Journal of Crop Science Research

Research | Vol 2 Iss 1

How Plant Cope Environmental Stresses: An Overview

Vinay Kumar Pandey[1*]

[1]Department of Botany, Lucknow University, Lucknow, Uttar Pradesh, India

[*]**Corresponding author:** Vinay Kumar Pandey, Department of Botany, Lucknow University, Lucknow, Uttar Pradesh, India., Tel: 7416659160; E-Mail: vkpbot@gmail.com

Received: December 14, 2016; **Accepted:** January 28, 2017; **Published:** February 06, 2017

Abstract

Rapid growth in human population, ultimately affect our environment in many ways. For example, increase in food demands results in deforestation, and loss of soil fertility. Invasion of new plant species also disturb ecological balance and biodiversity. Plant applied various physiological mechanisms to sustain itself in changed environmental condition. Most of the local cultivars hardly survive in changed environmental conditions because nature takes millions of year for genetic modification. Rise of new cultivars, by gene manipulation may overcome these stress related issues. But what about wild plant varieties is a matter of discussion. In this review we discuss that how plant cope these stresses. How many types of stresses and what are the mechanisms they applied for tolerance? Although it is difficult to cover all physiological aspects governing in plant during, such condition. This review outlines the recent research findings and discusses the challenges, with particular emphasis on plant ability to cope with stress.

keywords: ***Soil fertility; Abiotic stress; Gene manipulation; Biotechnology***

Introduction

Green plants are the smartest creation of Mother Nature. Our planet is liveable for aerobic organism because respiratory waste released by green photosynthetic organism. Unfortunately, green photosynthetic plants are now facing a threat due to anthropogenic activities [1-8]. How plant sustains them in this catastrophic environment, and what are mechanism they applied, is object for review article. Fortunately, lots of research work was done earlier by our scientific community on plant physiology [9-15]. The whole review article is divided in 5 heading with subheadings.

It's not possible for us to cover all topics related to subject line but we tried here to touch every aspect relevant to this.

Abiotic and Biotic Stresses

Plant has intimate relation to their environment especially with abiotic components [16,17]. Plant adopted unique strategies to cope extreme environmental changes [18-21]. Priming is one of the mechanisms they employed to enhance their defence mechanism. It enhances the resistance in plant against environmental stresses [22-27]. Among abiotic stresses cold stress is adversely affecting the plant productivity especially in tropical and subtropical climate [28-31]. Plants growing in temperate areas are less sensitive to cold stress in compare to tropical vegetation. Cold tolerant and cold sensitive species are differing

in response to low temperature because of genetic variability. If we successfully disclose the molecular mechanism, that might be utilized for cultivar improvement through biotechnology [32-40].

Besides low temperature, salinity and drought are other abiotic factors which adversely affect the crop yield in subtropical deserts [41-46]. Interestingly, some halophilic bacteria and Achaea showing promising hands towards salt tolerance. These microorganisms tolerate high salt concentration either by storing salt in cytoplasm or by accumulation of uncharged organic compounds to maintain an osmotic potential with surroundings [47-51]. These nature borne techniques can be exploited for development of salt tolerant crop varieties.

Because of sessile nature to environmental stresses, plants are severely affected by environmental stresses such as extreme temperature, salinity, drought, waterlogging, and heavy metal [52-57]. Drought is a common major issue in arid and semiarid areas. Under drought condition, plants generate active oxygen species which can induce oxidative stress. Active Oxygen Species (AOS) can destruct the cell membrane system, and cause serious metabolic disturbances. Plants have limited ability to destroying active oxygen species. In adverse condition, this balance is shift towards more AOS accumulation [58-64]. Due to these consequences, plants express some morphological symptoms such as reduction in height, leaf length, loss in fresh and dry weight and biomass yield. Some desert plants surpass drought stresses with their unique feature to survive under high salinity and low water condition. Tapping the advancement of genetic manipulation, new cultivars with drought resistance can be grown in arid areas.

