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Popular Article

Role Of New Generation Phytohormones on Abiotic Stress

***S. Pazhanisamy[1], V. Ishwarya and M. Janani Priyadharshini**
[1]Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute Karaikal, Puducherry, India- 609 603
Department of Agronomy, RVS Agricultural College, Thanjavur, TamilNadu, India- 613 402
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Introduction

Plants are subjected to stress due to a large number of factors that reduce the productivity and economic instability of farmers. Due to an increase in the population, the use of automobiles and other electronics which emit toxic gases into the atmosphere also increases. It will lead to a condition called global warming. Global warming increases the temperature by 2-4°C. A rise in temperature results in a climatic change on the planet. Climatic change causes various abiotic stresses to the plants, and it is caused due to factors like temperature, water, air, light, etc. Abiotic stress gains more attention and care than biotic stress. The natural defense mechanism of plants can regulate abiotic stress. Phytohormones generate the natural defense. Phytohormones are chemical messengers that regulate plants' growth, development and metabolism. Phytohormones help in abiotic stress like drought, frost, flooding, heat, salinity, etc., by their signal transduction pathways. It also activates internal and external stimuli to avoid abiotic stress conditions. The new generation of phytohormones like brassinosteroids, salicylic acid, jasmonic acid, peptides, polyamines, prohexadiene-ca, 1-methyl cyclopropane plays a vital role in abiotic stress.

Role of Brassinosteroids on abiotic stress

Brassinosteroids (BRs) are polyhydroxy steroid hormones isolated from rapeseed. Brassinolide is the first isolated brassinosteroid. It promotes plants' growth and development, including root development, seed germination and dormancy. Brassinosteroids increases cell division when the auxin and cytokinin are in limited amount. In addition, it also gives defense against

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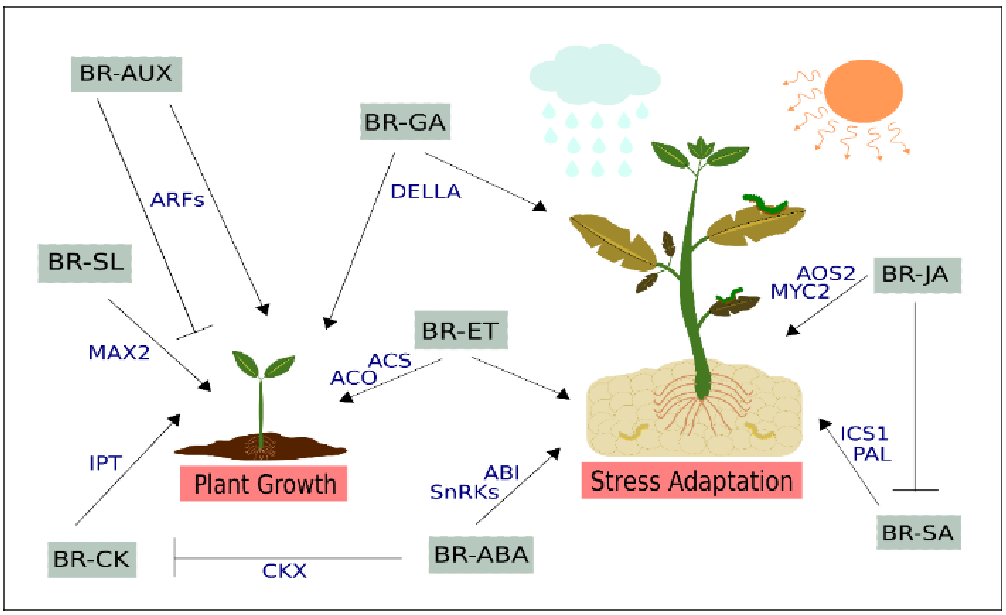
abiotic stress like heat, cold, drought, heavy metals, salinity and pesticides. Brassinosteroids are present in the cell surface by brassinosteroids receptors, leading to phosphorylation which activates the central transcription factor called "Brassinazole-Resistant1(BZR1)" that controls the transcription of genes that are responsive to brassinosteroids in the nucleus. It increases the activity of photosynthesis when the plants are prone to stress, resulting in increased growth and biomass. It enhances carbon dioxide assimilation and increases the chlorophyll content. Brassinosteroids also mitigate abiotic stress by increasing the production of osmoprotectants and antioxidants. It also mitigates salt stress by ethylene biosynthesis, reducing the production of antioxidants and regulates the chilling stress by the factor BZR1 which produces Respiratory burst oxidase homolog 1(RBOH1) and H_2O_2 production in the apoplast. This results in increased sensitivity to photoinhibition, which gives resistance against chilling stress.



