UNIVERSITI PUTRA MALAYSIA

PRODUCTION, SELECTION, CHARACTERIZATIONS AND SOMATIC EMBRYOGENESIS OF MALAYSIAN SALT-TOLERANT RICE (Oryza sativa L. cv. MR219) THROUGH CALLOGENESIS

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By

NAHID KALHORI

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

June 2017

This thesis is dedicated to:

My parents for their endless love and support &
my brother for his encouragement

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

PRODUCTION, SELECTION, CHARACTERIZATIONS AND SOMATIC EMBRYOGENESIS OF MALAYSIAN SALT-TOLERANT RICE (*ORYZA SATIVA* L. CV. MR219) THROUGH CALLOGENESIS

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June 2017

Chairman : Rosimah Nulit, PhD
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Rice is one of the most important staple foods for human. However, millions hectares of land in the South and Southeast Asia were left uncultivated or grown with very low yields due to salinity. Therefore, the main objective of this study is to produce salt-tolerant Malaysia *Indica* rice cv. MR219) lines *in vitro*. The phenotypes, biochemical contents and seed germination capability of mother plant and salt-tolerant MR219 lines were compared. Firstly, MR219 callus was produced, then, callus was cultured separately on MS media supplemented with 2 mg/L 2,4-D and different concentration of NaCl (0, 50, 100, 200, and 300 mM NaCl) to produce salt-tolerant MR219 callus. Morphological comparison shows that MR219 callus from MS media yellowish color, soft, friable and nodular proliferating, however, callus produced in 100 mM NaCl are compact-type and blackish-brown and acutely-necrotic at 300 mM NaCl. Fresh and dry weight, water content, growth rate of MR219 callus and total protein content decreased as concentration of NaCl increased. On other hand, total proline content, total soluble sugar, lipid peroxidase and the activity of ascorbate peroxidase and catalase were increased. Histological analysis of salt-tolerant MR219 callus revealed that salinity negatively affected on development somatic embryos. Callus from 50 mM and 100 mM NaCl had been selected as salt-tolerant callus and was cultured on MS media supplemented with 2 mg/L kinetin and 1 mg/L BAP for shoot induction. Then, callus was subcultured in MS media supplemented with 0.5 mg/L BAP, 1 mg/L kinetin, 1 mg/L IBA and 0.5 mg/L NAA for root formation. At acclimatization stage, only MR219 plantlets from control (MS only) and 50 mM NaCl were survived and transferred to paddy soil. MR219 plantlets produced from 50 mM NaCl is called First generation (F1) salt-tolerant MR219. After 70 days, seeds of F1-salt-tolerant MR219 lines was successfully obtained. Following this, the grain characteristics of mother plant and F1-salt-tolerant MR219 lines were compared. Comparative

study on phenotyes, leaves morphology, and root system found no variation between mother plant and second generation (F2)-salt-tolerant MR219 lines. Biochemical contents which are proline content, total soluble sugar and total protein showed no significant difference between mother plant and F2-salt-tolerant MR219 line. Seeds of F1-salt-tolerant MR219 was examined its germination capability in saline. Results found that seeds of F1-salt-tolerant MR219 able to germinate and growth in 50 mM and 100 mM NaCl. As conclusion, salt-tolerant MR219 rice was produced *in vitro* and have potential to be commercialized. The protocol to produce salt-tolerant rice can be used to produce other salt-tolerant plant.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGHASILAN, PEMILIHAN, PENCIRIAN DAN SOMATIK EMBRIOGENESIS PADI MALAYSIA YANG BERTOLERANSI DENGAN KEMASINAN MELALUI KALOGENESIS

Oleh

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Padi merupakan makanan ruji utama manusia. Walaibagaimanapun berjuta-juta kawasan penanaman padi di Selatan dan Asia Tenggara terbiar dan pengeluaran padi semakin berkurangan disebabkan oleh kemasina. Kajian ini dilakukan bertujuan untuk menghasilkan padi (*Oryza sativa* cv. MR219) yang toleran dengan kemasinan secara *in vitro.* Kajian ini bermula dengan penghasilan kalus MR 219, kemudian kalus ini dikultur secara berasingan pada MS media yang mengandungi 2 mg/L 2,4-D dan kepekatan NaCl yg berbeza (0, 50, 100, 200, and 300 mM NaCl) untuk mehasilkan MR219 kalus yang bertoleransi dengan kemasinan. Kajian perbandingan ke atas morfologi, fisiologi, kandungan biokimia dan histologi diantara kalus MR219 (dari MS sahaja) dan kalus MR219 yang toleran dengan kemasinan dilakukan. Kalus MR219 tanpa rawatan kemasinan menunjukkan warna putih kekuningan, lembut, rapuh dan berbentuk nodular. Walaubagaimanapun, kalus yang tumbuh daripada 100 mM NaCl adalah padat dan berwarna coklat-kehitaman, akut-nekrotik pada 300 mM NaCl. Kajian juga mendapati berat basah dan kering, kandungan air, kadar pertumbuhan kalus MR219 dan kandungan protin menurun dengan meningkatnya kepekatan NaCl. Manakala, kandungan prolina, kandungan gula terlarut, aktiviti lipid peroksidase dan askorbat peroksidase kalus MR219 meningkat dengan bertambahnya kepekatan NaCl. Aktiviti enzim katalase bertambah pada kalus yang toleran pada 50 mM dan 100 mM NaCl. Analisis histologi ke atas kalus MR219 yang toleran dengan kemasinan mendapati saiz zon meristematik berkurang. Kalus yang tumbuh pada 50 mM dan 100 mM NaCl telah dipilih sebagai kalus yang toleran terhadap kemasinan. Seterusnya, kalus ini disubkultur pada MS media yang diperkaya dengan 2 mg/L kinetin, 1 mg/L dan 0.5 mg/L NAA untuk pertumbuhan pucuk. Diikuti dengan subkultur pada MS media yang ditambah 0.5 mg/L BAP, 1 mg/L kinetin, 1 mg/L IBA dan 0.5 mg/L NAA

selama 4 minggu untuk pembentukan akar. Di peringkat aklimatasi, hanya anak-anak padi MR219 yang terhasil dari kawalan (MS sahaja) dan 50 mM NaCl berupaya untuk membesar dan dipindahkan ke pot yang mengandungi tanah sawah untuk kajian seterusnya. Anak-anak padi MR219 yang toleran dengan 50 mM NaCl dinamakan sebagai generasi pertama (F1) padi MR219 yang toleran dengan kemasinan. Selepas 70 hari, bijibenih F1 padi MR219 yang toleran dengan kemasinan berjaya dituai. Kajian perbandingan ke atas ciri-ciri morfologi pokok, morfologi daun dan jenis sistem akar generasi kedua (F2) padi MR219 yang toleran dengan kemasinan adalah sama dengan pokok induk. Kandungan biokimia iaitu prolina, kandungan gula larut dan protein menunjukkan tidak signifikan (t-test, $p > 0.05$) antara pokok induk dan F2-padi MR219 yang toleran dengan kemasinan. Bijibenih F1 padi MR219 yang toleran dengan kemasinan berupaya untuk bercambah dan membesar dalam 50 mM dan 100 mM NaCl. Sebagai kesimpulan, padi MR219 yang toleran kepada kemasinan berjaya dihasilkan secara *in vitro* dan berpotensi untuk dikomersialkan. Protokol penghasilan padi yang toleran dengan kemasinan ini boleh digunapakai untuk penghasilan tumbuhan lain yang toleran dengan kemasinan.

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I certify that a Thesis Examination Committee has met on 7 June 2017 to conduct the final examination of Nahid Kalhori on his thesis entitled "Production, Selection, Characterizations and Somatic Embryogenesis of Malaysian Salt-Tolerant Rice (*Oryza sativa* L. cv. MR219) through Callogenesis" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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Declaration by graduate student

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LIST OF ABBREVIATIONS

APX	Ascorbate peroxidase
Ca^{2+}	Calcium ion
$CaCl_2$	Calcium chloride
CAT	Catalase
Cl^-	Chloride ion
CO_2	Carbon Dioxide
dSm^{-1}	DeciSiemens per meter
DW	Dry weight
EC	Electrical conductivity
ESP	Exchangeable sodium percentage
FAO	Food and agriculture organization
FW	Fresh weight
GR	Glutathione reductase
H^+	Hydrogen ion
HCO_3	Bicarbonate
H_2O_2	Hydrogen peroxide
ddH_2O	Distilled water
DNA	Deoxyribonucleic acid
K^+	Potassium ion
kcal	Kilocalorie
KCl	Potassium chloride
M	Molar
MARDI	Malaysian agriculture research & Development institute
Mha	Million hectares
MR	Malaysian rice
mg	Milligram
mg/g	Milligram per gram

mg/L	Milligram per litre
Mg^{2+}	Magnesium ion
$MgSO_4$	Magnesium sulphate
ml	Millilitres
mM	Mili molar
µl	Micro Litter
Na^+	Sodium ion
NaCl	Sodium chloride
NADP	Nicotinamide Adenine Dinucleotide Phosphate
NADPH	Reduced Nicotinamide Adenie Dinucleotide Phosphate
Na_2SO_4	Sodium sulphate
NO_3^-	Nitrate
O_2^{2-}	Superoxide
$^1O_2$	Singlet oxygen
O^-	Superoxide radicals
OA	Osmotic adjustment
$OH^\bullet$	Hydroxyl radicals
pH	Potential hydrogen
QACs	Quaternary ammonium compounds
ROS	Reactive oxygen species
SE	Standard error
SO_4^{2-}	Sulphate
SOD	Superoxide Dismutase
UK	United Kingdom
UPM	Universiti Putra Malaysia
USA	United States of America
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republics

UV	Ultraviolet
V	Voltage
X	Time
°C	Degree Celsius
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Background of study

Salinity as a major environmental constraint to crop productivity commonly occurs in arid and semiarid regions (Shrivastava & Kumar, 2015). Under high salt stress conditions, most of the crop plants are susceptible and unable to survive. Increased salinization in coastal areas and arable land is predicted to become a huge problem throughout much of the world. Approximately 6.5% of world's total area and about 20% of the cultivated area has already been affected by soil salinity. All over the world, about 397 million ha of land have been affected by different types of salts such as sodium chloride (NaCl), calcium chloride ($CaCl_2$), sodium sulphate (Na_2SO_4), and magnesium sulfate ($MgSO_4$) (Diédhiou, 2006). These type of salts are highly soluble into water and releasing salt ions such as Na^+, Ca^{2+}, Mg^{2+}, Cl^- and SO_4^{2-} (Hakim *et al.*, 2014).

