



Global warming and the effect of climate change on fruit growers of himachal pradesh

SHIPRA JOSHI , Department of Humanities , Graphic Era Hill University,
Dehradun, Uttarakhand, India 248002,

Abstract

The distribution, phenology, fruit, and occurrences of disease and pests in perennial fruit crops are all heavily influenced by the climate. Climate elements like temperature, rainfall, etc. have a direct correlation with the physiological processes that regulate fruit trees' growth and productivity, making these aspects of fruit production vulnerable to climate change. The future of food production is questionable in the face of global warming and anomalous precipitation despite rising atmospheric CO₂, which is essential for plant photosynthetic activity. There is also a lack of data on how climate change can really affect pests and illnesses, which might have an impact on future food supplies. Research has shown that uneven weather patterns make it difficult to maintain consistent crop yields and quality. Problems with plant diversity and land appropriateness would worsen. As a result of these threats, it is important to quantify the consequences of these factors, as well as the efficacy of adaptation and mitigation techniques, in order to ensure the continued success of the global fruit producing industry. This review article offers a concise discussion of the impact of climate change on different fruit crops and how to deal with these impending difficulties.

Keywords: climate, physiological, sensitive, atmosphere, plant, challenges, mitigate

DOI Number: 10.48047/nq.2019.17.02.1998 **NeuroQuantology**2019;17(02): 177-184

177

Introduction

Climate change is a result of interactions between the biosphere, hydrosphere, cryosphere, and other spheres. Man-made

emissions are generally accepted as a major contributor to the current state of global warming. "A shift in atmospheric composition that, in addition to the



natural climatic shift that has happened over the same time period, is the result of human activity. The Earth's climate has been relatively stable for at least the last 10,000 years, although it has altered throughout time due to things like volcanic eruptions and continental movements.”

The best estimates suggest that an increase of 1.8 to 4 degrees Celsius in global mean temperatures by 2100 would lead to more extreme weather events including heat waves, cold snaps, and floods. Increased greenhouse gas emissions increase the atmosphere's opacity to reflected infrared rays, but this is ultimately offset by a rise in the surface-troposphere system's temperature. “NASA data from October 2020 shows that atmospheric CO₂ concentration has reached a record high of 415 parts per million, after a significant increase to 400 parts per million in 2014. Air temperature increased by 0.74°C between 1906 and 2005, and further increases of 0.5 to 1.2°C are anticipated by 2020, 0.88 to 3.16°C by 2050, and 1.56 to 5.44°C by 2080.” The latest annual average anomaly (2019) was 0.99°C. By 2100, the world's average temperature might increase by as much as 6 degrees Celsius, and atmospheric CO₂ levels could climb by as much as 550 to 850 parts per million.

The IPCC predicts that the “mean temperature in the Indian subcontinent would increase by 0.5 to 1.2 degrees Celsius by 2020, 0.88 to 3.16 degrees Celsius by 2050, and 1.56 to 5.44 degrees Celsius by 2080. Abnormal rainfall and an unexpected high or low temperature regime” are the fundamental elements of

climate change, both of which have extensive ramifications for agriculture and horticulture.

Impact on Flora Especially Fruits' Growth

Climate, a crucial aspect of the environment, has a major bearing on the yield of fruit crops. “Changes in plant vigour, canopy development, and procreative traits like fruiting ability and reduced fruit size, as well as quality characteristics like reduced colour development, reduced juice content, decreased shelf life, and increased pest attack, all contributed to poor fruit quality and low fruit production.” Historically occupied regions of temperate crops are at danger of experiencing major production challenges in the near future due to the inability of these crops to adjust to rapid changes in weather at a certain period of the growing season.

Changes in business structure and location may affect tropical fruits and areas as a result of predicted temperature and rainfall shifts. Changes in the effectiveness and availability of irrigation systems, as well as the rising need for irrigation due to climate change, are projected to be major issues for tropical fruit. Sunburn, fruit cracking, and tip burn are only few examples of minor pests, illnesses, and physiological problems that might occur, along with the increased risk of incursions into new crops.

Recent modelling efforts that include lengthy temperature records suggest that rising minimum temperatures are responsible for a significant amount of the current trend of global warming. Perpetual fruit trees are especially



vulnerable to climate change since their yield is dependent on persistently low temperatures throughout the growth season.

Climate Change Impact on Phenology of Fruit Crops

One of the most well-known effects of climate change is a change in the phenological timing of plant development. Climate change has affected both the vegetative and reproductive phases of fruit plants. The flowering stage of fruit growth is important for output and productivity. Changes in climate have affected blooming, fruiting, and ultimately harvest. Early cold in January and December is important for determining how much cooling is needed, therefore its absence has a negative effect.

