Review Article

THE REGULATION OF STRESS RESPONSES IN FRUIT CROPS IS INFLUENCED BY PLANT HORMONES: A REVIEW

Comment [W11]: Guideline for Authors
Review papers::
-Word length of 5000-9000
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ABSTRACT:

Stress is a pervasive challenge in modern agriculture, impacting fruit crop yields and quality. This review explores the critical functioning of phytohormones in regulating fruit crop stress responses. Plant actions, such as abscisic acid (ABA), salicylic acid (SA), jasmonic acid (JA), and ethylene, play pivotal roles in orchestrating the physiological and molecular mechanisms that enable fruit crops to cope with a myriad of abiotic and biotic stressors. This article provides a comprehensive overview of how these hormones interact and modulate stress-responsive pathways, influencing plant growth, development, and fruit production. Understanding the intricate interplay between plant hormones and stress responses is essential for developing innovative strategies to enhance stress tolerance in fruit crops, ultimately securing global food supplies and improving agricultural sustainability.

Keywords: Plant Hormones ,Agricultural Sustainability, Stress Responses, marker-assisted selection

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INTRODUCTION

Different ecological stressors can fundamentally influence organic product harvests. These stressors are comprehensively ordered into two kinds: biotic and abiotic, contingent upon their temperament. Biotic pressure is instigated by life forms like parasites, microorganisms, infections, nematodes, bugs, and weeds. Then again, abiotic stress is frequently connected with natural variables like geography, environment, and soil conditions, impacting plant development and efficiency[1]. As indicated by the FAO's "The Territory of Food and Horticulture 2007," under 3.5% of the all out world land region is thought of as liberated from abiotic stress reasonable for development. With environmental change causing a nonstop decrease in green harvest yields, worries about these stressors are heightening [2]In order to survive in adverse environmental conditions, plants must employ defensive mechanisms to neutralize the harmful effects of abiotic stressors on their growth and development. Studies have demonstrated that abiotic stressors can reduce fruit and vegetable output by up to 70%, as demonstrated by[3]. During abiotic stress, plants may experience morphological changes at the molecular, physiological, biochemical and molecular levels. Examples of morphological changes include a decrease in shoot and root development and flower loss, a decrease in fruit setting and distorted fruit shape. Furthermore, stress can affect nutrient levels and their content, as well as photosynthesis rate, respiration rate, water loss rate, and absorption rate. It is imperative to address these challenges in agricultural practices to ensure sustainable fruit crop production in the face of increasing environmental pressures[3].Postharvest illnesses induced by pathogen infection are one of the primary causes of fruit loss in economic value and waste. causing fruits susceptibility to pathogens was recently noticed and demonstrated to be an effective method to avoid and manage diseases after harvest with the study of the processes for fruit-pathogen relations[4]. Fruit detects pathogens quickly and activates an efficient, complex, and finely controlled network of hormone-mediated defencesignalling pathways[5].The expression of a broad set of genes is controlled downstream of this signalling network, with an emphasis on the formation of pathogenesis-related (PR) amino acids, the creation of phytoalexins, and the construction of external obstacles (cuticles and cell walls). [6]By chelating ferrous ions, anthocyanins prevent the production of hydroxyl radicals and efficiently eliminate hydrogen peroxide and superoxide produced by trauma, abrupt temperature changes, or intense sunlight[7]. Anthocyanins may also form complexes with the metalloid elements boron (B) and germanium (Ge), which have both metal and nonmetal characteristics. Furthermore, anthocyanins can postpone leaf senescence and extend leaf life, particularly in plants grown in low-nutrient environments[8].Abiotic stressors that affect agriculture worldwide include floods, low temperatures, high salinity, nutrient shortages, and heavy metal pollution. These issues are predicted to get worse in the future as a result of ongoing global climate change and human activity[9].Small molecules called plant hormones cooperate to control every facet of a plant's existence, from the establishment of patterns throughout development to the way a plant reacts to both abiotic and biotic stressors[10]. Plant hormones have been proven in several studies to modulate anthocyanin production, resulting in increased stress resistance[11]. Folar anthocyanin accumulation and stress response are specifically mediated by phytohormones like abscisic acid We explore the function of plant hormone in anthocyanin biosynthesis, as well as the mechanisms of crop hormone-mediated anthocyanin buildup and related abiotic stress tolerance, in this review. The current evaluation would spark greater research into plant hormones that regulate anthocyanin biosynthesis in order to increase plant stress tolerance and give some recommendations for crop production.In the future, further research is still required to determine whether or not plant hormones may increase the quantity of anthocyanin of plants, thereby improving their resilience to stress[11].