Crop plants exhibit a spectrum of reactions against salinity. Salt stress has two primary harmful effects; osmotic and ionic stress (Diédhiou, 2006). Osmotic stress leads to reduction of water uptake by root, and accumulation and toxicity of specific ions caused ionic stress. Both ionic and osmotic stresses lead to reduced growth rates and eventually to plant death. Followed by primary stresses, oxidative damage as secondary stress may occur (Gupta & Huang, 2014). Limited CO_2 fixation because of stress conditions leads to a decrease in (1) carbon reduction by Calvin cycle and (2) oxidized NADP to serve as an electron acceptor in photosynthesis (Roach & Krieger-Liszkay, 2014). When ferrodoxin is over reduced during photosynthetic electron transfer, electrons may be transferred from photosystem (PS)-I to oxygen to form superoxide (O^{2-}_2) radicals by Mehler reaction (Khan *et al.*, 2015) which triggers chain reactions that generate more aggressive oxygen radicals containing $^1O_2$, H_2O_2, $O^{\bullet-}_2$, and $OH^{\bullet}$, which are known as reactive oxygen species (ROS).

Plants have developed complex mechanisms to adjust hyperosmotic stress and ionic imbalance by osmotic adjustment (OA). These mechanisms accumulate osmotic regulators such as sugars and proline to protect membrane integrity and stabilize enzymes against oxidative stress (Manai *et al.*, 2014). Meanwhile, to overcome the harmful effects of ROS, plants developed non-enzymatic and enzymatic antioxidant defenses systems. A non-enzymatic defense system involves phenolic compounds and lipid peroxidation. An enzymatic defense system include catalase (CAT; E.C.

1.11.1.6), and ascorbate peroxidase (APX; E.C. 1.1.1.11) (Abogadallah, 2010; Sharma *et al.*, 2012; Ismail *et al.*, 2014).

1.2 Problem Statement

Glycophytes such as rice are very sensitive to saline soil especially at the early stage of growth, with height, root length, emergence of new roots, and dry matter affected significantly by salinity (Pearson *et al.*, 1966; Akbar *et al.*, 1972). Rice has no various strategies and mechanisms to deal effectively with the excessive presence of salt and therefore does not grow well on saline soil (Galvan-Ampudia & Testerink, 2011). Salinity caused a negative impact on a number of yield components including stand establishment, panicles, delayed flowering, tillers and spikelets per plants, floret sterility, and individual grain size and even delayed heading (Kar & Shaw, 2013). Under salinity condition, rice yields decrease 12% for every unit (dS/m) increase in EC_e (average root-zoon EC of saturated soil extract) above 3.0 dS m^{-1} (Maas & Hoffman, 1977).

The need for the development of salt tolerant rice is well documented (Flowers & Yeo, 1995). Breeding programme for salt tolerance in rice is difficult due to the involvement of several genes and insufficient knowledge about mechanism (s) controlling the characters (Yeo *et al.*, 1990). The other important issue that the increasing demand of rice consumers in the 21st century cannot be met only by traditional breeding efforts. In order to ensure the food security, plant cell and tissue culture techniques are being used for the genetic improvement and developing salt tolerant lines of rice throughout the world. Tissue culture techniques elucidate the cellular mechanisms involved in salt tolerance by using as study system *in vitro* selected NaCl tolerant cell lines (Davenport *et al.*, 2003; Gu *et al.*, 2004). Cell lines with enhanced tolerance to NaCl have been isolated from crop plants and various biochemical processes appear to contribute to the adaptation of cells to salinity. Besides the use of tissue culture in selection of salt tolerant cell lines, these lines have been used to regenerate salt tolerant plants (Shankhdhar *et al.*, 2000; Miki *et al.*, 2001). Several researches has developed salt tolerant plants especially using *in vitro* selected NaCl tolerant rice cell lines (Lutts *et al.*, 1999; Ahmad *et al.*, 2007; Khaleda *et al.*, 2007; Tariq *et al.*, 2008; Evangelista *et al.*, 2009; Rattana & Bunnag, 2015) and a wide range of plant species including cereals, vegetables, fruits and other commercially important plant species such as cauliflower (Elavumoottil *et al.*, 2003), sugarcane (Badawy *et al.*, 2008), sunflower (Alvarez *et al.*, 2003), lemon (Piqueras *et al.*, 1996), potato (Sabbah & Tal, 1990; Queiros *et al.*, 2007), and wheat (Zair *et al.*, 2003).

1.3 Objectives of Study

Malaysia *Indica* rice (*Oryza sativa* L. cv. MR219) was a cross resulted between MR137 and MR151 rice varieties which was produced by the Malaysian Agriculture Research and Development Institute (MARDI) in year 2001 (Panjaitan *et al.*, 2009). This rice variety is considered as high yielding rice and has good quality in term of shape and taste, but it is sensitive to environmental changes. According to Bot *et al.* (2000), land area in Malaysia is salt affected which restricted high production of rice. Therefore, this rice has been chosen in the present study.

Thus, the objectives of study are:

1. To produce, screen, select and regenerate first generation (F1) salt-tolerant MR219,
2. To compare the histological changes of MR219 callus under NaCl treatment,
3. To compare the histological changes of root structure between mother plant and F1-salt-tolerant MR219,
4. To compare the phenotypes and biochemical contents (total proline, total soluble sugar and total protein) between mother plant and F2-salt-tolerant MR219, and
5. To evaluate the germination capability of seeds of F1-salt-tolerant MR219 in NaCl solution.

REFERENCES

Abdul-Baki, A. A., & Anderson, J. D. (1973). Vigor determination in soybean seed by multiple criteria. *Crop Science, 13*(6), 630-633.

Abogadallah, G. M. (2010). Insights into the significance of antioxidative defense under salt stress. *Plant signaling & behavior, 5*(4), 369-374.

Aebi, H. (1974). Catalase. Methods in enzymatic analysis. *New York: Acadamic Press, 2*, 673–677.

Agastian, P., Kingsley, S. J., & Vivekanandan, M. (2000). Effect of Salinity on Photosynthesis and Biochemical Characteristics in Mulberry Genotypes. *Photosynthetica, 38*(2), 287-290.

Ahmad, M. S. A., Javed, F., & Ashraf, M. (2007). Iso-osmotic effect of NaCl and PEG on growth, cations and free proline accumulation in callus tissue of two indica rice (*Oryza sativa* L.) genotypes. *Plant Growth Regulation, 53*(1), 53-63.

Ahmed, C. B., Rouina, B. B., & Boukhris, M. (2008). Changes in water relations, photosynthetic activity and proline accumulation in one-year-old olive trees (*Olea europaea* L. cv. Chemlali) in response to NaCl salinity. *Acta Physiologiae Plantarum, 30*(4), 553-560.

Akbar, M., Yabuno, T., & Nakao, S. (1972). Breeding for Saline-resistant Varieties of Rice: I. Variability for Salt Tolerance among Some Rice Varietles. *Japanese Journal of Breeding, 22*(5), 277-284.

Akinbile, C., El-Latif, K. A., Abdullah, R., & Yusoff, M. (2011). Rice production and water use efficiency for self-sufficiency in Malaysia: A review. *Trends in Applied Sciences Research, 6*(10), 1127.

Ali, M. N., Ghosh, B., Gantait, S., & Chakraborty, S. (2014). Selection of rice genotypes for salinity tolerance through morpho-biochemical assessment. *Rice Science, 21*(5), 288-298.

Almeida, D. M., Almadanim, M. C., Lourenço, T., Abreu, I. A., Saibo, N. J., & Oliveira, M. M. (2016). Screening for abiotic stress tolerance in Rice: salt, cold, and drought. *Environmental Responses in Plants: Methods and Protocols*, 155-182.

Alvarez, I., Tomaro, M. L., & Benavides, M. P. (2003). Changes in polyamines, proline and ethylene in sunflower calluses treated with NaCl. *Plant Cell, Tissue and Organ Culture, 74*(1), 51-59.

Amirjani, M. R. (2010). Effect of NaCl on some physiological parameters of rice. *Eur J Biol Sci, 3*(1), 6-16.

Amirjani, M. R. (2011). Pigments and Enzyme Activity of Rice. *International Journal of Botany, 7*(1), 73-81.

Andrea, B., & Tani, C. (2009). Ultrastructural effects of salinity in *Nicotiana bigelovii* var. bigelovii callus cells and *Allium cepa* roots. *Caryologia, 62*(2), 124-133.

Apel, K., & Hirt, H. (2004). Reactive oxygen species: metabolism, oxidative stress, and signal transduction. *Annual Review of Plant Biology 55*, 373-399.

