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An elaborative Analysis of Induced Water stress and role of plant bio-chemicals in regulation and adaptation

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Abstract:
Environmental stresses bring about a wide range of responses in plants from genetic changes to the changes in growth rate and yield. Tolerance to abiotic stresses is very complex, due to the intricacy of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development. Stress is an altered physiological condition caused by factors that tend to disrupt the equilibrium. Strain is any physical and chemical change produced by the stress. The term "stress" is used with various meanings; the physiological definition is responses in different situations. The flexibility of normal metabolism allows the response initiation to the environmental changes, which fluctuate regularly and are predictable over daily and seasonal cycles. Every deviation of a factor from its optimum does not necessarily result in stress. Stress is a constraint or highly unpredictable fluctuations imposed on regular metabolic patterns to cause injury, disease or aberrant physiology.

I. Introduction

The growth and survival of plants depend more upon water availability than any other environmental factors (1). Yet the environment often fails to provide optimum conditions for water availability; a discrepancy arises whenever water is used or lost faster than it is absorbed by roots (2). Terrestrial plants growing in any natural environment are rarely free from water stress during more than a few days. Even in the humid tropics, the plants undergo brief stress due to dynamic changes in the climatic conditions (3). Plant water status is determined by the balance between water losses in transpiration to the atmosphere and water absorption from the soil. When transpiration exceeds absorption, cell turgor falls which negatively affects plant physiological processes and consequently their productivity, distribution and competitive relationships (4). Numerous studies have reported a myriad of changes in physiological processes by water stress. Species inhabiting in drought-prone environments, show different strategies which enable them to overcome soil water deficits (5).

Classically, plant resistance to drought has been divided into escape, avoidance and tolerance strategies (6). Escape strategies rely on successful reproduction before the onset of severe stress. Plants can also endure drought conditions by avoiding tissue dehydration, while maintaining tissue water potential as high as possible, or by tolerating low tissue water potential. Dehydration avoidance is common in annuals and perennials and is associated with a variety of adaptive traits, which involve minimization of water loss and maximization of water uptake (7). The drought tolerance is determined by a number of mechanisms that increase tolerance of plant tissues to dehydration (8). Dehydration tolerant species function under low plant water potentials to facilitate water uptake from drying soils by maintaining a soil-to-leaf water potential gradient, which also facilitates a rapid recovery after drought (9). Both high osmotic potential and low elasticity help in rapid decrease of water potential with a given change in water content (10).

Plants growing in nature are frequently exposed to many stresses such as drought, low temperature, salt, flooding, heatand oxidative stress. Drought is a meteorological term, commonly defined as a period without significant rainfall. Drought stress is considered to be a moderate loss of water, which leads to stomatal closure and limitation of gas exchange (11). Generally drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by transpiration or/and evaporation. Drought stress tolerance is seen in almost all plants but its extent varies from species to species and even within species (12). Drought stress is characterized by reduction of water content, diminished leaf water potential and turgor loss, closure of stomata and decrease in cell enlargement and growth. Severe water stress may result in the arrest of photosynthesis, disturbance of metabolism and finally the plant death (13).Water stress inhibits cell enlargement more than cell division. It reduces plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters (14). In plants, a better understanding of the morpho-anatomical and physiological basis of changes in water stress resistance could be used to select or create new varieties of crops to obtain a better productivity under water stress conditions (15). The reactions of plants to water stress differ significantly at various organizational levels depending upon intensity and duration of stress as well as plant species and its stage of growth (16). Understanding plant responses to drought is of great importance and also a fundamental part for making the crops stress tolerant (17). The plant growth decrease is much greater under water deficit than that under other environmental stresses (18). The effects of drought stress on crops have been extensively studied but on medicinal and aromatic herbs are very little (19).Therefore, the effect of water stress in the growth and survival of medicinal herbs in arid regions as well as dry tropical need to be evaluated and their appropriate growing conditions need to be determined (20).

