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Impact of climatic change on vegetable crops and its mitigation strategies

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Abstract
Vegetables play an important role in the economy of India as well as in our well balanced diet. The constituents of vegetables have good therapeutic value due to anti carcinogenic and antioxidant properties. Nature has endowed our country with vast diversity of land, soil and of varied agro-climatic conditions. But unluckily the crops productivity are being hit by the consequences of climatic change such as global warming changes in seasonal and monsoon pattern, biotic and abiotic factors under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pests and disease problems are common and they render the vegetable cultivation unprofitable. Drought and salinity are the two important consequences of increase in temperature worsening vegetable cultivation vegetable crops are very sensitive to climatic vagaries and sudden rise in temperatures as well as irregular precipitation at any phase of crop growth can affect the normal growth.
For reducing malnutrition and alleviating poverty in developing countries through improved production and consumption of safe vegetables will involve adaptation of current vegetable systems to the potential impact of climatic change. To mitigate the adverse impact of climatic change on productivity and quality of vegetable crops there in need to develop sound adaptation strategies.

Keywords: climatic change, abiotic factor, vegetables, productivity.

Introduction

Climate change may be a change in the mean of the various climatic parameters such as temperature, precipitation, relative humidity and atmospheric gases composition etc. and in properties over a longer period and a larger geographical area. It can also be referred as any change in climate over time, whether due to natural variability or because of human activity. According to Schneider et al. vulnerability of any system to climate change is the degree to which these systems are susceptible and unable to service with the adverse impacts of climate change. They also explained the concept of risk as which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, impacts and adaptation. The changing patterns of climatic parameters like rise in atmospheric temperature, changes in precipitation patterns, excess UV radiation and higher incidence of extreme weather events like droughts and floods are emerging major threats for vegetable production in the tropical zone. Vegetable crop are very sensitive to climatic vagaries and sudden rise in temperature as well as irregular precipitation at any phase of crop growth can affect the normal growth, flowering, pollination, fruit development and subsequently decrease the crop yield.
Vegetables play an important role in the economy of India as well as in our well balanced diet. The constituents of vegetables have good therapeutic value due to anti carcinogenic and antioxidant properties. Nature has endowed our country with vast diversity of land, soil and of varied agro-climatic conditions. But unluckily the crops productivity are being hit by the consequences of climatic change such as global warming changes in seasonal and monsoon pattern, biotic and abiotic factors under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pests and disease problems are common and they render the vegetable cultivation unprofitable. Drought and salinity are the two important consequences of increase in temperature worsening vegetable cultivation vegetable crops are very sensitive to climatic vagaries and sudden rise in temperatures as well as irregular precipitation at any phase of crop growth can affect the normal growth.
In contrast, there has been comparatively little emphasis on the impact of environmental change on nutritionally important (non staple) vegetables and legumes,

which appear to be relatively sensitive to environmental changes. For example, tomatoes and beans have lower failure point temperatures (the ambient tem-perature at which growth stops) than staple crops and are more vulnerable to heat stress. Furthermore. several vegetables and legumes are particularly vulnerable to develop visual injury (and hence marketability) due to environmental stress, notably small bleached spots due to high O_3 exposure, with legumes, leafy vegetables, and Solanaceae (including tomatoes and brinjal) among the most sensitive crops. To date there has been no overarching review of the global evidence of the impact of changing environmental exposures on the yields and nutritional quality of (non staple) vegetables and legumes.

Micronutrient deficiencies are a significant public health concern, affecting an estimated 2 billion people worldwide. Ensuring sufficient dietary intake of vegetables and fruit has been identified as critical in efforts to prevent and mitigate micronutrient deficiencies, as well as to tackle non communicable diseases (NCDS) such as cardiovascular disease.

Impact of Climate Change on Vegetable Production and Its Management Practices

Impact of climatic changes on vegetable production

Temperature: Fluctuation in daily mean marimum and minimum temperature is the primary effect of climate change that adversely affects vegetable production, as many plant physiological, bio-chemical and metabolic activities are temperature dependent. The occurrence of high temperature the vegetable production in tropical and arid areas. High temperature causes a significant alteration in morphological, physiological, biochemical and molecular response of the plant and in turn affects the plant growth, development and yield. Hazra *et al*. summarized the symptoms causing fruit set failure at high temperatures in tomato; this includes bud drop, abnormal flower development, poor pollen production, dehiscence, and viability, ovule abortion and poor viability, reduced carbohydrate availability, and other reproductive abnormalities.

Germination of vegetable seeds greatly suppressed at 12 and 45ºC, respectively besides germination will not occur at 42ºC in watermelon, summer squash, winter squash and pumpkin seeds.

Drought: This stress causes an increase of solute concentration in the environment (soil), leading to an osmotic flow of water out of plant cells. This leads to an increased water loss in plant cells and inhibition of several physiological and biochemical process such as photosynthesis, respirations etc. Thereby reduces productivity of most vegetable.

