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Climate change crash on fruit crops and management approaches

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Abstract
Global warming and climate change is the greatest apprehension of mankind in 21st century. Fruit trees, as perennial in nature have less adaptability to climatic change. The productivity and quality was reduced due to the environmental stresses such as increasing temperature, reduction in irrigation water availability, flooding and salinity. Due to irregularity of climate change variability is seen in the commercial varieties of fruits, which performs poorly in an unpredictable manner. Due to melting of ice cap in the Himalayan regions particularly plants that grown under open field conditions gets severely affected. Due to high temperature the physiological disorders are more distinct e.g. Spongy tissue of mango and fruit cracking in litchi etc. Impact of climate changes on fruit production can be minimized by some of the solutions to sustain the productivity and modification of present horticultural practices. Developing crops tolerant to high temperature, resistant to pests and diseases, short duration and producing good yields under stress conditions will be the main strategies to meets these challenges. New plant breeding techniques (NPBTs) aim to overcome traditional breeding limits for fruit tree species, in order to obtain new genotype with improved organoleptic individuality and confrontation to biotic and abiotic stress along with fruit quality achieved over centuries by (clonal) selection. Knowledge on the gene(s) controlling a precise peculiarity is essential for the use of new plant breeding techniques NPBTs, such as genome editing and cisgenesis, transgenic breeding, e.g. genome editing in citrus via transgenesis has successful results for resistivity to Citrus bacterial canker.

Keywords: climate, management, fruit crops, temperature

Introduction
Climate change is posturing a great threat to horticulture and food security globally. Global mean temperatures increased by 0.74 ˚C during last 100 years and it is estimated that there will be an increment in global annual mean temperatures at a range of 1.8-4.0 ˚C during the year 2100; which will lead to increase variability in rainfall and enhance frequency of extreme weather events such as heat waves, cold waves, droughts and floods. (India is the third largest emitter of greenhouse gases (GHG) which accounts for 7% of global GHG emission after China and United States. India has been experiencing more seasonal disparity in temperature (Christensen *et al.* 2007) [6]. Longevity of heat waves across India has extended in recent years with warmer night temperatures and hotter days and this trend is expected to continue. The average temperature change is predicted to be 2.33 °C-4.78 °C with a doubling in CO_2 concentrations. These heat waves will lead to increased variability in summer monsoon precipitation, which will result in drastic effects on the agriculture and horticulture sector in India (Kumar and Goutam, 2014) [17]. Fruit trees as perennial in nature have less adaptability to climate than annual crops (MAFF, 2015). The changed climatic parameters affect the crop physiology, biochemistry, floral biology, biotic stresses like disease-pest incidence etc. and eventually resulted to the reduction of yield and quality of fruit crops. Therefore, it is a big challenge to the scientists of the world. Developing management strategies is the most important measures to reduce the devastating effect of climate change.

Impact of climatic variables in fruit crops
Temperature strain
High temperature leads to adverse effect on pollination, abortions of flower, fruit drop etc. which usually results in the delay of fruit maturation and reduction in fruit quality. Ledesma *et al.* (2008) [21] notified that in strawberry high day/night temperature of 30/25 °C reduces the number of inflorescences, and fruits in cultivars e.g. 'Nyoho' and 'Toyonoka' when compared with plants grown at 23/18 °C. High temperatures also reduce colour development and leads to

several physiological disorders like Spongy tissue of mango, fruit cracking and black spot in custard apple. The mango fruits harvested from clean cultivation showed 15.55 and 18.33 per cent occurrence of spongy tissue under Paria and Ghadoi conditions respectively at 52.40 °C mean soil surface temperature (Katrodia *et al.* 1989) [16]. Winter chill is essential for most of the temperate fruit trees that fall dormant in the winter in order to avoid frost damage and do not resume growth until a certain amount of winter chill has accumulated for fulfilling their chilling requirement. Insufficient chilling greatly influences flower initiation and fruit coloration, texture as well as certain disorders like sunburn and cracking in apple, apricots and cherries (Rai *et al.* 2015) [27].

