Use of Biotechnology to Improve the Tolerance in Rice (Oryza sativa) to Drought Stress

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Abiotic stress factors are the main limitations to plant growth and yield in agriculture. Among them, drought stress, which is caused by water deficit, is probably the most impacting adverse condition and the most widely encounter Rice (Oryza Sativa L.) is one of the most important cereal crops that provides a staple diet for almost half of the world's population. However, rice yield and quality are affected by environmental stress. Drought is one of the most common environmental stresses affecting rice growth and productivity. There's the possible development of biotechnological tools to address the critical problems of crop improvement for a sustainable agriculture. Among the available biotechnological tools, the in-vitro culture alone or combined with mutagenesis, which are induced with physicochemical or biological agents by using (PEG) can be exploited to increase genetic variability and mutants, as a potential source of new commercial cultivars, in-vitro culture environments. Following this, it is preferred that there are more studies on finding the varieties of rice tolerant to drought stress by using biotechnological in order to reduce the risk of abiotic stress, which is the most important stresses of drought on agriculture and rice production.

Key words: Tolerance in rice, Drought stress, Biotechnological tools, Environmental stresses.

The second most commonly refined cereals, after wheat, in the world is Rice (Oryza sativa) and is a staple food for over half the world’s inhabitants. Recently, note experts difficult environmental stresses, for instance waterlogged soil, saline, frost, and high temperature, and drought decrease crop yields and damage quality, which guide to food insecurity. Under intense stress circumstances, crops totally fail, which in sequence may guide to high food prices, food shortage, migration of inhabitants from rural and villages insecurity.

One of the explanations to have a secure and sustainable food manufacture is to breed diversities that are tolerant to stress circumstances during their development and growth. Such inhabitants can be irradiated in vitro to bring grown, multiplied and mutations in the field for the choice of required genotypes. Applying a mixture of in vitro and mutation methods, new genotypes can be produced in a crop of rice; the instruction of mutations proposes the option to create only a
restricted number of the required genetic alterations in varieties and genotypes, which are adjusted to the local eco-climatic situations. Local researches demonstrated that alterations are able of a direct impact on the genetic material and its factors, particularly DNA (DNA) that is dependable for the constancy of the relocation of characteristics from one generation to another. Therefore, the “Coordinated Research Project on the In-Vitro Techniques for the Selection of Radiation Induced Mutations Adapted to Adverse Environmental Conditions” was commenced and centred mainly on the enhancement of vegetative proliferated plants.

Now a day’s technology of plant tissue culture allocate the construction of large inhabitants of plants in a short period and on a year round foundation in the laboratory. Tissue culture and plant cell have been a practical tool to research stress tolerance instruments under in vitro situations. In vitro culture methods reduce environmental differences because of described controlled conditions, nutrient media, and homogeneity of stress function. Additionally, the simplicity of such managements facilitates studying large plant inhabitants and stress actions in a short period of time and restricted space.

Reproduction of drought stress by Polyethylene Glycol (PEG) brings drought stress on the plant sand important difference from the control carries on to enhance with the rising solute probable (Øs). PEG-6000 has long been used as a consistent indicator under laboratory situations for checking the drought tolerant genotypes. This is for the reason that polyethylene glycol performs as a non-penetrating osmotic agent effecting into rising solute probable (Øs) and obstruction of a combination of water by the root system. Drought screening applying some seed technological parameters has been set up to be quite functional in a number of crops. Under laboratory situations. This method can be further expanded to test drought tolerance in other genotypes.

Alteration methods in mixture with the in-vitro culture have become a significant instrument in improvement locally modified cultivars. Since the mid-twentieth century to this day, many studies were done to identify how to enhance the construction of rice. Under situations of drought stresses it is reviewed in the current study, the applying of some biotechnology in the improvement tolerance of rice to drought.