EFFECT OF PLANT GROWTH REGULATORS IN FRUIT CROPS

Apple

The major goal of this study is to illustrate how plant growth regulators affect Gala apples. They're taking 300 mg of L-1 ethephon, 400 mg of L-1 pro-hydro jasmonate, & 400 mg of L-1 abscisic acid. Following the application of these developmental regulators, the red colour of the fruit is enhanced, and chlorophyll degradation occurs. However, the purpose of this experiment was to improve the colour of The regular apples (Malus Domestica). Ethylene is the primary development regulator used in improving fruit red colour when applied in the type of Ethrel; the use of it advances fruit development, allows shortly harvest, and increases red colour in fruit skin; however, in order application may reduce an organoleptic quality and fruit storage potential after harvest [12].

On the other hand, prohydrojasmonate improves the red colour of the Multinational Gala cultivar, and both jasmonate is and abscisic acid are thought to have an advantageous effect upon fruit ripening; these varieties include Fuji as Gala [13].

Guava

The role of growth regulators in the cultivation of guava (Psidium guajava L.), Guava is a significant fruit crop farmed commercially in the world's subtropical to tropical regions. In comparison to other countries, productivity in India is poor. Several techniques have been developed to help with this, including HDP, crop control, orcharding, the use of superior cultivars and hybrids, and the use of development regulators. Plant growth regulators, one of these technologies, play an important function in all phases of development and development since they aid to boost ultimate yield and produce quality. It has been demonstrated that the application of PGRs is a potent instrument for increasing fruit output directly or indirectly based on our needs [14]. The use of GA3 promotes germination and shortens the germination time. PGRs play an important role in guava propagation because guava is a severely root that is propagated through cuttings, lumber, semi-hardwood, and wood limiting due to cutting containing IBA at 1000ppm improved rooting percentage by 37%, and cutting treated about NAA as well as dilute water made from coconuts generated fully developed roots and shoots [14]. Plant growth regulators aid in the improvement of fruit crop establishment, quality, and yield. A study on the impact of growth regulators on plants in promoting fruit set, excellence, and production in fruit crops was presented. We are achieving some remarkable results in terms of growth, production, and quality by using plant growth regulators [14]. NAA (40, 50, and 60 ppm) or GA3 as a (40, 50, and 60 ppm) effects on the setting of fruit and production of blackberry cv. Bhagwa. We found that NAA 40 ppm had been very effective in increasing the amount of fruits per plants (62.44), the length of the fruit (8.66cm), diameter of the fruit (8.71cm), fruit mass (262.23g), fruit weight (255.44ml), technical assistance (16.760 Brix, overall sugar), (15.58%), decreasing sugar (13.83%), and preventing sugar reduction (1.75%) . In the present study, the effects of GA3 with 100 ppm, 6-beta- (BAP) at one hundred ppm, and lactic acid at 250 ppm on the fruit establish, fruit preservation bundle weight, sweetness, and yield [15] were observed.

THE INVOLVEMENT OF GA IN CROP DEFENSIVE REACTION

Gibberellins (GAs) are mainly recognised as phytohormones that play critical roles in highly and organs of reproduction growth, flowering, growth, growth of leaves, and the lengthening of stems. However, recent research has shed light on the crucial involvement of GAs in plant defense responses under stressful conditions. Studies have revealed that GA signaling and metabolism constitute vital environmental components that respond to stressors[16]. Notably, it has been observed that ABA activates GA signaling but expression of the DREB2 gene represses it, potentially leading to stunted growth in rice with GA deficiency symptoms. Intriguingly, the administration of exogenous GA has been found to restore normal growth in such instances. Additionally, the synthesis of key GA biosynthesis genes, significantly reduced in plants exposed to stress, particularly salt stress [14].This insight underscores the intricate interplay between GA and stress responses, emphasizing their potential as crucial regulators in the plant's ability to cope with challenging environmental conditions. Unraveling the molecular mechanisms governing the crosstalk between GA signaling and stress pathways opens avenues for targeted strategies in crop improvement and stress tolerance. Moreover, understanding the dynamics of GA in stress conditions provides valuable knowledge for agricultural practices, paving the way for innovative approaches to enhance plant resilience and productivity in the face of adverse environmental challenges[17].