Flower bud initiation is inhibited in many plants due to low temperature. Specific chilling requirements of pome and stone fruits and pollination will be affected adversely. Dormancy breaking will be earlier. Flower bud initiation is inhibited in many plants (Kumar and Kumar, 2007) [18].

Water strain

Water constitute foremost ingredient in plants. It makes a major part of plant biomass. About 90 per cent of cytoplasm of plant is constituted by water alone. Thus water is major part of plant irrespective of plant part. Water is essential in hydraulic process in the plant and acts as a carrier of nutrients from the soil to green plant tissue. Water stress in plants will leads to various physiological biochemical changes that ultimately result in reduction in growth and yield. Unseasonal rain followed heavy dew attack during the blossoming season in mango resulted in reduced fruit set, increased fruit drop at pea stage and also increased the heavy incidence of sooty mould and powdery mildew with production loss of 80-90 per cent in Gujarat (Varu *et al*. 2015). Field studies has proved that the banana cultivars like Robusta, Karpuravalli and Rasthali are quite sensitive to soil moisture stress at flowering stage and causes reduction in bunch weight to the extent of 42.07%, 25.0% and 18.83% respectively (Ravi *et al.* 2013) [30].

Relative humidity

Humid air directly contributes to problems such as foliar and root diseases, slow drying of the growing medium, plant stress, loss of quality, loss in yields, etc. Fluctuation in relative humidity can cause the poor fruit set and an excessive drop of the fruits in oranges, mandarins and most of the subtropical and temperate fruit crops. The individual fruit (fingers) of ‘Sucrier’ (*Musa acuminata*, AA Group) banana exhibited a high rate of drop at RH (94±1%) where as if the fruit was held at low RH (68±3%) finger drop was absent (Saengpook *et al.* 2007) [32].

Wind

Wind has both direct and indirect effect on plant growth. In high winds, leaves can be stripped of from the plants and under extreme conditions plant stem may be broken or plants uprooted. In custard apple maximum black spot (35.63%) on the skin of fruit reported in the year 2009 may be due to high wind speed recorded in the same year (Varu *et al.* 2010).

Frost

Tropical and subtropical fruit tress exhibit a distinct physiological damage when they are exposed to low temperature below 10 ºC, common type damages include, death of dormant flower buds, frost damage otender shoots, flowers and mature fruits. Some of fruit crops like papaya, beal, mango, custard apple are more susceptible when the temperature goes below 10 ºC (Kumar, 2017) [19].

Effect of elevated CO_2 and GHG

Carbon dioxide is important because carbon atoms form the structural skeleton of the plant. A doubling of carbon dioxide levels may increase plant growth by 40-50% though continuous high levels saturate the plant's ability to use carbon dioxide and the benefits decrease with time (Lal and Ahmed, 2014) [20]. Rising distinct CO_2 level and climate change may also influence secondarily on crops through effects on pests and disease. Indications suggested that pests, such as aphids and weevil larvae, respond positively to elevated CO_2 (Newman *et al.* 2004) [25]. In strawberry, elevated CO_2 and high temperature caused 12 percent and 35 per cent decrease in fruit yield at low and high nitrogen, respectively (Rajan *et al.* 2020) [28].

Alleviation strategies

Impact of climate change on fruit production can be reduced by certain mitigating strategies.

Crop management practices

Modification in crop management practices like changing cropping pattern including cropping systems, intercropping, alternative crops, crop diversification and relocation of crops in alternative areas, e.g. in an intercropping experiment comprised of mango ginger, turmeric, tomato, cowpea, French bean, ragi, niger, upland paddy and control (without intercrop), the results of the study revealed that the growth of mango plants was appreciably influenced by the intercropping systems tried with an increase in growth measured in terms of height, girth, canopy area and shoot growth of the concerned trees (Swain *et al.* 2012). Panchal *et al.* (2017) [26] stated that most viable agroforestry system on the basis of NPV (Net Present Value), Benefit Cost Ratio (BCR), Equivalent Annual Income (EAI) and compounded revenue was Agri-silvi-horticultural systems (ASH) system followed by Agri-horticultural systems (AHS). Off season production in mango could be achieved by imposing a set of treatments on varieties responding to chemicals. The treatment induced the trees to flower during July - August so that fruits could be harvested during December - January. The off-season production of mango is highly economical advantageous as getting a premium price in the market (Devi *et al.* 2019) [7].