Improve Stress Tolerance

Genetic engineering and transgenic plants

Plant response to different environmental stresses is a crucial to their productivity. Both biotic and abiotic components affect plant growth significantly but abiotic stress play major role [65-71]. Plants having a set of genes that can be divided in to two major classes, gene encoding functional proteins and genes encoding regulatory proteins. Due to practical limitations scientist are choosing functionally related genes for genetic manipulation [72-78]. However, thousands of genes related to stress tolerance were identified and few of them are found suitable to impart gene for stress tolerance in plants. Therefore, transcription factor operating in early stage of stress is a potential tool for genetic engineering [79-81]. Among the various transcription factors, homeobox genes were well expressed phenotypically and identified as most appropriate gene for abiotic stress response. Another example is APETALA2/ethylene response element-binding protein (AP2/EREBP) transcription factor family. It's reported from Arabidopsis plant. AP2 family genes not only enhance stress tolerance in Arabidopsis plant but, also in crop plants. Therefore transgenic plants with AP2 family genes can easily survive in harsh environmental menaces.

Osmotic potential regulator: osmoprotectants

It was noticed that few plants under adverse environmental condition adopted new pathway i.e. osmoprotectant pathway. These maintain osmotic potential of cell through stabilizing membranes and proteins during stress condition. Osmoprotectants /compatible solutes primarily include glycine, proline, ectoine, betaines, trehalose, and polyols [82-87]. Thus, we required a more elaborate approach to look past the current scenario.

Epigenetic modifications in plants

Crop breeders are now applying nongenetic or epigenetic determinants that could modify gene expression heritably and reversibly (without changing the gene sequence). These include histone modifications, DNA methylation, nucleosome positioning, and small (sm) RNAs [88-91]. They modify the properties of chromatin and change gene transcriptional states.

Nitric oxide emerges as a tool to resolve stress related physiological disorders in plants. Nitric oxide works as signalling agent and involve in detoxification of reactive oxygen [92,93]. We required more interrogation on various pathways where nitric oxide plays a crucial role.

Competitiveness, Coexistence and stress tolerance are few characters which can be observed among various weed species. Availability of the sophisticated molecular tools provides us an opportunity to transfer genetic material from weeds to crop plant for stress resistance.

Arbuscular Mycorrhiza: a warrior against abiotic stress

A group of fungi colonizes in plant roots known as mycorrhiza is emerges as new tools in stress tolerance. These mucorrhiza form extensive network of hyphae and secretes some biochemical like glomalin. These mechanisms include enhanced growth by prevention of nutrient deficiency and ion toxicity, osmotic adjustment in water stress condition, enhancing the activities of antioxidants and prevention of oxidative damage, restriction of entry of toxic ions and immobilization of heavy metals in soil or plant roots [94,95].

Biofertilizers: an eco-friendly approach towards abiotic stress

Generally chemical fertilizers are expensive and cause eutrophication, ion toxicity, reduce organic matter and soil borne microorganism. In compare to fertilizers, biofertilizer are inexpensive and enhance soil fertility without harming natural soil ecosystem [96,97]. Biofertilizers are rich source of organic nutrient and provide natural environment to beneficial microorganism. These microorganisms secrete antibiotics which are effective against plant pathogen.

Biotic Stress

Like abiotic stresses, biotic stress also plays a vital role in plant growth and development. Continuous plant-pathogen interaction is generated a complex immune system that consists of preformed barriers and induced responses. In last decades, plant biologist collected valuable information related to plant-pathogen interaction, which can be applied in crop improvement by genetic manipulation [98-101]. Plant breeding has helped in isolation of stress tolerant plant species. These species might be helpful in development of resistant varieties.

Global Meetings

Climate change is causing threat to our habitable environment and food security. Plant biologists all over the world are looking for proper solution to diminish the effect of climate change. Omicsconerence.com will organize several conferences worldwide to provide a platform to scientific community to combat this problem. 21st Global Food Engineering Conference is one of them where they will discuss the cutting age technology in field of food engineering. 7th European Food Safety & Standards Conference is another one in this list, where we will focus on role of biotech in crop improvement programme and designing of stress tolerant crop varieties. 8th World Congress on Agriculture & Horticulture will be organized around the theme “Growing Aspects of Agriculture”. For sustainable growth it’s essential for us to include developing countries in

global effort. So they are organizing one such conference meeting in Thailand i.e. 2nd International Conference on Plant Science & Physiology. Some others related conferences are 7th International Conference on Global Food Safety; 6th International Conference on Food Safety & Regulatory Measures.

