Clonal propagation of *Acacia catechu* Willd. by shoot tip culture. *Plant Growth Regul.*, 31: 143-145.

Khanum, F., T. Husnain, S. Riazuddin and M.P. Gordon. (1997) .*In vitro* regeneration of Basmati rice. *Pak. J. Biochem.* (62: 11-14).

Kant, T., Kothari, S. L., Kononowicz, H., Hodges, T. K. (2001). Agrobacterium tumefaciens-mediated transformation of rice using coleoptile and mature seed-derived callus. *J. Plant Biochem. Biotechnol*. 10:121-126.

Kamal, M.A.H.M., Al Munsur, M.A.Z., Hossain M.S., Begum, S. (2009). Comparative studies of callus induction and plant regeneration from mature embryos in rice mutant. *J. Bangladesh Agril.Univ*. 7(1): 39-45.

Khaleda, L., & Al-Forkan, M. (2006). Genetypic variability in callus induction and plant regeneration through somatic embryogenesis of five deepwater rice (*Oryza sativa* L.) cultivars of Bangladesh. *African Journal of Biotechnology*, 5 (16): 1435-1440.

Khan, Z.I. Hussain, A. & Sadiq, M. (2000). Role of plant growth regulators (auxin and cytokinin) in callus induction in rice (*Oryza sativa L.*) C.V. DM-25. *Pakistan J. Biol. Sci*., 3 (1): 157-159.

Khan, S.A., Rashid, H., Fayyaz, M. (2008). Rapid micropropagation of three elite Sugarcane (*Saccharum officinarum* L.) varieties by shoot tip culture. *African Journal of Biotechnology*- Vol. 7: 2174–2180.

Khanna HK and Raina SK (1999) *Agrobacterium*-mediated transformation of *indica* rice cultivars using binary and superbinary vectors. *Aust J Plant Physiol* 26: 311–324.

Khush,G.S. (1984). In: JP Gustafsom (ed). Gene manipulation in plant improvement, plenum. N.Y., 8: 61-94.

Kumar, R., K. Sharma, and V. Agarwal. (2005). *In vitro* clonal propagation of *Holarrhena antidysenterica* (L.) Wall. through nodal explants from mature trees. *In Vitro Cell. Dev. Biol.—Plant* 41:137–144.

Kisaka, H., Sano, H., Kameya,T . (1998). Characterizationof transgenic rice plants that express rgpl, the gene for a small GTP-binding protein from rice. *Theor. Appl. Genet*. 97:810-815.

Lertrat, K., Pulam, T. (2007). Breeding for increased sweetness of sweet corn. *International Journal of Plant Breeding* 11:-27-30.

Lee, L., Schroll, RE., Grimes, HD., & Hodges TK. (1989). Plant regeneration from indica rice (*Oryza sativa* L.) protoplasts. *Planta* 325-333.

Lee, S. J., Kim, B. D., Paek, K. H. (1993). *In vitro* plant regeneration and Agrobacterium-mediated transformation from cotyledon explants of hot pepper (*Capsicum annuum* cv. Golden Tower). *Korean J. Plant Tiss. Cult*. 20:289-294.

Leifert, C., Morris, C.E. and Waites. W.M. (1994). Ecology of microbial saprophytes and pathogens in tissue culture and field-grown plants: Reasons for contamination problems *In Vitro. Critical Reviews in Plant Science* 13: 139-183.

Letham, DS. (1973). Cytokinins from *Zea mays*. *Phytochemistry* 12: 2445-2455.

Letham, D.S. (1974) Regulators of cell division in plant tissue XX. The cytokinins of coconut milk. *Physiol.Plant* 32:66-70.

Li, W., Masilamany, P., Kasha, K., Pauls, K (2002). Developmental, tissue culture, and genotypic factors affecting plant regeneration from shoot apical meristems of germinated *Zea mays* L. seedlings. *In Vitro Cell. Dev. Biol.* Plant- 38:285-292.

Li, H.P., Huang, T., Wang, C.X., Liao, Y.C. (2009). An efficient regeneration system of barley cultivars from leaf base segments. *Biol. Plant*. 53: 733-736.

Malaysian Agricultural Research and Development Institute (MARDI). (2002).High Yielding Rice Varieties- MR219. Retrieved 21st July 2011 from http://www.mardi.my/c/document_library/.