**Rice (Oryza sativa)**

The second main crop international fits in the genus Oryza and has two cultivated and 22 feral variety. The cultivated variety are Oryzaglaberrima and Oryza sativa. Oryza sativa is produced all over the world. Several cultures have proof of early rice cultivation, containing India, China, and the evolutions of Southeast Asia. Conversely, the original archaeological proof appears from eastern and central China and times to 7000–5000 BC (Encyclopædia Britannica, 2010). Is sophisticated in more than 50 countries across Australia, Europe, Africa, South America, North America, and Asia, covering a whole land area of 164 million hectares with a construction level of about 723 million metric tons (FAO 2011). Rice is the basis of 27% of nutritional energy and 20% of nutritional protein in the expanding world (Redoña, 2004). Regarding 90% of the whole rice developed in the world is created by 200 million small cultivators (Tonini and Cabrera, 2011). Rice is fundamental to the lives of billions of people around the world, and producing rice is the main particular applying of land for creating food, covering 9% of the earth’s arable land. Calories from rice are mostly significant in Asia, particularly among the poor, where it reports for 50-80% of daily caloric eating (Gramene Reference ID 8380, 2001). As a consequence of increasing in income and population in main rice-consuming countries, the command for rice has been progressively rising over the years. Mohanty (2009) assessed that the worldwide command for rice will enhance from 465 million ton in 2012 to about 487 million ton in 2020. Consequently, a sustainable development in rice construction internationally is required to make sure maintain human health, food security, and maintain the livelihoods of millions of small cultivators. One of the most severe long-term challenges to attain sustainable development in rice construction is weather change (Vaghefi et al., 2011; Wassmann and Dobermann, 2007; IFPRI, 2010). Rice sustainability and productivity are intimidated by abiotic and biotic stresses, and the outcomes of these stresses can be additional heightened by remarkable changes in worldwide climate. One of the significant ways to make sure food safety and at the same time
present feasible incomes for poor rice cultivators in the future is to expand new rice diversities that are more tolerant of the undesirable effects of a more unstable climate (Mackill et al., 2010; Haefele et al., 2010).

**Abiotic stress**

Dealing with plant environmental stress is the base of sustainable agriculture. Stress is an experience that limits crop efficiency or devastates biomass. Stress can be biotic, reasoned by diseases and insects, or abiotic, which may containair pollution, salinity, flooding, mineral deficiency, metal toxicity, adverse temperature, adverse pH, and drought. Among the abiotic stresses having an effect on crop efficiency, drought is considered as most destructive (Borlaug and Dowswell, 2005).

**Definition of drought**

Droughts happen in all parts of the world counting areas that normally obtain very high rainfall. Droughts reproduce water shortages over a area for extensive periods of time such as a year, a season, or a month. Numerous variables such as humidity winds, temperature, and geographic features, control changeability in the main water source i.e. precipitation over an area [Mishra & Singh, 2010]. Drought can be described as the deficiency of irrigation or rainfall for a period of time enough to reduce soil moisture and damage plants. Drought stress effects when water loss from the plant surpasses the capability of the plant’s roots to absorb water and when the plant’s water content is decreased enough to obstruct with usual plant procedures. Naturally, water is generally the most restrictive feature for plant growth.