Ara, N., Nakkanong, K., Lv, W., Yang, J., Hu, Z., & Zhang, M. (2013). Antioxidant enzymatic activities and gene expression associated with heat tolerance in the stems and roots of two cucurbit species ("*Cucurbita maxima*" and "*Cucurbita moschata*") and their interspecific inbred line "*Maxchata*". *International Journal of Molecular Sciences, 14*(12), 24008-24028.

Arora, N., Bhardwaj, R., Sharma, P., & Arora, H. K. (2008). 28-Homobrassinolide alleviates oxidative stress in salt-treated maize (*Zea mays* L.) plants. *Brazilian Journal of Plant Physiology, 20*(2), 153-157.

Arzani, A., & Mirodjagh, S.-S. (1999). Response of durum wheat cultivars to immature embryo culture, callus induction and *in vitro* salt stress. *Plant Cell, Tissue and Organ Culture, 58*(1), 67-72.

Asch, F., Dingkuhn, M., & Dorffling, K. (2000). Salinity increases CO 2 assimilation but reduces growth in field-grown, irrigated rice. *Plant and soil, 218*(1), 1-10.

Ashraf, & Harris, P. (2013). Photosynthesis under stressful environments: an overview. *Photosynthetica, 51*(2), 163-190.

Ashraf, & OLeary, J. (1997). Ion distribution in leaves of salt-tolerant and salt-sensitive lines of spring wheat under salt stress. *Acta Botanica Neerlandica, 46*(2), 207-217.

Ashrai, M., & McNelly, T. (1990). Improvement of salt tolerance in maize by selection and breeding. *Plant Breeding, 104*(2), 101-107.

Ayala-Astorga, G. I., & Alcaraz-Meléndez, L. (2010). Salinity effects on protein content, lipid peroxidation, pigments, and proline in *Paulownia imperialis* (Siebold & Zuccarini) and *Paulownia fortunei* (Seemann & Hemsley) grown *in vitro*. *Electronic Journal of Biotechnology, 13*(5), 13-14.

Azizi, P., Rafii, M. Y., Abdullah, S. N. A., Hanafi, M. M., Maziah, M., Sahebi, M., Ashkani, S., Taheri, S., & Jahromi, M. F. (2016). Over-Expression of the Pikh Gene with a CaMV 35S Promoter Leads to Improved

Blast Disease (*Magnaporthe oryzae*) Tolerance in Rice. *Frontiers in Plant Science, 7*, 773.

Babu, S., Sheeba, A., Yogameenakshi, P., Anbumalarmathi, J., & Rangasamy, P. (2007). Effect of salt stress in the selection of salt tolerant hybrids in rice (*Oryza sativa* L). under *in vitro* and *in vivo* condition. *Asian Journal of Plant Sciences, 6*(1), 137-142.

Badawy, O., Nasr, M., & Alhendawi, R. (2008). Response of sugarcane (*Saccharum* species hybrid) genotypes to embryogenic callus induction and *in vitro* salt stress. *Sugar Tech, 10*(3), 243-247.

Barakat, M., & Abd-El-Latif, T. (1995). *In vitro* selection for drought tolerant lines in wheat. 1. Effect of polyethylene glycol on the embryogenic cultures. *Alexandria Journal of Agricultural Research (Egypt)*.

Bartwal, A., Mall, R., Lohani, P., Guru, S., & Arora, S. (2013). Role of secondary metabolites and brassinosteroids in plant defense against environmental stresses. *Journal of plant growth regulation, 32*(1), 216-232.

Basu, S., Gangopadhyay, G., & Mukherjee, B. B. (2002). Salt tolerance in rice *in vitro*: Implication of accumulation of Na^+, K^+ and proline. *Plant Cell, Tissue and Organ Culture, 69*(1), 55-64.

Basu, S., Gangopadhyay, G., Mukherjee, B. B., & Gupta, S. (1997). Plant regeneration of salt adapted callus of *Indica* rice (var. Basmati 370) in saline conditions. *Plant Cell, Tissue and Organ Culture, 50*(3), 153-159.

Bates, L., Waldren, R., & Teare, I. (1973). Rapid determination of free proline for water-stress studies. *Plant and Soil, 39*(1), 205-207.

Ben-Hayyim, G., & Goffer, Y. (1989). Plantlet regeneration from a NaCl-selected salt-tolerant callus culture of Shamouti orange (*Citrus sinensis* L. Osbeck). *Plant Cell Reports, 7*(8), 680-683.

Bennici, A., & Tani, C. (2012). Ultrastructural characteristics of callus cells of *Nicotiana tabacum* L. var. BELW3 grown in presence of NaCl. *Caryologia, 65*(1), 72-81.

Bidabadi, S. S., Meon, S., Wahab, Z., & Mahmood, M. (2010). Study of genetic and phenotypic variability among somaclones induced by BAP and TDZ in micropropagated shoot tips of banana (*Musa* spp.) using RAPD markers. *Journal of Agricultural Science, 2*(3), 49.

Bimpong, I. K., Manneh, B., Sock, M., Diaw, F., Amoah, N. K. A., Ismail, A. M., Gregorio, G., Singh, R. K., & Wopereis, M. (2016). Improving salt tolerance of lowland rice cultivar 'Rassi'through marker-aided backcross breeding in West Africa. *Plant Science, 242*, 288-299.

Blanco, F. F., & Folegatti, M. V. (2002). Salt accumulation and distribution in a greenhouse soil as affected by salinity of irrigation water and leaching management. *Revista brasileira de engenharia agricola e ambiental, 6*(3), 414-419.

Blumwald, E., Aharon, G. S., & Apse, M. P. (2000). Sodium transport in plant cells. *Biochimica et Biophysica Acta (BBA)-Biomembranes, 1465*(1), 140-151.

Bot, A., Nachtergaele, F., & Young, A. (2000). *Land resource potential and constraints at regional and country levels*: Food & Agriculture Org.

Bowler, C., Montagu, M. v., & Inze, D. (1992). Superoxide dismutase and stress tolerance. *Annual review of plant biology, 43*(1), 83-116.

Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal Biochem, 72*, 248-254.

Cachorro, P., Olmos, E., Ortiz, A., & Cerda, A. (1995). Salinity-induced changes in the structure and ultrastructure of bean root cells. *Biologia Plantarum, 37*(2), 273-283.

Castillo, M., Andreu, P., Marin, J., & Arbeloa, A. (2007). *Root acclimatization of the micropropagated fruit tree rootstock'adafuel'(Prunus dulcis (mill.) da webb× P. persica (L.) batsch).* Paper presented at the III International Symposium on Acclimatization and Establishment of Micropropagated Plants 812.

Cerdà, A., & Garcıa-Fayos, P. (2002). The influence of seed size and shape on their removal by water erosion. *Catena, 48*(4), 293-301.

Chandrasekharan, H., Sarangi, A., Nagarajan, M., Singh, V., Rao, D., Stalin, P., Natarajan, K., Chandrasekaran, B., & Anbazhagan, S. (2008). Variability of soil–water quality due to Tsunami-2004 in the coastal belt of Nagapattinam district, Tamilnadu. *Journal of Environmental Management, 89*(1), 63-72.

Chen, Wang, S. M., Jing, R. L., & Mao, X. G. (2009). Cloning the PvP5CS gene from common bean (*Phaseolus vulgaris*) and its expression patterns under abiotic stresses. *Journal of Plant Physiology, 166*(1), 12-19.

Chhabra, R. (2004). Classification of salt-affected soils. *Arid Land Research and Management, 19*(1), 61-79.

Cramer, G. (1994). Response of maize (*Zea mays* L.) to salinity. *Handbook of Plant and Crop Stresses. Marcel Dekker, New York*, 449-459.

da Silva Lobato, A. K., de Oliveira Neto, C. F., dos Santos Filho, B. G., Da Costa, R., Cruz, F. J. R., Neves, H., & dos Santos Lopes, M. J. (2008). Physiological and biochemical behavior in soybean (*Glycine max* cv. Sambaiba) plants under water deficit. *Australian Journal of Crop Science, 2*(1), 25-32.

Daneshmand, F., Arvin, M., & Kalantari, K. (2010). Physiological responses to NaCl stress in three wild species of potato *in vitro*. *Acta Physiologiae Plantarum, 32*(1), 91-101.

Davenport, S. B., Gallego, S. M., Benavides, M. P., & Tomaro, M. L. (2003). Behaviour of antioxidant defense system in the adaptive response to salt stress in *Helianthus annuus* L. cells. *Plant Growth Regulation, 40*(1), 81-88.

Dawood, M., Taie, H., Nassar, R., Abdelhamid, M., & Schmidhalter, U. (2014). The changes induced in the physiological, biochemical and anatomical characteristics of Vicia faba by the exogenous application of proline under seawater stress. *South African Journal of Botany, 93*, 54-63.

de Azevedo Neto, A. D., Prisco, J. T., Enéas-Filho, J., de Abreu, C. E. B., & Gomes-Filho, E. (2006). Effect of salt stress on antioxidative enzymes and lipid peroxidation in leaves and roots of salt-tolerant and salt-sensitive maize genotypes. *Environmental and Experimental Botany, 56*(1), 87-94.

de Azevedo Neto, A. D., Prisco, J. T., Enéas-Filho, J., Medeiros, J.-V. R., & Gomes-Filho, E. (2005). Hydrogen peroxide pre-treatment induces salt-stress acclimation in maize plants. *Journal of Plant Physiology, 162*(10), 1114-1122.