Maeda, E. (1965) Rate of lamina inclination in excised rice leaves. *Physiol. Plant.* 18: 813-827.

Mauseth, J.D. (1976). Cytokinin- and gibberellic acid-induced effects on the structure and metabolism of shoot apical meristems in *Opuntia polyacantha* (Cactaceae). *American Journal of Botany* 63: 1295:1301.

McManus MT Osborne DJ. (2005). Hormones, signals and target cells in plant development. *Cambridge: Cambridge University Press.*36: 390-395.

Medina. R., Faloci M., Marassi MA., Mroginski LA. (2004). Genetic stability in rice micropropagation. *Biocell.*28(1): 13-20.

Michalczuk, L., Ribnicky, D.M., Cooke, T.J., Cohen, J.D. (1992). Regulation of indole-3-acetic acid biosynthetic pathways in carrot cell cultures. *Plant Physiol.* 100:1346–1353.

Mórocz, S., Donn, G., Németh, J., & Dudits, D. (1990). An improved system to obtain fertile regenerants via maize protoplasts isolated from highly embriogenic suspension culture. *Theor Appl Genet* 80:721-726.

MUDA Agricultural Development Authority (2012). Available online :- http://www.mada.gov.my/info.

Mudge, K.W., Borgman,C.A., Neal, J.C & Weller, H.A. (1987). Present limitations and future prospects for commercial micropropagation of small fruits. *Proc. Intl. Plant Prop. Soc.* 36:538-543.

Murashige T. & Skoog F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue culture. *Physiol. Plant*.30:473-479.

Murashige, T. (1974). Plant propagation through tissue culture. .*Ann. Rev. Plant Physiol.* 25:135-166.

Murch, S.J., Krishna Raj, S & Saxena, P.K. (2000). Tryptophan is a precursor for melatonin and serotonin biosynthesis in *in vitro* regenerated St. John's wort (Hypericum perforatum L. cv.Anthos) plants.*Plant Cell Rep*. 19, 698-704.

Mythili, P.K., Seetharama, N., Reddy, V.D.(1999) Plant regeneration from embryogenic cell suspension cultures of wild sorghum (*Sorghum dimidiatum* Stapf.)- *Plant Cell Rep*. 18:424-428.

Nagib, A., Hossain, S.A., Alam., M.F., Islam, R and Sultana, R.S. (2003). Virus free potato tuber seed production through meristem culture in tropical Asia. *Asian Journal of Plant Sciences*: 1682-3974.

Nishi. T., Yamada. Y., & Takahashi.E. (1968). Organ redifferentiation and plant restoration in rice callus. *Nature (London)*, 219: 508-509.

Nitsch, J.P. & Nitsch, C. (1956). Auxin-dependent growth of excised *Helianthus* tissues. *Am. J. Bot*. 43: 839-851.

Nobre ,J., Davey, MR., Lazzeri, PA., Cannel, ME. (2000). Transformation of barley scutellum protoplasts: regeneration of fertile transgenic plants. *Plant Cell Reports*-9, 1000-1005.

North, J.J., Ndakidemi, P.A., Laubscher, C.P. (2012). Effects of various medium compositions and wounding treatments on in vitro growth and regeneration of bird of paradise (*Strelitzia reginae*). *Academic journals* Vol.7 (10) 1992-2248.

Norton, J. P., & Boll, W. G. (1954). Callus and shoot formation from tomato roots *in vitro. Science*, 119: 220-221.

Novák F.J and Irena Mašková. (1979).Apical shoot tip culture of tomato. *Scientia Horticulturae*, Elsevier scientific Publishing. 51:337-344.

Nowak, B., Miczynski, K., & Hudy, L. (2004). Sugar uptake and utilization during adventitious bud differentiation on *in vitro* leaf explant of Wegierka Zwykla plum (*Prunus domestica*). *Plant Cell, Tissue Organ Cult*., 76: 255-260.

O'Connor-Sanchez, A., Cabrera-Ponce, J. L., Valdez-Melara, M., Tellez- Rodriguez, P., Pons-Hernandez, J. L., Herrera-Estrella, L. (2002). Transgenic maize plants of tropical and subtropical genotypes obtained from calluses containing organogenic and embryogenic-like structures derived from shoot tips. *Plant Cell Rep*. 21:302-312..

Ortiz R.&Vuylsteke D. (1996).Advances in *Musa* genetics. *IITA Research Letter*, 13:1–9.