**Drought Stress on Rice**

Drought is the most important environmental stress on agricultural construction international (Cattivelli et al.2008) and an incredible attempt is being concerned to progress crop yields in the face of rising water dearth. Drought has an effect onphotosynthetic activity, yield, pigment content, membrane integrity, osmotic adjustments, and water relations, plant growth (Benjamin and Nielsen 2006). Drought-prone areas and probable agricultural land with no irrigation system in place have been less developed than those with expanded irrigation systems or more consistent rainfall because of problems and high costs of expanding enhanced technologies. Consequently, rice yields are demonstrating a stable reducing international in unirrigated and drought-prone regions. Drought is extensive in several areas and are supposed to cause, by 2050, severe drought of more than 50% of all arable lands (Vinocur and Altman, 2005). The globe food grain construction requires to be doubled by the year 2050 to meet the food commands of the ever-rising inhabitants (Tilman et al., 2002), which is going to achieve 9 billion by that time (Virmani and Ilyas-Ahmed, 2007). Abiotic stresses show a main challenge in our mission for sustainable food construction, as these may decrease the potential yields by 70% in crop plants (Katiyar-Agarwalet al., 2006). Although, if the crop experiences an early drought, thus influencing germination, afterwards the suboptimal plant inhabitants is the main cause of low grain yield. Early season drought strictly decreases germination and stand organization mainly because of decreased water uptake during the imbibitions phase of germination, decreased energy deliver, and damaged enzyme performances (Okcu et al. 2005; Taiz and Zeiger 2010). Development is an permanent enhance in weight, size, or volume, which comprises the stages of cell elongation, cell division, and discrimination. Both cell enlargement and cell division are had an effect on under drought because of damaged enzyme activities, reduced energy supply and loss of turgor, (Kiani et al. 2007; Farooq et al. 2009; Taiz and Zeiger 2010). Even though roots were less influenced than shoots (Liu et al. 2011). Drought as well reduced leaf area because of loss of turgor and decreased leaf numbers (Farooq et al. 2010). All these issues supply to decreased dry matter accretion and grain yield under drought. The study of diversified developmental and growth occasions in crop plants with regard to time is named crop phenology. Drought powerfully influences crop phenology by limitation the crop growth cycle with a few exemptions. While drought happens during the vegetative phase of crop development, it may significantly reduce financial yield. Drought stress during grain and reproductive filling stages is more disturbing (Reddy et al. 2003; Vijay 2004; Yadav et al. 2004; Lafitte et al. 2007).

World rice construction applies about 1,578 km3 of water which is 30% of the fresh water
applied international (Trijatmiko, 2005). Rice, as a paddy field crop, is mainly vulnerable to water stress and its most vulnerable to harm from water shortage, consistent with the available statistics, the proportion of drought influenced land region in the world more than doubled from the 1970s to the early 2000s, timing in relation to plant growth phase and concentration of the stress can all differ significantly (Witcombe et al., 2008 and Wani et al., 2010). Of all the cereals, rice (Oryza sativa) is most vulnerable to water stress (Tao et al., 2006; Yang et al., 2008). It is assessed that 50% of world rice construction is influenced by drought (Bouman, et al. 2005). Water shortage is becoming progressively more common in irrigated regions because of falling water tables. Genetic development of rice for drought tolerance through predictable breeding is slow as a result of the low heritability of yield under stress, low inherent difference in the field and the restriction that there is typically only one experimentally droughted crop yearly (Ribaut et al., 1997). Drought can delay transplanting, seeding, and/or crop organization, drought typically communicate with the tillering phase which can originate decline in rooting and tillering capabilities, leaf senescence, root function or even death, and effect finally in diminish of efficient yield and heads loss. Leaf gas exchange and leaf expansion are two such responsive procedures that can be reserved by drought stress. At the plant level, decreased leaf region is possibly the clear mechanism by which plants and crops limit their water loss in reaction to drought (Sadras and Milory, 1996). Rahman et al. (2002) stated that tiller number, plant height, panicle length, panicle number, 1000-grain weight, number of filled grains per panicle, total dry matter (TDM), harvest index (HI), and yield were reduced with stress. Grain yield was decreased noticeably in all cultivars with drought beginning at panicle beginning or at pinnacle. Water stress at pinnacles decreased grain yield more than other stress actions. The diminution in yield mainly effected from the decreased in productive panicle number and overflowing grain proportion. Kumar et al. (2006) set up that the proportion of untaken grain was considerably higher in sites that were influenced by drought at reproductive phase. Rahimi and Mostajeran, (2009) stated that one of the major difficulties of rice production and cultivation is the shortage of water sources, particularly during phases of low precipitation which have an effect on the vegetative development rate and the amount of yield.

Consequently, expanding drought-tolerant rice diversities and decreasing water expenditure during rice construction is critical to enhanced rice yield. Because of the multifaceted polygenic nature of drought tolerance, tries to develop this feature through predictable breeding have met with little achievement. On the other hand, the classification and relocate of genes that present tolerance / resistance to drought stress through transgenic machinery is frequently planned as one resolution for defending crops beside a water stress environment and rising crop yields international, mainly in less expanded regions that are intimidated by food shortage and low crop efficiency (Nelson et al. 2007).