Fertilizer, manure and biomass management through reduce use and production of synthetic fertilizers, use of slow-releasing fertilizers especially nitrification inhibitors like Dicyandiamide (DCD) applied with organic manures and urea decrease cumulative N_2O emission by 24.18-32.55% (Mohamed *et al.* 2016) [23]. Nan fertilizers applied alone and in conjunction with organic materials have the potential to reduce environmental pollution owing to significant less losses and higher absorption rate (Iqbal, 2019) [13].

Soil supervision practices

Soil management for increasing soil carbon (%) by using organic fertilizers, reduced tillage, avoid soil compaction, improvement in crop residue and weed management and changes in land use management practices. Deep tillage or soil cultivation to loosen compact soil layers, particularly the clay subsoil, has been suggested to improve drainage in the subsoil, thus reducing water logging (Gardner *et al.* 1992) [9].

Another way of reducing waterlogging is through a similar application of large volume of organic matter with high N levels are placed over soil layers. This practice is referred to as sub-soil manuring (Celestina *et al.* 2018) [4]. Experiments carried out in Victoria, Australia demonstrated that Lucerne pellets and commercial poultry manure can significantly improve soil properties and crop growth as well as yield by improving subsoil structure and supplying N (Gill *et al.* 2012) [10]. Tillage to break the salty layer closer to the root surface, Planting on elevated beds in crops like Guava (cv. Allahabad Safeda) and bael (cv. NB-5) plants at a height of 2 feets and irrigated with marginally saline water (3-4 dS m^{-1}) minimized the possibility of direct contact between plant roots and saline water table (Singh *et al.* 2018) [37].

Cultivars and root stocks assortment

One of the strategies to improve fruit tree response to changing climatic conditions is the use of tolerant rootstock genotypes and cultivars. The use of abiotic and biotic tolerant rootstocks and cultivars would minimize the immediate effects of adverse conditions and enable the plant to recover quickly.

Table 1: Salinity tolerant rootstocks

Fruit crops	Rootstock	References
Almond	GF677	(Zrig *et al.* 2015)
Pomegranate	Tab-o-Larz	Karimi and Hassanpour (2017) [15]
Mango	13-1	Sharma and Manjeet, 2020 [35]

Cultural practices

The deleterious effects of unpredictable climatic conditions can be managed by changed in farm management practices. The bagging of mango fruits at marble stage with brown paper and scurting bag gave maximum fruit retention (%), while bagging with newspaper bag gave highest fruit weight and fruit of newspaper and brown paper bags are free from spongy tissue (Haldankar *et al.* 2015) [11]. Bagging of pomegranate fruits with bags was reducing fruit cracking and sunburn physiological disorders (Mohamed, 2014) [23]. It was reported that in banana sun burn damage on uncovered bunch was the highest (13.40%) and the lowest value (1%) was obtained from blue polythene bag (Rubel *et al.* 2019) [31].

Use of anti-traspirants like chitosane, kaolin, etc. which reflect the heat radiation from plant parts so they reduce the water losses through transpiration and reduce the temperature of fruit and leaf surface and other chemicals. In pomegranate use of foliar spray of Kaolin (inert clay) @ 5% during hot summer months is useful in reducing the sunscald. High temperature damage to trunk cambium can be cracked by spraying or painting the bark of exposed trunks and branches with reflective white coating (Sharma and Manjeet, 2020) [35].

One strategy to maintain or increase yields in the face of a changing temperature is to adjust the farm climate by using shade net on the trees. Covering Washington navel orange trees grown on sandy soil with shade net especial for certain period was very effective at protecting orange trees and led to improve the growth, increase the yield and maintain fruit quality (Abd El-Naby *et al.* 2020) [1].