Societies

Some prominent societies are working on this to finds suitable solution, like Nepal Herbs and Herbal Products Association (NEHHPA) is an association of herbal producers. Another one European Biotechnology Thematic Network Association (EBTNA), which is an association of biotechnology professionals. Open access journal also play a major role in dissemination of latest research in scientific community. Journal of Plant Physiology & Pathology and VEGETOS: An International Journal of Plant Research is publishing quality research article in field of plant physiology. Journal of Fertilizers & Pesticides is enhancing our information for sustainable use of fertilizer.

Conclusions

Climate change are not only influencing the human but also affecting the plant in the form of abiotic and biotic stresses. It is challenge in front of plant biologist to find useful techniques and tools that can help the plant to survive in the stressful condition. But still some question to be answered. How some tolerant plant varieties cope these stresses? What are the mechanism they applied to overcome adverse condition? We are successfully applying genetically modified crop varieties as cultivars. The development of GM crops will help in generating higher yields against changed environmental condition.

REFERENCES

1. Abdi N, Wasti S, Slama A, et al. Comparative Study of Salinity Effect on Some Tunisian Barley Cultivars at Germination and Early Seedling Growth Stages. J Plant Physiol Pathol. 2016;4:3.
2. Yakoub ARB, Benabderrahim MA, Ferchichi A. Physiological and Agro-morphological Responses of Tossa Jute (*Corchorus olitorius* L.) to Drought Stress. J Plant Physiol Pathol. 2016;4:3.
3. Jena P, Pradhan C, Patra HK. Effects of Chelate-Assisted Chromium (Cr+6) on Growth, and Chromium Bioaccumulation in Paragrass (Brachiaria mutica Forssk.Stapf). J Plant Physiol Pathol. . 2016;4:3.
4. Nogia P, Tomar V, Sidhu GK, et al. Elucidation of an Array of Nitrate Transporter Paralogs in Arabidopsis Thaliana Genome. J Plant Physiol Pathol. 2016;4:3.
5. Otusanya MO, Enikuomehin O, Popoola A, et al. Effects of Calcium Fertilization on the Susceptibility of Dioscorea Species to the Yam Storage Pathogens *Aspergillus Niger* van Tiegh and *Botryodiplodia Theobromae* Pat. J Plant Physiol Pathol. 2016;4:3.
6. Reggia L, Hupman K, Johnson GA, et al. Arabidopsis Rapid Movement Response to Electrical Stimulation. J Plant Physiol Pathol. 2016;4:2.
7. Kumar S, Rao S, Reddy BVS, et al. Heterosis and Inbreeding Depression in Tropical Sweet Sorghum (*Sorghum bicolor* (L.) Moench). J Plant Physiol Pathol. 2016;4:2.
8. Mishra P, Prasad SM. Mounting Insights over Human Wellness by Utilizing Plant's Primed Defense against Precise/Mild Oxidative Stress. J Plant Physiol Pathol. 2016;4:2.
9. Sipai AH, Jat JR, Rathore BS. Effect of Phosphorus, Sulphur and Biofertilizer on Growth, Yield and Nodulation in Mungbean on Loamy Sand Soils of Kutch. J Plant Physiol Pathol. 2016;4:2.