Deivanai, S., Xavier, R., Vinod, V., Timalata, K., & Lim, O. (2011). Role of exogenous proline in ameliorating salt stress at early stage in two rice cultivars. *Journal of Stress Physiology & Biochemistry, 7*(4).

Dibax, R., Eisfeld, C. d. L., Cuquel, F. L., Koehler, H., & Quoirin, M. (2005). Plant regeneration from cotyledonary explants of *Eucalyptus camaldulensis*. *Scientia Agricola, 62*(4), 406-412.

Diédhiou, C. J. (2006). Mechanisms of salt tolerance: sodium, chloride and potassium homeostasis in two rice lines with different tolerance to salinity stress.

Din, A. R. J. M., Ahmad, F. I., Wagiran, A., Samad, A. A., Rahmat, Z., & Sarmidi, M. R. (2016). Improvement of efficient *in vitro* regeneration potential of mature callus induced from Malaysian upland rice seed (*Oryza sativa* cv. Panderas). *Saudi Journal of Biological Sciences, 23*(1), S69-S77.

El-baky, A., Hanaa, H., Amal, A., & Hussein, M. (2003). Influence of salinity on lipid peroxidation, antioxidant enzymes and electrophoretic patterns of protein and isoenzymes in leaves of some onion cultivars. *Asian Journal of Plant Sciences, 2*(8), 633-638.

El-Banna, Y., & Attia, T. (1999). Root Tip Meristematic Cell and Leaf Chloroplast Structurein Three Barley (*H. vulgare* L.) Genotypes Exposed to Salinity Stress. *Cytologia, 64*(1), 69-76.

El-Mashad, A. A., & Mohamed, H. I. (2012). Brassinolide alleviates salt stress and increases antioxidant activity of cowpea plants (*Vigna sinensis*). *Protoplasma, 249*(3), 625-635.

El Hadrami, A., Daayf, F., Elshibli, S., Jain, S., & El Hadrami, I. (2011). Somaclonal variation in date palm *Date Palm Biotechnology* (pp. 183-203): Springer.

Elavumoottil, O., Martin, J., & Moreno, M. (2003). Changes in sugars, sucrose synthase activity and proteins in salinity tolerant callus and cell suspension cultures of *Brassica oleracea* L. *Biologia Plantarum, 46*(1), 7-12.

Elmaghrabi, A., Ochatt, S., Rogers, H., & Francis, D. (2013). Enhanced tolerance to salinity following cellular acclimation to increasing NaCl levels in *Medicago truncatula*. *Plant Cell, Tissue and Organ Culture (PCTOC), 114*(1), 61-70.

Elstner, E. F. (1982). Oxygen activation and oxygen toxicity. *Annual Review of Plant Physiology, 33*(1), 73-96.

Endress, R. (1994). *Plant cell biotechnology*: Springer.

Errabii, T., Gandonou, C. B., Essalmani, H., Abrini, J., Idaomar, M., & Skali-Senhaji, N. (2006). Growth, proline and ion accumulation in sugarcane callus cultures under drought-induced osmotic stress and its subsequent relief. *African Journal of Biotechnology, 5*(16).

Evangelista, F. C., Aldemita, R. R., & Ungson, L. B. (2009). Callusing and regeneration potential of rice (*Oryza sativa* L.) genotypes towards the development for salt tolerance. *Philippine Journal of Science, 138*(2), 169-176.

FAO. (1993). Rice in Human Nutrition. Retrieved 2th Jan, 2017 from: http://www.fao.org/docrep/t0567e/T0567E07.htm

FAO. (2012). Rice production in the Asia-pacific region: issues and perspectives. Retrieved 2th Jan, 2017 from http://www.fao.org/docrep/003/x6905e/x6905e04.htm.

Fatima, S., Mujib, A., & Tonk, D. (2015). NaCl amendment improves vinblastine and vincristine synthesis in *Catharanthus roseus*: a case of stress signalling as evidenced by antioxidant enzymes activities. *Plant Cell, Tissue and Organ Culture (PCTOC), 121*(2), 445-458.

Fedina, I., Georgieva, K., & Grigorova, I. (2002). Light-dark changes in proline content of barley leaves under salt stress. *Biologia Plantarum, 45*(1), 59-63.

Flowers, T., & Yeo, A. (1995). Breeding for salinity resistance in crop plants: where next? *Functional Plant Biology, 22*(6), 875-884.

Foyer, C. H., & Noctor, G. (2005). Oxidant and antioxidant signalling in plants: a re-evaluation of the concept of oxidative stress in a physiological context. *Plant Cell Environment, 28*(8), 1056-1071.

Galvan-Ampudia, C. S., & Testerink, C. (2011). Salt stress signals shape the plant root. *Current Opinion in Plant Biology, 14*(3), 296-302.

Gandonou, C. B., Errabii, T., Abrini, J., Idaomar, M., Chibi, F., & Senhaji, S. (2005). Effect of genotype on callus induction and plant regeneration from leaf explants of sugarcane (*Saccharum* sp.). *African Journal of Biotechnology, 4*(11).

Gandonou, C. B., Errabii, T., Abrini, J., Idaomar, M., & Senhaji, N. S. (2006). Selection of callus cultures of sugarcane (*Saccharum* sp.) tolerant to NaCl and their response to salt stress. *Plant Cell, Tissue and Organ Culture, 87*(1), 9-16.

Gatilestari, E. (2006). *In vitro* selection and somaclonal variation for biotic and a biotic stress tolerance. *Biodiversitas, 7*, 297-301.

Gill, S. S., & Tuteja, N. (2010). Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. *Plant Physiology and Biochemistry, 48*(12), 909-930.

Gopitha, K., Bhavani, L., & Senthilmanickam, J. (2010). Effect of the different auxins and cytokinins in callus induction, shoot, root regeneration in sugarcane. *International Journal of Pharma and Bio Sciences, 1*(3), 1-7.

Gu, R., Liu, Q., Pei, D., & Jiang, X. (2004). Understanding saline and osmotic tolerance of Populus euphratica suspended cells. *Plant Cell, Tissue and Organ Culture, 78*(3), 261-265.

Gupta, B., & Huang, B. (2014). Mechanism of salinity tolerance in plants: physiological, biochemical, and molecular characterization. *International journal of genomics, 2014*.

Hakim, M., Juraimi, A., Hanafi, M., Ismail, M., Rafii, M., Islam, M., & Selamat, A. (2014). The effect of salinity on growth, ion accumulation and yield of rice varieties. *Journal of Animal and Plant Sciences, 24*(3), 874-885.

Harb, A., Awad, D., & Samarah, N. (2015). Gene expression and activity of antioxidant enzymes in barley (*Hordeum vulgare* L.) under controlled severe drought. *Journal of Plant Interactions, 10*(1), 109-116.

Hare, P. D., & Cress, W. A. (1997). Metabolic implications of stress-induced proline accumulation in plants. *Plant Growth Regulation, 21*(2), 79-102.

Hariadi, Y., Marandon, K., Tian, Y., Jacobsen, S. E., & Shabala, S. (2011). Ionic and osmotic relations in quinoa (*Chenopodium quinoa* Willd.) plants grown at various salinity levels. *Journal of Experimental Botany, 62*(1), 185-193.

Hasanuzzaman, M., Nahar, K., & Fujita, M. (2013). Plant response to salt stress and role of exogenous protectants to mitigate salt-induced damages *Ecophysiology and responses of plants under salt stress* (pp. 25-87): Springer.

Hasegawa, P. M., Bressan, R. A., Zhu, J.-K., & Bohnert, H. J. (2000). Plant cellular and molecular responses to high salinity. *Annual Review of Plant Biology, 51*(1), 463-499.

Hashim, M. M. a., Yusop, M. K., Othman, R., & Wahid, S. A. (2015). Characterization of nitrogen uptake pattern in Malaysian rice MR219 at different growth stages using 15N isotope. *Rice Science, 22*(5), 250-254.

Hayat, S., Hayat, Q., Alyemeni, M. N., Wani, A. S., Pichtel, J., & Ahmad, A. (2012). Role of proline under changing environments: A review. *Plant Signaling & Behavior, 7*(11), 1456-1466.

He, S., Han, Y., Wang, Y., Zhai, H., & Liu, Q. (2009). *In vitro* selection and identification of sweetpotato (*Ipomoea batatas* (L.) Lam.) plants tolerant to NaCl. *Plant Cell, Tissue and Organ Culture, 96*(1), 69-74.

Heath, R. L., & Packer, L. (1968). Photoperoxidation in isolated chloroplasts. I. Kinetics and stoichiometry of fatty acid peroxidation. *Archives of Biochemistry and Biophysics, 125*(1), 189-198.

Hernandez, J., Olmos, E., Corpas, F., Sevilla, F., & Del Rio, L. (1995). Salt-induced oxidative stress in chloroplasts of pea plants. *Plant Science, 105*(2), 151-167.

Hernández, J. A., & Almansa, M. S. (2002). Short-term effects of salt stress on antioxidant systems and leaf water relations of pea leaves. *Physiologia Plantarum, 115*(2), 251-257.

Heszky, L. (1990). Restoration of the regeneration potential of long-term cell culture in rice (*Oryza sativa* L.) by salt pretreatment. *Journal of Plant Physiology, 136*(3), 336-340.

Hossain, Z., Mandal, A. K. A., Datta, S. K., & Biswas, A. K. (2007). Development of NaCl-tolerant line in *Chrysanthemum morifolium* Ramat. through shoot organogenesis of selected callus line. *Journal of Biotechnology, 129*(4), 658-667.