Wind breaks or shelter belts helps in modification of the microclimate of orchard as well as soil and windbreak also provide shelter for pollinating insects, protect orchard from wind erosion and other natural disaster, etc. under frost conditions the mortality percentage of fruit plants surrounded by wind breaks was 2.97 to 30.81%, whereas in the absence of these barrier led to mortality up to 91.43% (Rathore *et al.* 2012) [29].

Mulching which conserve the soil moisture, improve soil microclimate, microbial activity and soil health.

Table 2: Increase in yield of fruit crops through plastic mulching

Crop	Yield (T/Ha.)		Increase in yield (%)
	Unmulched	Mulched	
Guava	18.36	23.12	25.93
Mango	4.93	7.16	45.23
Papaya	73.24	120.29	64.24
Ber	7.02	8.92	27.06
Pineapple	10.25	11.75	14.63

Shirish *et al.* 2013 [36]

Water/Irrigation management

Implementing new or improving existing irrigation systems like drip irrigation, sprinkler irrigation and Deficit irrigation techniques helps to cope up the abiotic stress conditions. In pomegranate regulated deficit irrigation (RDI: no watering until fruit set stage, while and then watering was applied similar to control) reduced the early season vegetative growth, postponed the first flowering wave and on the one hand accelerated next blooming wave with maximum WUE (Selahvarzi *et al.* 2017) [34]. Application of partial root-zone drying on a cultivated table grape (*Vitis vinifera* L. cv Rizamat) there was an increased water use efficiency by 26.7-46.4% of edible grape by 3.88-5.78% (Taisheng *et al*. 2008).

Carbon sequestration

Process of removing carbon from the atmosphere and depositing it in reservoir is known as carbon sequestration or storage of carbon dioxide. Carbon sequestration in the agriculture sector refers to the capacity of agriculture lands and forests to remove carbon dioxide from the atmosphere. Carbon dioxide is absorbed by trees, plants and crops through photosynthesis and stored as carbon in biomass in tree trunks, branches, foliage and roots and soils (EPA, 2008) [8]. Fruit orchard have great role in terrestrial carbon sequestration through photosynthesis and stored as carbon in tree biomass such as trunks, foliage, branch, roots and soil and also it provides food and income to the farmers. The trees with thick vegetation, broad and clustered leaves were found to be better CO_2 sequesters (Ishaq *et al.* 2014) [14]. The net C sink in apple orchards in China ranged from 14 to 32 Tg C, and C storage in biomass from 230 to 475 Tg C between 1990 and 2010. The estimated net C sequestration in Chinese apple orchards from 1990 to 2010 was equal to 4.5% of the total net C sink in the terrestrial ecosystems in China. Therefore, apple production systems can be potentially considered as C sinks excluding the energy associated with fruit production in addition to provide fruits (Wu *et al.* 2012). The total above ground biomass carbon stalk per hectare as estimated for aonla was 33.07 kg C/ha, in mango it was 30.6 kg C/ha and in tamarind it was 36.96 kg C/ha and in sapota were 12.86 kg C/ha, in ramphal was 83.1 kg C/ha and for custard apple it was 73.5 kg C/ha (Chavan *et al.* 2011) [5].

Breeding approaches

New plant breeding techniques (NPBTs) aim to overcome traditional breeding limits for fruit tree species, in order to obtain new varieties with improved organoleptic traits and resistance to biotic and abiotic stress and to maintain fruit quality achieved over centuries by (clonal) selection. Knowledge on the gene(s) controlling a specific trait is essential for the use of NPBTs, such as genome editing and cisgenesis, transgenic breeding, e.g. genome editing in citrus via transgenesis has successful for induced resistance to Citrus bacterial canker in sweet orange and grapefruit using the resistance gene CsLOB1 (Salonia *et al.* 2020) [33].

