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IMPLICATIONS OF CLIMATE CHANGE IN VEGETABLE CROPS

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Abstract:

Global warming and climate change is the greatest concern of mankind in 21st century. The established commercial varieties of vegetables will perform poorly in an unpredictable manner due to aberration of climate. The present challenges like global climate change, water and soil pollution, less water availability, urbanization etc adds up to the situation. In combination with elevated temperatures, decreased precipitation could cause reduction in availability of irrigation water and increase in evapo-transpiration, leading to severe crop water-stress conditions. Vegetable production is threatened by increasing soil salinity particularly in irrigated croplands which provide 40% of the world's food. The most effective way is to adopt conservation agriculture, using renewable energy, forest and water conservation, reforestation etc. To sustain the productivity, modification of present horticultural practices and greater use of greenhouse technology are some of the solutions to minimize the effect of climate change. Development of new cultivars of horticultural crops 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.

Key Words: Climate, disorder, Vegetable crops

Introduction

India with diverse soil and climate comprising several agro-ecological regions provides ample opportunity to grow a variety of vegetable crops which form a significant part of total agricultural produce in the country vegetable crops play a unique role in India's economy by improving the income of the rural people. Cultivation of vegetable crops is labour intensive and as such they generate lot of employment opportunities for the rural population. Vegetables are also rich source of vitamins, minerals, proteins, and carbohydrates etc. which are essential in human nutrition. Hence, these are referred to as protective foods and assumed great importance in nutritional security of the people. Thus, cultivation of horticultural crops plays a vital role in the prosperity of a nation and is directly linked with the health and happiness of the people. The knowledge about the impact of climate change on vegetable crops is limited. Addressing problems of climate change is more challenging in horticulture crops compared to annual food crops. The issues of climate change and solution to the problems arising out of it requires thorough analysis, advance planning and improved management. The crop productivity is subjected to number of stresses and potential yields are seldom achieved with stress.

Climate change is predicted to cause an increase in average air temperature of between 1.40C and 5.80C, increases in atmospheric CO2 concentration, and significant changes in rainfall pattern (Houghton *et al.* 2001). Impact of climate change on four sectors

of the economy, namely Agriculture, Water, Natural Ecosystems and Biodiversity and Health in four climate sensitive regions of India, namely the Himalayan region, the Western Ghats, the Coastal Area and the North-East Region. The present challenges like global climate change, water and soil pollution, less water availability, urbanization etc adds up to the situation. In combination with elevated temperatures, decreased precipitation could cause reduction in availability of irrigation water and increase in evapotranspiration, leading to severe crop water-stress condition. The nature and magnitudes of stress vary. Climate change poses serious challenges to human and places unprecedented pressure on the sustainability of horticulture industry. Therefore, the development of horticultural crops that can withstand stress will be the single most important step we may take to adapt the changes we have faced today and will face in the future.

Examples of climate change in Vegetable crops

Two major parameters of climate change that has far reaching implications on agriculture in general and horticulture in particular are more erratic rainfall patterns and unpredictable high temperature spells will consequently reduce crop productivity. Latitudinal and altitudinal shifts in ecological and agro-economic zones, land degradation, extreme geophysical events, reduced water availability, rise in sea level and solemnization are postulated (FAO 2004).

The climate change will have many impacts on horticulture and a few examples are given below.

1. A study conducted at IISR, Calicut using GIS models have shown that many areas presently suitable for spices would become unsuitable in another 25 years. There would be new areas which are presently unsuitable, become highly suitable for cultivation of spices. This will be applicable in other horticultural crops.

2. Production timing will change due to rise in temperature. Due to rise in temperature, photoperiods may not show much variation. As a result, photosensitive crop will mature faster.

3. The winter regime and chilling duration will reduce in temperate regions affecting the temperate crops.

4. Pollination will be affected adversely because of higher temperature. Floral abortions flower and fruit drop will be occurred frequently.

5. The requirement of annual irrigation will increase and heat unit requirement will be achieved in much lesser time.

6. 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 capsicum. Tip burn and blossom end rot will be the common phenomenon in tomatoes.

