INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY ADVANCED RESEARCH TRENDS
ISSN : 2349-7408
VOLUME II, ISSUE I, FEBRUARY 2015

CONSEQUENCES AND IMPACT OF CLIMATE CHANGE IN HORTICULTURE

REKHA EDA* & K.N.D. BHAVANI
HC&RI, Dr. Y.S.R.H.U., Andhra Pradesh
*rekhapht@gmail.com

ABSTRACT

Global warming and climate change is the greatest concern of mankind in 21st century. Climate plays a significant role in plant growth and productivity. The established commercial varieties of fruits, vegetables and flowers will perform poorly in an unpredictable manner due to aberration of climate. Melting of ice cap in the Himalayan regions will reduce chilling effect required for the flowering of many of the horticultural crops like Apple, Saffron, Rhododendron, Orchid, etc. Commercial production of horticultural plants particularly grown under open field conditions will be severely affected. Hence there is a need to protect these valuable crops for sustainability against the climate change scenario. Production timing will change due to rise in temperature. The winter regime and chilling duration will reduce in temperate regions affecting the temperate crops. Pollination will be affected, Floral abortions, flower and fruit drop occurs frequently. To sustain the productivity, modification of present horticultural practices, greater use of greenhouse technology, development of new cultivars tolerant to high temperature, resistant to pests and diseases, short duration and producing good yield under stress conditions, as well as adoption of hi–tech horticulture and judicious management of natural resources will be the main strategies to meet this challenge.

Keywords: Climate, Horticulture, Temperature, Stress, Yield.

Introduction:

Over the years, Horticulture has emerged as one of the potential agricultural enterprise in accelerating the growth of economy. Its role in the country's nutritional security, poverty alleviation and employment generation is becoming important. It offers not only a wide range of options to the farmers for crop diversification, but also provides ample scope for sustaining large number of Agro industries which generate huge employment opportunities. At present, horticulture is contributing 24.5% of GDP from 8% land area. India with diverse soil and climate comprising several agro-ecological regions provides ample opportunity to grow a variety of horticulture crops. These crops form a significant part of total agricultural produce in the country comprising of fruits, vegetables, root and tuber crops, flowers, ornamental

plants, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms. Horticultural crops play a unique role in India's economy by improving the income of the rural people. Cultivation of these crops is labour intensive and as such they generate lot of employment opportunities for the rural population. Fruits and vegetables are also rich source of vitamins, minerals, proteins, and carbohydrates etc. referred to as protective foods and assumed great importance as nutritional security of the people. Fruits and vegetables are not only used for domestic consumption but also substantial quantities are exported in fresh and processed form, bringing much needed foreign exchange for the country. These groups of crops also provide ample scope for achieving bio-diversity and diversification to maintain ecological balance and to create sustainable agriculture and can make an impact on the national economy in the years to come.

Climate plays a significant role in plant growth and productivity. The term 'Climate Change' commonly refers to influences on climate resulting from human practices. Increases in the concentration of greenhouse gases in the atmosphere resulting largely from burning of fossil fuels and deforestation, have led to an observed and projected warming of the earth known as greenhouse effect. As the effects of climate change become more evident, it is essential that growers develop their businesses to adapt to these changes, maximising the opportunities and minimising the costs and risks.

Impacts of climate change:

Reduced requirement for greenhouse heating and therefore reduced energy costs (heating accounts for 90% of energy used in glasshouses), Potentially less CO2 needed for glasshouses. There may be a possible increase in yields due to more carbondioxide available for growth and canopy development but the effect will be limited by availability of water and nitrogen. In the tropics, high temperature conditions are often prevalent during the growing season and, with a changing climate, crops in this area will be subjected to increased temperature stress. Water availability is expected to be highly sensitive to climate change and severe water stress conditions will affect crop productivity Vegetable production is threatened by increasing soil salinity particularly in irrigated croplands which provide 40% of the world's food (FAO, 2004).

Earlier spring growth due to milder winters, shorter seed dormancy periods and subsequent earlier germination. However, increased temperature can cause closure of stomata to conserve water, with prolonged high temperatures reducing photosynthesis and ultimately damaging the crop.

Coastal regions can expect much faster percolation of sea water in inland water tables causing more salinity. Due to increase in temperature, Production timing will change and photoperiods may not show much variation. The winter regime and chilling duration will reduce in temperate regions affecting the flowering and pollination in temperate fruits.

Climate change challenges for Horticulturists:

Productivity:

Efficient and accurate irrigation and water use will be crucial to maintain competitive advantages for growers. Low spring and summer rainfall could reduce yields and increase the need for irrigation. Increased autumn and winter extreme rainfall incidents could increase soil erosion and soil saturation, and increase options for winter water storage. Potentially more water is required for higher yields and canopy cover. Some crops may be badly damaged by high temperatures particularly brassicas (cauliflower and broccoli). Fruit mineral production and composition could be affected. Warmer winters and reduced frosts will weaken vernalisation, potentially reducing yields in some crops. More heat tolerant varieties are required to meet the needs of a changing climate, and these must be able to match the yields of conventional, non-heat tolerant varieties under non-stress conditions.