Htwe, N. N., Maziah, M., Ling, H. C., Zaman, F. Q., & Zain, A. M. (2013). Responses of some selected Malaysian rice genotypes to callus induction under *in vitro* salt stress. *African Journal of Biotechnology, 10*(3), 350-362.

IRRI. (2007). Rice Races. Retrieved 1th Jan, 2017 from: http://www.knowledgebank.irri.org/ericeproduction/0.1._Morphology_of_the_rice_plant.htm.

IRRI. (2015). The International Rice Genebank. Retrieved 2th Jan, 2017 from: http://irri.org/our-work/research/genetic-diversity/international-rice-genebank

Ismail, A., Seo, M., Takebayashi, Y., Kamiya, Y., Eiche, E., & Nick, P. (2014). Salt adaptation requires efficient fine-tuning of jasmonate signalling. *Protoplasma, 251*(4), 881-898.

Jain, M., Mathur, G., Koul, S., & Sarin, N. (2001). Ameliorative effects of proline on salt stress-induced lipid peroxidation in cell lines of groundnut (*Arachis hypogaea* L.). *Plant Cell Reports, 20*(5), 463-468.

Jaleel, C. A., Gopi, R., Sankar, B., Manivannan, P., Kishorekumar, A., Sridharan, R., & Panneerselvam, R. (2007). Studies on germination, seedling vigour, lipid peroxidation and proline metabolism in *Catharanthus roseus* seedlings under salt stress. *South African Journal of Botany, 73*(2), 190-195.

Javed, F. (2002). *In vitro* salt tolerance in wheat I: growth and ion accumulation in *Triticum aestivum*. *International Journal of Agriculture and Biology 4*, 459-461.

Jebara, S., Jebara, M., Limam, F., & Aouani, M. E. (2005). Changes in ascorbate peroxidase, catalase, guaiacol peroxidase and superoxide dismutase activities in common bean (*Phaseolus vulgaris*) nodules under salt stress. *Journal of Plant Physiology, 162*(8), 929-936.

Jin, S., Mushke, R., Zhu, H., Tu, L., Lin, Z., Zhang, Y., & Zhang, X. (2008). Detection of somaclonal variation of cotton (*Gossypium hirsutum*) using cytogenetics, flow cytometry and molecular markers. *Plant Cell Reports, 27*(8), 1303-1316.

Jithesh, M., Prashanth, S., Sivaprakash, K., & Parida, A. K. (2006). Antioxidative response mechanisms in halophytes: their role in stress defence. *Journal of Genetics, 85*(3), 237-254.

Jones, B., Gunnerås, S. A., Petersson, S. V., Tarkowski, P., Graham, N., May, S., Dolezal, K., Sandberg, G., & Ljung, K. (2010). Cytokinin regulation of auxin synthesis in Arabidopsis involves a homeostatic feedback loop regulated via auxin and cytokinin signal transduction. *The Plant Cell, 22*(9), 2956-2969.

Joyia, F. A., & Khan, M. S. (2013). Scutellum-derived callus-based efficient and reproducible regeneration system for elite varieties of indica rice in Pakistan. *International Journal of Agriculture and Biology, 15*, 27-33.

Kalman, D. S. (2014). Amino acid composition of an organic brown rice protein concentrate and isolate compared to soy and whey concentrates and isolates. *Foods, 3*(3), 394-402.

Kandil, A., Sharief, A., & Ahmed, S. (2012). Germination and seedling growth of some chickpea cultivars (*Cicer arietinum* L.) under salinity stress. *Journal of Basic & Applied Sciences, 8*, 561-571.

Kar, P. K., & Shaw, B. P. (2013). Differential expression of choline monooxygenase transcript determines the plant to be glycine betaine accumulator or non-accumulator. *Development, 3*, 383-386.

Karadimova, M., & Djambova, G. (1993). Increased NaCl-tolerance in wheat (*Triticum aestivum* L. and *T. durum* desf.) through *in vitro* selection. *In Vitro Cellular & Developmental Biology-Plant, 29*(4), 180-182.

Karthikeyan, A., Pandian, S. T. K., & Ramesh, M. (2009). High frequency plant regeneration from embryogenic callus of a popular indica rice (*Oryza sativa* L.). *Physiology and Molecular Biology of Plants, 15*(4), 371-375.

Katsuhara, M., & Kawasaki, T. (1996). Salt stress induced nuclear and DNA degradation in meristematic cells of barley roots. *Plant and Cell Physiology, 37*(2), 169-173.

Katsuhara, M., Otsuka, T., & Ezaki, B. (2005). Salt stress-induced lipid peroxidation is reduced by glutathione S-transferase, but this reduction of lipid peroxides is not enough for a recovery of root growth in *Arabidopsis*. *Plant Science, 169*(2), 369-373.

Kaymakanova, M. (2009). Effect of salinity on germination and seed physiology in bean (*Phaseolus vulgaris* L.). *Biotechnology & Biotechnological Equipment, 23*(sup1), 326-329.

Khaleda, L., Ahmed, A., Marzan, L., & Al-Forkan, M. (2007). Identification of callus induction and plant regeneration responsiveness in presence of NaCl in *in vitro* culture of some deepwater rice (*Oryza sativa* L.) cultivars. *Asian Journal of Plant Sciences*.

Khan, M. N., Mobin, M., Mohammad, F., & Corpas, F. J. (2015). *Nitric Oxide Action in Abiotic Stress Responses in Plants*: Springer International Publishing.

Khorami, A., & Safarnejad, A. (2011). *In vitro* selection of *Foeniculum vulgare* for salt tolerance. *Notulae Scientia Biologicae, 3*(2), 90.

Khush, G. S. (1997). Origin, dispersal, cultivation and variation of rice *Oryza: From molecule to plant* (pp. 25-34): Springer.

Kishor, K., Polavarapu, B., & Sreenivasulu, N. (2014). Is proline accumulation per se correlated with stress tolerance or is proline homeostasis a more critical issue? *Plant Cell Environ, 37*(2), 300-311.

Kole, C., Muthamilarasan, M., Henry, R., Edwards, D., Sharma, R., Abberton, M., Batley, J., Bentley, A., Blakeney, M., & Bryant, J. (2015). Application of genomics-assisted breeding for generation of climate resilient crops: progress and prospects. *Frontiers in plant science, 6*, 563.

Koyro, H.-W. (1997). Ultrastructural and physiological changes in root cells of Sorghum plants (*Sorghum bicolor× S. sudanensis* cv. Sweet Sioux) induced by NaCl. *Journal of Experimental Botany, 48*(3), 693-706.

Kripkyy, O., Kerkeb, L., Molina, A., Belver, A., Rodríguez-Rosales, P., & Donaire, J. P. (2001). Effects of salt-adaptation and salt-stress on extracellular acidification and microsome phosphohydrolase activities in tomato cell suspensions. *Plant Cell, Tissue and Organ Culture, 66*(1), 41-47.

Krishna, H., Alizadeh, M., Singh, D., Singh, U., Chauhan, N., Eftekhari, M., & Sadh, R. K. (2016). Somaclonal variations and their applications in horticultural crops improvement. *3 Biotech, 6*(1), 54.

Kumar, K., & Gariya, H. S. (2016). Morphology of callus, shoots, roots and leafs of *Withania somnifera* (Cultivated and Wild) *in vitro* tissue culture conditions with different hormones concentration.

Lai, K.-L., & Liu, L.-F. (1988). Increased Plant Regeneration Frequency in Water-Stressed Rice Tissue Cultures. *Japanese Journal of Crop Science, 57*(3), 553-557.

Lee, & Huang, W. L. (2014). Osmotic stress stimulates shoot organogenesis in callus of rice (*Oryza sativa* L.) via auxin signaling and carbohydrate metabolism regulation. *Plant Growth Regulation, 73*(2), 193-204.

Lee, Jeon, H., & Kim, M. (2002). Optimization of a mature embryo-based *in vitro* culture system for high-frequency somatic embryogenic callus induction and plant regeneration from japonica rice cultivars. *Plant Cell, Tissue and Organ Culture, 71*(3), 237-244.

Leva, A., Rinaldi, L., & Petruccelli, R. (2012). *Somaclonal variation in tissue culture: a case study with olive*: INTECH Open Access Publisher.

Li, Y. (2008). Effect of salt stress on seed germination and seedling growth of three salinity plants. *Pakistan Journal of Biological Sciences, 11*(9), 1268-1272.

Lin, Y. J., & Zhang, Q. (2005). Optimising the tissue culture conditions for high efficiency transformation of indica rice. *Plant Cell Reports, 23*(8), 540-547.

Lokhande, Nikam, T., Patade, V., Ahire, M., & Suprasanna, P. (2011). Effects of optimal and supra-optimal salinity stress on antioxidative defence, osmolytes and *in vitro* growth responses in *Sesuvium portulacastrum* L. *Plant Cell, Tissue and Organ Culture (PCTOC), 104*(1), 41-49.

Lokhande, Nikam, T. D., & Penna, S. (2010). Biochemical, physiological and growth changes in response to salinity in callus cultures of *Sesuvium portulacastrum* L. *Plant Cell, Tissue and Organ Culture (PCTOC), 102*(1), 17-25.

Luan, Z., Xiao, M., Zhou, D., Zhang, H., Tian, Y., Wu, Y., Guan, B., & Song, Y. (2014). Effects of salinity, temperature, and polyethylene glycol on the seed germination of sunflower (*Helianthus annuus* L.). *The Scientific World Journal, 2014*.

Łukasik, I., Goławska, S., & Wójcicka, A. (2012). Effect of cereal aphid infestation on ascorbate content and ascorbate peroxidase activity in triticale. *Polish Journal Of Environmental Studies, 21*, 1937-1941.