Mechanism of Brassinosteroids to abiotic stress

Role of Salicylic acid on abiotic stress

Salicylic acid plays an essential role in plant growth and development. It is ortho-hydroxybenzoic acid and extracted from white willow as saliciline. The stress tolerance level of plants ranges from 0.1 mM to 0.5 mM. The mechanism involved is redox regulation in plant cells. They increased the antioxidant involved in ROS scavenging, which is involved in H_2O_2 detoxifying. The endogenous form of salicylic acid enhances the conductivity of stomata, photosynthesis, the efficiency of carboxylation and photosynthesis oxygen evaluation. It involves cell expansion and

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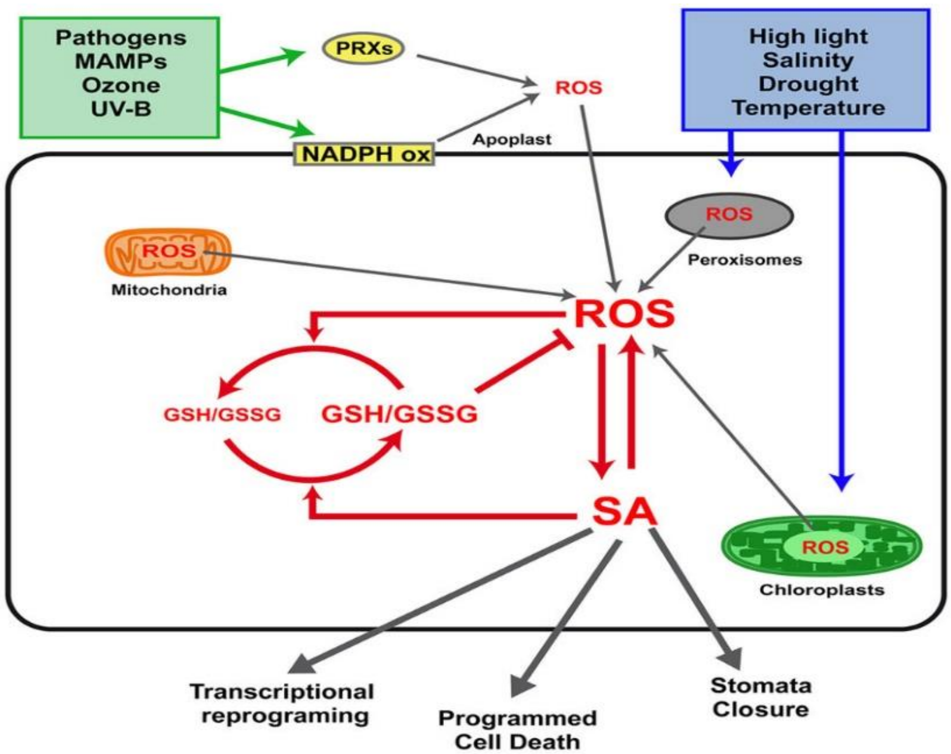
elongation during stress conditions leading to increased growth of root cells of the meristem. It contributes to the increased germination rate and shoots and root elongation during stress levels. There is a direct relationship between GA3 synthesis and Salicylic acid which gives resistance against abiotic stress. It mainly deals with heavy metal toxicity like cadmium with signalling mechanisms of reactive oxygen species (ROS). It involves cell wall construction, balancing the uptake of Cd and other ions, refining the antioxidant defence system, and regulating photosynthesis, glutathione synthesis and senescence.