Conclusion

Global climate changes are likely to put forth pressure on the fruit production system for attainment of future fruit production targets. Several mitigation measures which reduce the concentrated gases in the atmosphere that are responsible for climate change and fruit crops have a great role in the mitigation of these gases through carbon restoration by photosynthesis. At present suitable adaptation, strategies can help to reduce negative impact in the short term to a limited extent. The changed climatic parameters affect the crop physiology, biochemistry, floral biology, biotic stresses like disease-pest incidence etc. and ultimately results to the reduction of yield and quality of fruit crops. Therefore developing management strategies is the most important measures to reduce the devastating effect of climate change and meet these challenges. Developing crops tolerant to high temperature, resistant to pests and diseases, short duration and producing good yields under stress conditions will be the main strategies to meets these challenges.

Reference

1. Abd El-Naby SKM, Esmail AMAM, Baiea MHM, Amin OAE, AmrAbdelkhalek AM. Mitigation of heat stress effects by using shade net on washington navel orange trees grown in Al-Nubaria region, Egypt. Acta Sci. Pol. HortorumCultus 2020;19(3):15-24.
2. Anindita Roy Dora DK, Sethi K, Sahu S, Dash DK, Parida A. Studies on variability of different cashew landrace in Bhubaneswar. International Journal of Current Micro Biology And Applied Sciences 2017;6 (8):2643-2646.
3. Anindita Roy, Dora DK, Sethi K, Sahu S, Dash DK, Parida A. Studies on biometric parameter of cashew in Bhubaneswar condition. International Journal of Current Micro Biology And Applied Sciences 7(12):433-438.
4. Celestina C, Midwood J, Sherriff S, Trengove S, Hunt J, Tang C. Crop yield responses to surface and subsoil applications of poultry litter and inorganic fertiliser in south-eastern Australia. Crop Pasture Sci 2018;69:303-316.
5. Chavan BL, Rasal GB. Potentiality of Carbon Sequestration in Six Year Ages Young Plant from University Campus of Aurangabad. Global Journal of researches in engineering Chemical engineering 2011;11(7):15-20.
6. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X *et al*. Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Cambridge University Press. Cambridge, United Kingdom 2007.
7. Devi AN, Arulmozhiyan R, Balamohan TN. Induction of off-season flowering in mango through farmer's participatory research in Krishnagiri district under NAIP. Journal of Pharmacognosy and Phytochemistry 2019;8(5):2466-2471.
8. EPA. Carbon Sequestration in Agriculture and Forestry 2008. www.epa.gov/sequestration/index.html
9. Gardner B, Nielsen D, Shock C. Infrared thermometry and the crop water stress index. I. History, theory, and baselines. J Prod. Agric 1992;5:462-466.
10. Gill J, Clark G, Sale P, Peries R, Tang C. Deep placement of organic amendments in dense sodic subsoil increases summer fallow efficiency and the use of deep soil water by crops. Plant Soil 2012;359:57-69.
11. Haldankar PM, Parulekar YR, Kireeti A, Kad MS, Shinde SM, Lawande KE. 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.
12. IPCC. Climate Change - Mitigation. Fourth assessment report of the intergovernmental panel on climate change 2007.
13. Iqbal MA. Nano-fertilizers for sustainable crop production under changing climate - a global perspective. Intech Open 2019. DOI:10.5772/intechopen.89089.
14. Ishaq SE, Obinna O, Azua ET. Sequestration and carbon storage potential of tropical forest reserve and tree species located within Benue State of Nigeria. Journal of Geoscience and Environment Protection 2014;2:157-166.
15. Karimi HR, Hassanpour N. Effects of salinity, rootstock, and position of sampling on macro nutrient concentration of pomegranate cv. Gabri. Journal of Plant Nutrition 2017;40(16):2269-2278.
16. Katrodia JS, Sheth IK. Spongy tissue development in mango fruit of cultivar alphonso in relation to temperature and its control. Acta Hort 1989;231:827-834.
17. Kumar R, Gautam HR. Climate Change and its Impact on Agricultural Productivity in India. J Climatol Weather Forecasting 2014;2:1. DOI: 10.4172/2332-2594.1000109
18. Kumar R, Kumar KK. Managing physiological disorders in litchi. Indian Horticulture 2007;52:22-24.
19. Kumar R. Effect of frost on fruit crops and their management 2017. www.biotecharticles.com.
20. Lal S, Ahmed N. Strategies to minimize impact of climate change on fruit production 2014. www.biotecharticle.com
21. Ledesma NA, Nakata M, Sugiyama N. Effect of high temperature stress on the reproductive growth of strawberry cvs. 'Nyoho' and 'Toyonoka'. Scientia Horticultrae 2008;116(2):186-193.
22. Chandrasekhar M, Sethi K, Tripathy P, Mukherjee SK, Panda PK, Roy A. Performance of released cashew (*Anacardium occidentale* L.) varieties under hot and humid climatic zone of Odisha. Indian journal of Agriculture and research 2018;52(2):152-156.
23. Mohamed AW. Effect of bagging type on reducing pomegranate fruit disorders and quality improvement. Egypt J Hort 2014;41(2):263-278.
24. Mohamed S, Mohamed MH, Samsuri AW, Halimi SM, Begum M, Maisarah JN. Impact of nitrification inhibitor with organic manure and urea on nitrogen dynamics and N_2O emission in acid sulphate soil. Bragantia 2016;75(1):108-117.
25. Newman JA. Climate change and cereal aphids: the relative effects of increasing CO2 and temperature on aphid population dynamics. Global Change Biol 2004;10:5-15.
26. Panchal JS, Thakur NS, Jha SK, Kumar V. Productivity and carbon sequestration under prevalent agroforestry systems in Navsari district, Gujarat, India. Int. J Curr. Microbiol. App. Sci 2017;6(9):3405-3422.
27. Rai R, Joshi S, Roy S, Singh O, Samir M, Chandra A.