Pests and diseases:

New pests, diseases and weeds. Possible increase in mycotoxin risk due to changes in fungal growth. Temperatures are not cold enough to eliminate or reduce pests, diseases and weeds, leading to larger surviving and breeding populations. This could create more resilient populations and more of a management problem for farmers.

Environmental stress:

Environmental stress is the primary cause of crop losses worldwide, reducing average yields for most major crops by more than 50 per cent. Climatic changes will influence the severity of environmental stress imposed on vegetable crops. The response of plants to environmental stresses depends on the plant developmental stage and the length and severity of the stress (Bray, 2000 et al**.**). Plants may respond similarly to avoid one or more stresses through morphological or biochemical mechanisms (Capiati, 2006 et al.). Environmental interactions may make the stress response of plants more complex or influence the degree of impact of climate change.

Extreme events

More incidences of flooding and drought and the resultant erosion. Wind damage to infrastructure (especially glasshouses). Increasing unpredictability of weather. Variability and increased uncertainty of water supply (for irrigators).

Impacts of climate change on horticulture:

The key concerns of climate change lies with water availability, waste management, energy efficiency, changes in pest and diseases and carbon management by cultivation. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes and heat waves are known to negatively impact agricultural production and farmers livelihood. It has been projected by the recent report of the IPCC and a few other global studies that unless we adapt, there is a probability of 10–40% loss in crop production in India by 2080–2100 due to global warming, despite beneficial aspects of increased CO2.Depending on the farm location, climate change could affect the horticultural industry through increased crop water needs, reduced water availability, greater crop damage due to frosts and heat stress, increased pest and disease activity, increased damage from extreme weather events and changing production regions (where the crops grow) or cropping cycles. Hazelnuts require 1200 hours of chilling at 5 to 7°C. If they experience < -5°C at flowering, the crop will be damaged. Citrus fruits suffer a production loss when temperatures over 37^{o}C are experienced. Approximately 75% of the fruit and 83% of vegetables and grapes are grown under irrigation, and these crops will likely be impacted by water shortages in the future. The reduction in the total number of grapes produced, grape maturity occurs earlier in the season and severe leaf and bunch stress. Variable climate conditions in future mean that the cropping calendar is likely to change, particularly with earlier harvesting in a warmer climate.

Consequences of climate change in horticultural crops:

Effect on Fruit crops:

High temperature and moisture stress also increase sunburn and cracking in apples, apricot and cherries and increase in temperature at maturity will lead to fruit cracking and burning in litchi (Kumar and Kumar, 2007). Pollination will be affected adversely because of higher temperature. Floral abortions flower and fruit drop will be occurred frequently in tropical fruits. The requirement of annual irrigation will increase and heat unit requirement will be achieved in much lesser time. . Many new physiological disorders are developed. Earlier and quicker ripening for eg. with a 2°C raise in temperature, some apple varieties could bloom and mature up to 3

weeks earlier. Due to high temperature physiological disorder of horticultural crops will be more pronounced *eg.* spongy tissue of mango, fruit cracking of litchi, flower and fruit abscission in solanaceous fruit and vegetables. Air pollution also significantly decreased the yield of several horticultural crops and increases the intensity of certain physiological disorder like black tip of mango. Due to severe cold wave; horticultural crops suffer a yield loss of 10-100 % depending upon crop and variety. Production of apple in Himachal Pradesh in last two decades showed a decreasing trend. The global warming has caused loss of vigor, fruit bearing ability, reduction in size of fruits, less juice content, low color, reduced shelf life and increasing attack of pests resulting low production and quality of apples. In mango, unusual or very early flowering is experienced. However, there was no fruit set due to this flowering. Leaf scorching, twig dying are common symptoms of heat stroke in bearing and non-bearing mango plants. In guava, there is severe increase in pests and diseases due to climate change. Fruit fly in guava is becoming alarming due to hot and humid conditions. The crops like peach, plum, which requires low chilling temperature also showing sign of decline in productivity. Abnormal high temperature during winter cause poor flowering, irregularity in flowering duration, pattern of flowering and poor yield in pear due to non-availability of sufficient chilling hours during winter months. (Hazarika, 2013)

Effect on vegetables:

Many vegetable crops namely tomato, water melon, potato, squash, soybeans, cantaloupe, peas, carrot, beet, turnip, etc are more susceptible to air pollution damage. Yield of vegetable can be reduced by 5-15 percent when daily ozone concentrations reach to greater than 50 ppb (Raj Narayan, 2009).Higher temperatures will reduce tuber initiation process in potato, reduced quality in tomatoes and pollination in many crops. In case of crucifers, it may lead to bolting; anthocyanin production may be affected in apples and capsicum. In pepper, high temperature exposure at the pre-anthesis stage did not affect pistil or stamen viability, but high post-pollination temperatures inhibited fruit set, suggesting that fertilization is sensitive to high temperature stress (Erickson and Markhart 2002). Tip burn and blossom end rot will be the common phenomenon in tomatoes. It is estimated that under the combined influence of change in temperature and CO2, the productivity of potato cultivars will not be affected in 2020 over the baseline scenario, but will decline in when the total geographical area of Punjab is considered. It is further shown that if the present distribution of potato acreage within Punjab remains unaltered in future, there will be benefits from climate change as the potential productivity of Kufri Badshah,