Lutts, Kinet, J., & Bouharmont, J. (1999). Improvement of rice callus regeneration in the presence of NaCl. *Plant Cell, Tissue and Organ Culture, 57*(1), 3-11.

Maas, E. V., & Hoffman, G. (1977). Crop salt tolerance\-current assessment. *Journal of the irrigation and drainage division, 103*(2), 115-134.

Maclean, J. L. (2002). *Rice almanac: Source book for the most important economic activity on earth*: Int. Rice Res. Inst.

Mahajan, S., & Tuteja, N. (2005). Cold, salinity and drought stresses: an overview. *Archives of Biochemistry and Biophysics, 444*(2), 139-158.

Mahmood, M., Normi, R., & Subramaniam, S. (2010). Optimization of suitable auxin application in a recalcitrant woody forest plant of *Eurycoma longifolia* (Tongkat Ali) for callus induction. *African Journal of Biotechnology, 9*(49), 8417.

Manai, J., Gouia, H., & Corpas, F. J. (2014). Redox and nitric oxide homeostasis are affected in tomato (*Solanum lycopersicum*) roots under salinity-induced oxidative stress. *Journal of plant physiology, 171*(12), 1028-1035.

Mansour, M., & Salama, K. (1996). Comparative responses to salinity in wheat genotypes differing in salt tolerance. 1.-seeding growth and mineral relations. *Egyptian Journal of Physiological Sciences (Egypt)*.

Mansour, M., Salama, K., Ali, F., & Abou Hadid, A. (2005). Cell and plant responses to NaCl in *Zea mays* L. cultivars differing in salt tolerance. *General and Applied Plant Physiology 31*(1-2), 29-41.

Marcelis, L., & Van Hooijdonk, J. (1999). Effect of salinity on growth, water use and nutrient use in radish (*Raphanus sativus* L.). *Plant and soil, 215*(1), 57-64.

Matkowski, A. (2008). Plant *in vitro* culture for the production of antioxidants—a review. *Biotechnology Advances, 26*(6), 548-560.

Meloni, D. A., Gulotta, M. R., Martínez, C. A., & Oliva, M. A. (2004). The effects of salt stress on growth, nitrate reduction and proline and glycinebetaine accumulation in *Prosopis alba*. *Brazilian Journal of Plant Physiology, 16*(1), 39-46.

Miki, Y., Hashiba, M., & Hisajima, S. (2001). Establishment of salt stress tolerant rice plants through step up NaCl treatment *in vitro*. *Biologia Plantarum, 44*(3), 391-395.

Miller, J. J., & Curtin, D. (2006). Electrical conductivity and soluble ions. *Soil Sampling and Methods of Analysis*, 161-171.

Mishra, B. (2004). *Present status issues and future strategies for increasing quality rice production and export.* Paper presented at the National Symposium on strategies for enhancing export of quality rice held at NBPGR, New Delhi.

Moghaieb, R. E., Saneoka, H., & Fujita, K. (2004). Effect of salinity on osmotic adjustment, glycinebetaine accumulation and the betaine aldehyde dehydrogenase gene expression in two halophytic plants, *Salicornia europaea* and *Suaeda maritima*. *Plant Science, 166*(5), 1345-1349.

Mohamed, M., Harris, P., & Henderson, J. (2000). *In vitro* selection and characterisation of a drought tolerant clone of *Tagetes minuta*. *Plant Science, 159*(2), 213-222.

Molassiotis, A., Sotiropoulos, T., Tanou, G., Kofidis, G., Diamantidis, G., & Therios, E. (2006). Antioxidant and anatomical responses in shoot culture of the apple rootstock MM 106 treated with NaCl, KCl, mannitol or sorbitol. *Biologia Plantarum, 50*(1), 61-68.

Muniz, A. W., de Sá, E. L., Dalagnol, G. L., & Américo Filho, J. (2013). Rooting and acclimatization of micropropagated marubakaido apple rootstock using *Adesmia latifolia* rhizobia. *SpringerPlus, 2*(1), 437.

Munns. (1985). Na^+, K^+ and Cl^- in xylem sap flowing toi shoots of NaCl treated barley. *Journal of Experimental Botany, 36*.

Munns, & Tester, M. (2008). Mechanisms of salinity tolerance. *Annual Review of Plant Biology, 59*, 651-681.

Murakami, K., Takashi, K., & Ogawa, K. (2004). *Morphological variation of corms in plants regenerated from calluses of taro (Colocasia esculenta Schott).* Paper presented at the V International Symposium on *In Vitro* Culture and Horticultural Breeding 725.

Murashige, T., & Skoog, F. (1962). A revised medium for rapid growth and bio assays with tobacco tissue cultures. *Physiologia Plantarum, 15*(3), 473-497.

Mutert, E., & Fairhurst, T. (2002). Developments in rice production in Southeast Asia. *Better Crops International, 15*, 12-17.

Nanjo, T., Kobayashi, M., Yoshiba, Y., Sanada, Y., Wada, K., Tsukaya, H., Kakubari, Y., Yamaguchi-Shinozaki, K., & Shinozaki, K. (1999). Biological functions of proline in morphogenesis and osmotolerance revealed in antisense transgenic Arabidopsis thaliana. *The Plant Journal, 18*(2), 185-193.

Ochatt, S., Marconi, P., Radice, S., Arnozis, P., & Caso, O. (1998). *In vitro* recurrent selection of potato: production and characterization of salt tolerant cell lines and plants. *Plant Cell, Tissue and Organ Culture, 55*(1), 1-8.

OECD. (1999). Consensus document on the biology of *Oryza sativa* (rice). Report No. ENV/JM/MONO(99)26. *OECD Environment health and safety publications, Paris.*

Ozgur, R., Uzilday, B., Sekmen, A. H., & Turkan, I. (2013). Reactive oxygen species regulation and antioxidant defence in halophytes. *Functional Plant Biology, 40*(9), 832-847.

Panjaitan, S. B., Abdullah, S. N. A., Abdul Aziz, M., Meon, S., & Omar, O. (2009). Somatic embryogenesis from scutellar embryo of *Oryza sativa* L. var. MR219. *Pertanika Journal of Tropical Agricultural Science, 32*(2), 185-194.

Parida, A. K., & Das, A. B. (2005). Salt tolerance and salinity effects on plants: a review. *Ecotoxicology and Environmental Safety, 60*(3), 324-349.

Patnaik, J., & Debata, B. (1997). Regeneration of plantlets from NaCl tolerant callus lines of *Cymbopogon martinii* (Roxb.) Wats. *Plant Science, 128*(1), 67-74.

Pearson, G., Ayers, A., & Eberhard, D. (1966). Relative salt tolerance of rice during germination and early seedling development. *Soil Science, 102*(3), 151-156.

Pessarakli, M., & Szabolcs, I. (1999). Soil salinity and sodicity as particular plant/crop stress factors. *Handbook of Plant and Crop Stress, 2*.

Piqueras, A., Hernández, J. A., Olmos, E., Hellín, E., & Sevilla, F. (1996). Changes in antioxidant enzymes and organic solutes associated with adaptation of citrus cells to salt stress. *Plant Cell, Tissue and Organ Culture, 45*(1), 53-60.

Plader, W., Malepszy, S., Burza, W., & Rusinowski, Z. (1998). The relationship between the regeneration system and genetic variability in the cucumber (*Cucumis sativus* L.). *Euphytica, 103*(1), 9-15.

Poesen, J., & Savat, J. (1981). Detachment and transportation of loose sediments by raindrop splash: Part II Detachability and transport ability measurements. *Catena, 8*(1), 19-41.

Pontaroli, A. C., & Camadro, E. L. (2005). Somaclonal variation in *Asparagus officinalis* plants regenerated by organogenesis from long-term callus cultures. *Genetics and Molecular Biology, 28*(3), 423-430.

Purohit, M., Srivastava, S., & Srivastava, P. (1998). Stress tolerant plants through tissue culture. *Plant tissue culture and molecular biology: application and prospects. Narosa Publishing House, New Delhi*, 554-578.

Quan, L. J., Zhang, B., Shi, W. W., & Li, H. Y. (2008). Hydrogen peroxide in plants: a versatile molecule of the reactive oxygen species network. *Journal of Integrative Plant Biology, 50*(1), 2-18.

Queiros, F., Fidalgo, F., Santos, I., & Salema, R. (2007). *In vitro* selection of salt tolerant cell lines in *Solanum tuberosum* L. *Biologia Plantarum, 51*(4), 728-734.

Racchi, M. L. (2013). Antioxidant Defenses in Plants with Attention to *Prunus* and *Citrus* spp. *Antioxidants, 2*(4), 340-369.

Rahaman, M. M., Chen, D., Gillani, Z., Klukas, C., & Chen, M. (2015). Advanced phenotyping and phenotype data analysis for the study of plant growth and development. *Frontiers in Plant Science, 6*.

Rai, M. K., Jaiswal, V., & Jaiswal, U. (2010). Regeneration of plantlets of guava (*Psidium guajava* L.) from somatic embryos developed under salt-stress condition. *Acta Physiologiae Plantarum, 32*(6), 1055-1062.

Rai, M. K., Kalia, R. K., Singh, R., Gangola, M. P., & Dhawan, A. (2011). Developing stress tolerant plants through *in vitro* selection—an overview of the recent progress. *Environmental and Experimental Botany, 71*(1), 89-98.

Rains, D., Croughan, T., & Stavarek, S. (1980). *Selection of salt-tolerant plants using tissue culture*: Springer.