Implications of Changing Climate on Productivity of Temperate Fruit Crops with Special Reference to Apple. J Horticulture 2015;2:2. DOI: 10.4172/2376-0354.1000135.

28. Rajan R, Ahmad MF, Pandey K, Aman A, Kumar V. Climate Change and Resiliencein Fruit Crops 2020, 336-354.
29. Rathore AC, Raizada A, Jaya PJ, Sharda VN. Impact of chilling injury on common fruit plants in the doon valley. Current Science 2012;102(8):1107-1111.
30. Ravi I, Uma S, Vaganan MM, Mustaffa MM. Phenotyping bananas for drought resistance. Front Phys 2013;4(9). doi:10.3389/fphys.2013.00009
31. Rubel MHK, Hossain MM, Hafiz MMH, Rahman MM, Khatun MR. Effect of banana bunch covering technology for quality banana productionin Bangladesh. Progressive Agriculture 2019;30(3):238-252.
32. Saengpook C, Ketsa S, Wouter G, Doorn V. Effects of relative humidity on banana fruit drop. Postharvest Biology and Technology 2007;45:151-154.
33. Salonia F, Ciacciulli A, Poles L, Pappalardo HD, La Malfa S, Licciardello C. New Plant Breeding Techniques in Citrus for the Improvement of Important Agronomic Traits. A Review. Front. Plant Sci 2020;11:1234. doi: 10.3389/fpls.2020.0123.
34. Selahvarzi Y, Zamani Z, Fatahi R, Ali-Reza T. Effect of deficit irrigation on flowering and fruit properties of pomegranate (*Punica granatum* cv. Shahvar). Agricultural Water Management 2017;192:189-197.
35. Sharma S, Manjeet. Heat Stress Effects in Fruit Crops: A Review. Agricultural Reviews 2020;41(1):73-78.
36. Shirish SP, Tushar ST, Satish AB. Mulching: A Soil and Water Conservation Practice. Research Journal of Agriculture and Forestry Sciences 2013;1(3):26-29.
37. Singh A, Kumar A, Datta A, Yadav RK. Evaluation of guava (*Psidium guajava*) and bael (*Aegle marmelos*) under shallow saline watertable conditions. Indian Journal of Agricultural Sciences 2018;88:720-725.