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Recent Technologies to Mitigate the Adverse Effects of Climate Change in Fruit Crops

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SUMMARY

The effects of climate change on horticulture sector are still uncertain. Research is needed to define the current limits to these resistances and the feasibility of manipulation through modern genetic techniques. Both crop architecture and physiology may be genetically altered to adapt to changing environmental conditions. Climate projection and resilience methods need to be identified for mitigation in immediate future of climate uncertainity. The continuation of current and new initiatives to research potential minimize the effects of climate change at farm, regional, national and international level and will help to provide a more detailed picture of how world horticulture and agriculture could change. Only then may we see the implementation of policies and other adaptations in agricultural systems that would minimize the negative effects of climate change and exploit the beneficial effects.

INTRODUCTION

Climate change is the greatest concern of mankind in 21st century. Melting of ice cap in the Himalayan regions will reduce chilling effect required for the flowering of many of the temperate fruit crops. Due to high temperature physiological disorder of fruit crops will be more pronounced in tropical and subtropical fruit crops. Climate change, particularly increasing temperatures, altered rainfall patterns and climate variability will affect dramatically the productivity of crops and their regional distribution in the next decades with severe impacts on food security. Over the past decade or so the fruit growers experienced by the most commonly encountered climatic conditions. Earth's climate has always naturally cycled through change, caused by how much of the sun's energy was absorbed by the atmosphere. In fact over the past 650,000 years, the Earth has gone through seven ice ages and warming periods. Since 1750, the average amount of energy coming from the Sun either remained constant or increased slightly. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded there's a more than 95 percent probability that human activities over the past 50 years have warmed our planet.

Mitigating Strategies

Crop improvement : Biotechnology can respond positively towards reducing vulnerability of natural and human systems to climate change effects. Conventional agricultural biotechnology methods such as energy-efficient farming, use of biofertilizers, tissue culture and breeding for adaptive varieties are among feasible options that could positively address the potential negative effects of climate change and thereby contributing to carbon sequestration initiatives.

Table1. Genetic engineering strategies for biotic and abiotic stress tolerance and quality enhancement in horticultural crops.

Crop	Gene and genetic transformation method used	Trait improvement
Apple	Osmyb4; Agrobacterium tumefaciens-mediated gene transfer	Enhanced tolerance to drought and low temperature stress in transgenic plants
Banana	MusaWRKY71; Agrobacterium tumefaciens-mediated gene transfer	Enhanced tolerance to drought, salinity and high temperature
Citrus	P5CS gene; Agrobacterium tumefaciens-mediated gene transfer	Enhanced tolerance to drought and low temperature stress in transgenic plants
Strawberry	Osmotin; Agrobacterium tumefaciens-mediated gene transfer	Enhanced tolerance to salinity stress in transgenic plants

Bio- Chemicals

Anti-tranpirants: Antitranspirants are the chemical compound which favours reduction in rate of transpiration from plant leaves by reducing the size and number of stomata and gradually hardening them to stress (Ahmed *et al., 2014*). It contains mainly magnesium (Mg) and calcium (Ca) as main component to increase photosynthesis and plant growth (Marinates *et al* 2020).

- Stomatal closing : PMA, Attrazine
- Film Forming : Mobileaf, Hexadeconol, Silicones etc
- Reflectant : Kaoline
- Growth Retardants : Cycocel

Plant growth regulators

ABA, ethylene and Jasmonic acid PGRs are involved in the regulation of plant responses to abiotic stress. These PGRs can interact in antagonistic or cooperative way, depends upon the stress. Abiotic stress like water deficit, salinity and heat stress production of enzymes depends upon the the genetic makeup of the plants, to produce the PGRs help them to show resilience against stress or mitigation.

Table 2.Use of plant growth regulators in reducing effects of extreme climate

Growth regulator		**Fruit crop**	**Stress**
Polyamines	Spermidine, putrecine	Pomegranate	Salt stress
	Spermidine	Troyer citrange	Salt stress
Growth retardant	Paclobutrazol ppa a	Ber	Drought and high temperature
		Apple	Water stress
Brassinosteroid	24-epibrassinolide	Tomato	Thermo-tolerance

Protective Structures

Shade netting: Shade netting is one of the emerging techniques used by growers to protect their orchards against various biotic and abiotic stresses, such as excessive solar radiation, insects, hail as well as wind. There are different shade netting systems used in the fruit industry, these include insect proof screens, anti-hail and photoselective nets.

Anti hail nets: Anti-hail nets may change the microclimate of orchards and hence modify the physicochemical and sensory characteristics of fruits.The anti-hail net is a physical barrier installed over an orchard that is intended to protect the plants against damage by hail and strong wind and to reduce damage from birds. In apples, the net also reduces sunburn and russeting, providing better color and skin uniformity.

Agro-Techniques

Crop Modeling: Modelling is the use of equations or sets of equations to represent the behaviour of a system. In effect crop models are computer programmes that mimic the growth and development of crops (USDA, 2007).

Crop models	**Sources**
APSIM	http://www.apsim.info/
AquaCrop	http://www.fao.org/land–water/databases-and- software/aquacrop/en/
CropSyst	http://modeling.bsyse.wsu.edu/CS_Suite/index.html
DAISY	https://daisy.ku.dk/
DSSAT	https://dssat.net/
EPIC	https://epicapex.tamu.edu/epic/
InfoCrop	http://infocrop.iari.res.in
MONICA	http://monica.agrosystem-models.com
STICS	https://www6.paca.inra.fr/stics_eng/
WOFOST	https://www.wur.nl/en/Research-Results/Research- Institutes/Environmental-Research/Facilities- Products/Software-andmodels/WOFOST.htm

Cloud Seeding: (Making it Rain) The Science of Weather Manipulation

Cloud seeding adds substances(silver iodide) to clouds by shooting them from the ground or dropping them from planes. Air already contains water vapor, but cloud seeding can encourage the water to condense until it falls from the sky.

Anti -hail shock wave generator comprising: An anti-hail shock wave generator **(Fig1)** or cannon is known in the art from U.S. Pat. No. 3,848,801. It is believed that transport of positive ions from ground level to cloud level by the succession of shock waves is largely responsible for the disruption of the formation of hail nuclei. By using the known device, crop damage due to hail has been known to be completely eliminated or at least significantly reduced without any adverse environmental effects, however, to achieve good results, special care must be taken to operate the device properly starting about 15-25 minutes before a hail storm in order to disrupt sufficiently the hailstone formation process.

Fig 1.

The Fog Collectors: Harvesting Water from Thin Air: Fog harvesting technology **(Fig 2)** consists of a single or double layer mesh net supported by two posts rising from the ground. Mesh panels can vary in size.

Fig. 2.

Anti-frost Candles: Anti-frost candles for arboriculture to protect your vineyards and orchards from frost, it's equal to a kind of antifreeze for fruit growing, so anti-frost candle also be called "antifreeze candles" which can protect fruits against frostbite. Due to the warming of the air, your crops are rapidly protected from frost.

Fig 3.

REFERENCES

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Amarante CVT, Steffens CA, Mota CS, Santos HP (2007) Radiation, photosynthesis, yield, and fruit quality of 'Royal Gala' apples under hail protection nets. Pesq Agrop Brasileira 42:925–931Parmar N, KH Singh, D Sharma, L Singh, P Kumar Biotech, (2017) Genetic engineering strategies for biotic and abiotic stress tolerance and quality enhancement in horticultural crops: a comprehensive review.