10. Yinyan S, Yongnian Z, Xiaochan W. Development and Prototype Experiment of Environmental Self-Propelled and Orderly Harvester for *Artemisia selengensis* Turcz. J Plant Physiol Pathol. 2016;4:2.
11. Mohapatra S, Mittra B. Induction of Glutathione, Ascorbate and Associated Enzymes by a Low Dose CdCl2 Pre-treatment Alleviate Fusarium Induced Oxidative Stress in Wheat. J Plant Physiol Pathol. 2016;4:1.
12. Gupta DK, Tawussi F, Hamann L, et al. Moderate Uranium Disturbs the Nutritional Status and Induces Oxidative Stress in Pisum sativum L. J Plant Physiol Pathol. 2016;4:1.
13. Abduyeva-Ismayilova SM. Effect of Physiological Acid Salts on Swelling, Germination and Growth Processes of Seedlings. J Plant Physiol Pathol. 2016;4:1.
14. Bezić N, Vuko E, Ruščić M,, et al. *Helichrysum italicum* (Roth) G. Don - Essential Oil Composition and Activity on Tobacco Mosaic Virus Infection. J Plant Physiol Pathol. 2016;4:1.
15. Nomura H, Shiina T. Plant Endosymbiotic Organellar Calcium Signaling under Biotic and Abiotic Stresses. J Plant Physiol Pathol. 2016;4:1.
16. Vaidya S, Vanaja M, Sathish P, et al. Impact of Elevated CO2 on Growth and Physiological Parameters of Groundnut (*Arachis hypogaea* L.) Genotypes. J Plant Physiol Pathol. 2014;3:1.
17. Dewir YH, El Mahrouk ME, Hafez YM, et al. Antioxidative Capacity and Electrolyte Leakage in Healthy Versus Phytoplasma Infected Tissues of *Euphorbia coerulescens* and *Orbea gigantea*. J Plant Physiol Pathol. 2015;3:1.
18. Pillai G, Jayaraj R. Identification of Endophytic Fungi/oppurtunistic Pathogen from the Perennial Herb of Amaranthaceae Family. J Plant Physiol Pathol. 2015;3:1.
19. Bakakina YS, Kolesneva EV, Sodel DL, et al. Low and High Temperatures Enhance Guanylyl Cyclase Activity in Arabidopsis Seedlings. J Plant Physiol Pathol. 2014;2:4.
20. Ren YL, Zhang HZ, Wu JG, et al. Analysis of Embryo, Cytoplasmic and Maternal Effects on Seven Essential Amino Acid Traits in Rapeseed. J Plant Physiol Pathol. 2014;2:4.
21. Mahmoud AFA, Abo-Elyousr KAM. Genetic Diversity and Biological Control of Rhizoctonia solani Associated with Root Rot of Soybean in Assiut Governorate, Egypt. J Plant Physiol Pathol. 2014;2:4.
22. Tanabe S, Yokotani N, Nagata T, et al. Spatial Regulation of Defense-Related Genes Revealed by Expression Analysis using Dissected Tissues of Rice Leaves Inoculated with *Magnaporthe oryzae*. J Plant Physiol Pathol. 2014;2:4.
23. Schlosser AJ, Martin JM, Beecher BS, et al. Enhanced Rice Growth is Conferred by Increased Leaf ADP-Glucose Pyrophosphorylase Activity. J Plant Physiol Pathol. 2014;2:4.
24. Jahan AA, Anis M. Changes in Antioxidative Enzymatic Responses during Acclimatization of in Vitro Raised Plantlets of *Cardiospermum halicacabum* L. against Oxidative Stress. J Plant Physiol Pathol. 2014;2:4.
25. Srivastava S. Arsenic Induced Changes in Growth and Physiology of Maize (Zea mays L.) Seedlings and its Possible Amelioration Using Phosphate. J Plant Physiol Pathol. 2014;2:3.
26. Das K, Mandal C, Ghosh N, et al. Effects of Exogenous Spermidine on Cell Wall Composition and Carbohydrate Metabolism of Marsilea Plants under Cadmium Stress. J Plant Physiol Pathol. 2014;2:3.
27. Sharma S, Kaur N, Kaur S, et al. Ascorbic Acid Reduces the Phytotoxic Effects of Selenium on Rice (*Oryza Sativa* L.) by Up-Regulation of Antioxidative and Metal-Tolerance Mechanisms. J Plant Physiol Pathol. 2014;2:3.
28. Mohanty M, Patra HK. Hexavalent Chromium Induced Toxicological, Physiological and Biochemical Alterations in *Sesbania Sesban* L. Seedlings. J Plant Physiol Pathol. 2014;2:3.