Odour, R.O., Njagi, E.N.M ., Ndung's , S., Machuka, J.S. (2006). *In vitro* regeneration of dryLand Kenyan maize Genotypes through somatic embryogenesis. *Int. J. Bot.* 2(2): 146-151.

Padua VLM., Fernandez LD., de Oliveira DE., Mansur E. (1998). Effects of auxin and light treatments of donor plants on shoot production from *indica*-type rice (*Oryza sativa* L.). *In Vitro Cell Dev Biol - Plant* 34: 285-288.

Padua, VLM., Ferreira, RP., Meneses, L., Uchoa, N., Margis-Pinheiro, M., Mansur, E. (2001).Transformation of Brazilian elite *Indica*-type rice by electroporation of shoot apex explants. *Plant Mol. Biol. Rep.* 19:55–64.

Pant, B & Thapa, D. (2012). *In vitro* mass propagation of an epiphytic orchid, *Dendrobium primulinum* Lindl. through shoot tip culture. *African Journal of Biotechnology:* 1684–5315.

Pareddy, D, & Petolino, J. (1990). Somatic embryogenesis and plant regeneration from immature inflorescences of several elite inbreds of maize. *Plant Sci.* 67: 211-219.

Paszkiewicz, S, & Butzen, S. (2007). Corn Hybrid Response to Plant Population. *Crop Insight* . Trademarks and service marks of Pioneer Hi-Bred International, Inc 1716 1-15.

Patel, A.A., Patel, S.R., Patel, C.L & Prajapati, B.S.(2001). Effects of media composition on *in vitro* multiplication of sugarcane varieties. *Ind. J. Gene. Plant Breed*. 61(1): 82-83.

Pereira, A.S., Bertoni, B.W., Appezzato-da-Gloria, B., Alba, R.B., Araujo, A.H.J., Lourenco, M.V., Franca, S.C. (2000). Micropropagation of *Pothomorphe umbellate* via direct organogenesis from leaf explants. *Plant Cell Tissue Organ. Cult.*, 60: 47-53.

Perrot-Rechenmann, C, & Napier, R.M. (2005). Auxins. *Vitam Horm* 72**:** 203–*233*

Perrot-Rechenmann, C & Tromas. A. (2010). Recent progress in auxin biology. *C. R. Biologies* 333:297–306.

Pescitelli, S. M., Johnson, C. D.; Petolino, J. F (1990). Isolated microspore culture of maize: effect of isolation technique, reduced temperature and sucrose level. *Plant Cell Rep*. 8:628-631.

Petersen, K.K., Hansen, J., & Krogstrup, P. (1999) Significance of different carbon sources and sterilization methods on callus induction and plant regeneration of *Miscanthus ogiformis Honda* 'Giganteus'. *Plant Cell Tiss Org Cult* 58, 189-197.

Pingali PL., & Pandey S. (2001). Meeting world maize needs:technological opportunities and priorities for the public sector,(pp 1–24). In Pingali PL (eds) 1999/2000 world maize facts and trends. CIMMYT, Mexico.

Pierik, R.L.M. (1987). *In vitro* Propagation of Higher Plants. *Martinus Nizhoof Publisher*, Boston.

Philip, V.J, & Nainar, S.A.Z. (1986). Clonal propagation of *Vanilla planifolia* (Salisb) Ames using tissue culture. *J. Plant Physiol*. 122: 211-215.

Potrykus I.(1990) .Gene transfer to cereals: An assessment. *Bio Technology*- 8 pp. 535–542.

Rabe, E.(1990) Stress physiology: the functional significance of the accumulation of nitrogen-containing compounds. *J. Hortic. Sci.* 65: 231-243.

Rajkarnikar, K.M. (2011). Propagation of *Cymbidium aloifolium* (L.) Sw. *In vitro* by Seeds. *Bull. Dept. Pl. Res. Thapathali, Ktm, Nepal*. 33: 27-30.

Rakshit, S., Rashid, Z., Sekhar, J.C., Fatma, T., Dass, S. (2010). Callus induction and whole plant regeneration in elite Indian maize (*Zea mays* L.) inbreds. *Plant Cell Tissue Organ Cult.* 100: 31-37.

Ramesh M., Murugiah V., Gupta AK. (2009). Efficient in vitro plant regeneration via leaf base segments of indica rice (Oryza sativa L.). *Ind J Exp Biol* .47:68–74.