Mechanism of Salicylic acid to abiotic stress

Role of Jasmonic acid on abiotic stress

Jasmonic acid is a derivative of linoleic acid and can be converted into many derivatives like methyl jasmonate. It is a plant immune hormone naturally synthesized by plants. It involves root development and the developing of reproductive organs in plants. The signalling mechanism of jasmonic acid is mainly by gene expression and coordinates with other phytohormones during stress. It regulates the antioxidant metabolism, synthesis of osmolytes and accumulation of metabolites. It also increases the Ascorbate peroxidases, glutathione reductase and ascorbic oxidase, which results in stress mitigation. Jasmonic acid decreases the salinity stress by reducing the uptake of Sodium with an increase in the uptake of Calcium and Magnesium levels. It also eliminates the toxicity of

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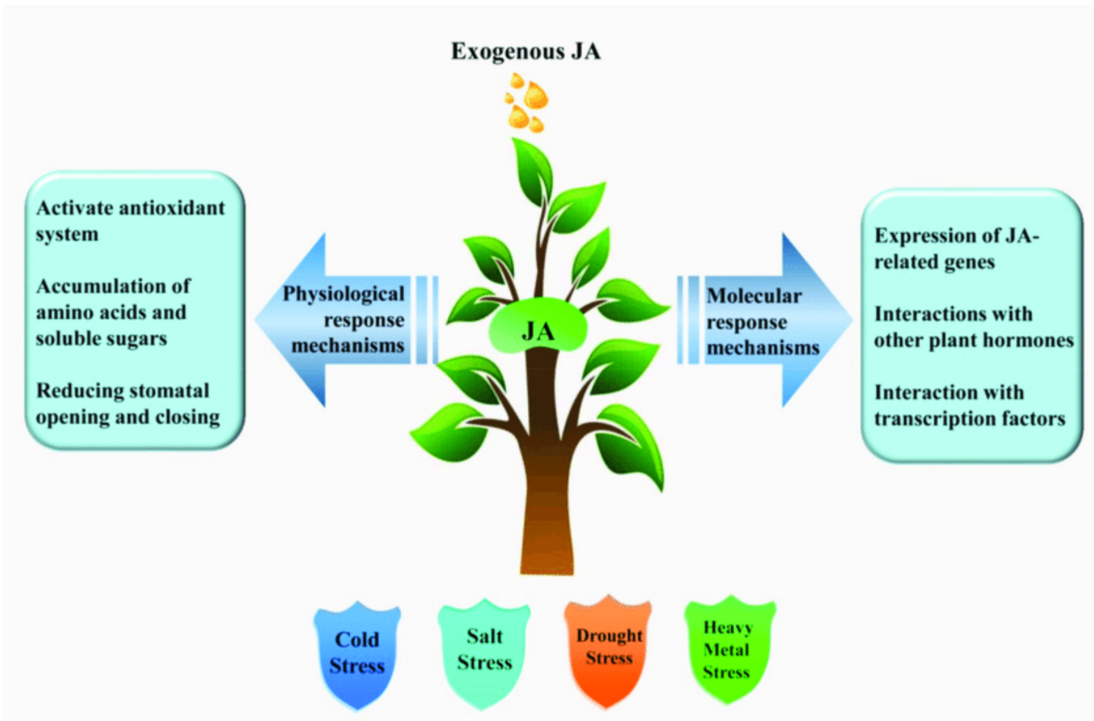
heavy metals by increasing the osmolytes accumulation while increasing the antioxidant concentration, preventing plants' damage by heavy metals and minimizes cadmium toxicity. It reduces plants' chilling and heat stress and regulates the accumulation of amino acids and soluble sugars. It controls the stomatal opening and closing, thereby causing osmotic stress. It also regulates drought by increasing the activity of enzymes catalase, superoxide dismutases, peroxidase, chloramphenicol acetyltransferase, glutathione reductase and non-enzymatic antioxidants.



Mechanism of Jasmonic acid to abiotic stress

Role of Peptides on abiotic stress

Nowadays, peptides can act as phytohormones that regulate plant growth and development. The signalling peptides are small peptides of 5-20 amino acids. These mobile peptides are recognized by leucine-rich repeat (LRR)-receptor-like kinases. It also controls the adaption and tolerance against abiotic stress. These peptides mitigate dehydration, heat, salinity, etc. CLE peptides are involved in root cell maintenance, meristem tissue, vascular tissue, shoot elongation and stomatal opening and closing and regulate the water deficiency by gene expression to reduce the dehydration stress. IDA (Inflorescence Deficient in Abscission) regulates the abscission of the floral organ and lateral root emergence. PSK peptide (Phytosulfokine-α) regulates osmotic stress tolerance. CAPE Peptides, RALF Peptides, and AtPEP3 are against Salinity stress. IDA-LIKE (IDL) peptides are involved in