Growth analysis:

With the changing environment the individual plants exhibit the phenotypic plasticity (21) and also this is one of the solutions to the problem of adaptation to heterogeneous environment (4). The phenotypic plasticity enables a plant to change its growth patterns as it encounters different environment condition (11). The interaction between the individual species and its heterogeneous environment brings the phenotypic plasticity (8) as it plays an important role in the ecology and evolution of the most plant species. The evolutionary biologist and ecologist take a great interest in plasticity (9). The architectural plasticity and their relation with the water stress are less studied (11). The plasticity itself evolves under selection (14) and under genetical control (12). It allows species to adjust in a new environment (22), resulting from dispersal of individual, disturbances and seasonal influences (23).

The growth analysis is employed to investigate the dependence of the growth capacity of a plant genotype on internal factors (11) and the interaction between plant growth and its environment (8). Plant growth analysis is an explanatory, holistic and integrative approach of interpreting plant form and function. It uses simple primary data, such as weights and contents of plant components to investigate processes within and involving the whole plant (7). Growth analysis also plays an important role in the comparison of genotypes often as part of breeding programme (8).

Plant water stress and their governess on the plant physiology:

Plant water relations are a large and diverse subject, and plant responses to water scarcity are complex. Terrestrial plants growing in any natural environment are rarely free from water stress during more than a few days. Even in the humid tropics, the plants undergo brief stress due to dynamic changes in the climatic conditions (5). Plant water status is determined by the balance between water losses in transpiration to the atmosphere and water absorption from the soil. When transpiration exceeds absorption, cell turgor falls which negatively affects physiological processes and therefore affect their productivity, distribution and competitive relationships (13). Numerous studies have reported a myriad of changes in physiological processes by water stress. However, species inhabiting in drought-prone environments, among them the plants, present different strategies which enable them to overcome soil water deficits (22). Classically, plant resistance to drought has been divided into escape, avoidance and tolerance strategies (4). Escape strategies rely on successful reproduction before the onset of severe stress. Plants can also endure drought conditions by avoiding tissue dehydration, while maintaining tissue water potential as high as possible, or by tolerating low tissue water potential. Dehydration avoidance is common to both annuals and perennials and is associated with a variety of adaptive traits, which involve minimizing water loss and maximizing water uptake (4). On the other hand, drought tolerance is determined by a number of mechanisms that increase tolerance of plant tissues to dehydration (5). Dehydration tolerant species function under low plant water potentials to facilitate water uptake from drying soils by maintaining a soil-to-leaf water potential gradient, which also facilitates a rapid recovery after drought (23). Both high osmotic potential and low elasticity help in rapid decreases of water potential with a given change in water content (24).

Stress is an altered physiological condition caused by factors that tend to disrupt the equilibrium. Strain is any physical and chemical change produced by a stress (25). The term stress is used with various meanings, the physiological definition and appropriate term as responses in different situations. The flexibility of normal metabolism allows the response initiation to the environmental changes, which fluctuate regularly and are predictable over daily and seasonal cycles. Thus every deviation of a factor from its optimum does not necessarily result in stress. Stress being a constraint or highly unpredictable fluctuations imposed on regular metabolic patterns cause injury, disease or aberrant physiology. Plants are frequently exposed to many stresses such as drought, low temperature, salt, flooding, heat, oxidative stress and heavy metal toxicity, while growing in nature. Drought is a meteorological term and is commonly defined as a period without significant rainfall. Generally drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by transpiration or evaporation. Drought stress tolerance is seen in almost all plants but its extent varies from species to species and even within species. Water deficit and salt stresses are global issues to ensure survival of agricultural crops and sustainable food production (26). Conventional plant breeding attempts have changed over to use physiological selection criteria since they are time consuming and rely on present genetic variability (27). Tolerance to abiotic stresses is very complex, due to the intricate of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development (21). High yield potential under drought stress is the target of crop breeding. In many cases, high yield potential can contribute to yield in moderate stress environment (20). Drought stress is considered to be a moderate loss of water, which leads to stomatal closure and limitation of gas exchange. Desiccation is much more extensive loss of water, which can potentially lead to gross disruption of metabolism and cell structure and eventually to the cessation of enzyme catalyzed reactions (19). Drought stress is characterized by reduction of water content, diminished leaf water potential and turgor loss, closure of stomata and decrease in cell enlargement and growth. Severe water stress may result in the arrest of photosynthesis, disturbance of metabolism and finally the death of plant (5).Water stress inhibits cell enlargement more than cell division. It reduces plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters (6). In plants, a better understanding of the morpho-anatomical and physiological basis of changes in water stress resistance could be used to select or create new varieties of crops to obtain a better productivity under water stress conditions (4). The reactions of plants to water stress differ significantly at various organizational levels depending upon intensity and duration of stress as well as plant species and its stage of growth (29). Understanding plant responses to drought is of great importance and also a fundamental part for making the crops stress tolerant (13).

