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Climate Change and Its Impact on Fruit Crops

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Climate change is an observed reality. The change in natural vegetation and ecology is one of many adverse effects resulted from the climate change. One of the best documented effects of climate change is the changing timing of plant growth activity, known as change in phenology. Alteration in between the duration of vegetative and reproductive phase is taking place due to climate change. In most fruit crops, generally higher temperature decreased the days interval required for flowering by reducing the vegetative phase. Warming is most deleterious for tropical insects than species at higher latitudes. Despite the rising atmospheric CO2, food production in future is uncertain with global warming and altered precipitation. Loss in plant diversity and area suitability will further increase the problem. Under such threats in global fruit production a plan based on strategic scientific assessment of such impacts should be quantified with adaptation and mitigation approaches.

Keywords: Climate, ecological, food security, global warming, phenology, productivity

Introduction

Climate change is 'a change that is attributed directly or indirectly to human activity which alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods'. Climate change is projected to cause an increase in temperature, variations in rainfall, and an increase in frequency of extreme events such as heat, cold waves, frost days, droughts, floods, etc. Various plant processes like vegetative growth, flowering, fruiting and fruit quality are highly vulnerable to climate changes. Two major parameters of climate changes that have far reaching implications on plants are more erratic rainfall patterns and unpredictable high temperature spells which are consequently expected to reduce crop productivity. Drought reduced fruit set and increased fruit cracking in pomegranate and litchi. Temperature increase affects photosynthesis directly, causing alterations in sugars, organic acids, flavonoid contents, firmness, and antioxidant activity. Rise in atmospheric carbon dioxide levels persistently affected post-harvest quality causing sugar content reduction in potatoes and tuber malformation incidence of common scab. An increase in atmospheric temperature and change of rainfall pattern affected the banana cultivation in some countries. In various fruit crops, moisture stress and high temperature during flowering strongly influences the pollen and ovule quality and consequently the fruit set and yield. The promotion of stigma and stamen sterility in papaya is mainly because of the higher temperature, which caused flower drops as well as sex changes in female and hermaphrodite flowers. Development of new varieties with higher yield potential and resistance to multiple stresses (drought, flood, salinity) should be the key to maintain yield. Improvement in germplasm of important tropical and subtropical fruit crops for heat stress tolerance should be one of the targets of breeding programs. Location specific soil and water conservation models, protocol for organic farming, conservation horticulture,

development of biotic and abiotic stress tolerance rootstocks, etc., are some of the strategies to mitigate the impact of climate change.

Impact on phenology:

Time change of different physiological activities i.e. phenology is one of the most pronounced effect of climate change. In temperate fruits, flower induction is deeply influenced by temperature, especially low temperature, however, strong interaction between genotype, photoperiod and temperature interactively control flowering. Advancing trends in bloom dates of many trees indicate that dormancy breaking processes are indeed changing most likely in response to climate change.

Impact on patterns of blooming

According to climatic changes alter the pattern of blossoming, bearing and, therefore, fruit yield and the quality of apple deterioriate under Western Himalayan condition of India. The greater rise in winter and spring (January to March) temperatures lead to earlier flowering, which coincides with the time of spring frost resulting in a remaining risk of frost damage to apple flowers. In temperate climate areas, frost can also represent the main cause of weather related damage to crops. Apple and other temperate fruit are vulnerable to spring (late) frosts. During the bloom stage, a single event with temperatures going a few degrees below zero is sufficient to damage flower buds or even kill them. While light frosts result in the deterioration of fruit quality, severe frosts threaten the harvest itself.

Impact on dormancy and chilling requirement

The plants use the dormancy mechanism to protect its sensitive tissue from unfavourable climatic condition. There might be alteration in the adaptability of many temperate fruit crop in the near future due to rapid climate change, and severe productivity problems might arise as well. Commercially successful cultivation of many fruit and nut trees requires the fulfillment of a winter chilling requirement, which is specific for every tree cultivar. Lack of chilling as in mild winter conditions result in abnormal pattern of bud-break and development in temperate fruit trees.