Rasco-Gaunt, S., Liu, D., Li, C. P., Doherty, A., Hagemann, K., Riley, A., Thompson, T., Brunkan, C., Mitchell, M., Lowe, K. (2003). Characterization of the expressiono f a novel constitutivem aizep romoterin transgenic wheat and maize. *Plant Cell Rep*. 21:569-576.

Rattanpal, H.S., Gill, M.I.S., Sangwan, A.K. (2009). Micropropagation of strawberry through meristem culture. *International Society for Horticultural Scienc:* 890-2009.

Ravikumar, R., Ananthakrishnan, K., Karthirayan, K & Ganapathi, A. (1998) . *In vitro* shoot propagation of *Dendrocalamus strictus* nees. *Plant Cell Tiss. Org. Cult*., 52: 189-192.

Razdan MK. (2003) Introduction to plant tissue culture. 2nd edn. *Science Publishers*, Enfield.

Rechenmann C.P (2011) Cellular responses to auxin: Division versus expansion. *Cold Spring Harb prespect Bio*l 2:1446.

Rodriguez A. P. M., Vendrame W. A. (2003). Micropropagation of tropical woody species. *In:* Jain S. M., Ishii K. (Eds.). Micropropagation of Woody Trees and Fruits. Kluwer Academic Publishers, Dordrecht, Boston, London: 153-179.

Rout, G. R., Samantaray, S., Das, P. (2000). *In vitro* manipulation and propagation of medicinal plants. *Biotechnol Adv*. 18:91-120.

Sairam, R . V., Parani,M ., Franklin,G ., Lifeng,Z ., Smith,B ., MacDougall, J., Wilber,C ., Sheikh,H ., Kashikar, N., Meeker,K ., Al-Abed,D ., Berry, K., Vierling, R., Goldman, S. L. (2003). Shoot meristem: an ideal explant for *Zea mays* L. transformation. *Genome*.6:323-329.

Sandhu, J. S., Gosal, S. S., Gill, M. S. (1995). Micropropagation of *Indica* rice through proliferation of axillary shoots. *Euphytica* 81:139–142.

Schaeffer G.W and Smith H.H (1962). Auxin-kinetin interaction in tissue cultures of nicotiana species & tumor-conditioned Hybrids. *Plant Physiol*.38 (3): 291–297.

Seeliger, I. (1956). Über die Kulture isolierter Wurzeln der Robinie (*Robinia pseudoacacia* L.) (The Culture of Black Locust isolated roots). *Flora.*144: 47–83.

Shabbir, A., Hameed, N., Ali, A,. Bajwa, R. (2009). Effect of different cultural conditions on micropropagation of rose (*Rosa indica* L.). *Pak. J. Bot.* 41(6): 2877-2882.

Shibli, R.A., Smith,L.A.M &. Spomer, L.A.(1992). Osmotic adjustment and growth responses of three (*Chrysanthmum morifolium* Ramat.) cultivars to osmotic stress induced *in vitro*. *J. Plant Nutr*., 15: 1373-1381.

Skirvin, R.M., K.D. McPheeters & M. Norton. (1994). Sources and frequency of somaclonal variation. *Hort. Sci*., 29: 1232-1237.

Skoog, F., and Miller, C.O. (1965) Chemical regulation of growth and organ formation in plant tissue cultured *in vitro.* In E.Bell,Harper & Row (Eds).

Molecular and cellular aspects of development. New York Press,USA. 81: 481-494.

Smith, RH., Murashige, T. (1970) *In vitro* development of isolated shoot apical meristems of angiosperms. *Am J Bot* -57: 562-568.

Smith, R.H, Murashige, T. (1982). Primordial leaf and phytohormone effect on excised shoot apical meristem of *Coleus blumei* Benth. *Am. J. Bot*. 69(8): 1334-1339.

Smith C.W., Betran J., Runge E.C.A. (2004). Corn: Origin, history, technology, and production. (pp 231-244). *Wiley Publication.* 4- 0471411841.

Sridhar, T.M & Naidu C.V. (2011). Effect of Different Carbon Sources on *In Vitro* Shoot Regeneration of *Solanum nigrum* (Linn.) - An Important Antiulcer Medicinal Plant. *Journal of Phytology :3(2): 78-82*

Srinivasan, C., Isabel, M.G., Padilla & Scorza, R. (2005). *Prunus* spp., almond, apricot, cherry, nectarine, peach and plum. In biotechnology of fruits and nut crops, eds. RE. Litz. Vol-29, pp512-542. UK: *CABI Publishers*.