29. Karabulut AB, Önal Y, Gul M, et al. Nutri-Protection and Mediterranean Diet: Bitter Apricot Kernel and Amygdalin Treatment Effects on a Battery of Oxidative Stress and Apoptosis Biomarkers. J Plant Physiol Pathol. 2014;2:3.
30. Oliveira JTA, Barreto ALH, Vasconcelos IM, et al. Role of Antioxidant Enzymes, Hydrogen Peroxide and PR-Proteins in the Compatible and Incompatible Interactions of Cowpea (*Vigna unguiculata*) Genotypes with the Fungus *Colletotrichum gloeosporioides*. J Plant Physiol Pathol. 2014;2:3.
31. Gopal R, Sharma YK. Effects of Chromium (VI) on Groundnut (*Arachis Hypogeae* L.) Metabolism. J Plant Physiol Pathol. 2014;2:2.
32. Amri E. Variation in Pre-Dispersal Seed Predation and Seed Traits among Provenances of *Dalbergia Melanoxylon* (Guill. & Perr.). J Plant Physiol Pathol. 2014;2:2.
33. Abo-Elyousr KAM, Zein El-Abdean W, Hassan MHA, et al. Enhance Suppressive Effect of Compost on Soybean Rhizoctonia Root Rot by Soil Treatment with *Trichoderma harzianum*. J Plant Physiol Pathol. 2014;2:2.
34. Rosmana A, Asry N, Tresnaputra US. Low Water Availability Enhancing Soil Receptivity to Fusarium Pathogen: Case of Root Rot on Mulberry. J Plant Physiol Pathol. 2014;2:2.
35. Dutta P, Islam MN, Mondal S. Interactive Effect of Arsenic Stress and Seed Phytate Content on Germination and Seedling Development of Different Vegetable Crops. J Plant Physiol Pathol. 2014;2:2.
36. Ajay Kumar G. *Colletotrichum gloeosporioides*: Biology, Pathogenicity and Management in India. J Plant Physiol Pathol. 2014;2:2.
37. Cruz AF, Soares WRO, Blum LEB. Impact of the Arbuscular Mycorrhizal Fungi and Bacteria on Biocontrol of White Root Rot in Fruit Seedlings. J Plant Physiol Pathol. 2014;2:1.
38. Cruz AF, Pires MC, Soares WRO, et al. Soil-Borne Plant Pathogens Associated to Decline of Grapevine Grown in Greenhouse. J Plant Physiol Pathol. 2014;2:1.
39. Singh AU, Prasad D. Management of Plant-parasitic Nematodes by the Use of Botanicals. J Plant Physiol Pathol. 2014;2:1.
40. Seleim MA, Abo-Elyousr KA, Mohamed AAA, et al. Peroxidase and Polyphenoloxidase Activities as Biochemical Markers for Biocontrol Efficacy in the Control of Tomato Bacterial Wilt. J Plant Physiol Pathol. 2014;2:1.
41. Thivya N, Srilakshmi K V, Bhuvaneswari S, et al. Phytoaccumulation of Chromium and Copper by *Mentha spicata* L. J Plant Physiol Pathol. 2014;2:1.
42. Sinha P. Modulation of Oxidative Stress Responsive Enzymes and Non-Enzymatic Components by Excess Nickel in C. *Lanatus Lanatus* Var. Fistulosus. J Plant Physiol Pathol. 2014;2:1.
43. Sobhy II AH, Abo-Elyousr KAM, Abdel-Rahim IR. Effect of Certain Plant Extracts to Control Purple Blotch Disease of Onion Plants (*Allium cepa* L.). Upas. J Plant Physiol Pathol. 2013;1:4.
44. Sinha P, Sharma YK, Shukla AK. Oxidative Stress Responsive Enzymes and Non-Enzymatic Components in Response to Excess Cadmium in Pigeon Pea (*Cajanus cajan* Mill) Cv. Upas. J Plant Physiol Pathol. 2013;1:4.
45. Srivastava S, Sharma YK. Altered Growth, Photosynthetic Machinery and Induced Oxidative Stress in Spinach in Response to Arsenic Stress. J Plant Physiol Pathol. 2013;1:4.
46. Srivastava S, Sharma YK. Arsenic Phytotoxicity in Black Gram (*Vigna Mungo* L. Var. PU19) and its Possible Amelioration by Phosphate Application. J Plant Physiol Pathol. 2013;1:3.
47. Freire MGM, Souza CLM, Portal TP, et al. Effect of Castor Bean Oil on Post-Harvest Fungal Pathogen of Coconut: *Lasiodiplodia theobromae*. J Plant Physiol Pathol. 2013;1:3.