Rajabi, A., Khayamim, S., Abbasi, Z., & Ober, E. (2014). Salt Stress and Sugar Beet Improvement: Challenges and Opportunities *Improvement of Crops in the Era of Climatic Changes* (pp. 121-150): Springer.

Ramesh, M., Murugiah, V., & Gupta, A. K. (2009). Efficient *in vitro* plant regeneration via leaf base segments of indica rice (*Oryza sativa* L.).

Rao, S., & Jabeen, F. (2013). Optimization of Protocols for Callus Induction, Regeneration and Acclimatization of Sugarcane (*Saccharum officinarum* L.) Cultivar CO-86032. *Current Trends in Biotechnology & Pharmacy, 7*(4).

Rao, S., & Patil, P. (2011). *In Vitro* Selection of Salt Tolerant Calli Lines and Regeneration of Salt Tolerant Plantlets in Mung Bean (*Vigna radiata* L. Wilczek). *Biotechnology-Molecular Studies and Novel Applications for Improved Quality of Human Life, 1*, 197-212.

Rattana, K., & Bunnag, S. (2015). Differential salinity tolerance in calli and shoots of four rice cultivars. *Asian Journal of Crop Science, 7*(1), 48.

Ray, T., Dutta, I., Saha, P., Das, S., & Roy, S. (2006). Genetic stability of three economically important micropropagated banana (*Musa* spp.)

cultivars of lower Indo-Gangetic plains, as assessed by RAPD and ISSR markers. *Plant Cell, Tissue and Organ Culture, 85*(1), 11-21.

Redfern, S. K., Azzu, N., & Binamira, J. S. (2012). Rice in Southeast Asia: facing risks and vulnerabilities to respond to climate change. *Build Resilience Adapt Climate Change Agri Sector, 23*, 295.

Reinhardt, D., & Rost, T. (1995). Salinity accelerates endodermal development and induces an exodermis in cotton seedling roots. *Environmental and Experimental Botany, 35*(4), 563-574.

Rejeb, K. B., Abdelly, C., & Savouré, A. (2014). How reactive oxygen species and proline face stress together. *Plant Physiology and Biochemistry, 80*, 278-284.

Roach, T., & Krieger-Liszkay, A. (2014). Regulation of photosynthetic electron transport and photoinhibition. *Current Protein and Peptide Science, 15*(4), 351-362.

Rout, G., Senapati, S., & Panda, J. (2008). Selection of salt tolerant plants of *Nicotiana tabacum* L. through *in vitro* and its biochemical characterization. *Acta Biologica Hungarica, 59*(1), 77-92.

Rueb, S., Leneman, M., Schilperoort, R. A., & Hensgens, L. (1994). Efficient plant regeneration through somatic embryogenesis from callus induced on mature rice embryos (*Oryza sativa* L.). *Plant Cell, Tissue and Organ Culture, 36*(2), 259-264.

Sabbah, S., & Tal, M. (1990). Development of callus and suspension cultures of potato resistant to NaCl and mannitol and their response to stress. *Plant Cell, Tissue and Organ Culture, 21*(2), 119-128.

Sahoo, K. K., Tripathi, A. K., Pareek, A., Sopory, S. K., & Singla-Pareek, S. L. (2011). An improved protocol for efficient transformation and regeneration of diverse indica rice cultivars. *Plant methods, 7*(1), 1.

Sajid Aqeel Ahmad, M., Javed, F., & Ashraf, M. (2007). Iso-osmotic effect of NaCl and PEG on growth, cations and free proline accumulation in callus tissue of two indica rice (*Oryza sativa* L.) genotypes. *Plant Growth Regulation, 53*(1), 53-63.

Sajid, Z. A., & Aftab, F. (2012). Role of salicylic acid in amelioration of salt tolerance in potato (*Solanum tuberosum* L.) under *in vitro* conditions. *Pakistan Journal of Botany, 44*, 37-42.

Sajid, Z. A., & Aftab, F. (2014). Plant regeneration from *in vitro*-selected salt tolerant callus cultures of *Solanum tuberosum*. *Pakistan Journal of Botany, 46*(4), 1507-1514.

Sakhanokho, H. F., & Kelley, R. Y. (2009). Influence of salicylic acid on *in vitro* propagation and salt tolerance in *Hibiscus acetosella* and *Hibiscus moscheutos* (cv 'Luna Red'). *African Journal of Biotechnology, 8*(8).

Sánchez-Blanco, M., Bolarin, M., Alarcon, J., & Torrecillas, A. (1991). Salinity effects on water relations in *Lycopersicon esculentum* and its wild salt-tolerant relative species *L. pennellii*. *Physiologia Plantarum, 83*(2), 269-274.

Sankar, P. D., Saleh, M. A. M., & Selvaraj, C. I. (2011). Rice breeding for salt tolerance. *Research in Biotechnology, 2*(2).

Schobert, B., & Tschesche, H. (1978). Unusual solution properties of proline and its interaction with proteins. *Biochimica et Biophysica Acta (BBA)-General Subjects, 541*(2), 270-277.

Shabala, L., Cuin, T. A., Newman, I. A., & Shabala, S. (2005). Salinity-induced ion flux patterns from the excised roots of Arabidopsis sos mutants. *Planta, 222*(6), 1041-1050.

Shankhdhar, D., Shankhdhar, S., Mani, S., & Pant, R. (2000). *In vitro* selection for salt tolerance in rice. *Biologia Plantarum, 43*(3), 477-480.

Shannon, M., Rhoades, J., Draper, J., Scardaci, S., & Spyres, M. (1998). Assessment of salt tolerance in rice cultivars in response to salinity problems in California. *Crop Science, 38*(2), 394-398.

Shanthi, P., Jebaraj, S., & Geetha, S. (2010). *In vitro* screening for salt tolerance in rice (*Oryza sativa*). *Electronic Journal of Plant Breeding, 1*, 1208-1212.

Sharma, P., Jha, A. B., Dubey, R. S., & Pessarakli, M. (2012). Reactive Oxygen Species, Oxidative Damage, and Antioxidative Defense Mechanism in Plants under Stressful Conditions. *Journal of Botany, 2012*, 26.

Shereen, A., Ansari, R., Flowers, T., Yeo, A., & Ala, S. (2002). Rice cultivation in saline soils *Prospects for Saline Agriculture* (pp. 189-192): Springer.

Shereen, A., Mumtaz, S., Raza, S., Khan, M., & Solangi, S. (2005). Salinity effects on seedling growth and yield components of different inbred rice lines. *Pakistan Journal of Botany, 37*(1), 131-139.

Shimazaki, Y., Ookawa, T., & Hirasawa, T. (2005). The root tip and accelerating region suppress elongation of the decelerating region without any effects on cell turgor in primary roots of maize under water stress. *Plant Physiology, 139*(1), 458-465.

Shrivastava, P., & Kumar, R. (2015). Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. *Saudi journal of biological sciences, 22*(2), 123-131.

Silveira, J. A. G., de Almeida Viégas, R., da Rocha, I. M. A., Moreira, A. C. d. O. M., de Azevedo Moreira, R., & Oliveira, J. T. A. (2003). Proline accumulation and glutamine synthetase activity are increased by salt-induced proteolysis in cashew leaves. *Journal of plant physiology, 160*(2), 115-123.

Singh, K., & Chatrath, R. (2001). Salinity tolerance. *Application of physiology in wheat breeding. CIMMYT, Mexico, DF*, 101-110.

Skirvin, R. M., McPheeters, K. D., & Norton, M. (1994). Sources and frequency of somaclonal variation. *HortScience, 29*(11), 1232-1237.

Ślesak, H., Popielarska, M., & Góralski, G. (2005). Morphological and histological aspects of 2, 4-D effects on rape explants (*Brassica napus* L. cv. Kana) cultured *in vitro*. *Acta Biologica Cracoviensia Series Botanica, 47*(1), 219-226.

Smirnoff, N., & Cumbes, Q. J. (1989). Hydroxyl radical scavenging activity of compatible solutes. *Phytochemistry, 28*(4), 1057-1060.

Stobbe, H., Schmitt, U., Eckstein, D., & Dujesiefken, D. (2002). Developmental stages and fine structure of surface callus formed after debarking of living lime trees (*Tilia* sp.). *Annals of botany, 89*(6), 773-782.

Sudharani, M., Reddy, P. R., & Jayalakshmi, V. (2012). A Comprehensive Review on “Genetic Components Of Salinity Tolerance in Rice (*Oryza sativa* L.)”. *International Journal of Applied Biology and Pharmaceutical Technology, 3*, 312-322.

Sumithra, K., Jutur, P., Carmel, B. D., & Reddy, A. R. (2006). Salinity-induced changes in two cultivars of *Vigna radiata*: responses of antioxidative and proline metabolism. *Plant Growth Regulation, 50*(1), 11-22.

Summart, J., Thanonkeo, P., Panichajakul, S., Prathepha, P., & McManus, M. (2010). Effect of salt stress on growth, inorganic ion and proline accumulation in Thai aromatic rice, Khao Dawk Mali 105, callus culture. *African Journal of Biotechnology, 9*(2).

Talei, D., Valdiani, A., Yusop, M. K., & Abdullah, M. P. (2013). Estimation of salt tolerance in *Andrographis paniculata* accessions using multiple regression model. *Euphytica, 189*(1), 147-160.

Tang, W., & Newton, R. J. (2005). Polyamines reduce salt-induced oxidative damage by increasing the activities of antioxidant enzymes and

decreasing lipid peroxidation in *Virginia pine*. *Plant Growth Regulation, 46*(1), 31-43.