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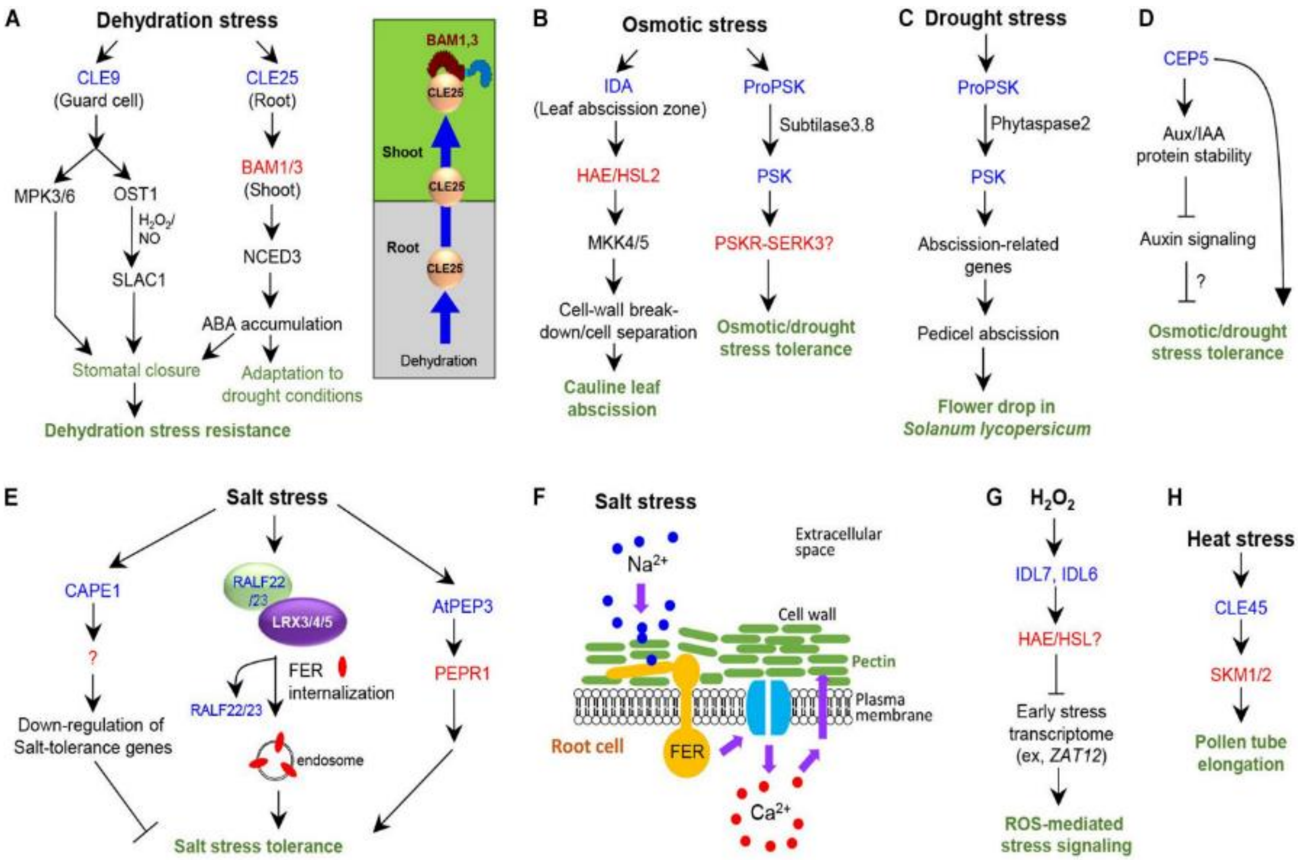
ROS-mediated stress signalling. CLE45 peptides against heat stress response. Peptides also give nutrient deficiency stress response against nitrogen and phosphate deficiency.



Mechanism of Peptides to abiotic stress

Role of Polyamines on abiotic stress

Polyamines are low-molecular-weight polycationic amines present in all living being. In addition to plant growth and development of plants, it also mitigates abiotic stress. The antistress property of polyamines is attributed to their acid-neutralizing, antioxidant, and cell-wall-stabilizing abilities. The level of polyamines like putrescine, spermidine, and spermine increases during stress. Through the ion channels of the plant, it regulates ion homeostasis. It also regulates the stomatal opening and closure, thereby mitigating water stress. It increases the production of antioxidants, and signalling occurs by the Reactive oxygen species mechanism. It produces compatible solutes and maintains the osmotic balance. Other abiotic stress factors are done by modulating the gene expression. Polyamine-triggered Nitrous Oxide modulation and polyamine-dependent nitrosoproteome modulation are contributed mainly to polyamine-mediated stress responses.