The photosynthesis and photosynthetic capacity are reduced during limited water conditions. Further, the biochemical capacity was also affected by the water stress as indicated by a decrease in sucrose phosphate synthase (SPS) and invertase activities, which affect the availability and utilization of sucrose.

Water availability: After Studying green house it is reported on the effect of water stress on nutritional quality. The overall effects are mixed and varied substantially by crop group; leafy vegetable appeared to be positively affected.

Salinity: Salinity is a serious problem that reduces growth and productivity of vegetable crops in many salt-affected areas. Excessive soil salinity reduces productivity of many agricultural crops, including most vegetables, which are particularly sensitive throughout the ontogeny of the plant. Salinity causes a significant reduction in germination percentage, germination rate, and root shoots length and fresh root and shoot weight in cabbage.

Flooding: Flooding effects the physiology of the vegetable plants. One of the earliest plant physiological responses to soil flooding is the reduction in stomatal conductance. It causes an increase in leaf water potential, decease in stomatal conductance resulting in significant reduction in carbon exchange rate and elevation of internal CO_2 concentration. The vegetative and reproductive growth of plants is negatively affected by flooding due to detrimental impacts on physiological functioning. In sensitive crop plants, flooding causes leaf chlorosis and reduces shoot and root growth, dry matter accumulation and total plant yield. Floods can make the spread of water-borne pathogens easier, droughts and heat waves can predispose plants to infection, and storms can enhance wind-borne dispersal of spores.

Management practices for adapting climate change

Improved stress tolerance through grafting: Grafting vegetable is one of the promising tools for modifying the root system of the plant for enhancing its tolerance to various abiotic stresses. In vegetable crops, grafted plants are now being used to improve resistance against abiotic stresses like low and high temperatures, drought, salinity and flooding if appropriate tolerant rootstocks and used. Yetisir *et al.*, reported that melons grafted onto hybrid squash rootstocks were more salt tolerant than the non-grafted melons.

Developing climate resilient vegetables: Attempts to improve the slat tolerance of crops through conventional breeding programs have very limited success due to the genetic and physiologic complexity of this trait. In addition, tolerance to saline conditions is a developmentally regulated, stage specific phenomenon; tolerance at one stage of plant development does not always correlate with tolerance at other stage. Success in breeding for salt tolerance requires effective screening methods, existence of genetic variability, and ability to transfer the genes to the species of interest. Most commercial tomato cultivars are moderately sensitive to increased salinity and only limited variation exists in cultivate species.

Genetic variation for salt tolerance during seed germination in tomato has been identified within cultivated and wild species.

Biotechnology: Increasing crop productivity in unfavorable environments will require advanced technologies to complement traditional methods, which are often unable to prevent yield losses due to environmental stress. Genes have been discovered and gene functions understood. This has opened the way to genetic manipulations of gene associated with tolerance to environmental stresses. Environmental stress tolerance is a complex trait and involves many genes. In response to stresses, both RNA and protein expression profiles change. The genes are involved with transcription modulation, ion transport, transpiration control and carbohydrate metabolism.

Result

In the absence of adaptation strategies, increasing ambient temperature in (sub) tropical areas, tropospheric O_3. Water salinity, and decreasing water availability would all negatively affect vegetable and legume yields. Increasing CO_2 concentrations will have a positive impact on vegetable and legume yields, although these increase might be substantially at-tenuated in the presence of other environmental stressors (namely raised tropospheric O_3 and increased ambient temperatures) and may level off at CO_2 concentration increases above baseline of >400 ppm.

The severity and spread of many diseases is closeted to moisture in the environment. While rainfall is forecast to decrease slightly in some areas, both rainfall and humidity may increase in others. Such alterations in climate are likely to bring new challenges in terms of disease control.

Temperature can effect the rated of growth, development, and mortality of pests. Elevated temperatures may result in population increases due to shorter life cycles and faster generation times. Higher temperatures result in less cold stress and longer growing seasons for warm climate pests and more heat stress for temperate species.

Conclusion

Fruits and vegetable contain significant levels of biologically active components impart health benefits basic nutrients Elevated CO_2 has been found to increase concentrations of many biologically active components including sugars ascorbic acid. Phenols starch anthocyanins and flavonoids. However, increased CO_2 may reduce protein and mineral content in produce. Increased CO_2, temperature and water availability can affect photosynthsis, reproductive growth and mineral uptake. Which may result in poor growth of vegetable crops. This could lead to lower nutritive values.

The impacts of climate change on growth, development, yield and quality of crops. The focus should also be on development of adaptation technologies and quantify the duration, flowering, fruiting, fruit size and ripening of vegetable crops with reduced productivity and economic yield.

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