Straus, J, & La Rue, C.D. (1954). Maize endosperm tissue grown *in vitro* :Cultural requirements. *Am. J. Bot*. 41: 687-692.

Sticklen M.B., & Obray H.F (2005). Invited Review: Shoot apical meristem-A sustainable explant for genetic transformation of cereal crops. *In vitro cell.Dev. Biol*: 41:187-200.

Subedi, K.D., & Ma, B.L. (2009). Assessment of some major yield-limiting factors on maize production in a humid temperate environment. *Field Crops Research*. 110(1): 10. -16.

Sul, I.W. & Korban, S.S. (1998). Effects of media, carbon sources and cytokinins on shoot organogenesis in the christmas tree, scot pine (*Pinus sylvestris*). *J. Hort. Sci. Biotech*: 73: 822-827.

Sunitibala, H & Kishor, R. (2009). Micropropagation of *Dendrobium transparens* L. from axenic pseudobulb segments. *Indian Journal of Biotechnology*: 8-448-452.

Suprasanna, P., Rao, K.V., Reddy, G.M. (1986). Plantlet regeneration from glume calli of maize (*Zea mays* L.). *Theor. Appl. Genet*. 72: 120-122.

Swamy, K.M., Balasubramanya, S., Anuradha, M. (2010). *In vitro* multiplication of patchouli through direct organogenesis. *Afr. J. Biotechnol*: 9(14) 2069.

Tanwer , B..S., Faheem, M., Singh1, S., Khan, M & Shahzad, A. (2011). *In vitro* Regeneration of multiplication shoots in *Catharanthus roseus*- An important medicinal plant. *Pelagia Research Library*. 0976-8610.

Tauquer, A., Abbasi, N.A., Hafiz, I & Ali, A. (2007). Comparison of sucrose and sarbitol as main carbon energy sources in micropropagation of peach root stock GF- 677. *Pak. J. Bot.* 39(4):1269.

The STAR. (2012) Hybrid padi to boost yield. . Retrieved 23rd March, 2012, from http://www.thestar.com.my.

Thorpe, T.A. (1994): Morphogenesis and regeneration. In: Plant Cell and Tissue Culture, Vasil, I.K., Thorpe, T.A. (eds),. *Kulwer Acedemic Publishers*.66: 2-36.

Ting, Y.C., Yu, M., & Zheng, W.Z. (1981). Improved anther culture of maize. *Plant Sci. Lett.* 23: 139-145.

Torrey, J. G. (1958). Endogenous bud and root formation by isolated roots of *Convolvulus* grown *in vitro. Plant Physiol*. 33: 258-263.

Torrey, J. G. (1966). The initiation of organized development in plants. *Advan. Morphogenesis*- 5: 39-91.

United States Department of Agriculture. (2011). World Agricultural Demand and Supply Estimates. Issn: 1554-9089 (pp 44-98)

United States Department of Agriculture (2012). Grain and Feed Annual- Malaysia. *Global Agricultural Information Network.* Retrieved 1 February 2012, from http://www. usda.gov

Vaghefi N., Shamsudin M.N, Makmom A & Bagheri M. (2011). The economic impacts of climate change on the rice production in Malaysia. *International Journal of Agricultural Research, 6: 67-74.*

Valizadeh, M, Kazemi Tabar, S.K and Nematzadeh G.A. (2007). Effect of Plant Growth Regulators on Callus Induction and Regeneration of Cumin (*Cuminum cyminum*). *Asian Journal of Agricultural Research,* 1: 17-22.

Vasil, V., Srivastava, V., Castillo, A. M., Fromm, M. E., Vasil, I. K. (1993). Rapid production of transgenic wheat plants by direct bombardment of cultured immature embryos. *Bio/Technology* 11:1553-1558.

Vladimir S, Gilbertson L, Adae P, Duncan D (2006). Agrobacterium mediated transformation of seedling-derived maize callus. *Plant Cell Rep*. 25: 320-328.

Wang, P. J. & Hu C.V (1982). *In vitro* mass tuberization and virus free seed potato production in Taiwan. *Amer. Pot. Journ.* 59**:** 33-39.

Wang A. (1987). Callus induction and plant regeneration from maize mature embryos. *Plant Cell Rep.,* 6: 360-362.