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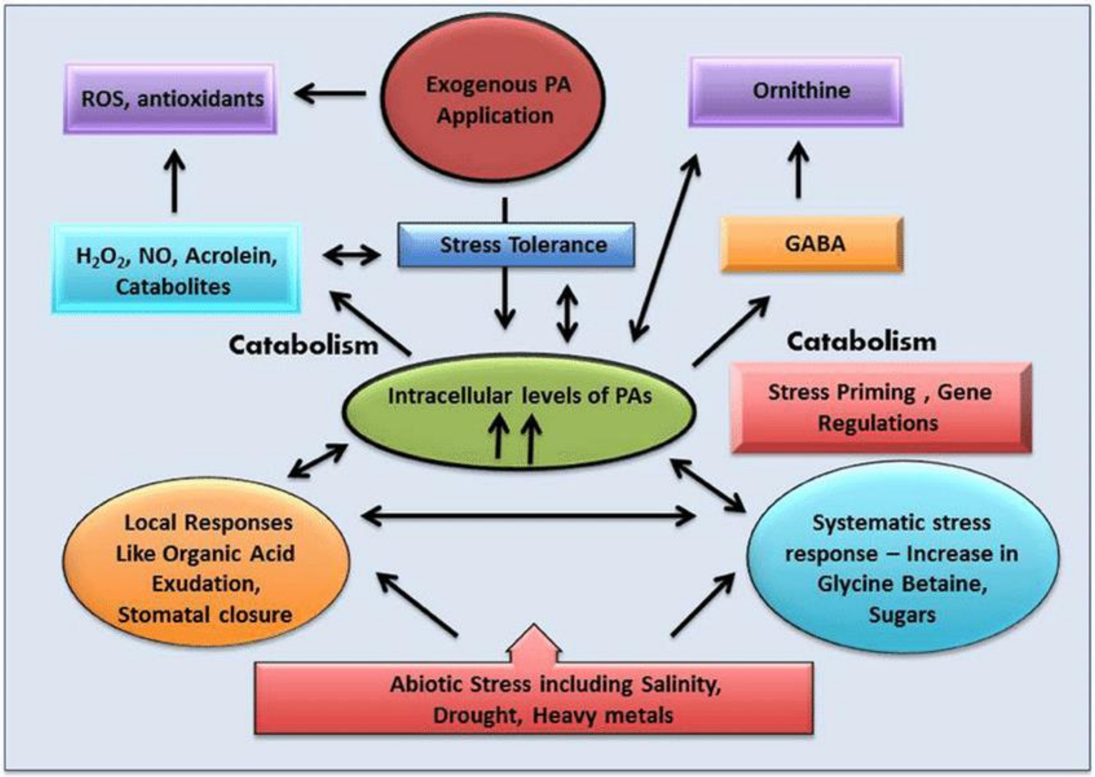

Mechanism of Polyamines to abiotic stress

Role of Prohexadiene-Ca on abiotic stress

Prohexadione-calcium (Pro-Ca) has been used as a plant growth regulator. This compound inhibits gibberellin (GA) biosynthesis by blocking 3, β-hydroxylation of GA20 to GA1, which plays a vital role in overcoming abiotic stress. It mainly contributes to plant salinity-alkali stress by modifying morphological parameters such as shoot and root growth, gas exchange parameters such as carbon dioxide concentration, transpiration rate, chlorophyll fluorescence, membrane damage, ROS accumulation, antioxidant production, soluble sugars and proline content.

Conclusion

In the era of fertilizers, pesticides and fungicides, the naturally producing phytohormones which mitigate abiotic stress is adorable and have a specific place in organic farming techniques. The usage cost is relatively lower than the conventional protection method against abiotic stress. It is an economically and environmentally effective technique. It not only plays a vital role in the mitigation of abiotic stress. It is also involved in plants' growth, development, metabolism and physiological process. It regulates seed germination, root and shoot elongation, vegetative growth, flowering, pod development, senescence etc. Especially the new generation of phytohormones plays a vital role in

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giving resistance against abiotic stress. It is essential to encourage the use of phytohormones against abiotic stress.

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