7. Coastal regions can expect much faster percolation of sea water in inland water tables causing more salinity

Effect of vegetable crops

India is the second largest producer of vegetables in the world (ranks next to China) and accounts for about 15% of the world's production of vegetables. The current production level is over 90 MT and the total area under vegetable cultivation is around 6.2 million hectares

which is about 3% of the total area under cultivation in the country. Environmental stress is the primary cause of crop losses worldwide, reducing average yields for most major crops by more than 50% (Bray *et al.* 2000). 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, 2002). Plants may respond similarly to avoid one or more stresses through morphological or biochemical mechanisms (Capiati *et al.* 2006). Environmental interactions may make the stress response of plants more complex or influence the degree of impact of climate change. Lists of some abiotic stress vegetables and their varieties have been presented in Table-1 and 2 respectively.

High temperatures can cause significant losses in tomato productivity due to reduced fruit set, and smaller and lower quality fruits. Pre-anthesis temperature stress is associated with developmental changes in the anthers, particularly irregularities in the epidermis and endothesium, lack of opening of the stromium, and poor pollen formation (Sato et al. 2002). Hazra *et al.* (2007) reported that symptoms causing fruit set failure at high temperatures in tomato s includes bud drop, abnormal flower development, poor pollen production, dehiscence, and viability, ovule abortion and poor viability, reduced carbohydrate availability, and other reproductive abnormalities. 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). Plant sensitivity to salt stress is reflected in loss of turgor, growth reduction, wilting, leaf curling and epinasty, leaf abscission, decreased photosynthesis, respiratory changes, loss of cellular integrity, tissue necrosis, and potentially death of the plant.

Most of the vegetable crops are highly sensitive to flooding and genetic variation with respect to this character is limited. Flooded crops especially in tomato plants accumulate endogenous ethylene that causes damage to the plants (Drew 1979). Under low oxygen levels stimulate an increased production of an ethylene precursor, 1-aminocyclopropane-1-carboxylic acid (ACC), in the roots. The severity of flooding symptoms increases with rising temperatures; rapid wilting and death of tomato plants is usually observed following a short period of flooding at high temperatures (Kuo *et al.* 1982). During the last 40-50 years air pollution level increasing at an alarming rate in the developing countries and causing potential threat to the crop production. Sulphar dioxide, nitrogen oxide, hydrofluride, ozoneand acid rain are the primary air pollutant. Ozone has adverse effect on vegetable production in terms of reducing growth, yield and quality. Risk of the air pollution is more when vegetable crops grown close to the densely populated areas. A recent study indicated that the ambient air pollution significantly decreased the yield upto more than 50 percent incase of Brassica oleracia, Lactuca sativa and Raphanus sativus. Many vegetable crops namely tomato, water melon, potato, squash, soyabeans, 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 2009).

Table 1. List of some abiotic stresses vegetable crops

Sl. No.	Tolerant	Crop
1	Drought tolerant	Chilli, melons, tomato, onion
2	Heat tolerant	Peas, tomato, beans, Capsicum
3	Salinity tolerant	melons, peas, onion, Kale turnip, palak
4	Flooding/ excess moisture tolerant	tomato, onion, chilli

Source: Rai and Yadav (2005)

Table 2. List of some variety and advanced line tolerant to abiotic stress.

S.N.	Tolerant	Crop	Variety	Advanced Line
1	Drought/rainfed	Tomato	Arka Vikas	RF- 4A
		Onion	Arka Kalyan	MST-42 and MST-46
		Chilli	Arka Lohit	IIHR Sel.-132
2	Photo insensitive	Dolichos	Arka Jay, Arka Vijay, arka Sambram, Arka Amogh, Arka Soumya	IIHR-16-2
		Cow pea	Arka garima, Arka Suman, Arka Samrudhi	
3	High temperature	Capsicum		IIHR Sel.-3
		French bean		IIHR-19-1
		Peas		IIHR-1 and IIHR-8
		Cauliflower		IIHR 316-1 and IIHR-371-1

Source: Rai and Yadav (2005)

Conclusion:

Horticulturists will have to play a significant role in the climate change scenario and proper strategies have to be envisaged for saving horticulture The most effective way is to adopt conservation agriculture, using renewable energy, forest and water conservation, reforestation etc. to sustain the productivity modification of present horticultural practices and greater use of green house technology are some of the solutions to minimize the effect of climate change. Development of new cultivars of horticultural crops 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 land use resources will be the main strategies to meet these challenge.

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