SALICYLIC ACID'S ROLE IN PLANT DEFENCE RESPONSE

Salicylic acid (SA) is a phenolic molecule that is formed in plants via the pathway of phenylalanine systems. In the pharmaceutical industry, the SA or its chemical equivalents are utilised to create medications such as as codeine as a morphine, which the drug digitalis, and taxol-like chemicals. the SA levels in different crops vary between 1 mg to 1 kg of vegetative tissue. Vegetation require this molecule for seed development, growing seedlings, metabolism, stomatal opening, and ageing[18]. By boosting the antioxidant system to preserve transpiration, SA has the capacity to promote plant tolerance to a number of external stimuli, including salt-induced stress, cold, heavy metal strain, and high light exposure. This chemical is significant in plants because it promotes the formation of acute reactions (HR) or systemically established resistance. Furthermore, it influences a number of biological processes, including thermogenesis, ion intake, or stress-related death of cells. In the context of stress tolerance, the complex activities and interactions of hormones in fruit crops are key components[19].

HORMONAL CONTROL OF REACTIONS TO GROWTH UNDER HIGH-TEMPERATURE STRESS

Temperature, together with moisture, has a significant impact on the development of plants.When conditions are right, plants may grow faster and bloom earlier than normal. Plants grown in cold conditions have more upright leaves, whereas plants produced in warm wet conditions have a higher proportion of horizontal to downward leaves whatever the yield or bunch size, banana growth is lower in the subtropical regions than in tropical regions, and they required ideal temperatures about 21-22C, with pauses above 38 or 39C and below 9 or 10C for excellent growth[20]. When temperature rises beyond a sunburn's boundary (38 degrees Celsius), chlorophyll degrades and bananas choke.The fruit may be able to endure stress by undergoing morphological and/or physiological changes that allow it to avert or delay drying in the arid or semi zone. For maximum fruit growth, custard apple trees need a wet warm temperature, as well as high humidity, during blooming. They can also withstand temperatures that are extremely cold (below zero°C to up forty degree C). Soil temperatures at 10°C can induce substantial freezing damage, resulting in the cell wall instability[21].

HORMONAL MODULATION OF GROWTH RESPONSES IN THE PRESENCE OF WATER STRESS

The quantity and duration of water stress in diverse crops affects agricultural production by 13 to 94%.Plants require moisture for their regular metabolic functions and membrane transport systems. Because fruits and nuts are typically offered on the market by fresh weight, yield is mostly controlled by the amount of water that is contained[22]. The effect of drought occurs in the wet and arid or semi tropics when roots do not have sufficient moisture or when transpiration rates increase with temperature.inadequate the process of precipitation severe circumstances, increased wind speed, inadequate moisture storage, and varying degrees of accessibility of water all impede the expression of agricultural plant genetic traits Plants used physical (the water apply effectiveness, leaf ability to use water, in contrast the amount of water, osmosis change, regulates evaporation, effective stomatal actions, and stress adjusting),[23] physiologic (reduced area of leaves, leaf shaping, obtained fluid substance, decreased develop quantity, significant quantity of roots and weight, a less straight branch, in effect germination framework, small plant relative to quantity, earlier maturation), and biochemical reactions (antiosmotic change, controlled transpiration Drought is to blame for the significant decrease in yield[24].Flood has the same effect on fruit crops as drought, causing a reduced respiration zone surrounding the soil's roots and increasing soil-borne illnesses. As a result, important studies have been created on how various hormones impact water stress management in fruit plants[25].