Wang, J. X., Sun, Y., Cui-Gui, M., Hu, J. J. (2001). Transgenic maize plants obtained by pollen-mediated transformation. *Acta Bot. Sin*. 43:275-279.

Waseem, K., Jilani, M.S., Khan, M.S., Kiran, M & Khan, G. (2011). Efficient *in vitro* regeneration of chrysanthemum (*Chrysanthemum morifolium* L.) plantlets from nodal segments. *African Journal of Biotechnology*. 168: 1477-1484.

Werner, T., Motyka, V., Strnad, M., & Schmülling, T. (2001). Regulation of plant growth by cytokinin. *Proc. Natl. Acad. Sci. USA* 98, 10487*–10492.*

Winicur ZM., Zhang GF., Staehelin LA. (1998). Auxin deprivation induces synchronous golgi differentiation in suspension-cultured tobacco BY-2 Cells. *Plant Physiol* .117:501–513.

Wolter, K.E & Skoog, F. (1966) Nutritional requirements of Fraxinus callus cultures. *Am. J. Bot*. 53: 263–269

Wopereis, M.C.S., Defoer, T., Idinoba, P., Diack, S., and Dugué, M.J.(2009). Curriculum for Participatory Learning and Action Research (PLAR) for Integrated Rice Management (IRM) in Inland Valleys of Sub-Saharan Africa – Technical Manual.. *Africa Rice Center (WARDA)* Isbn- 92 9113 3248.

Wysokinska, H & Lisowska, K.(2000). *In vitro* propagation of *Catalpa ovata* G. Don. *Plant Cell, Tissue and Organ Culture* 60: 171–176.

Yamada, Y., Yang Z. Q., Tang, D. T. (1986) Plant regeneration from protoplast derived callus of rice *(Oryza sataiva* L.). *Plant Cell Reports* 5: 85-88.

Yoshida T (1996). *In vitro* propagation of hybrid rice *(Oryza sativa L.) 1*. Tissue-cultured shoot primordia. *JARQ* 30: 1-8.

Zazimalova, E., Brezinova, A., Holik, J., & Opantrny, Z. (1996). Partial auxin deprivation affects endogenous cytokinins in an auxin dependent, cytokinins-independent tobacco cell strain. *Plant Cell Rep.*, 16: 76-79.

Zelcer A., O. Sofermans & S. Izhar. (1983). Shoot Regeneration in Root Cultures of *Solanaceae*. *Plant Cell Reports* 2:252-254.

Zhang, K, & Letham, D.A. (1996). Cytokinins control the cell cycle at mitosis by stimulating the tyrosine dephosphorylation and activation of p34 ^{cdc2}-like H1 histone kinase. *Planta* .200:2-12

Zhang, S., Zhong, H., Sticklen, M. B. (1996). Production of multiple shoots from shoot apical meristems of oat (*Avena sativa* L.). *J. Plant Physiol*. 148:667-671.

Zhang,S ., WilliamsC arrier, R., Lemaux,P . G. (2002). Transformation of recalcitrant maize elite inbreds using in vitro shoot meristematic cultures induced from germinated seedlings. *Plant Cell Rep*. 21:263-270.

Zhong, H.; Srinivasan, C.; Sticklen, M. B. (1992) Morphogenesis of corn (*Zea mays* L.) *in vitro* I. Formation of multiple shoot clumps and somatic embryos from shoot tips. *Planta*. 187:490–497.

Zhong, H., Wang, W., Sticklen, M. B.(1998). *In vitro* morphogenesis of *Sorghum bicolor* (L.) Moench: efficient plant regeneration from shoot apices. J. *Plant Physiol*. 153:719–726.

Zhong, H., Teymouri, F., Chapman, B., Maqbool, S., Sabzikar, R., El- Maghraby, Y., Dale, B., Sticklen, M. B. (2003).The dicot pea (*Pisum sativum* L.) rbcS transit peptide directs the Alcaligenes eutrophus polyhydroxybutyrate enzymes into the monocot maize (*Zea mays* L.) chloroplasts. *Plant Sci*. 165:455-462.

Zuraida A.R., Naziah B., Zamri Z., Sreeramanan S.(2011) Efficient plant regeneration of Malaysian *indica* rice MR219 and 232 via somatic embryogenesis system. *Acta Physiol Plant, 11738*-011-0739-3.