Inadequate freezing caused incomplete apple flowers and low fruit set. Chilling hours had an impact on the quality and quantity of blooming and fruiting. Blooming times for apples and pears have accelerated by 1.6 days per decade as a result of a 0.45°C/decade (1973-2009) rise in early spring temperatures.

During the last quarter of a century, temperatures have risen by around 1.8 degrees Celsius.

18 Late blooming, extended flowering periods, and an extended time between flowering & harvest in apple are only some of the phenological disruptions caused by insufficient cooling needs during warm seasons.

Impact of Climate Change on Fruit Crop's Physiology: CO₂ Effect

1.

The physiological status of a plant may be altered by an increase in atmospheric CO₂ levels. It's an essential component of photosynthesis, the process by which plants generate their own biomass. Yet, the benefits may be nullified by an increase in temperature and a change in the pattern of rainfall. Grapes in Portugal are naturally more efficient at using water because their net photosynthetic rate has increased in response to rising CO₂ while their stomatal conductance has decreased. They found that increasing the CO₂ in the air generally increased yields, with no discernible positive or negative effects on grape ripening. "Even though they were well into middle age and reproductive maturity, sour orange trees were especially vulnerable to the elevated CO₂ levels (17 years)."

"Root biomass, leaf biomass, branch biomass, fruit biomass, and total biomass" were all considerably greater in CO₂ enriched (350-650 ppm of CO₂) trees at the time of final harvest compared to trees growing under ambient circumstances. These advantages under enriched CO₂ for plant biomass production are often outweighed by the heat created by "CO₂-linked global warming in open habitats and soil water evaporation, which in turn reduces growth periods, decreases yield, and increases yield variability."

Temperature Effect

"Temperature regulates the physiological functions of the plants. Imbalanced temperatures causes to following impacts viz.,

Heat stress



2. Inadequate chilling for temperate crops
3. Disruption in pollination activity”

Heat stress causes transpiration to rise, which shuts stomata and limits CO₂ uptake, which in turn stimulates respiration and inhibits photosynthesis. The number of cold hours is predicted to drop by 30–60% by 2050 and by up to 80–90% by 2100, as stated in the National Climate Assessment 2014. Peach trees that don't get enough cold weather have erratic phenological (growth and development) patterns, leading to problems like late blooming and a longer flowering time. These characteristics are strongly linked to cold buildup in stone fruit species. Warm winters cause flower abortion, which in turn reduces fruit production.

Pollination activity, which is responsible for 35% of global food supply, is severely impacted by temperature stress. Disruptions in plant-pollinator interactions may occur when there are mismatches in phenology (the timing of a plant's growth) and distribution (its spread). *Apis mellifera*, a honeybee species, has shifted its active period ahead of the peak blooming times of its preferred food species, indicating that temporal alterations are already observable in emerging nations. The hazard is greater for self-incompatible, pollinator-limited, or pollinator-specific crop species. Increases in temperature during the mango panicle's development stage might expedite its growth, reducing the number of days available for effective pollination. A flower bud may change into a leafy shoot when temperatures at night are warm enough.

Since fruit trees take so much longer to bloom, they are particularly vulnerable to the effects of global warming. Hormones crucial to trees' growth and development are affected by temperature.

Temperature and precipitation were shown to have a negative effect on mango, banana, papaya, and sapota yields and productivity in Navasari district, Gujarat, India during a ten-year period (2007-2017).

Climate Change Impact on Quality of Fruits

While trying to earn a profit in the export market, quality requirements are of paramount importance. The optimal conditions for adequate pigmentation and secondary metabolites formation, which are fundamental necessities in producing excellent fruits, are being disrupted by the changing climatic settings. Raising temperatures have a negative effect on the quality of grape wine production because they hasten the maturity period of the grapes and reduce acidity and pigmentation. Citrus, grapes, and litchi will likely develop fruitlets and reach maturity at a quicker rate if temperatures rise. In the event that fruits mature and ripen more quickly, the window of time during which they are readily available might be reduced. “Since direct sunlight slows ripening by decreasing the activity of cell wall enzymes (cellulase and polygalacturonase) during development, mandarins cultivated in full sun (35 °C) were 2.5 times firmer than those grown in shade (20 °C). 38 High surface temperatures brought on by prolonged exposure to sunlight hasten the ripening



process and other processes associated with it.”