48. Malafaia CB, Silva TD, do Amaral DOJ, et al. Evaluation of the Resistance and Differential Induction of Chitinases in Tomato in Response to Inoculation with *Fusarium oxysporum* f. sp. lycopersici. J Plant Physiol Pathol. 2013;1:3.
49. Vinod Kumar, Singh AU, Singh HS. Initial Population Density its Effect on the Pathogenic Potential and Population Growth of *Rotylenchulus reniformis* on Cowpea (*Vigna unguiculata* L.). J Plant Physiol Pathol. 2013;1:3.
50. Dang QL. Improving the Quality and Reliability of Gas Exchange Measurements. J Plant Physiol Pathol. 2013;1:2.
51. Leo Daniel AE, Venkateswarlu B, Suseelendra D, et al. Effect of Polymeric Additives, Adjuvants, Surfactants on Survival, Stability and Plant Growth Promoting Ability of Liquid Bioinoculants. J Plant Physiol Pathol. 2013;1:2.
52. Shi CH, Zheng DD, Jin XL, et al. Analysis of Genetic Relationships between Seed Nutrient Traits and Plant Agronomic Traits in Indica Rice (*Oryza sativa* L.). J Plant Physiol Pathol. 2013;1:2.
53. Zimowska B. Occurrence and Characterization of *Phyllosticta plantaginis*. J Plant Physiol Pathol. 2013;1:1.
54. Awasthi K, Sinha P. Nickel Stress Induced Antioxidant Defence System in Sponge Gourd (*Luffa Cylindrical*). J Plant Physiol Pathol. 2013;1:1.
55. Kumar A, Sarin NB. RNAi: A Promising Approach to Develop Transgenic Plants Against Geminiviruses and Insects. J Plant Physiol Pathol. 2013;1:1.
56. Singh A, Kaushal N, Sharma R, et al. Effect of Elevated Temperature on in vitro Microtuberization of Potato Genotypes with Different Thermotolerance Levels. Vegetos. 2016;29:3.
57. Roy C, Jha RN, Kishore Chandan, et al. Differential response of Germplasm to Inter-Specific Hybridization of Brassica spp. Vegetos. 2016;29:2.
58. Sunil N, Vinod Kumar, Panwar NS, et al. Analysis of Diversity and Distribution of Pongamia [*Pongamia pinnata* (L.) Pierre] Germplasm Collections from Two Distinct Eco-Geographical Regions in India. Vegetos. 2016;29:3.
59. Upadhyay V, Kushwaha KPS, Pandey P. Evaluation of Abiotic and Biotic Elicitors for Induction of Defense Related Enzymes in Pea against U. Viciae–Fabae (Pers.) J. Schrot. Vegetos. 2016;29:3.
60. Mali SS, Naik SK, Bhatt BP. Spatial Variability in Soil Properties of Mango Orchards in Eastern Plateau and Hill Region of India. Vegetos. 2016;29:3.
61. Kamran RV, Toorchi M, Mogadam M, et al. Genetic Evaluation of Crown Freezing Tolerance and Some Physiological Traits in Barley (*Hordeum vulgare* L.) Lines. Vegetos. 2016;29:3.
62. Srivastava A, Srivastava P, Sharma A, et al. Evaluation of RIL Population Derived from Traditional and Modern Cultivar of Wheat (C 518/2* PBW 343) for Yield Potential under Drought Stress Conditions. Vegetos. 2016;29:3.
63. Fard KG, Zakizadeh H, Ghasemnezhad M, et al. Response of Six Turf Species to Cadmium Stress: Displaying the Most Tolerant Cultivar. Vegetos. 2016;29:3.
64. Hassanen RA, Morsy AA, Saleh HA. Leaf Dust Accumulation and Air Pollution Tolerance Indices of Three Plant Species Exposed to Urban Particulate Matter Pollution from a Fertilizer Factory. Vegetos. 2016;29:3.
65. Sambathkumar S, Durairaj C, Ganapathy N, et al. Temporal Variation in the Incidence of Legume Pod Borer, Maruca vitrata Geyer (Lepidoptera: Crambidae) on Cowpea and Lablab and it's Relationship with Abiotic Factors. Vegetos. 2016;29:2.
66. Prakash D, Benbi DK, Saroa GS, et al. Dependence of Soil Organic Carbon on available Iron and Manganese Concentrations in Submerged Rice Soils. Vegetos. 2016;29:2.
67. Ivanov VB, Alexandrova VV, Usmanov IYu, et al. Comparative Evaluation of Migrating Anthropogenic Impurities in Ecosystems of the Middle Ob Region through Bioindication and Chemical Analysis. Vegetos. 2016;29:2.