II. Conclusion :

Although the effects of drought stress on crops have been extensively studied, the researches on the behaviour of medicinal and aromatic herbs under water deficit have not been so extensive. Nowadays water deficit is known as an important limiting factor of yield increase in arid and semiarid regions and growth decrease is much greater under water deficit than that under other environmental stresses. It is more important in regions which experience the problem due to climate change but have not been paid attention because global environment change programs show the growth of water deficit in future and the recurrence of much more severe events in most parts of the world. Environmental stresses bring about a wide range of responses in plants from genetic changes to the changes in growth speed and yield. Therefore, in order to understand the conditions for the survival of medicinal herbs in arid regions, their responses to water deficit need to be evaluated and their appropriate growing conditions should be determined.

References:

[1]. Porcher MH, Multilingual multiscript plant name data base (1995-2020) I L F R - The University of Melbourne, *www plantnames unimelb edu au/Sorting/Bacopa html#monnieri*1995.

[2]. Nonami H, Plant–water relations and control of cell elongation at low water potentials, J Plant Res, 111: 373–382, 1998.

[3]. Mirsa A, and SrivastavaNK, Influence of water Stress on Japanese mint, *Journal of Herbs Species and Medicinal plants*, 7 (1): 51-58, 2000.

[4]. Younis ME, El-Shahaby OA, Abo-Hamed SA and Ibrahim A, Effects of water stress on growth pigments and $^{14}CO_2$ assimilation in three sorghum cultivars, *J Agron Crop Sci*, 185, 2:73- 82, 2000.

[5]. Yuan Lu Y, Xi-P Deng and Sang-S Kwak, Over expression of Cu Zn superoxide dismutase Cu- Zn SOD and ascorbate peroxidise APX in transgenic sweet potato enhances tolerance and recovery from drought stress, *African Journal of Biotechnology*, Vol 9, 49, pp 8378-8391, 2010.

[6]. Zaman A, Islam R and Joarder OI,Field performance and biochemical evaluation of micropropagated mulberry plants,*Plant Cell Tissue and Organ Culture*, 51: 61–64, 1997.

[7]. Verma P, Ecological analysis of nitrogen loading on herbaceous diversity under different moisture regimes, Ph D Thesis, Banaras Hindu University, 2011.

[8]. Miura Y, Fukui H, and Tabata M, Clonal propagation of chemically uniform fennel plants through somatic embryoids, *Planta Med*, 53: 92–94; 1987.

[9]. Letchamo W and Gosselin A, Light temperature and duration of storage govern the germination and emergence of *Taraxacum officinale* seed, *J Hortic Sci*, 71: 373–377, 1996.

[10]. Kramer PJ, Changing concepts regarding plant water relations, *Plant Cell Environ*, 11:565—568, 1988.

[11]. Levitt J, Response of plant to Environmental stress, vol II, Academic press, New York, 1980.