The red hue of apple fruit is crucial to the industry. The temperature of the environment is a major role in whether or not apple fruits become red during growth. Cross-sectional studies of cultivated fruits showed that, at higher temperatures, the anthocyanin colours remained confined to the cells of the outermost layers of the flesh and skin. The size of the treated cells quickly surpassed that of the untreated cells and continued to grow over time. Discs heated to temperatures below 30 degrees Celsius showed greater red colour density. Apples are more susceptible to sunburn and fruit breaking as a consequence of extreme temperature and moisture stress, drastically diminishing fruit quality. 45 When pear is exposed to high temperatures, the occurrence of water cores increases.

Impact of Climate Change on Area Suitability of Fruit Crops

Changes in the pattern of rainfall have an impact on the annual fluctuations in the fruit yield, blooming, and quality of tropical plants. Warming over the last several decades has widened the tropical zone, making formerly unimportant areas more significant for tropical crops. Changing climate conditions for tropical fruits may be dramatically altered by even a single degree Celsius. Some currently viable regions for fruit crops may become just partially suitable, and new potentially suitable places may appear. Intensified effects of rising temperatures on the

reproductive biology of these crops are anticipated.

Limiting vegetative growth and decreasing fruit set are two of the most noticeable consequences of high temperatures on crop yield. High temperatures and humidity levels put additional stress on fruit crops, especially those that lose a lot of water via transpiration. Changes in the optimal climate for the high-quality cultivation of Dashehari and Alphonso mangoes might occur with a temperature increase of 0.7°C to 1.0°C. The ideal climate for growing a certain kind of mango When temperatures increase, the yield of dashehari drops substantially, and the distribution of the mango cultivar alfonso is likely to be confined to the Ratnagiri region due to its low adaptability.

Climate Change Impact on the Pest & Disease Incidence in relation to Fruit Crop

The incidence of pests and diseases in fruit crops has changed as a result of climate change. The introduction of new pests, the elevation of formerly minor pests to significant pest status, and the failure of resistance mechanisms are all possible outcomes of changes in flowering time and temperature.

According to the 2012 annual report from the National Research Center for Bananas, Sigatoka disease has suddenly become a major concern in Maharashtra, where it had previously been ignored. Stormy rains raise the risk of bacterial gummosis in pome and stone fruits. The stages and speeds at which pathogens evolve, as well as the resistance of hosts and the physiology of host-pathogen interactions,



may be affected by climate change. Insects in the tropics (those closest to their physiological peaks) are more likely to suffer from global warming than their northern counterparts. "Citrus greening (mealy bug), papaya ring spot (aphid), pineapple wilt (mealy bug), and other vector-borne viruses may be reduced in tropical climates if vector insect populations are reduced."

Changes in temperature and precipitation patterns throughout the course of the year have a significant influence on the life cycles of many insect pests. "The likelihood of invasion by migratory pests and interspecific interactions might both rise and shift as a result of climate change's effects on distribution, population growth, generation size, overwintering, developmental seasons, crop-pest phenology synchronisation, and so on." Mango cv. Chausa was shown to be more vulnerable to fruit fly growth at temperatures between 20 and 35 degrees Celsius. The prevalence of the codling moth in apples and the timing of critical life stages for pest management are both susceptible to changes in future climate.

Contingency Planning for the Future Even if all emissions were to cease right this second, the temperature would continue to rise for decades before stabilising, thus adaptation is essential, but mitigation is still required. Many key tipping points will be reached if the pace of increase is not slowed down, hastening climate change to the point where adaptation will not be enough. Combining adaptation with mitigation is the most effective strategy for maximising the benefits of each. The ability to breed new cultivars for possible

habitats was hampered by the continuous destruction of plant genetic diversity under a changing climatic scenario. As monoculture grows around the globe, a loss of genetic variety is occurring in horticultural crops. The extinction of many species has been hastened by climate change, which many of these organisms cannot tolerate. The capability for the horticultural sector to endure disease, insect, and environmental problems depends critically on plant variety.

The easiest way to ensure the longevity of tropical fruit is to use location-specific cultivation practises and adaptive cultivars. "New farming methods and energy- and water-saving technology (such as fruit bagging, fertigation, mulching, etc.) should be implemented. Newspaper-bagged mangoes at the marble stage had the maximum fruit weight and were free of spongy tissue, whereas those bagged in brown paper with a scurting bag had the highest fruit retention (%)." As a result of being packaged in prgmen bags, pomegranate fruit was protected from sun damage and shattering.

