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Conceptual

The New Insights of Abiotic Stress in Agriculture

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Abiotic stresses are the prime limiting factors for agricultural production and productivity. Crop plants need to muddle through adverse external pressure fashioned by environmental and edaphic conditions/abiotic stresses with their intrinsic biological mechanisms, failing which their growth, development, and productivity suffer adversely. Dominant abiotic stresses comprise drought, high/low temperature, soil salinity, light intensity, submergence, hypoxic conditions and nutrient starvation. Approximately 64% of the global land area is affected with water deficit (Drought), 13% with flood (anoxia), 6% with soil salinity, 9% with mineral deficiency, 15% with acidic soils and 57% with soil acidity. Abiotic stresses adversely affect growth, development, and significantly limit the global agricultural productivity through impairing cellular physiology/biochemistry via elevating reactive oxygen species (ROS) generation. The enhanced production of ROSs during stress can pose a threat to cells but it is also thought that elevated ROSs act as signals for the activation of stress-response and defense pathways. The product of these defense pathways are bioactive compounds (also known as secondary metabolites), which leads to the plant defense mechanism against the osmotic stress occurred and neutralize these ROSs and prevent the disruptions in plants cellular physiology/biochemistry. These secondary metabolites are divided in many groups like phenols, flavonoids, alkaloids, steroids, terpens, wax, gum, tannins, suberin etc. This is the one aspect to see the abiotic stresses in agriculture.

The other side of abiotic stresses in agriculture is the commercial applications of high valued secondary metabolites produced under these conditions. The plant based secondary metabolite industry is a multi-billion dollar business. From 2016 to 2021, the combined annual growth rate of 7.5% (CAGR) should reach the global nutraceutical market from $ 198.7 to $ 285.0 billion by 2021 in 2016. These compounds have a number of commercial applications in pharmaceuticals, agrochemicals, flavors, fragrances, colors, bio-pesticides, and food additives. Owing to these, the secondary metabolites are in extensive demand and various commercial preparations are available in the market.

Under natural conditions, plant produce these secondary metabolites along with its necessary primary metabolites but in very minutes quantity (less than 1% dry weight) and depends greatly on the physiological and developmental stage of the plant. These metabolites are not involved in normal growth, development and breeding of the plant but to facilitate interaction with the biotic environment and the establishment of a defense mechanism. Generally, the production of these secondary metabolites is restricted to only few taxonomic groups. Under extreme climatic conditions of biotic and abiotic stresses, production of these compounds is trigged multi-fold in plant to cope with the resulted osmotic stress and scavenge the ROSs to prevent the impairing of cellular physiology and biochemistry of plants. Likewise, when a specific abiotic stress in a precise quantity is implicated on plants, the synthesis of some specific bioactive compounds is increased by many folds.

In conclusion, all type of stresses have harmful effects on plants growth and development but the recent emergence of massive commercial application of these metabolites, these abiotic stresses are successfully implicated on plants for triggering their bioactive compound production potential. This strategy is being used to produce bioactive compounds through plants at commercial level. However, The extensive research on this strategy is under progress in different institutions and yet to be reached at commercial level.

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