[12]. Mohapatra HP and Rath SP,*In vitro* studies of *Bacopa monnieri*-an important medicinal plant with reference to its biochemical variations, *Indian J Exp Biol*, 43: 313-316, 2005.

[13]. Oliveira Neto CF, Silva Lobato AK, Costa RCL, Santos Filho BG, Silva Maia WJM, Cruz FJR, Gonçalves-Vidigal MC, Alves GAR, Neves HKB, and Santos Lopes MJ, Carbon compounds and chlorophyll contents in sorghum submitted to water deficit during three growth stages, *Journal of Food Agriculture & Environment*, Vol 7 (3&4), 588-593, 2009.

[14]. Olsen CS, The trade in medicinal and aromatic plants from central Nepal to northern India, *Economic Botany*, 52: 279-292, 1998.

[15]. Pradhan GB, and Dash MC, Seasonal variation in plant biomass and net primary productivity of a Savanna type hill ecosystem of Sambalpur India, *Tropical ecology*, 25: 172-178, 1984.

[16]. Prakash JC, Sirsi M, Comparative study of the effects of brahmi (*Bacopa monniera*) and chlorpromazine on learning in rats, *J Sci Indust Res*, 21:93-6 1962.

[17]. Vermani A, Navneet P and Chauhan A, Physico-chemical analysis of ash of some medicinal plants growing in Uttarakhand, *India Nat Sci*, 8: 88-91, 2010.

[18]. Syman H, A green house study on root dynamics of cactus pears *Opuntia ficus–indica* and *O. Robusta*,*Journal of Arid Enviroments*, 65: 529- 542, 2006.

[19]. Tadesse M, Lommer WJM, Vanderputten PEL and Struik PC, Development of leaf area and leaf number of micropropagated potato plants, *Netherlands J of Ag Sci*, 49: 15-32, 2001.

[20]. Vieira RF and Skorupa LA, Brazilian medicinal plants gene bank, *Acta Hort*, 330:51–58, 1993.

[21]. Sumathy T, Subramanian S, Govindasamy S, Balakrishna K and Veluchamy G, Protective role of *Bacopa monniera* on morphine induced hepatotoxicity in rats, *Phytother Res,* 15: 643–5, 2001.
[22]. Richardson DM and Pysek P, Plant invasions: merging the concepts of species invasiveness and community invasibility *Prog Phys Geogr,* 30:409–31, 2006.
[23]. Rodriguez LF, Can invasive species facilitate native species? Evidence of how when and why these impacts occur *Biological Invasions,* 8: 927-939, 2006.
[24]. Zarco-Tejada PJ, Berjo´N A and Miller JR, Stress detection in crops with hyperspectral remote sensing and physical simulation models, In: Proceedings of Airborne Imaging Spectroscopy, Workshop Bruges, Belgium: Belgian Federal Science Policy, 2004.
[25]. Soliman W, Fujimori M, Tase K and Sugiyama S, Oxidative stress and physiological damage under prolong heat stress in C_3 grass *Lolium perenne,Grassland Sc*, 57: 101-106, 2011.
[26]. Song MH, Xu XL, Hu QW, Tian YQ, Ouyang H and Zhou CP, Interactions of plant species mediated plant competition for inorganic nitrogen with soil microorganisms in an alpine meadow, *Plant Soil,* 297:127–137, 2007.
[27]. Rastogi S, Pal R Kulshreshtha DK Bacoside A3-a triterpenoid saponin from Bacopa monniera *Phytochem*, 36:133-7 1994.
[28]. H. Naseem, A. Bano, Role of plant growth-promoting rhizobacteria and their exopolysaccharide in drought tolerance of maize, J. Plant Interact., 9 (2014), pp. 689-701
[29]. E. Rolli, R. Marasco, G. Vigani, B. Ettoumi, F. Mapelli, M.L. Deangelis, et al. Improved plant resistance to drought is promoted by the root-associated microbiome as a water stress-dependent trait, Environ. Microbiol., 17 (2014), pp. 316-331