HORMONAL REGULATION OF GROWTH RESPONSES UNDER SALT STRESS

An excess of chlorine from sodium NaCl causes salinity in the soil. Increased concentrations of unnecessary minerals, which are soluble in irrigation water, impair proper growth and reproduction. [26]When the concentration of salt in water used for irrigation goes over a certain threshold, it may have a negative impact on the balance of osmotic forces, ion intake, water change, transpiration, photosynthesis, protein creation, nucleic acid production of cells, enzyme activity, and general health Plants are divided into two groups according to their tolerance to salt strain: (I) halophytes, which are capable of surviving and reproducing even at levels of salt as high as 200 mmNaCl, and (ii) glycophytes, which cannot thrive in salty conditions [27]. Decreased total leaf area and development, yellowing and burning at the edges and points, delayed leaf death, stem decline, covering, damage, and leaf burning are all stress indicators in glycophytes Severe aridity causes salt buildup in young leaves, interfering with normal photosynthesis by inducing pigment loss and blocking the Calvin process enzyme. The most sensitive or tolerant types include structural anomalies such as higher leaf size, higher chloride buildup and reduced Mg2, and a lower Mg2 concentration[28].

HORMONAL CONTROL OF DEVELOPMENT REACTIONS WITH HEAVY METAL STRESS

Metal ions are essential for the growth and survival of all living creatures in our galaxy's immense size[26]. The components of living creatures are classed as significant, small or trace elements based on their relevance in proper biological functioning. Plants that absorb excessive amounts of microelements such as lead, zinc, copper, and magnesium may experience harmful consequences. Redox reactions are carried out by iron, copper, and iron, whilst precious metals, mercury, lead, copper, Al, and other metals influence enzymatic functions in plant cells. Because transition metals, like iron and copper, include unattached electron pairs, they reduce the effectiveness of oxygen catalysis[25].

Heavy metal poisoning in nature is a global hazard that concerns agricultural ecosystems These chemicals are crucial for plants development and growth at trace levels, and they play a vital role in metabolism by activating several digestion-related processes. When the concentration of metallic elements has increased a certain point, they may have an adverse effect on grow biological functioning, resulting in decreased biomass growth, photosynthesis rates nutritional adoption or water loss relations [27]. Furthermore, excessive levels can induce cell toxicity by generating reactive oxygen species varieties (ROS), decreasing antioxidant function, and inflicting significant injury to tissues .Previous research has demonstrated that employing plant growth-promoting phytohormones can increase protection by lowering the effects of toxic substances in crops Previous study has demonstrated that significant metal use raises ABA (abscisic acid) content in crops Heavy metals including zinc, aluminium, nickel, and cadmium have been demonstrated to raise ABA concentrations in crops observed that at temperatures above freezing (30/35°C), ABA modulates and boosts Cadmium tolerance in rice seedlings[28].

CONCLUSION AND FUTURE PROSPECTS

In conclusion, the intricate regulation of stress responses in fruit crops is undeniably influenced by the complex interplay of various plant hormones. This dynamic relationship between hormones such as abscisic acid, ethylene, and jasmonic acid plays a pivotal role in orchestrating a cascade of molecular events that enable fruit crops to withstand and adapt to various stressors. The understanding of these hormonal regulatory mechanisms not only enhances our knowledge of plant physiology but also holds significant implications for agricultural practices. As we delve deeper into the intricacies of stress response regulation, there arises a promising opportunity to harness this knowledge for the improvement of crop resilience and productivity. By deciphering the signaling pathways and molecular networks involved, researchers and agriculturists can develop targeted strategies to modulate hormone levels and enhance stress tolerance in fruit crops. This, in turn, may contribute to sustainable agriculture practices and the development of more robust and resilient crop varieties capable of thriving in diverse environmental conditions. Moreover, as climate change continues to pose unprecedented challenges to global agriculture, the importance of unraveling the regulatory mechanisms of stress responses becomes even more pronounced. The insights gained from studying the influence of plant hormones on stress regulation pave the way for innovative approaches in crop breeding, genetic engineering, and precision agriculture. By leveraging this knowledge, we can work towards ensuring food security and mitigating the impact of environmental stresses on fruit crop production.

In summary, the regulation of stress responses in fruit crops represents a captivating area of research with far-reaching implications for agricultural sustainability. As we continue to decipher the intricacies of hormonal control mechanisms, the potential to enhance crop resilience and adaptability becomes increasingly tangible. Through collaborative efforts across scientific disciplines and the implementation of novel agricultural strategies, we can aspire to cultivate a future where fruit crops not only endure environmental stresses but thrive in the face of adversity.

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Comment [W12]:
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2. *For Published paper:*
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