**Use some of biotechnology in rice tolerance to drought**

**Mutation**

Mutation breeding is an instrument applied to revise the nature and function of gens which are the basis of plant growth and building blocks and improvement, thus generating raw materials for economic crops and genetic improvement (Adamu, and Aliyu, 2007). Mutation could be described as a relatively and permanent rare modify in the number or series of nucleotides in a genome. Mutation happens naturally (unplanned mutation) or it can be unnaturally encouraged by different mutagenic agents which is consequently named inducible mutations (Singh, 1996). Mutation has been applied to create several cultivars with enhanced financial value and to revise plant and genetic developmental events (Van et al., 1990; Bertagen-Sagnard et al., 1996). Diverse mutagenic agents are applied to induce favourable mutation at high occurrence that comprises chemical mutagens and ionizing radiation (Ahloowalia and Maluszynski 2001). Mutations are the instrument applied to revise the character and function of genes which are the basis
of plants growth, the building blocks and development, thus generating raw materials for economic crops and genetic improvement (Adamu et al., 2004). Mutation origins different structural adjustments with DNA, such as an alteration in a single nucleotide foundation of a gene (point mutation), substitute of one nucleotide foundation by another, cutting of one or more foundation couples in the DNA series (frame modify mutation), chromosomal reorganization, duplication, or loss of a chromosome sections (Poehlman and Sleper, 1995). The initiation of mutation with compound mutagens relies on chemical mutagen attentiveness, period of action and other features (Alcantara et al., 1996). Induced mutation is achieved by the applying of chemical or physical mutagens. The rate of impulsive mutations is too low to be considered for useful purposes. Consequently, chemical or physical mutagens might be applied with in vitro or in vivo methods to enhance the mutation incidence (Lyakh and Lagron, 2005). Mutation methods in mixture with tissue culture techniques present influential technology to develop plants. It is probable to improved deep-rooted plants by changing particular characteristics by inducing. Recent studies stated that plant introduction to diverse doses of gamma (5ØþÞ)-irradiation may develop the tolerance to abiotic stress circumstances, for instance, drought and salt (Moussa, 2011 and Song at all 2012). Mutation method has been applied to generate many cultivars with enhanced financial value and study of plant and genetic developmental facts (Bertagen-Sagnard at all, 1996). Induced mutation has enormous serves and potentials as a flattering approach in genetic development of crops. A variety of mutagenic agents are applied to induce favourable mutation at high occurrence that comprises chemical mutagens and ionizing radiation (Ahloowalia, and Maluszynski, 2001). Gamma radiation, arranged of high energy photons, is a kind of ionizing radiation, capable to break through and cooperate with living tissues. It origins reduced growth rate and imitationability in company with DNA injury and morphological alterations (Kovalchuk at all, 2004 and Wiat at all, 2007). Although, irradiation with low doses is identified to have stimulatory results on plant development, a perception consigned to as hormesis (Calabrese, 2002). Information with reference to the applying of Gamma-ray as an instrument to develop seed dynamism is still insufficient. The procedure of seed priming achieved with osmotic agents persuades the pregermi-native metabolism, mainly the antioxidant reaction and DNA mendpurposes, guiding to improved germination effectiveness, an attribute highly considered for agricultural functions (Ventura, et al. 2012). Priming actions might as well progress stress tolerance in developing seeds, leaving a type of “stress memory” (Chen and Arora 2012). On the contrary with its high applicability, modest information is accessible on physical priming techniques (Vasilevski, 2003). **In vitro Tissue Culture**