Tariq, M., Ali, G., Hadi, F., Ahmad, S., Ali, N., & Shah, A. A. (2008). Callus induction and *in vitro* plant regeneration of rice (*Oryza sativa* L.) under various conditions. *Pakistan Journal of Biological Sciences, 11*(2), 255-259.

Teh, C. Y., Mahmood, M., Shaharuddin, N. A., & Ho, C. L. (2015). *In vitro* rice shoot apices as simple model to study the effect of NaCl and the potential of exogenous proline and glutathione in mitigating salinity stress. *Plant Growth Regulation, 75*(3), 771-781.

Tian, M., Gu, Q., & Zhu, M. (2003). The involvement of hydrogen peroxide and antioxidant enzymes in the process of shoot organogenesis of strawberry callus. *Plant Science, 165*(4), 701-707.

Tonon, G., Kevers, C., Faivre-Rampant, O., Graziani, M., & Gaspar, T. (2004). Effect of NaCl and mannitol iso-osmotic stresses on proline and free polyamine levels in embryogenic *Fraxinus angustifolia* callus. *Journal of plant physiology, 161*(6), 701-708.

Torabi, S., & Niknam, V. (2011). Effects of Iso-osmotic Concentrations of NaCl and Mannitol on some Metabolic Activity in Calluses of Two *Salicornia* species. *In Vitro Cellular & Developmental Biology - Plant, 47*(6), 734-742.

Tripathi, B. N., & Gaur, J. (2004). Relationship between copper-and zinc-induced oxidative stress and proline accumulation in *Scenedesmus* sp. *Planta, 219*(3), 397-404.

Türkan, I., & Demiral, T. (2009). Recent developments in understanding salinity tolerance. *Environmental and Experimental Botany, 67*(1), 2-9.

Umadevi, M., Pushpa, R., Sampathkumar, K., & Bhowmik, D. (2012). Rice-traditional medicinal plant in India. *Journal of Pharmacognosy and Phytochemistry, 1*(1).

USDA. (2015). Classification of *Oryza sativa* L.rice. Retrieved 2th Jan, 2017 from http: https://plants.usda.gov/core/profile?symbol=orsa

Václavík, T., Lautenbach, S., Kuemmerle, T., & Seppelt, R. (2013). Mapping global land system archetypes. *Global Environmental Change, 23*(6), 1637-1647.

Vajrabhaya, M., Thanapaisal, T., & Vajrabhaya, T. (1989). Development of salt tolerant lines of KDML and LPT rice cultivars through tissue culture. *Plant Cell Reports, 8*(7), 411-414.

Van Oosten, M. J., Costa, A., Punzo, P., Landi, S., Ruggiero, A., Batelli, G., & Grillo, S. (2016). Genetics of Drought Stress Tolerance in Crop Plants *Drought Stress Tolerance in Plants, Vol 2* (pp. 39-70): Springer.

Vijayan, K., Chakraborti, S., & Ghosh, P. (2003). *In vitro* screening of mulberry (*Morus* spp.) for salinity tolerance. *Plant Cell Reports, 22*(5), 350-357.

Vinod, K., Krishnan, S. G., Babu, N. N., Nagarajan, M., & Singh, A. (2013). Improving salt tolerance in rice: Looking beyond the conventional *Salt Stress in Plants* (pp. 219-260): Springer.

Wang, M., Zheng, Q., Shen, Q., & Guo, S. (2013). The critical role of potassium in plant stress response. *International Journal of Molecular Sciences, 14*(4), 7370-7390.

Wani, S. H., Lone, A. A., Da Silva, T., & Gosal, S. S. (2010). Effects of NaCl stress on callus induction and plant regeneration from mature seeds of rice (*Oryza sativa* L.). *Asian and Australasian Journal of Plant Science and Biotechnology, 4*(1), 57-61.

Wani, S. H., Sanghera, G. S., & Gosal, S. S. (2011). An efficient and reproducible method for regeneration of whole plants from mature seeds of a high yielding Indica rice (*Oryza sativa* L.) variety PAU 201. *New biotechnology, 28*(4), 418-422.

Watanabe, S., Kojima, K., Ide, Y., & Sasaki, S. (2000). Effects of saline and osmotic stress on proline and sugar accumulation in *Populus euphratica in vitro*. *Plant Cell, Tissue and Organ Culture, 63*(3), 199-206.

Wei, Q., Guo, Y., Cao, H., & Kuai, B. (2011). Cloning and characterization of an AtNHX2-like Na+/H+ antiporter gene from *Ammopiptanthus mongolicus* (Leguminosae) and its ectopic expression enhanced drought and salt tolerance in *Arabidopsis thaliana*. *Plant Cell, Tissue and Organ Culture (PCTOC), 105*(3), 309-316.

West, G., Inzé, D., & Beemster, G. T. (2004). Cell cycle modulation in the response of the primary root of *Arabidopsis* to salt stress. *Plant Physiology, 135*(2), 1050-1058.

Wicke, B., Smeets, E., Dornburg, V., Vashev, B., Gaiser, T., Turkenburg, W., & Faaij, A. (2011). The global technical and economic potential of bioenergy from salt-affected soils. *Energy & Environmental Science, 4*(8), 2669-2681.

Wijesekera, T., Iqbal, M., & Bandara, D. (2007). Plant regeneration *in vitro* by organogenesis on callus induced from mature embryos of three

rice varieties (*Oryza sativa* L. spp. indica). *Tropical Agriculture Research, 19*, 25-35.

Wu, J., Seliskar, D. M., & Gallagher, J. L. (2005). The response of plasma membrane lipid composition in callus of the halophyte *Spartina patens* (Poaceae) to salinity stress. *Am J Bot, 92*(5), 852-858.

Yadav, S., Irfan, M., Ahmad, A., & Hayat, S. (2011). Causes of salinity and plant manifestations to salt stress: a review. *Journal of Environmental Biology, 32*(5), 667.

Yamaguchi, T., & Blumwald, E. (2005). Developing salt-tolerant crop plants: challenges and opportunities. *Trends Plant Sci, 10*(12), 615-620.

Yang, Y., Wei, X., Shi, R., Fan, Q., & An, L. (2010). Salinity-induced Physiological Modification in the Callus from Halophyte *Nitraria tangutorum Bobr*. *Journal of Plant Growth Regulation, 29*(4), 465-476.

Yasar, F., Ellialtioglu, S., & Kusvuran, S. (2006). Ion and lipid peroxide content in sensitive and tolerant eggplant callus cultured under salt stress. *European Journal of Horticultural Science*, 169-172.

Ye, J., Kao, K., Harvey, B., & Rossnagel, B. (1987). Screening salt-tolerant barley genotypes via F1 anther culture in salt stress media. *Theoretical and Applied Genetics, 74*(4), 426-429.

Yeo, A., Yeo, M., Flowers, S., & Flowers, T. (1990). Screening of rice (*Oryza sativa* L.) genotypes for physiological characters contributing to salinity resistance, and their relationship to overall performance. *Theoretical and Applied Genetics, 79*(3), 377-384.

Yoshida, S., Forno, D., Cock, J., & Gomez, K. (1976). Routine procedure for growing rice plants in culture solution. *Laboratory manual for physiological studies of rice*, 61-66.

Yu, Z., Sun, M., Wei, H., KONG, Y.-j., & KONG, H.-l. (2007). Effects of salt and drought intercross stresses on activity of cell defense enzymes in leaves of *Gleditsia sinedsis Lam*. Seedlings. *Journal of Central South University of Forestry & Technology, 27*(6), 29-32.

Zacchini, M., & De Agazio, M. (2004). Micropropagation of a local olive cultivar for germplasm preservation. *Biologia Plantarum, 48*(4), 589-592.

Zair, I., Chlyah, A., Sabounji, K., Tittahsen, M., & Chlyah, H. (2003). Salt tolerance improvement in some wheat cultivars after application of *in vitro* selection pressure. *Plant Cell, Tissue and Organ Culture, 73*(3), 237-244.

Zamani, S., Bybordi, A., Khorshidi, M., & Nezami, T. (2010). Effects of NaCl salinity levels on lipids and proteins of canola (*Brassica napus* L.) cultivars. *Advances in Environmental Biology, 4*, 397-403.

Zhang, Wang, Z., Wang, N., Gao, Y., Liu, Y., Wu, Y., Bai, Y., Zhang, Z., Lin, X., Dong, Y., Ou, X., Xu, C., & Liu, B. (2014). Tissue Culture-Induced Heritable Genomic Variation in Rice, and Their Phenotypic Implications. *PloS one, 9*(5), e96879.

Zhang, Yang, Y., He, W., Zhao, X., & Zhang, L. (2004). Effects of salinity on growth and compatible solutes of callus induced from *Populus euphratica*. *In Vitro Cellular & Developmental Biology-Plant, 40*(5), 491-494.

Zhao, F. a., Fang, W., Xie, D., Hou, J., Yang, X., Zhao, Y., Tang, Z., Nie, L., & Lv, S. (2015). Identification of early salt stress responsive proteins in seedling roots of upland cotton (*Gossypium hirsutum* L.) employing iTRAQ-based proteomic technique. *Frontiers in Plant Science, 6*, 732.

Zörb, C., Mühling, K. H., Kutschera, U., & Geilfus, C.-M. (2015). Salinity stiffens the epidermal cell walls of salt-stressed maize leaves: is the epidermis growth-restricting? *PloS one, 10*(3), e0118406.

Zuraida, A., Zulkifli, A., Habibuddin, H., & Naziah, B. (2012). Regeneration of Malaysian Rice variety MR219 via somatic embryogenesis. *Journal of Tropical Agriculture and Food Science, 39*(2), 167-177.