Kufri Jyoti and Kufri Pukhraj will increase by in 2020, although the potential productivity will again decline to baseline values in 2055 (Dua**,** 2013 et al.) Assessment on impact of climate change on major crops in ecologically sensitive areas, viz. the Western Ghats (WG), coastal districts and northeastern (NE) states of India, using Info Crop simulation model, projected varying impacts depending on location, climate, projected climate scenario, type of crop and its management. Irrigated rice and potato in the NE region, rice in the eastern coastal region and coconut in the WG are likely to gain. Losses were also significant in other crops, such as mustard, peas, tomatoes, onion, garlic and other vegetable and fruit crops (Naresh kumar, 2011et al.)

Fruit set failure at high temperatures in tomato includes bud drop, abnormal flower development, poor pollen production, dehiscence, and viability, ovule abortion and poor viability, reduced carbohydrate availability, and other reproductive abnormalities(Hazra, 2007 et al).

Effect on flower crops:

Melting of ice cap in the Himalayan regions will reduce the chilling requirement for the flowering of many of the ornamental plants like Rhododendron, Orchid, Tulips, Alstromerea, Magnolia, Saussurea, Impatiens, Narcissus etc. Commercial production of flowers particularly grown under open field conditions will be severely affected leading to poor flowering, improper floral development and colour. Low temperatures shut down flowering in Jasmine ($<19^0$C) and lead to reduction in flower size. Flowers do not open up fully in tropical orchids wherever temperatures below 15^0C. There are changes in flowering phenology of *Rhododendron arboreum* in Indian central Himalaya due to climate change (Kailash, 2014 et al).

Conclusions:

Climate change will impact on the agronomy, economics, and environmental aspects of horticultural production. Under conditions of changing water availability, growers need to consider both short-term and long-term coping strategies. Enhancing adaptation of tropical production systems to changing climatic conditions is a huge undertaking. It requires the combined efforts of many national and international institutions and an effective and efficient strategy to be able to deliver technologies that can mitigate the effects of climate change on the diverse crops and production systems.

References:

Bray, E.A, Bailey-Serres, J. and Weretilnyk, E. (2000). *Responses to abiotic stresses: Biochemistry and molecular biology of plants. Gruissem, W., Buchannan, B. and Jones, R. (eds). ASPP, Rockville, MD 1158-1249.*

Capiati, D.A, Pais, S.M. and Tellez-Inon, M.T. (2006). *Wounding increases salt tolerance in tomato plants: evidence on the participation of calmodulin-like activities in cross tolerance signaling. Journal of Experimental Botany 57: 2391-2400.*

Datta, S. (2013). *Impact of climate change in Indian Horticulture- a review, International Journal of Science, Environment and Technology, Vol. 2, No 4, 2013, 661– 67.*

Dua, V. K., Singh, B. P., Govindakrishnan, P. M., Sushil Kumar and Lal S. S. (2013). *Impact of climate change on potato productivity in Punjab – a simulation study, Current science, vol. 105, no. 6, 25 september.*

Erickson, A.N. and Markhart, A.H. (2002). *Flower developmental stage and organ sensitivity of bell pepper (Capsicum annuum L) to elevated temperature. Plant Cell Environ25:123-130.*

FAO, (2004). *Impact of climate change on agriculture in Asia and the Pacific. Twenty-seventh FAO Regional Conference for Asia and the Pacific. Beijing, China, 17-21 May 2004.*

Hazarika, T.K. (2013). *Climate Change and Indian Horticulture: Opportunities, Challenges and Mitigation Strategies, International Journal of Environmental Engineering and Management. ISSN 2231-1319, Vol. 4, No 6, pp. 629-63.*

Kailash, S.G., Ranbeer, S. R., Balwant Rawat and Indra D. Bhatt (2014). *Impact of climate change on the flowering of Rhododendron arboreumin central Himalaya, India. Current science, Vol. 106, No. 12, 25 June.*

Kumar, R. and Kumar, K. K. (2007). *Managing physiological disorders in litchi. Indian Horticulture 52 (1): 22-24.*

Naresh Kumar, S., Aggarwal, P. K., Swaroopa Rani, Surabhi Jain, Rani Saxena and Nitin hauhan (2011). *Impact of climate change on crop*

productivity in Western Ghats, coastal and northeastern regions of India, Current science, vol. 101, No. 3, 10 August.

Raj Narayan, (2009). *Air pollution–A threat in vegetable production. In: Sulladmath, U.V. and Swamy, K.R.M. International Conference on Horticulture (ICH-2009) Horticulture for Livelihood Security and Economic Growth, 158-159.*