68. Akbari DL, Akbari LF, Golakiya BA. Stimulation of Plant Growth and Drought Tolerance on Wheat by Endophytic Bacteria from Dry Environment. Vegetos. 2016;29:2.
69. Zhang J, Dong S, Dai X, et al. Plant Combined Effect of Plant Density and Nitrogen Input on Grain Yield, Nitrogen Uptake and Utilization of Winter Wheat. Vegetos. 2016;29:2.
70. Wu L, Duan C, Wang SM. Impact of Agricultural Activity and Climate Change on Spatio-Temporal Evolution in Soil Salinization in Manas River Basin, China. Vegetos. 2016;29:2.
71. Pandey VK, Tyagi S. Pharmaceutical Nanotechnology: A rising tide of Challenge & Opportunities. Research and Reviews: Res Rev J Pharm Nanotechnol.2016;4:2.
72. Pandey VK. Evaluation of Progress in Marine Biology: A Review. Res Rev: Res J Biol. 2016;4:3.
73. Pandey VK, Gopal R. Nickel Toxicity Effects on Growth and Metabolism of Eggplant. Intl J Veg Sci. 2010;16:351-360.
74. Rozentsve Q, Grebenkina T, Nesterov V, et al. Seasonal Dynamic of Morpho-Physiological Properties and the Lipid Composition of Plantago Media (Plantaginaceae) in the Middle Volga Region. Vegetos. 2015;29:1.
75. Sala M, Shanthi P, Selvi B, et al. Marker based Genetic Diversity of Rice Genotypes for Salinity Tolerance at Panicle Initiation Stage. Vegetos. 2016;29:1.
76. Das N, Mishra S, Chowdhury P, et al. Comparative Study of Fruiting Body Production of some Oyster Mushroom in Two Different Temperatures. Vegetos. 2016;29:1.
77. Pandey KK, Maurya D, Gupta G, et al. Yield Forecasting Models based on Weather Parameters for Eastern U.P. Vegetos. 2016;29:1.
78. Gupta S, Agnihotri S, Ali SM, et al. Physicochemical Analysis and Homology Modeling of Antioxidant Proteins of Foxtail Millet (Setaria Italica). Vegetos. 2016;29:1.
79. Radhouani, Ferchichi. Quality's Attributes of Tomato Conducted under Greenhouse in Relation to Climatic Conditions. Ginnala in China. Vegetos. 2016;29:1.
80. Parveen A, Kyunn WW. Antioxidant and Anti-Cholinergic Activities of Phenolic Compounds Isolated From Thymus linearis Collected from Dir, Pakistan. Vegetos. 2016;29:1.
81. Salmiyati, Heryansyah A, Kuncahyo B, et al. Partial Substitution of Inorganic with Organic Fertilizer for Enhancement Fresh Fruit Bunch (FFB) Productivity in Oil Palm Plantations. Expert Opin Environ Biol. 2016;5:2.
82. Rivadeneyra A, Rivadeneyra MA, Escamilla CV, et al. The influence of Salt Concentration on the Precipitation of Magnesium Calcite and Calcium Dolomite by Halomonas Anticariensis. Expert Opin Environ Biol. 2016;5:2.
83. Jaya kumar R, Muralidharan S, Sangeetha S, et al. Risk Assessment of Metal Contamination in the Vegetables and Fruits Sold at Farmer's Markets (Uzhavar Sandhai) Coimbatore, India. Expert Opin Environ Biol. 2015;4:3.
84. Abioye OP, Aliyu HG, Aransiola SA. Bio-Removal of Vat Dye from Textile Effluent by Candida Tropicalis and Candida Apis Isolated from Soil. Expert Opin Environ Biol. 2015;4:3.
85. Abantao SC, Apacible TC, Cortez SP, et al. Mangrove Species Diversity and On-site Impact Assessment of Mangal Coastal Areas. Expert Opin Environ Biol. 2015;4:3.
86. Nkansah MA, Somuah M. The Perception and Knowledge of Insecticides and Weedicides, Use and Safety Precautions among Chemical Sellers, Farmers and Home Tenants in Kumasi, Ghana. Expert Opin Environ Biol. 2014;4:2.