Plant tissue culture methods are critical to severalkinds of academic examination, in addition to many functional features of plant science. Presently, having become an established technology, the methods are not only applied for the studies in plant gene regulation and molecular biology but as well functional to molecular breeding and plant biotechnology. The comparisons of the results persuaded by the stress in the plant cultured in-vivo and in-vitro situations propose that the in-vitro system can be applied as a substitute to field valuations for revising the common consequence of water-stress on plant development and growth. The most extensively applied technique for the choice of genotypes tolerant to abiotic stress is the in-vitro choice pressure method. This is derived from the in-vitro culture of plant cells organs or tissues on a medium complemented with choosy agents, allocating regenerating and selecting plants with advantageous features (Rosa and Aurelio, 2012). Callus, as a commenced material in plant tissue culture, is described as an unorganized tissue accumulation producing on solid substrate by applying tissue culture skill, which can shape from numerous elements of large intact plants (Mineo 1990). During callus discrimination, only those highest and tangential cells in callus were motivated into energetically dividing cells, and the level of separation generally relies on the hormone equilibrium of the support medium and the physiological situation of the tissue. Dissimilarities in callus introduction among rice diversities were observed in some of the initial studies in rice tissue.
culture gained maximum callus arrangement in basmati rice cv. 370 on MS medium complemented with 2.0 mg/l of 2,4-D. Although, somatic embryogenesis was attained by means of MS medium complemented with 2 mg/l from each of 2,4-D and Kin. It has been stated that the subsequent features outcome plant regeneration occurrence in genotype, rice; developmental phase of calli in the explants, carbohydrates source, hormonal composition of the medium, biased drought or water stress inducing managements and other medium complements (Saharan et al., 2004). Ilahi et al. (2005) stated that callus of a local diversity of rice (Oryza sativa L. cv. Swat-II) was provoked and the occurrence of callus introduction was studied on customized MS medium by means of a diversity of mixtures of 2,4-D and Kin, they as well stated that addition of tryptophan to diverse mixtures of cytokinins and auxins enhanced the calli and embryogenic callus accumulation have been productively reproduced on MS complemented with 1.0 mg/l of Kin and 0.5 mg/l of NAA. Khatun et al. (2010) accounted that genotype dependence still plays a significant role for any plant tissue culture work and studied on callus regeneration and induction possible of twenty five rice cultivars through in vitro micro propagation and another culture found Pazuki. A and Sohani, M.M. (2013) that the most appropriate and responsive rice cultivar in callus beginning is in reducing order: Gb > Hm >> Hn e” Gr. consequently can be used in tissue culture refereed breeding program.

**Polyethylene glycol (PEG)**

PEG is nontoxic, non-ionic and inert and of high molecular weight. It is very soluble in water, and is accessible at a extensive range of molecular weights (e.g., PEG-4000, PEG-4500, PEG-6000, and PEG-8000), it reproduces water shortfallsituations in cultured cells in a comparable method to that practical in the cells of intact plants subjected to genuine drought circumstances, high molecular weight PEG (PEG-6000) persuades water stress in plants by diminishing the water possible of the nutrient explanation without being taken up and with no proof of toxicity (Wani et al., 2010). PEG is a polymer compound with several functions from manufacturingindustrialized to remedy, it persuades morphological alterations of delighted plantlets, counting considerable statement of epicuticular wax and customized leaf outside structure, it is applied to change the osmotic probable of nutrient explanation and thereforepersuades plant water shortage in a comparatively managed method, it was supposed that PEG of large molecular weight does not infiltrate plant tissues and therefore is a perfect osmotic for applying in hydroponics root medium (Michel and Kaufmann, 1973; Money, 1989). Al-Bahrayn (2002) studied the reaction of Hassawi rice (Oryza sativa) callus to differing amounts of PEG persuaded water stress counting callus growth, water substance and proline accretion. In recent years, PEG has been extensively applied to persuade water stress and drought tolerant cultivars have been recognized in several crops by expanding approaches derived from the applying PEG (Badiane et al. 2004).

**CONCLUSIONS**

Therefore, we could feel the danger of abiotic stress and most importantly of the drought on the growth and production of strategic crops including the rice that needs to be high water requirements. The advantage of biotechnology can be explored, such as tissue culture and mutation induction, and the use of (PEG) in breeding and the development of rice varieties tolerant to drought stresses can grow and give production under the conditions of drought stresses.

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