Farmers' main choice for dealing with the effects of climate change is site-specific adaptation, although relocating existing production systems to a more suited area is always a possibility. Because of their perennial nature, tropical fruit trees are thought to be more secure against global warming. In contrast to annual crops, which may store as little as 0 kilogramme of soil carbon per hectare, perennial crops can store as much as 1,100 kg of soil carbon per hectare and are more likely to produce abundant harvests even in hotter

climates. Soil carbon sequestration may be increased by controlling soil moisture and temperature, soil carbon depletion can be reversed, and extra agricultural land can be preserved to lower CO₂ emissions. Soil carbon sequestration may be promoted by practises such as manuring, limited tillage, residue assimilation, mulching, micro aggregation, and increasing soil biodiversity. Farmers may readily apply certain solutions with minimal extra cost, such as intermittent drying and site-specific nitrogen management, while others need monetary incentives and legislative assistance.

Conclusions

Humanity's greatest worry in the twenty-first century is climate change. Due to global climate change, it will be more difficult to meet future fruit production goals. Variations in temperature, precipitation, and humidity have altered the timing and pattern of growth and development, altered blooming behaviour, altered fruit quality, and prompted changes in the prevalence of pests and diseases. Distribution patterns, local populations of plants and pollinators, and flowering times all seem to have been affected by the temperature changes over the last several decades. New horticultural crop types that are heat- and pest-resistant and provide high yields under stress circumstances, as well as the utilisation of high-tech horticulture and responsible natural resource management, will be essential in meeting this issue. There is uncertainty about future food production despite the fact

that CO₂ levels in the atmosphere are steadily increasing. The future of food security is uncertain because of a lack of information on the actual consequences of pests and diseases in a warming environment, which may reduce fruit yield and fruit quality. Problems with plant diversity and land appropriateness would worsen. Threats to global fruit production of this kind call for a scientific assessment of the magnitude of those effects, as well as the efficacy of any potential adaptation or mitigation measures.

References

1. IPCC. Climate change 2007, impacts, adaptation and vulnerability. Cambridge/New York: Cambridge University Press; 2007a.
2. IPCC. A report of working group one of the intergovernmental panel on climate change summary for policy makers. Intergovernmental Panel on Climate Change; 2007b.
3. Sen, V., Rana, R.S., Chauhan, R.C. Impact of climate change variability on apple production and diversity in Kullu valley, Himachal Pradesh. *Indian Journal of Horticulture*, 2005;72(1):14-20.
4. Hoogenboom, G., Jones, J.W., Wilkens, P.W., Porter, C.H., Boote, K.J., Hunt, L.A., Royce, F.S. Decision support system for agrotechnology transfer (DSSAT) Version 4.5. Honolulu: University of Hawaii.
5. Kumar, R., Kumar, K.K. Managing physiological disorder in Litchi. *Indian Horticulture* 2007;52(1):22-24.
6. Rodrigo, J., Herrero, M. Effects of preblossom temperatures on flower



- development and fruit set in apricot. *Scientia Horticulturae*, 2002; 92: 125-135.
7. Pereira, J.M., Goncalves, B., Bacelar, E., Cunha, J.B., Coutinho, J., Correia, C.M. Effects of elevated CO₂ on grapevine (*Vitisvinifera* L.): Physiological and yield attributes. *Vitis*, 2009; 48(4): 159-165.
 8. Kimball, B.A., Idiso, S.B., Johnson, S., Rillig, M.C. Seventeen years of carbon dioxide enrichment of sour orange trees: final results. *Global Change Biology*, 2007; 13: 2171-2183.
 9. Atkinson, C.J., Taylor, J.M., Lucas, A.S. Temperature and irrigation effects on the cropping, development and quality of Cox's Orange Pippin and Queen Cox apples. *Scientia Horticulturae*, 1998; 75: 59-81.
 10. Mitra, S.K., Pathak, P.K., Debnath, S., Sarkar, A., Mondal, D. Elucidation of the factors responsible for cracking and sunburn in litchi and integrated management to minimize the disorders. *Acta Horticulturae*, 2010; 863: 225-234.
 11. More, T.A., Bhargava, R. Impact of climate change on productivity of fruit crops in arid regions. In: Singh HP, Singh JP, Lal SL (eds) *Challenges of climate change-Indian horticulture*. New Delhi: Westville Publishing House; 2010.
 12. Haldankar, P.M., Parulekar, Y.R., Kireeti, A., Kad, M.S., Shinde, S.M., Lawande, K.E. Studies on influence of bagging of fruits at marble stage on quality of mango cv. Alphonso. *Journal of Plant Studies*, 2015; 4(2): 12-20.