87. Adel AS, Lalung J, Efaq AN, et al. Removal of Cephalexin Antibiotic and Heavy Metals from Pharmaceutical Effluents using Bacillus subtilis Strain. Expert Opin Environ Biol. 2015;4:2.
88. Abioye OP, Adefisan AE, Aransiola SA, et al. Biosorption of Chromium by Bacillus subtilis and Pseudomonas aeruginosa Isolated from Waste Dump Site. Expert Opin Environ Biol. 2015;4:1.
89. Singh JS, Singh DP. Impact of Anthropogenic Disturbances on Methanotrophs Abundance in Dry Tropical Forest Ecosystems, India. Expert Opin Environ Biol. 2013;2:3.
90. Jayakumar R, Muralidharan S, Dhananjayan V, et al. Monitoring of Metal Contamination in the Eggs of Two Bird Species in India. Expert Opin Environ Biol. 2013;2:3.
91. Hartikainen ES, Hatakka A, Kahkonen MA. Impact of Cadmium, Chromium, Cobalt, Lithium and Manganese to the Growth of Fungi and Production of Enzymes. Expert Opin Environ Biol. 2013;2:3.
92. Martínez-Romero E. How do Microbes Enhance the Carrying Capacity of their Habitats? Expert Opin Environ Biol. 2012;1:1.
93. Steinberg CEW. Environmental Stress on Animals: Adverse or Beneficial? Expert Opin Environ Biol. 2012;1:1.
94. Thul ST, Sarangi BK, Pandey RA. Nanotechnology in Agroecosystem: Implications on Plant Productivity and its Soil Environment. Expert Opin Environ Biol. 2013;2:1.
95. Pokhrel LR, Scheuerman PR, Dubey B. Evaluation of Experimental Design Options in Environmental Nano-Science Research. Expert Opin Environ Biol. 2013;2:2.
96. Gao P, Sun X, Huang S, et al. Isolation and Identification of an Exopolysaccharides-Producing Shewanella frigidimarina Strain W32-2 from Antarctic Sediments. J Mar Biol Oceanogr. 2016;5:3.
97. Comba-González NB, Ruiz-Toquica JS, López-Kleine L, et al. Epiphytic Bacteria of Macroalgae of the Genus Ulva and their Potential in Producing Enzymes Having Biotechnological Interest. J Mar Biol Oceanogr. 2016;5:2.
98. Wäge J, Rohr S, Hardege JD, et al. Short-Term Effects of CO2-Induced Low pH Exposure on Target Gene Expression in *Platynereis dumerilii*. J Mar Biol Oceanogr. 2016;5:2.
99. Thorati M, Mishra JK, Kumar S. Isolation, Identification of Endophytic Fungi from Mangrove Roots along the Coast of South Andaman Sea, Andaman and Nicobar Islands, India. J Mar Biol Oceanogr. 2016;5:2.
100. Harasimiuk FB, Drost A, Nędzarek A, et al. Comparison of Biomass Growth in Microcystis aeruginosa Cultures Supplemented With Commercial Culture Mediums F2 and BG-11. J Mar Biol Oceanogr. 2016;5:4.
101. Rajpara RK, Dudhagara DR, Bhatt JK, et al. Isolation and Investigation of Biodegradation Potential of Multiple Polycyclic Aromatic Hydrocarbons (PAHs) Degrading Marine Bacteria near Bhavnagar Coast, India. J Mar Biol Oceanogr. 2015;4:2.