Impact on pollination

Climate change, with a potential to affect every component of agricultural ecosystems, is reported to impact bees at various levels, including their pollinating efficiency. The changing climate scenario has contributed in significant reduction in the population of the pollinating insects. If the temperature is either very low or very high there is no fertilization, thus affecting fruit set. The optimum temperature for pollination and fertilization in temperate fruits like apple, pear, plum, cherry etc. is between 20-25 °C. Low temperatures and rainy or foggy conditions had observed to have a negative effect during pollination.

Impact on pest and disease incidence

Climate change could alter stages and rates of development of pathogen, modify host resistance and physiology of host pathogen interactions. Climate change could lead to Changes in geographical distribution, Changes in population growth rates, Increased overwintering, Increase in the number of generation, Extension of developmental seasons, Changes in crop-pest synchrony of phenology, Changes in interspecific interactions of insects and Increased risk of invasion by migrant pests.

Impact on Fruit Quality

The production and quality of fresh fruits can be directly and indirectly affected by exposure to high temperature and elevated levels of carbon dioxide and ozone. The rise in the atmospheric co2 levels due to global climate change and horticultural practices has both

direct and indirect effect on secondary metabolite synthesis in plant. Temperature increases affects photosynthesis directly, causing alteration in sugars, organic acids, flavonoid content, and antioxidant activity.

Impact on Post-harvest quality

According to temperature variation can directly affect crop photosynthesis, and a rise in global temperature can be expected to have significant impact on the postharvest quality by altering important quality parameters such as synthesis of sugars, organic acids, antioxidant compounds, peel colour and firmness.

Approaches To Mitigate Impact of Climate Change

Dormancy avoidance: The methods which can prevent the plants from entering into dormancy condition helps in bud burst without requiring chilling temperature. The dormancy can be induced artificially by defoliating the trees just after the harvesting.The defoliation of the trees enable them to resume their annual crop cycle without chilling requirements and this type of practice has made the production of temperate fruits possible in countries like India and Kenya.

Manipulation of the chilling requirement of temperate: Once the tree cultivars are selected and planted in the orchard, it is required that they remain in production for decades. The need to anticipate and adapt to climatic changes is very much urgent for growers of tree crops. Even the already established commercial varieties of fruits might perform poorly in an unpredictable manner due to aberration of climate. This has led to the development of cultural, mechanical and chemical.

Heat treatment: Temperature is often considered the most important factor influencing phonological phases of fruit trees in temperate climates. Higher temperatures enhance biochemical reactions, which consequently prolong the growing season and influence phonological phases of individual plants. Heat shock proteins (HSPs) have been found in various plants and in some cases they have been found to increase with the chilling.

Evaporative cooling: The other approach to induce bud burst is to increase chilling hours by evaporative cooling of the buds under dormancy period. Evaporative cooling helps in reducing the bud temperature under mild winter condition and thereby increasing the number of chilling hours required for proper bud burst. Sprinkling with water to provide evaporative cooling during rest period.

Conclusion

The climate change affects not only the winter chilling of fruit crops but it also affects the other aspects like increase in the incidence of physiological disorders, pollination failure and phenology. Despite the rising atmospheric CO2, food production in future is uncertain with global warming and altered precipitation. At present, there is limited information regarding realistic impacts of pests and diseases in a hanging climate, which otherwise may influence future food security. The effect of climate change is not only productivity but also impaired fruit quality. Loss in plant diversity and area suitability due to climate change will further increase the problem. As global warming is considered inevitable, endeavour should thus be undertaken to manipulate the chilling requirements of the temperate fruit crops by various means. Under such threats in global fruit production a plan based on strategic scientific assessment of such impacts should be quantified with adaptation and mitigation approaches.